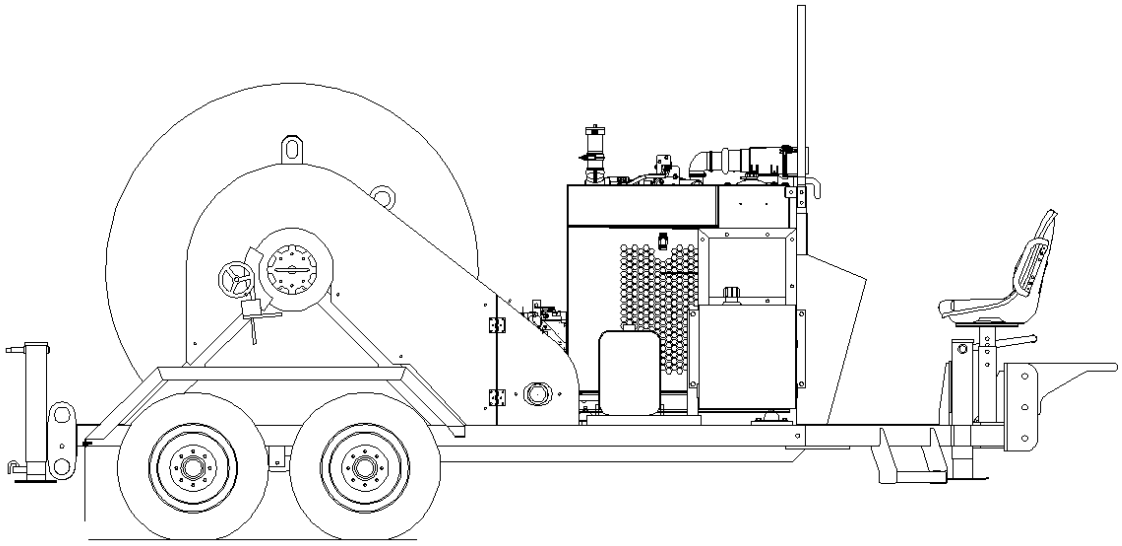
TSE INTERNATIONAL, INC.

bsi. ISO 9001 Quality Management FM 63723

Owner's Manual



Model: DPT40-B
Puller / Tensioner

Serial Number 19-5201-01

www.tse-international.com
5301 Shreveport Blanchard Hwy – Shreveport, Louisiana 71107 – USA
P: 318-929-2368 F: 318-929-4853

TSE International Inc. Warranty Policy

1. **Contact the TSE International Inc. service department to discuss problem and obtain a warranty claim number. Claim numbers will remain valid for 30 days allowing for sufficient time for submission to TSE. Warranties claimed without a valid claim number may be denied.**
2. **Please retain any defective parts for a period of 60 days. TSE reserves the right to inspect and/or evaluate any parts submitted for warranty consideration. Should TSE elect to inspect the parts, a RGA (Return Goods Authorization) number will be issued and the parts are to be returned prepaid to TSE. Items not returned within 30 days will result in the RGA closure and may result in a denial of the claim.**
3. **Warranty submission must be on the standard TSE International Inc. claim form. Claims that are not will be classified as pending until proper forms are submitted. All claims must have an estimated cost associated with each item under discrepancy.**
4. **Major subcomponents are warranted under separate manufacturer warranties. It is the responsibility of the owner/dealer of the equipment to fill out and register all subcomponent manufactures warranties. In the event of failure, arrangements can be made to deal with the subcomponent supplier directly. Examples for subcomponent manufactures are: Engines– John Deere, Cummins, Caterpillar, etc.**

Claims submitted as per above TSE International Inc. Equipment Warranty policy will be resolved within 30 days of receipt

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Recommendations for improving this publication are encouraged and should be forwarded to:

TSE INTERNATIONAL
5301 Shreveport-Blanchard Hwy.
Shreveport, Louisiana 71107

This is not a tension stringing operation procedures manual. No attempt is made or implied herein to instruct the user in methods peculiar to the individual application of the equipment described in this manual. The contents of this manual are intended as a basis of for operation, maintenance, and parts listing of the unit in its intended and anticipated use, as it stands alone in conjunction with other equipment.

The Equipment described in this manual is potentially dangerous if improperly or carelessly operated. For the protection of personnel and equipment, only competently trained operators who are critically aware of the proper procedures, operating parameters, and limitations, potential dangers, and application of this equipment should be allowed to touch the controls at any time.

PREMIUM CUSTOMER SERVICES

TSE supports its innovative products with Premium Customer Service. Our comprehensive Service Department provides TSE customers with the service, parts, and technical assistance they need to maintain their equipment in top operating condition.

For Customer Service on Your

Model DPT40-B

Serial No. 19-5201-01

PLEASE CALL 1-800-825-2402

Our People Care: Our Equipment is the Proof.

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HOW TO ORDER REPLACEMENT PARTS

In order that we may promptly send the exact replacement part required in the least amount of down time for you, the information listed below is necessary.

To order the replacement part, locate the part from the drawings in this manual and give the following information:

1. **Unit Model No. (From the plates on the unit's frame)**
2. **Unit Serial No. (From the plate on the unit's frame, will contain numbers only)**
3. **Part Number (If available)**
4. **Description (If part no. not available)**
5. **Quantity Required**

On large components such as transmissions, engines, multiple pump drives, etc., the manufacturer's serial number and spec. number is necessary to ensure receiving the proper replacement part.

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WARNING

The equipment described in this manual is neither designed nor intended for any application, alone or with in conjunction with any other equipment, that involves the lifting or moving of persons.

Safe operation of this equipment is dependent on use in compliance with the procedures outline in this section and the maintenance and inspection procedures in SECTION Ill with consideration of prevailing conditions.

The equipment described in this manual is potentially dangerous if improperly and carelessly operated. For the protection of personnel and equipment, only competently trained operators who are critically aware of the proper procedures, operating parameters and limitations, potential dangers, and application of this equipment should be allowed to touch the controls at any time.

There is potential DANGER of ELECTRICAL SHOCK when operating this machine. Ground the unit in accordance with the regulations of the using organization. Various methods of bonding, isolation and grounding can be used; a means suitable to the user should be selected and rigidly adhered to by ALL operating personnel.

Keep all shields and guards in place. Keep hands, feet and clothing away from power driven parts and moving parts. Observe all warning decals placed on the machine.

Make certain all personnel are clear of this equipment before starting engine or operation.

Before leaving the operators position, make sure that directional controls are in the neutral position and all brakes are set.

EQUIPMENT WARRANTY

TSE International Inc. (hereinafter sometimes referred to as "TSE") warrants that it will repair f.o.b. its factory, or furnish without charge f.o.b. its factory, a similar part to replace any material in its machinery which, during the earlier of 90 days after the said machinery is put into operation or six months after the date of shipment of the machinery from the plant, is proved to the satisfaction of the company to have been defective at the time it was sold, provided that all parts claimed defective shall be returned, properly identified, to TSE's factory, charges prepaid.

This Warranty to repair applies only to new and unused machinery, which, after shipment from the factory of TSE, has not been altered, changed, repaired or treated in any manner whatsoever unless such alteration, change, repair or treatment has been previously authorized in writing by TSE or has been performed by the authorized service representative of TSE.

This Warranty to repair is the only Warranty either express, implied or statutory, upon which the said machinery is sold; the companies liability in connection with this transaction is expressly limited to the repair or replacement of defective parts, all other damages and warranties, statutory or otherwise, being hereby expressly waived by the purchaser.

No representative of TSE has authority to change this Warranty or this contract in any manner whatsoever and no attempt to repair or promise to repair or improve the machinery covered by this contract by any representative of TSE shall waive any consideration of the contract or change or extend this Warranty in any manner whatsoever.

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GROUNDING EQUIPMENT AND METHODS

Grounding Equipment and Methods information is covered in the following publication:

"IEEE GUIDE TO INSTALLATION OF OVERHEAD TRANSMISSION LINE CONDUCTORS IEEE STD 524-2003"

The above publication is available through the following organization:

THE INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC.
3 PARK AVENUE
NEW YORK, NY 10016-5997
USA

DECALS

Your equipment was shipped from the factory with the decals on the following sheet.

Should any of these decals be missing, they could prevent the proper operation and/or maintenance of the unit which may result in personal injury or property damage.

If any of these decals are missing, please contact us for a replacement.

Order the decal(s) by stating the decal description, number, and quantity.

TSE INTERNATIONAL
5301 SHREVEPORT-BLANCHARD HWY.
SHREVEPORT, LA 71107

ATTENTION: **SERVICE MANAGER**

TELEPHONE: **800-825-2402**
FAX: **318-929-4853**

REV	DATE	CHANGE NUMBER	AMENDMENTS	BY	APPD
B	29JAN13		LIST UPDATED; ITEMS #33 & 34 ADDED	SB	JM

TSE LOGOS REQUIRED

ITEM	PART NUMBER	OPER DESC	DESCRIPTION	MATERIAL	UNIT QTY
25	D000214	1	DECAL– THIS MACHINE IS NEGATIVE GROUND		REF
24	D591712	4	LUBRICATE WEEKLY		REF
23	D590053	3	DANGER KEEP HANDS AWAY		REF
22	D592583	1	REMOVING REELSHAFT		REF
21	D591689	1	REELSHAFT WARNING		REF
20	D591440A	1	WARNING: REEL SHAFT BUSHING		REF
19	D590090	1	ENGINE THROTTLE		REF
18	D592727	3	DANGER		REF
17	D592064	1	WARNING–UNCOUPLING THE BREAKAWAY		REF
16	D000027	2	DECAL– LIFTING LUG		REF
15	D000722	1	DECAL– AW–46 PREMIUM HYD FLUID		REF
14	D000324	1	DECAL– CAUTION: REEL LIFT ARM MUST BE		REF
13	D591748	1	MAINTENANCE SCHEDULE		REF
12	D000213	1	DECAL– WARNING: BEFORE USING THIS		REF
11	D590030	1	CAUTION		REF
10	D000506	1	DECAL– CAUTION: DO NOT OPERATE...		REF
9	D000156	1	DECAL– DIESEL FUEL ONLY		REF
8	D000400	1	DECAL– DO NOT ENGAGE...ENGINE RNG		REF
7	D591437	4	ANCHORING LUG		REF
6	D000028	2	DECAL– GROUNDING BAR		REF
5	D592438	1	HIGH SPEED POLEMASTER DRIVE		REF
4	D591196	1	FREE WHEELING DISCONNECT INSIDE		REF
3	D591438G	1	DECAL– OPERATIONS – DPT40–B		REF
2	D000025	1	DECAL– 12 VOLT		REF
1	D000021	1	DECAL– MADE IN USA		REF

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE INCHES
DIMENSIONS IN [ ] ARE MM
-TOLERANCES-

A) ANGULAR ± 1/2°
B) DECIMAL (ONE) .X ± .06
(TWO) .XX ± .02
(THREE) .XXX ± .01
C) FRACTIONAL
1. GENERAL ± 1/32
2. SAWING, FLAME CUTTING, SHEARING & BREAKING ± 1/16
3. WELDING ± 1/8

TSE INTERNATIONAL INC
Shreveport, Louisiana, United States of America

MATL CERT N/R	TITLE DECAL PACKAGE, DPT40–B		
MATL TEST N/R	NEXT ASSEMBLY	DERIVED FROM 5602434A	
WELD TEST N/R	FIRST USED ON WO	SHEET 1	OF 2
EST LBS N/A	DRAWN SB / CHECKED / APPROVED	5600297	REV B
ACT LBS N/A	DATE 29JAN13	SCALE 1/1	

REV	DATE	CHANGE NUMBER	AMENDMENTS	BY	APPD

ITEM	PART NUMBER	OPER DESC	DESCRIPTION	MATERIAL	UNIT QTY
34	D600467	1	DECAL, USE HYDRAULIC FLUID ONLY	OPTIONAL	REF
33	D593689	2	DECAL, TORQUE NUTS TO 200 FT/LBS		REF
32	D000573	1	DECAL- POLEMASTER LEVELWIND		REF
31	D591755	1	DECAL- BRAKE CONTROL	OPTIONAL	REF
30	D000670	1	DECAL- FRONT JACK	OPTIONAL	REF
29	D000116	1	DECAL- CAUTION MOVING STABILIZER, KEEP	OPTIONAL	REF
28	D595835	1	DECAL- QUALIFIED OPERATORS ONLY		REF
27	D600285	1	ANCHORING DIAGRAM, DPT		REF
26	D000431	1	DECAL- PULLING CHART DPT-40-B		REF

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE INCHES
DIMENSIONS IN [ ] ARE MM
-TOLERANCES-

A) ANGULAR		± 1/2°
B) DECIMAL	(ONE) .X	± .06
	(TWO) .XX	± .02
	(THREE) .XXX	± .01
C) FRACTIONAL		
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3. WELDING		± 1/8

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MATL CERT N/R	TITLE DECAL PACKAGE, DPT40-B		
MATL TEST N/R	NEXT ASSEMBLY	DERIVED FROM 5602434A	
WELD TEST N/R	FIRST USED ON WO	SHEET 2	OF 2
EST LBS N/A	DRAWN SB / CHECKED / APPROVED	5600297	REV B
ACT LBS N/A	DATE 29JAN13	SCALE 1/1	

CONTENTS
DPT40-B

SECTION I
INTRODUCTION

GENERAL DESCRIPTION

The TSE Model DPT40-B is a trailer mounted single drum puller/tensioner powered by a three cylinder diesel engine and hydrostatic transmission. It incorporates the Timberland Quick-Change Reel Shaft System. The speed, torque, and direction of the transmission are regulated from the elevated, centrally located control panel to allow an infinitely variable control of line tension and speed within the specified performance parameters of the unit in both the pulling and tensioning mode of operation. Efficient cable wrapping is promoted by the hydraulically-powered, post-type levelwind.

WARNING/CAUTION: WHEN THIS SIGN APPEARS ON THESE PAGES, IT INDICATES WHERE SPECIAL ATTENTION SHOULD BE PAID TO THE INSTRUCTIONS GIVEN. PERSONAL INJURY OR DAMAGE TO THE EQUIPMENT MAY OCCUR IF THE INSTRUCTIONS ARE NOT FOLLOWED.

DIMENSIONS

Length	199 inches
Width	89 inches
Height	73 inches

PERFORMANCE

Continuous Torque:	70,000 in-lbs
Intermittent Torque:	80,000 in-lbs
Speed Range:	0-4 mph

WARNING: THESE VALUES ARE A MAXIMUM AND MUST NOT BE EXCEEDED.

REEL SPECIFICATIONS

Maximum Reel Diameter:	72 inch
Maximum Width:	54 inch
Maximum Weight:	6,000 lbs
Reel Shaft Diameter:	2-5/8 inch

WARNING: THESE VALUES ARE A MAXIMUM AND MUST NOT BE EXCEEDED.

UNDERCARRIAGE

Axle	Tandem 12,000 lb capacity
Tires	ST235/80R16
Brakes	Electric
Leveling Jacks	Manual Screw Type

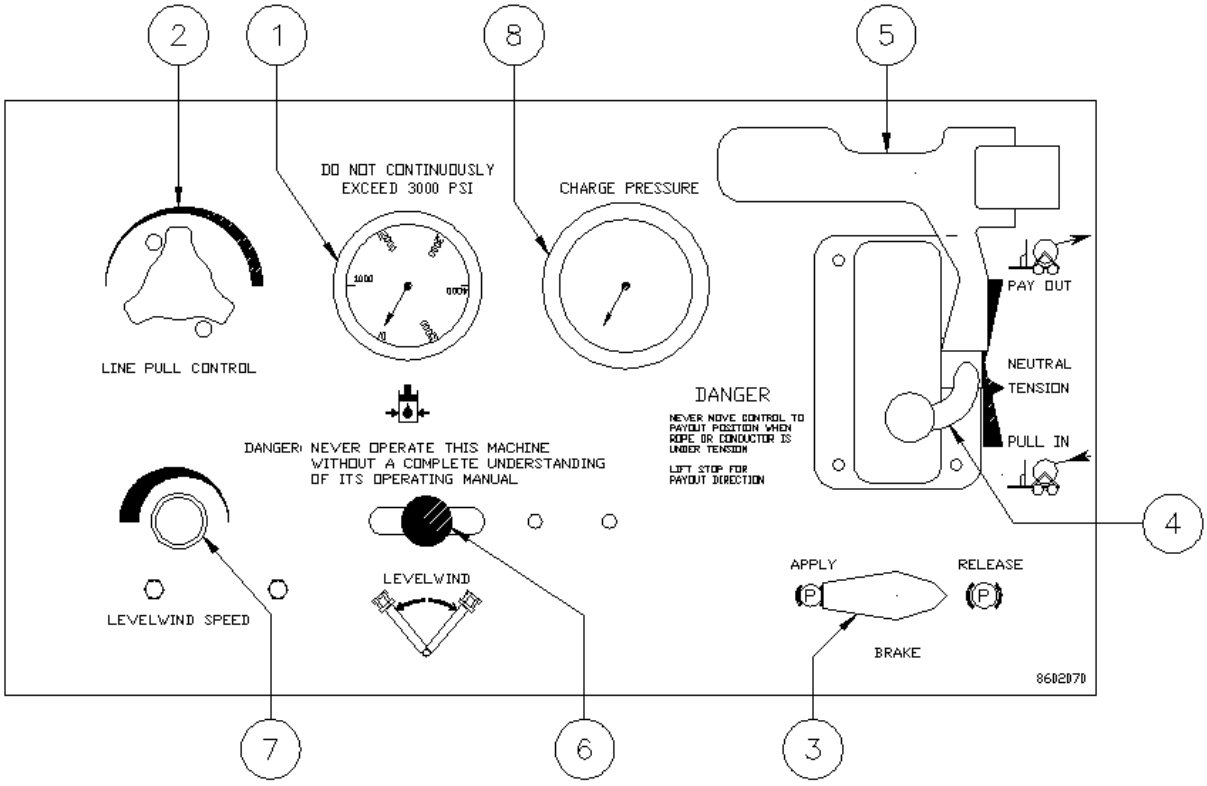
SECTION II
OPERATION

CONTROLS

The controls in Figure 1 are described below.

BEFORE OPERATING THIS EQUIPMENT FAMILIARIZE YOURSELF WITH ALL CONTROLS AND THEIR FUNCTION. ONLY FULLY TRAINED PERSONNEL SHOULD OPERATE THIS EQUIPMENT.

Figure 1: Control Panel



1. **Hydraulic Pressure Gauge** - This gauge shows the hydraulic pressure in the system. Do not continuously exceed 3000 psi during the operation of the machine.

2. **Linepull Control** - The pressure in the hydraulic system is regulated with this control knob also shown in Figure 2. Clockwise rotation of the Linepull Control increases pressure and therefore increases the Linepull. Counter clockwise rotation of the Linepull Control decreases pressure and therefore decreases the Linepull. Once the system pressure is set with the Linepull Control, the maximum Linepull will not exceed this setting. The Linepull can be set at any level from zero to the maximum Linepull rating.

Figure 2: Linepull Control Knob

3. **Brake Control** - The brake is spring applied and released by hydraulic pressure also shown in Figure 3. To hold the reel stationary, turn the Reel Brake Lever to the APPLY position. Turn to the RELEASE position before driving the reel.

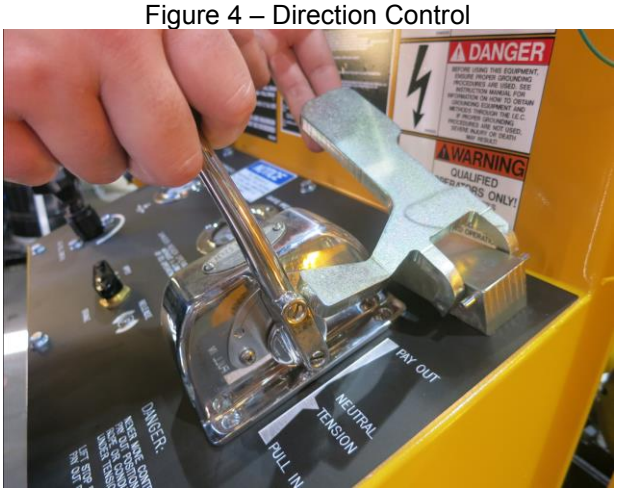
CAUTION: THE BRAKE IS DESIGNED TO HOLD THE CONDUCTOR UNDER STATIC CONDITIONS ONLY.

WARNING: THE HOLDING POWER OF THE BRAKES AND PROPER FUNCTIONING OF ALL MACHINE CONTROLS MUST BE VERIFIED BEFORE THE UNIT IS PUT INTO SERVICE TO ENSURE SAFE OPERATION. THIS IS PARTICULARLY IMPORTANT WHEN STRINGING IN THE VICINITY OF ENERGIZED LINES.

Figure 3: Brake Control

4. **Direction Control** - The reel turning speed (Linespeed) and direction is controlled by a single lever that regulates the degree of pump stroke in both directions from the NEUTRAL Position, also shown in Figure 4. Movement of the Direction Control Lever in either direction, away from the operator for 'Pay Out' and toward the operator for 'Pull In', increases the rotating speed of the reel. The reel will remain stationary with the Direction Control Lever in the NEUTRAL position.

Figure 4 – Direction Control



5. **Direction Lever Stop** - A Stop positioned in front of the Direction Control Lever will not allow the Lever to be put in the 'Pay Out' direction without the operator lifting the Stop handle to allow the Direction Control Lever to pass. The Stop automatically falls back into place when the lever is returned to the NEUTRAL position or to the 'Pull In' direction.

6. **Levelwind Direction Control** - Lateral movement of the Levelwind post is accomplished by moving the Levelwind Direction Control lever sideways in the direction you wish the Levelwind post to move.

7. **Levelwind Speed Control** - Sideways speed of the Levelwind post can be regulated with the Levelwind Speed Control knob.

8. **Charge Pressure Gauge** - This gauge indicates the system charge pressure and should be approximately 300 psi.

TOWING

Before towing always check the following:

1. Front and rear jacks are fully retracted
2. Operator protective screen is folded down
3. Wheel brakes are operational
4. Tires are inflated to proper pressure.
5. Wheel chocks are removed and stored away properly.
6. Lights are operational.
7. All reel shaft pins/locking pins are properly engaged.
8. Safety chains and breakaway switch connected.

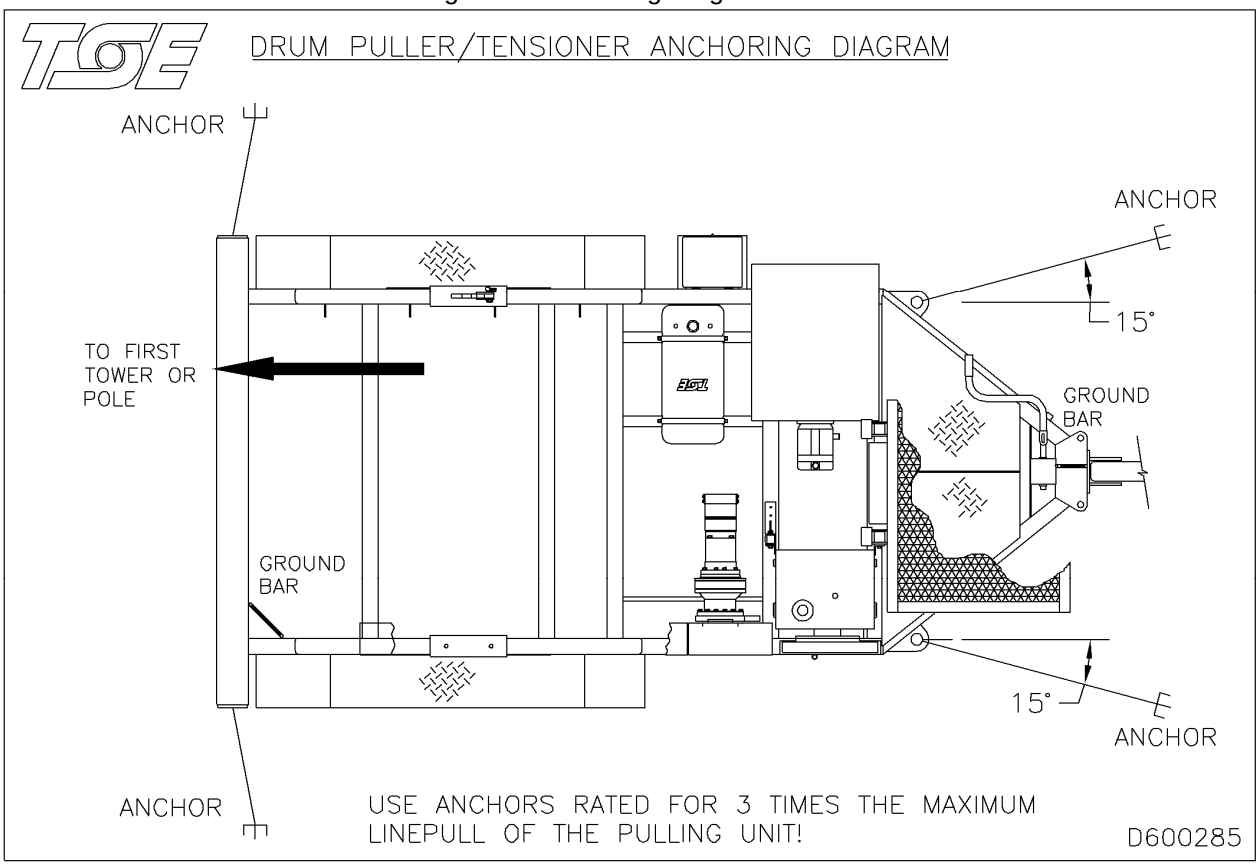
FIELD SET UP

Prepare the unit for operation as follows:

1. Locate the unit on level ground if possible, ensuring that the unit is aligned properly with the line to be pulled or tensioned.
2. Level the unit using the front and rear jacks.
3. It is highly recommended to put wheel chocks around each trailer tire to prevent movement of the trailer.

4. **PROPER ANCHORING OF THE MACHINE IS VERY IMPORTANT!** Anchor the unit using the anchoring lugs provided. Use an anchor that will hold three times the maximum pull of the unit.

Figure 5: Anchoring Diagram



5. **PROPER GROUNDING OF THE MACHINE IS VERY IMPORTANT!** The machine is equipped with grounding bars. To protect against electrical hazards due to induction or electrical contact, the system must be connected to a proper ground rod or the electrical system neutral. Follow proper grounding procedures as required by IEEE and/or the applicable standards in your area. Use of a ground mat and a running ground on the conductor are highly recommended.
6. Put a hazard barrier around the perimeter of the unit to keep unauthorized personnel away from the equipment.
7. Perform daily inspection and preventive maintenance as required.

PRE START CHECKLIST

1. Ensure that the Direction Control is in the NEUTRAL position.
2. Ensure that the Brake Control is in the APPLY position.

ENGINE START-UP

The engine manufacturer's manual, included in the Section V, contains detailed technical information regarding the engine including start up procedure. Make sure you read and understand the operating instructions contained therein. .

CAUTION: DO NOT ALTER THE RPM GOVERNER SETTING OF THE ENGINE. THE HYDRAULIC PUMP IS LIMITED TO A SPECIFIC MAXIMUM RPM AND CAN BE DAMAGED IF DRIVEN FASTER THAN THE GOVERNED ENGINE SPEED.

STOPPING THE ENGINE

1. Move the Direction Control to the NEUTRAL position.
2. Move the Brake Control to the APPLY position.
3. Decrease the engine speed to idle.
4. Allow the engine to idle for a few minutes to cool down.
5. Shut down the engine.

HYDRAULIC WARM UP (COLD WEATHER START-UP)

1. Start the engine.
2. Leave the Direction Control in the NEUTRAL position.
3. Allow the system to run slightly above idle for twenty minutes or until the indicator gauge on the suction filter reads less than ten inches vacuum.
4. Ensure that the Brake Control is in the APPLY position.
5. Increase engine speed to half-throttle.
6. Move the Direction Control to approximately half-stroke in the PULL IN direction.
7. Turn in Linepull Control clockwise until the Pressure Gauge reads 1,000 psi.
8. Allow system to run for:
   a. Ten minutes
   b. or until hydraulic oil reservoir feels warm to the touch
   c. or until the indicator gauge on the suction filter reads less than five inches vacuum

In extreme cold weather operations, special low temperature hydraulic oil is recommended.

PULLING (BEGINNING WITH SLACK ROPE)

The following procedure describes how to operate the DPT40-B when it is used as a puller and the rope is not under tension.

CAUTION: DO NOT FOLLOW THIS PROCEDURE WHEN THERE IS TENSION ON THE PULLING ROPE.

1. Increase the engine speed to full throttle. An engine operated at idle speed does not sufficiently power the hydraulic system and may let the brake drag causing damage or overheating of the brake and erratic control.
2. Ensure that the Brake Control is in the APPLY position.
3. Pull the Direction Control slightly in the PULL IN position.
4. Turn the Linepull Control clockwise until the Hydraulic Pressure Gauge reads 800 psi. This presets the linepull.
5. Move the Direction Control to the NEUTRAL position.
6. Confirm that the tensioner operator knows the pull is about to begin and has the tensioner correctly set.
7. Turn the Brake Control to the RELEASE position.
8. Slowly pull Direction Control slightly to the PULL IN position. The pulling reel should start to turn and tighten the pulling rope. When the pulling rope starts to move and pull the conductor, turn in the Linepull Control clockwise another ½ turn to have the relief pressure in the system set just slightly above the linepull at which you are working.

9. Slowly pull the Directional Control more into the PULL IN position until the desired linespeed is achieved.

NOTE: It may be necessary to turn the Linepull Control in several times from its initial setting as the pulling rope builds up on the pulling reel to maintain proper linepull and speed. Always turn the Linepull Control in ½ turn further than what is required to move the conductor, and this will ensure the puller will stall if a snag in the pulling rope or conductor occurs.

10. To stop the pull, move the Direction Control to the NEUTRAL position and turn the Brake Control to the APPLY position.

RESUMING A PULL AFTER STOPPING

This procedure describes how to start the pulling process after stopping while the pulling rope is still under tension. This procedure assumes the Linepull Control setting has not been changed from the previous operating position during the stop.

1. Confirm that the tensioner operator knows the pull is about to begin and has the tensioner correctly set.
2. Turn the Brake Control to the RELEASE position.
3. Move the Direction Control to the desired PULL IN position.

NOTE: This should start the pulling rope or conductor moving again at the same linepull as when you stopped. If the pulling rope or conductor remains stationary, slowly turn the Linepull Control clockwise until the pulling rope or conductor starts to move.

TENSIONING (BEGINNING WITH SLACK ROPE)

This procedure describes how to set the DPT40-B when it is used as a tensioner and the rope is not under tension.

WARNING: DO NOT FOLLOW THIS PROCEDURE WHEN THERE IS TENSION ON THE CONDUCTOR.

1. Increase the engine speed to full throttle. An engine operated at idle speed does not sufficiently power the hydraulic system and may let the brake drag causing overheating of the brake and erratic control.
2. Ensure that the Brake Control is in the APPLY position.
3. Put the Direction Control in the TENSION position.
4. Turn the Linepull Control clockwise until the Hydraulic Pressure Gauge reads 500 psi. This will preset a small amount of tension in the conductor.
5. Turn Brake Control to the RELEASE position.
6. Instruct the puller operator to start pulling.
7. As the line begins to move, adjust the Linepull Control until the desired stringing tension is achieved.

NOTE: You may have to adjust the Linepull Control to increase or decrease the tension in the conductor to maintain the correct stringing sag as the reel empties.

8. To stop the pull, the puller operator must stop pulling first.
9. Once the conductor stops moving, the tensioner operator can either leave the controls adjusted for resuming the pull, or if it is desired to stop for a considerable length of time, it is advisable to put the Brake Control in the APPLY position and return the Direction Control to the NEUTRAL position.

RESUMING TENSIONING AFTER A STOP

This procedure describes how a pull is to be resumed after a short stop when the Linepull Control and Direction Control are still set from the previous pull.

1. Move the Brake Control to the RELEASE position
2. Instruct the puller operator to begin pulling again.

NOTE: The tension in the conductor should revert to the previous setting before the stop.

PAYING OUT (BEGINNING WITH SLACK ROPE)

The following procedure describes how to pay out rope or conductor when it is not under tension.

CAUTION: DO NOT FOLLOW THIS PROCEDURE WHEN THE ROPE IS UNDER TENSION.

1. Increase the engine speed to full throttle. An engine operated at idle speed does not sufficiently power the hydraulic system and may let the brake drag causing damage or overheating of the brake.
2. Make sure the Brake Control is in the APPLY position.
3. Turn the Linepull Control fully counter clockwise to give zero linepull.
4. Turn the Brake Control to the RELEASE position.
5. Push the Direction Control slowly into the PAY OUT position. You will have to lift the Direction Lever Stop to allow the Direction Control to pass beyond the NEUTRAL position. Push Direction Control more into the PAY OUT position to increase the speed.

WARNING: NEVER PUT THE DIRECTION CONTROL LEVER IN THE PAY OUT POSITION WHEN PULLING ROPE OR WHEN THE CONDUCTOR IS UNDER TENSION!

6. To stop, pull the Direction Control to the NEUTRAL position. The Direction Lever Stop will fall back into place restricting movement into the PAY OUT direction once again.

PAYING OUT ROPE UNDER TENSION

This procedure describes how to pay out or loosen a pulling rope or conductor when it is under tension. This situation may occur, for example, when a conductor or pulling rope is to be backed into a grip. Essentially, the process is to tension out the rope or conductor at a controlled speed until the tension drops to zero, then use the Pay Out procedure above to continue to paying out the rope if desired.

1. Increase the engine speed to full throttle. An engine operated at idle speed does not sufficiently power the hydraulic system and may let the brake drag causing damage or overheating.
2. Move the Brake Control to the RELEASE position. This transfers the tension load in the rope or the conductor from the brake to the hydraulic system.
3. Slowly turn the Linepull Control counterclockwise. This will start to allow the reel to pay out the rope or conductor as the load pulls on it. Continue turning the Linepull Control until it is fully counterclockwise and no tension remains in the rope or conductor.
4. Use the payout procedure above for paying out more rope.

FREEWHEELING PAY OUT WITH OVERSPIN BRAKE

The freewheeling pay out mode disconnects the hydraulic drive system and allows the reel to rotate freely as the rope or conductor is pulled off. A drag brake prevents the reel from overspinning while in freewheel mode. This procedure is usually used when the pulling rope is being pulled from the puller end of the set-up to the tensioner end.

1. Make sure the reel is stationary.
2. Place the Direction Control in the NEUTRAL position.
3. Turn the Brake Control to the APPLY position.
4. Shut off the engine.
5. Remove the lock pin from the drive sprocket located behind the drive door shown in Figure 6.

WARNING: THERE MUST BE NO TENSION ON THE LINE WHEN REMOVING THE LOCKING PIN!

Figure 6: Opening Drive Door

6. Pull off the conductor or rope as required using the drag brake to prevent reel overspin.
7. When payout is complete, reinsert the lock pin in the drive sprocket. You may have to rotate the reel by hand to line up the lock pin hole.

PULLING UNDERGOUND (OPTIONAL)

This procedure describes how to use the DPT40-B as an underground puller with the optional underground pulling reel and heavy duty underground levelwind.

1. Load underground reel into machine (see Reel Loading procedure).
2. Reeve the pulling rope through the bottom guide rollers of levelwind with the rope exiting straight into the manhole.

CAUTION: DO NOT PULL WITH THE ROPE AT AN ANGLE. THIS MAY MOVE THE DPT40-B SIDEWAYS SUDDENLY.

3. Follow the pulling procedure above.

REMOVING THE REEL

1. Turn the reel until the drive arm and lifting loop are in vertical (up) position, shown in Figure 7.

Figure 7: Lifting Loop in Vertical Position

2. On the drive arm side, pull the ball lock pin straight up, and pull the reel shaft pin back enough to allow the reel shaft to be lifted up, shown in Figure 8.

Figure 8: Removing Reel Shaft Pin

3. On the lifting loop side, open the locking latch and swing it back out of the way, shown in Figure 9.

Figure 9: Removing Locking Latch

4. Attach lifting hooks to the drive arm and lifting loop. Ensure they are balanced so the reel remains level during lifting.
5. Lift the reel straight up.
6. Remove the bronze bearing from reel shaft.
7. Loosen the nuts on the lifting loop and remove it from reel shaft.
8. Remove reel shaft from reel.

!WARNING/CAUTION! NEVER ATTEMPT TO INSTALL OR REMOVE A REEL UNLESS THE DRIVE ARM LOOP IS IN THE UPRIGHT POSITION. IF THE REEL SHAFT PIN IS REMOVED WITH THE DRIVE ARM IN ANY OTHER POSITION, THE REEL MAY FALL OUT OF ITS SUPPORTED POSITION AND MAY CAUSE PERSONAL INJURY OR EQUIPMENT DAMAGE.

LOADING A REEL

1. Turn the reel drive until the shaft coupling drive teeth face up.
2. On the drive sprocket side, pull ball lock pin straight up and pull the reel shaft pin back enough to allow the reel shaft to be installed, shown in Figure 8.
3. On the lifting loop side, open the locking latch and swing it back out of the way, shown in Figure 9.
4. Put the reel shaft in the reel, making sure the conductor or rope will wind on or off from the top of the reel in the correct direction.
5. Make sure the reel shaft drive pins are fully engaged in reel drive holes.
6. Install the lifting loop tight against side of the reel to hold it firmly against the drive arm and keep it from sliding sideways. Torque nuts on locking collar to 200 ft-lbs.

ALWAYS MAKE SURE THAT THE REEL IS PUSHED TIGHT AGAINST THE DRIVE ARM AND HELD SECURELY BY LIFTING LOOP/LOCKING COLLAR.

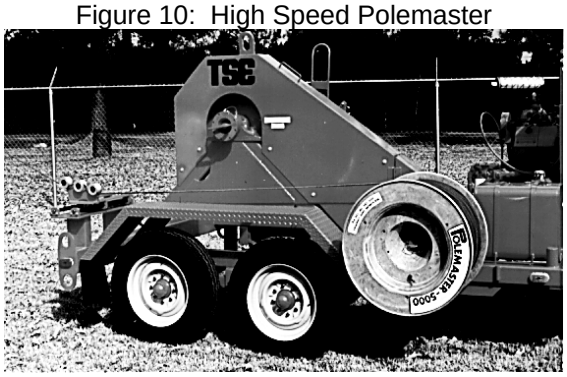
7. Install the bronze bearing on end of the reel shaft.
8. Attach lifting hooks to the drive arm and lifting loop, making sure they are balanced so the reel remains level during lifting.
9. Lower the reel in place engaging the reel shaft drive with its mating part and making sure the bronze bearing locates in the bearing support.
10. Push the reel shaft pin back into place and insert the ball lock pin to hold the reel shaft pin in place.
11. Swing the locking latch back into place over the bronze bearing and insert the safety pin.

!CAUTION/WARNING! THE REEL MUST BE OVERWOUND WHEN PLACED IN THE MACHINE AS VIEWED FROM THE OPERATORS POSTION. THE REEL SHAFT DRIVE ARM MUST BE INSERTED FROM THE SIDE OF THE REEL THAT WOULD TEND TO WIND IN THE PULLING ROPE.

HIGH SPEED POLEMASTER SETUP (OPTIONAL)

This section describes the operation of the High Speed PoleMaster Pilot Rope System shown in Figure 10. The High Speed Polemaster System is a very fast and productive method of installing the pulling rope in the stringing blocks ready for the pulling of the conductor. The Polemaster System consists of three or more drums of synthetic pilot rope, each with a brake shaft all of which are mounted to the first pole in front of the tensioner. The pilot ropes are then installed in the stringing blocks for each phase plus neutral from the tensioner end to the puller end.

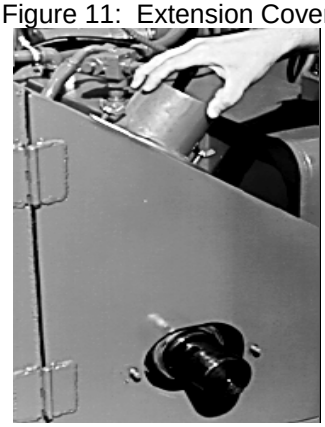
Figure 10: High Speed Polemaster



The end of one of the Polemaster pilot ropes is attached to the end of the pulling rope at the puller. At the tensioner, the corresponding Polemaster drum is removed from its brake on the pole and installed on the DPT40-B High Speed PoleMaster drive as detailed below.

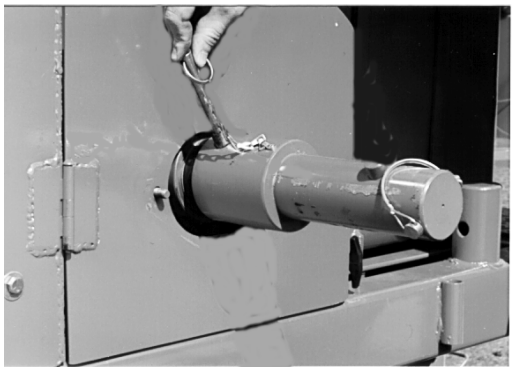
1. Disconnect the chain drive from the reel as described in Freewheeling Payout section. This allows the Polemaster drum to turn without also turning the reel shaft.
2. Remove the drive shaft extension cover from the drive door and store it on top of the door as shown in Figure 11.

Figure 11: Extension Cover



3. Remove the Polemaster drive shaft from its storage pin located on the frame.
4. Slide the Polemaster drive shaft onto the drive shaft extension, which sticks out from the drive door, and fully install the extension lock pin as shown in Figure 12.

Figure 12: Polemaster Shaft Installed on the Drive

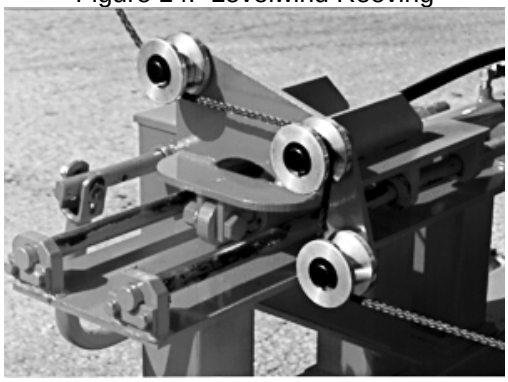


5. Slide the Polemaster drum onto the Polemaster drive shaft making sure the rope exits from the top of the drum toward the rear of the DPT40-B. You may have to rotate the Drum slightly to line up the Drive Slots in the Drum with the Shaft Drive Pins.
6. Insert the Drum Lock Pin as shown in Figure 13. Make sure the spring clip is installed correctly in order to keep the pin from falling out.

Figure 13: Polemaster Drum

7. Remove some rope from the Polemaster Drum and feed it around the guide sheaves of the Polemaster Levelwind as shown in Figure 14.

Figure 14: Levelwind Reeving



8. The installation of the drum and rope should be as shown in Figure 15. The Polemaster System is now ready to pull the pulling rope back to the conductor reel in the Tensioner.

Figure 15: Polemaster Setup

CAUTION: DAMAGE TO THE DRUM, ROPE AND/OR PERSONAL INJURY CAN RESULT FROM OVERLOADING THE POLEMASTER DRIVE SYSTEM.

HIGH SPEED POLEMASTER OPERATION (OPTIONAL)

1. Follow the procedure from the Pulling Sections using the pressure recommendations in the note below.

NOTE: The maximum 300 pounds linepull is reached at 500 PSI on the pressure gauge for an empty Polemaster reel and 1000 PSI on a full Polemaster reel.

2. Use the Polemaster Levelwind to evenly distribute the pilot rope across the Polemaster Drum so it does not pile in one spot and get tangled.
3. When the pulling rope for the first phase arrives at the Tensioner end, it is removed from the end of the pilot rope, and is attached to the end of the conductor.
4. In preparation for tensioning the conductor, remove the full Polemaster Drum from the DPT40-B.
5. Remove the Polemaster drive shaft and store.
6. Install the drive shaft extension cover on the hinged door.
7. Open the hinged door and reinstall the free wheeling lock pin as described. This reconnects the chain drive to the reel.
8. Proceed to tension the conductor as described in the Tensioning Sections.

SECTION III
MAINTENANCE

SCOPE

This section contains schedules, recommendations, and procedures designed to ensure that the equipment is prepared for safe and efficient operation and to prolong the service life of the equipment. These maintenance instructions constitute basic requirements for an operational environment that is not extreme in temperature, humidity, airborne abrasives, or other conditions which would require preventative maintenance techniques to combat. The using organization is encouraged to determine preventative maintenance requirements that are the result of environmental extremes.

SERVCIE SAFETY PRECAUTIONS

1. Before performing maintenance or repair work on any equipment, consult the manufacturer's instruction manual and follow the recommended procedures.
2. When servicing or repairing the equipment, shut down the engine unless it is required to be running for adjustment purposes.
3. Always use the proper tools for the job. Repair or replace any broken or damaged tools, including lifting equipment immediately.
4. Keep your head, hands, feet, and loose clothing away from power-driven parts.
5. Pressure can be maintained in the hydraulic circuits long after the power source and pump have been shut down. Relieve all trapped pressures before performing any service work to the hydraulic components.
6. When troubleshooting a hydraulic system for leaks, use a piece of cardboard or other material as detector rather than your hand. Pressurized hydraulic fluid escaping from a faulty component can penetrate the skin and cause serious injury.
7. Do not change the pressure setting of any hydraulic valves unless authorized instruction has been obtained.
8. Ensure that all tire and rim parts are undamaged and correctly assembled before inflating the tires.
9. Use an inflation cage, safety cables or some other safety device when inflating the tires. Do not exceed the tire manufacturer's recommended maximum pressure
10. Use caution when draining hot fluids from the machine. Splashing hot fluid can cause serious burns.
11. Ensure that the equipment is blocked so that it cannot shift or move during servicing.
12. Install all applicable safety locks before working on a piece of equipment. Disconnect electrical power before servicing electrical components.

FIRE PREVENTION

Fires can create severe emergencies where both human life and property may be lost. Even when confined, a fire may cause very expensive damage to your equipment. Fire can strike at anytime, not only when the equipment is used, but also when lift unattended between work shifts and nobody is around to fight it.

When working in a confined environment, it is impossible to prevent combustible dust from collecting in tight corners of the machine. This dust, in itself, may not cause a fire, however, when mixed with fuel, oil or grease in a hot an confined place, it can become a fire hazard.

To reduce the chances for a fire to break out, follow the preventative instructions listed below:

1. Inspect the machine daily for potential fire hazards and make any necessary repairs up immediately.
2. Always ensure that excess grease and oil accumulation, including spillage, are cleaned up immediately.
3. Use only nonflammable cleaning agents for cleaning the machine or any machine component.
4. Store oily rags and other combustible materials in a fireproof location.
5. Before performing repair work such as welding, the area surrounding the repair location should be cleaned and a fire extinguisher positioned close by.
6. Maintain a charged fire extinguisher on or near the machine at all times and know how to use it.

INSPECTIONS

Periodic inspection of the unit according to a regular schedule will establish the normal state of the unit for personnel associated with its operation and maintenance and provide a set of consistent conditions, which will tend to highlight any occurrence of a potentially hazardous malfunction.

On a daily basis walk around the unit and look closely for any indication of the following:

1. Loose threaded connections.
2. Metal fatigue or excessive corrosion.
3. Abraded hose surfaces.
4. Hydraulic fluid leakage.
5. Possible obstruction of moving parts – especially in the drive train.

To ensure proper operation and long life of your TSE International products, use only good quality lubricants and maintain a regular maintenance schedule as recommended by TSE International and our component suppliers.

Prior to start-up of new TSE International products, all fluid levels are to be checked to ensure correct operating levels. All lubrication and maintenance points are to be inspected and lubricated as illustrated on the Lubrication and Maintenance Instructions sheet.

While TSE International recommends specific intervals, they are intended as a minimum general guide for the maintenance of the equipment. Some job conditions and/or locations may dictate more frequent service intervals than have been recommended.

LUBRICATION DATA				
LUBRICANT	**LUBRICANT INFORMATION**	**GRADES**	**TSE PART #**	**APPLICATION**
AW46	TSE STANDARD HYDRAULIC FLUID (REFER TO HYDRAULIC OIL DECAL LOCATED ON HYDRAULIC RESERVOIR TO DETERMINE WHAT HYDRAULIC FLUID IS USED IN YOUR MACHINE)	ISO 46	567851	HYDRAULIC SYSTEM FLUID
UTILITY EP #2 GREASE	MULTIPURPOSE GREASE	-	-	BEARINGS, SHAFTS, FRICTION COMPONENTS
LUBRIPLATE CHAIN & CABLE FLUID	PENETRATING FLUID	SAE 10 ISO 32	-	CHAINS, WIRE ROPES, CABLES
SPARTAN EP150	INDUSTRIAL GEAR OIL	ISO 150	-	GEARBOXES (REDUCERS) - SEE VENDOR LITERATURE FOR VARIATIONS AND AMOUNTS
SUPER MPGO 80W90	PETROLEUM OIL BLEND	-	-	PUMP DRIVES

SUGGESTED MAINTENANCE SCHEDULE

The following schedule should be carried out by qualified personnel using proper lubricants to suit environmental and operating conditions.

NOTE: THESE ARE SUGGESTED RECOMMENDATIONS ONLY. SPECIFIC SITUATIONS MAY REQUIRE A DIFFERENT LUBRICATION SCHEDULE. ALTER AS NECESSARY.

SERVICE INTERVAL	HOURS	DAILY	WEEKLY	100	150	500	1000
	MONTHS			1	2	6	12
DESCRIPTION (5)							
BEARINGS		-	-	L	-	-	O
BUSHINGS		-	-	L	-	-	-
REELSHAFT BUSHINGS		L	-	-	-	-	-
PIVOT POINTS		-	X	L	-	-	-
CHAIN DRIVES		-	-	-	-	O	-
COUPLINGS		-	-	-	-	-	X
BOLTED CONNECTIONS		X	-	-	-	-	-
HYDRAULIC PLUMBING		X	-	-	-	-	-
HYDRAULIC RESERVOIR (4)		X	-	-	-	-	-
HYDRAULIC FILTERS (2)		-	-	-	R (3)	-	-
HYDRAULIC HOSES		-	-	-	-	X	-
MISC. COMPONENTS (1)		-	L	-	-	-	-

SYMBOL	
R	REPLACE
L	LUBRICATE
X	INSPECT & CORRECT
O	CLEAN & LUBRICATE
F	FLUSH & CHANGE

1. Items such as engines, pumps, pump drives, motors, reducers, brakes, etc. on your equipment should be serviced according to the manufacturer's maintenance schedule (see outside vendor literatures)
2. Hydraulic filter part numbers and descriptions can be found in the hydraulic schematic.
3. Change after the first 50 hours of use.
4. See the decal by the Hydraulic Reservoir.
5. Certain items may not be apart of your machine and DO NOT apply.

REV	DATE	CHANGE NUMBER	AMENDMENTS	BY	APPD
B	16JAN19	ECN-3407	ITEM #2 WAS 8600484 – OVERHEAD LEVELWIND ASSY	SB	JM

DPT40–B PULLER TENSIONER

– 48 HP WATER COOLED JOHN DEERE DIESEL ENGINE (FINAL TIER 4)
– 70,000 in. lbs. CONTINUOUS TORQUE RATING.
– 80,000 in. lbs. INTERMITTENT TORQUE RATING.
– 4,350 lbs. CONTINUOUS LINE PULL (6,000 FT OF 5/8" ROPE)
– 0–4 mph LINESPEED WITH INFINITE CONTROL.
– 12,000 LBS TANDEM AXLE TRAILER MOUNTED.
– FENDERS, MUDFLAPS, BREAKAWAY CHAINS, ELECTRIC TRAILER BRAKES.
(B) – OVERHEAD/UNDERGROUND LEVELWIND:
HYDRAULIC POWERED, WITH SWING–AWAY TOP OPENING ROLLER AND CONTROLLED FROM OPERATOR'S CONSOLE.
– OPERATOR SEAT, DELUXE PADDED SEAT ADJUSTABLE HORIZONTALLY & VERTICALLY.
– REAR STABILIZERS: TWO BOLT ON MECHANICAL TYPE STABILIZERS MOUNTED ON REAR.
– BOLT ON MANUAL FRONT JACK
– BRONZE OVERSPIN BRAKE:
16" DIAMETER BRONZE ALLOY VENTILATED DISC
MANUAL CONTROLLED CALIPER.
RECOMMENDED WHEN USING THE "FREE WHEEL" MODE.
– STANDARD LED HIGHWAY LIGHTING W/ 7PT TRAILER PLUG
– REFLECTIVE TAPE AS PER NHTSA

(A) CUSTOMER: CUSTOM TRUCK & EQUIPMENT
S/N: 19–5201–01 (TRL–17817)

PAINT: TSE YELLOW

ITEM	PART NUMBER	OPER DESC	DESCRIPTION	MATERIAL	UNIT QTY
13	D600775		DECAL, TRL–17817		2
12	6600802		JACK ASSY – MANUAL REAR		2
11	564723		DOCUMENT HOLDER		1
10	567851		OIL, HYDRAULIC (AW–46)		30
9	5602413		BOX, DOCUMENT STORAGE		1
8	561071		276 LG – 7 CONDUCTOR CABLE		23.0FT
7	7601116		LIGHTING DIAGRAM, 7 PT LED		1
6	5600297		DECAL PACKAGE, DPT40–B		1
5	6600600		JACK ASSY – MANUAL		1
4	880256		BRAKE CALIPER INSTALLATION		1
3	810307		16 INCH BRONZE DISC		1
2	8602493		LEVELWIND, OVER/UNDER – DPT40–B		1
1	8602060		GENERAL ASSEMBLY, FT4 DPT40–B		1

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE INCHES
DIMENSIONS IN [ ] ARE MM
-TOLERANCES-

A) ANGULAR		± 1/2°
B) DECIMAL	(ONE) .X	± .06
	(TWO) .XX	± .02
	(THREE) .XXX	± .01
C) FRACTIONAL		
1. GENERAL		± 1/32
2. SAWING, FLAME CUTTING, SHEARING & BREAKING		± 1/16
3. WELDING		± 1/8

TSE INTERNATIONAL INC
Shreveport, Louisiana, United States of America

MATL CERT N/R	TITLE DPT40B, FINAL ASSEMBLY		
MATL TEST N/R	NEXT ASSEMBLY	DERIVED FROM F602473	
WELD TEST N/R	FIRST USED ON WO 5201	SHEET 1	OF 1
EST LBS N/A	DRAWN TKR / CHECKED / APPROVED JM	F602474	REV B
ACT LBS N/A	DATE 20SEP18	SCALE 1/1	

ITEM	PART NUMBER	QTY	DESCRIPTION	MATERIAL	UNIT QTY
1	860759		REEL SHAFT ASSEMBLY		1
2	1100006	2	4 LG - 1/2 SQUARE	A-36	0.7FT
3		FT	HHCS 3/4-10NC X 2-1/2 LG C/W LW	GR 5	2
4	8602059		FRAME FABRICATION, FT4 DPT40-B		1
5	8602068		HYDRAULIC SCHEMATIC DPT-40B FT4		1
6	7601218		FUEL SYSTEM ASSY- DIESEL 18 US GAL		1
7	7600003		HYDRAULIC TANK REMORK - DPT-30		1
8		30	OIL, HYDRAULIC [SEE FINAL ASSEMBLY]		REF
9	566682		BATTERY- 750CCA		1
10	760248		BATTERY BOX		1
11	660178		BATTERY CABLE ASSY		1
12	7601126		ENGINE & PUMP ASSY JD 3029 FT4		1
13	5610171	1	27G LG - 7 CONDUCTOR CABLE		REF
14		FT	HEX NUT 1-8NC	GR 5	1
15	760178	1	FRAME, OIL COOLER MOUNT		REF
16	760033		TOW HITCH (SMALL)		1
17	561081		PIN- HITCH		2
18	6600006		SAFETY CHAIN		2
19			TRAILER WIRING DIAGRAM		REF
20	7601128		CONTROL CONSOLE ASSEMBLY		1
21		FT	GEAR OIL, EP-150		0.3GAL
22	713440		DRIVE ASSY		1
23	536616		FASTENER, HOOD		1
24	7601129		CHAIN GUARD		REF
25	215014	1	179 LG - ROLLER CHAIN 100 1-1/4 SP		15.0FT
26	216014		CONNECTOR LINK- CHAIN 100 1-1/4 SP		1
27	217014		OFFSET LINK- CHAIN 100 1-1/4 SP		1
28	537789		TIGHTENER- CHAIN		1
29		FT	SETSCREW- SQ HD 1-8NC X 4-1/2 LG		1
30	561988		MUD FLAP		2
31	5600946		TIRE AND WHEEL ASSY - ST235/80R16 LR-E		4
32	561356		SEAT, E-Z RIDER		1
33		FT	HHCS 1/2-13NC X 3/4 LG C/W LW	GR 5	4
34	561262		KLICK PIN		2
35	660002	1	SCREEN - OPERATORS CONSOLE		REF
36	566369		COOLER- HYDRAULIC		1
37	6600579		COVER ASSEMBLY		1
38	6600802	2	JACK ASSY - MANUAL REAR		REF
39	537544		BREAKAWAY SWITCH ASSY		1
40		FT	HHCS 5/8-11NC X 1-1/2 LG C/W LW,N	GR 5	18
41	6600600	1	JACK ASSY - MANUAL		REF
42	548870	1	JACK HYDRAULIC		REF
43	5603417		HANDLE ASSY, E-Z RIDER		1

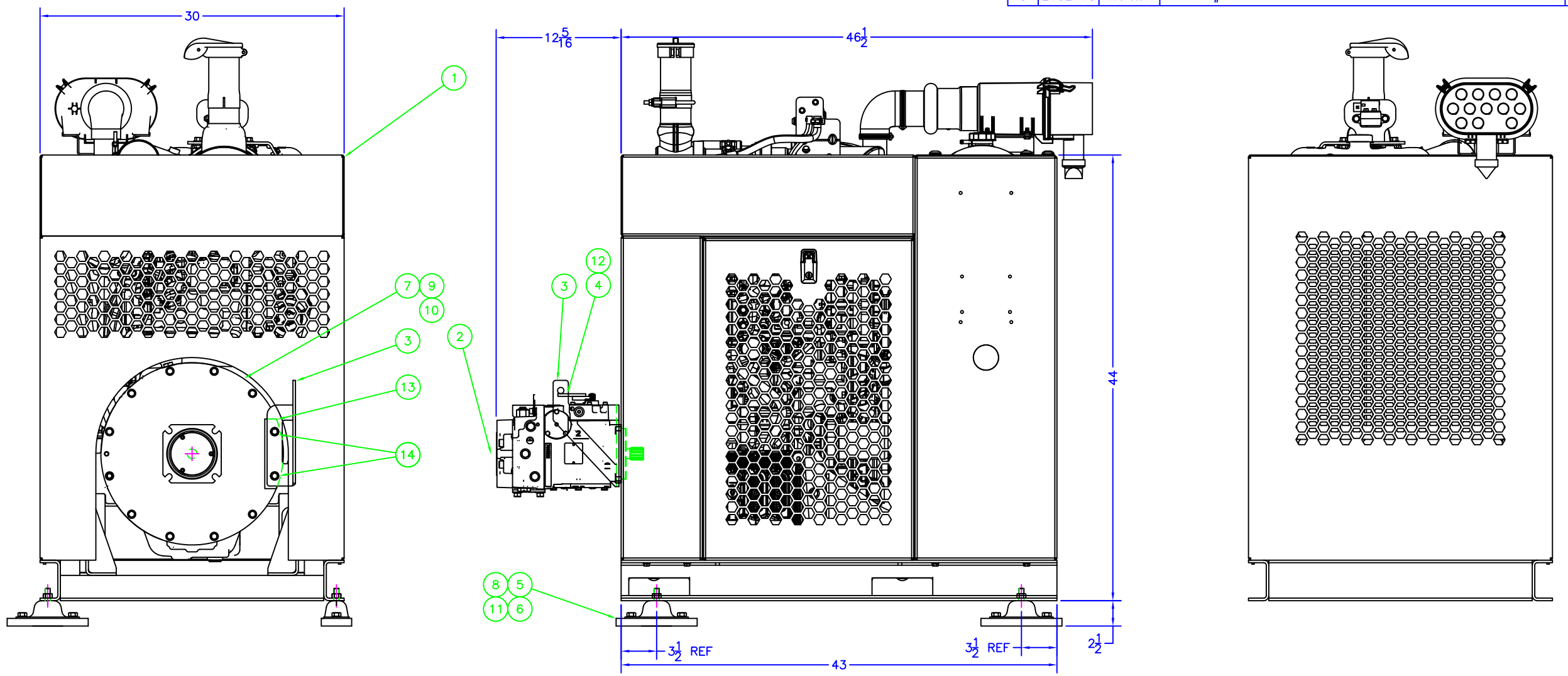
REV	DATE	CHANGE NUMBER	AMENDMENTS	BY	APPD
A	23DEC15		ITEM 24 WAS QTY 1	ACL	JW
B	16FEB16	ECN-1798	REMOVED IT 44, IT43 WAS 5602706, UPDATED VIEWS PICTORIALLY	ACL	JW
C	06JUN16		IT. 6 WAS 7800016, UPDATED VIEWS TO SHOW CHANGES IN FRAME	ACL	RB
D	12SEP17		REAR JACKS UPDATED TO BOLT ON TYPE; #38 ADDED, #40 WAS 6 ONLY	SB	JW

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE INCHES
DIMENSIONS IN [ ] ARE MM
-TOLERANCES-
A ANGULAR ±1/2°
B DECIMAL .XXX ± .010
.XX ± .02
.X ± .06
C FRACTIONAL ± 1/32
1 PLACE DECIMAL ± 1/16
2 PLACE DECIMAL ± 1/8
3 PLACE DECIMAL ± 1/4
D MATERIAL ± 1/8
2 WELDING

TSE INTERNATIONAL INC
Shreveport, Louisiana, United States of America

TITLE	GENERAL ASSEMBLY, FT4 DPT40-B
NEXT ASSEMBLY	F602017
FIRST USED ON NO.	4713
QTY	1
SHEET	1 OF 1
NEXT ASSY	N/R
VOLT	N/R
MATL SPEC	N/R
FINISH	N/R
ACL DRAWN	02DEC15
APPROVED	JW
SCALE	1/8
WEIGHT	N/R
REV	D
8602060	

REV	DATE	CHANGE NUMBER	AMENDMENTS	BY	APPD
A	16FEB16	ECN-1798	REMOVED IT. 15,16. ADDED SECTION A-A.	ACL	JM
B	03JUN16		ADDED IT. 15, IT. 4 WAS 3 LG. REMOVED SECTION A-A	ACL	RB
C	21SEP18	RFC-5054	ADDED IT# 16	TKR	JM



	ITEM	PART NUMBER	QPER DESC	DESCRIPTION	MATERIAL	UNIT QTY
C	16	5602825		COOLER WIRING SCHEMATIC		1
B	15	100021	1	P 1/4 PL 5 1/2 X 11 1/2	A-36	0.5SF
	14	281002		HHCS M10-1.50 X 35 MM LG	GR 8.8	2
	13	100041	1	P 3/8 PL 1 7/8 X 6 7/8	A-36	0.1SF
	12		FI	HHCS 1/4-20NC X 1 LG; C/W LNUT	GR 5	2
	11		FI	1/2-13NC HXCS X 1" C/W LW		8
	10		FI	HHCS 3/8-16NC X 3/4 LG	GR 5	8
	9		FI	M-10 X 1.5 HXCS X 25MMM LG. C/W LW	GR8.8	10
	8		FI	1/2"-13NC HXCS X 1 1/2" C/W LNUT	GR5	8
	7	5602618		PUMP DRIVE, SAE 3 TO SAE C-ZERO OFFSET		1
	6	560066		ENGINE MOUNTING PLATE		4
	5	541818		ENGINE MOUNT, 1/2 BOLT		4
B	4	105022	1	D 2 3/4 LG - 1/4 X 3/4 FLAT	A-36	0.3FT
	3	100021	1	P 1/4 PL 9 X 10 7/16	A-36	0.7SF
	2	567168		PUMP, HYD. 90R055 SERIES		1
	1	5603346		ENGINE, JOHN DEERE 3029HFC03		1

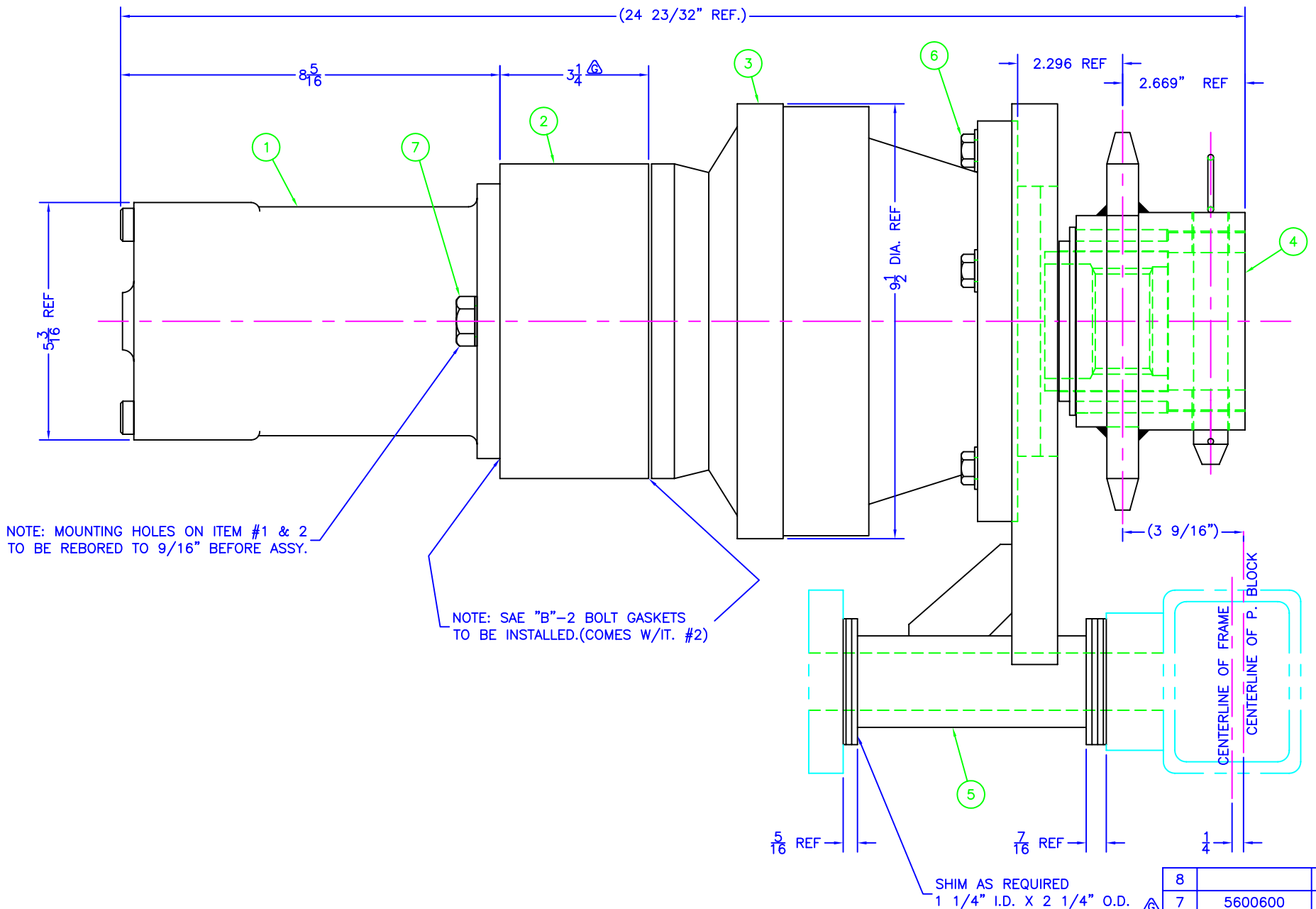
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE INCHES
DIMENSIONS IN [ ] ARE MM
-TOLERANCES-

A) ANGULAR ± 1/2°
B) DECIMAL (ONE) .X ± .06
(TWO) .XX ± .02
(THREE) .XXX ± .01
C) FRACTIONAL
1. GENERAL ± 1/32
2. SAWING, FLAME CUTTING, SHEARING & BREAKING ± 1/16
3. WELDING ± 1/8

TSE INTERNATIONAL INC
Shreveport, Louisiana, United States of America

MATL CERT	N/R
MATL TEST	N/R
WELD TEST	N/R
EST LBS	N/A
ACT LBS	N/A
TITLE	ENGINE & PUMP ASSY JD 3029 FT4
NEXT ASSEMBLY	8602060
FIRST USED ON WO	4713
DRAWN	ACL
CHECKED	
APPROVED	JM
DATE	09DEC15
SCALE	1/8
DERIVED FROM	7600759C
SHEET	1
OF	1
	7601126
REV	C

REV	DATE	CHANGE NUMBER	AMENDMENTS	BY	APPD
F	05JUN00		REDRAWN ON CAD	DY	RB
G	15MAY03		ITEM 7 WAS 539868, QTY 2; ITEM 2 WAS 4" LG	SB	



ITEM	PART NUMBER	OPER DESC	DESCRIPTION	MATERIAL	UNIT QTY
8		1	TRU ARC RING 5108-350		REF
7	5600600		CAPSCREW, M14 X 125MM LG		2
6		FI	7/16-14NC HXCS X 1 1/2"LG. C/W LW	GR-5	5
5	713443		DRIVE MOUNTING BRACKET		1
4	610420		SPROCKET HUB DRIVE ASSY		1
3	533669		REDUCER, PLANETARY-303L17.25		1
2	567367		HYDRAULIC BRAKE		1
1	533678		MOTOR- HYDRAULIC 5.04 CI		1

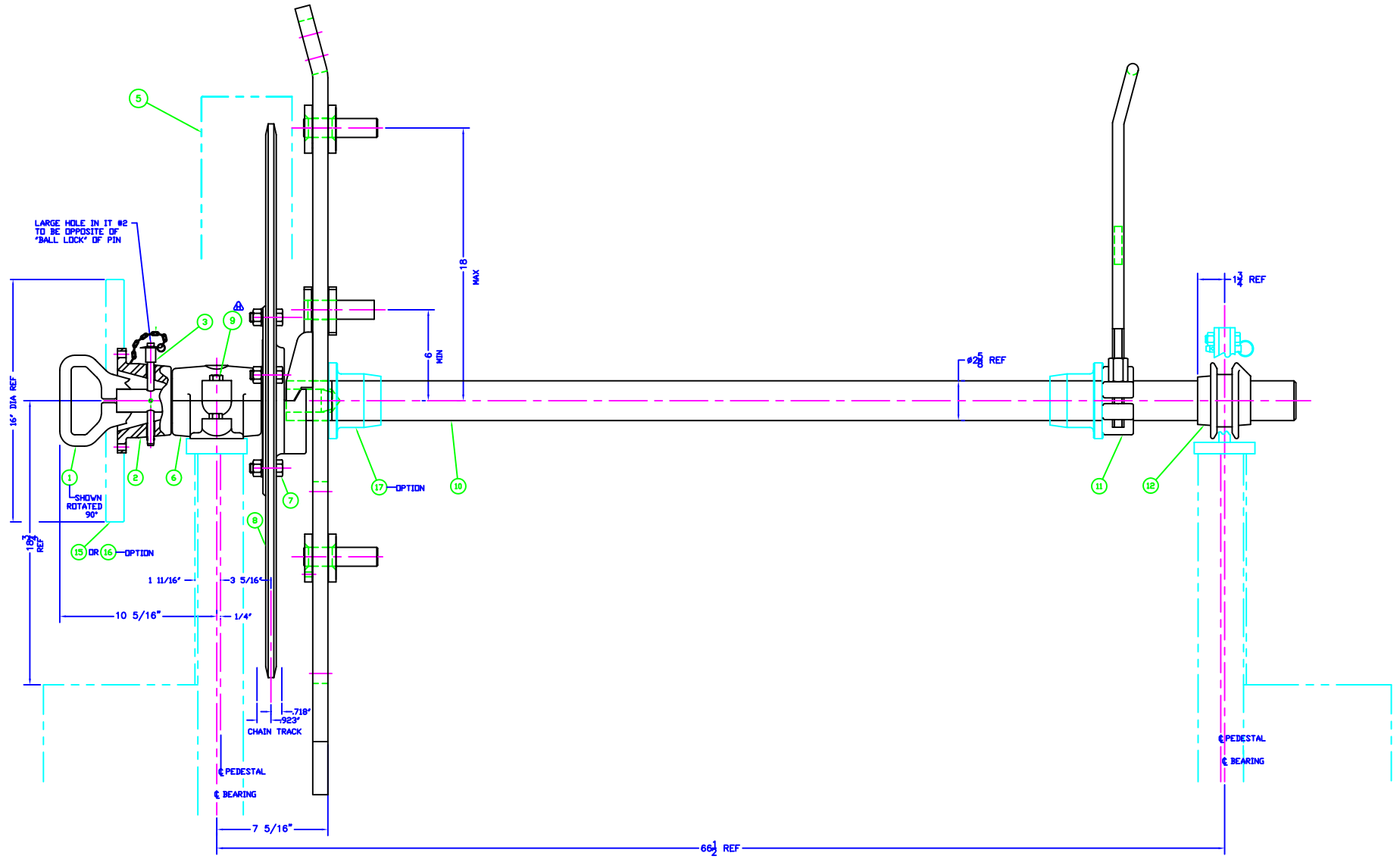
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE INCHES
DIMENSIONS IN [ ] ARE MM
-TOLERANCES-

A) ANGULAR		± 1/2°
B) DECIMAL	(ONE) .X	± .06
	(TWO) .XX	± .02
	(THREE) .XXX	± .01
C) FRACTIONAL		
1. GENERAL		± 1/32
2. SAWING, FLAME CUTTING, SHEARING & BREAKING		± 1/16
3. WELDING		± 1/8

TSE INTERNATIONAL INC
Shreveport, Louisiana, United States of America

MATL CERT N/R	TITLE DRIVE ASSEMBLY DPT-30B		
MATL TEST N/R	NEXT ASSEMBLY 809855	DERIVED FROM	
WELD TEST N/R	FIRST USED ON WO 4570	SHEET 1	OF 1
EST LBS N/A	DRAWN DS / CHECKED RJB / APPROVED GYB	713440	REV G
ACT LBS N/A	DATE 13JUNE83 / SCALE 1/2		

REV	DATE	CHANGE NUMBER	AMENDMENTS	BY	APPD
C	01NOV01	RFC1335	UPDATED & REDRAWN TO NEW FORMAT	SB	RB
D	17JUN10		ITEM #10 WAS 610635	SB	JM



ITEM	PART NUMBER	QTY	DESCRIPTION	MATERIAL	UNIT QTY.
17	609395	2	ADAPTER- SHAFT 3-1/2 OD X 2-5/8 ID		REF
16	810340	1	OVERSPIN BRAKE, BRONZE		REF
15	810151	1	BRAKE- OVERSPIN		REF
14					
13					
12	P01-8034-000		2 5/8 BRONZE BEARING		1
11	609337		REEL CLAMP/LOCKING COLLAR		1
10	660925		SHAFT ASSEMBLY		1
9		FI	HHCS 3/4-10NC X 2-1/2 LG C/W FW & NUT	GR 5	2
8	660924		SPROCKET REWORK- DRIVE		1
7		FI	HHCS 5/8-11NC X 1-3/4 LG C/W LW & NUT	GR 5	5
6	560784		PILLOW BLOCK		1
5	760614	1	CHAIN GUARD		REF
4					
3	538605		QUICK RELEASE PIN		1
2	810357		STUB SHAFT		1
1	610629		LOCKING PIN		1

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE INCHES
DIMENSIONS IN [ ] ARE MM
-TOLERANCES-
A) ANGULAR ± 1/2°
B) DECIMAL .XX ± .05
.XXX ± .02
.XXXX ± .01
C) FRACTIONAL ± 1/32
1. GENERAL
2. SAWING, FLAME CUTTING, SHEARING ± 1/16
3. BENDING ± 1/8
4. WELDING

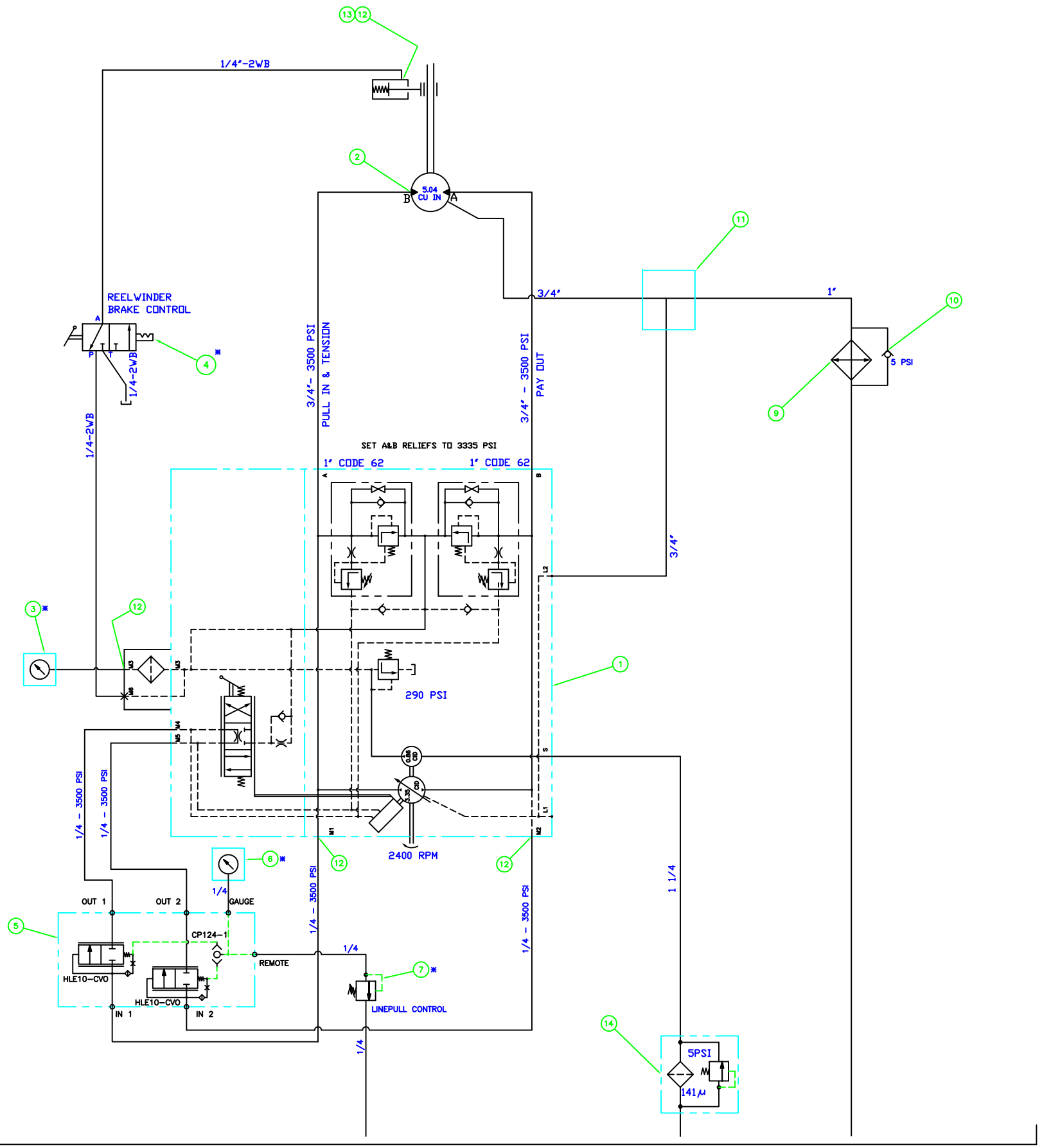
TIMBERLAND EQUIPMENT LIMITED
Woodstock, Ontario, Canada

MATL COMM N/R
MATL TEST N/R
WELD TEST N/R
EXT LBS N/A
EXT LBS N/A

TITLE REEL SHAFT ASSY- DPT-40B
NEXT ASSEMBLY
FIRST USED ON VIN
DRAWN RAP
CHECKED DS
APPROVED
DATE 31JAN90
SCALE 1/4
SERVES FROM
SHEET 1 OF 1

860759 REV D

REV	DATE	CHANGE NUMBER	AMENDMENTS	BY	APPD
A	15FEB16	ECN-1794	ADDED IT 15.	ACL	JM
B	08JUN16		REMOVED IT. 8. NOT REQUIRED.	ACL	RB
C	10AUG16		ITEM #5 WAS 5603263; ITEM #15 WAS 547193, NOT REQUIRED	SB	JM
D	05DEC18	RFC-5070	ITEM #14 WAS 5601184	SB	CJ



* DENOTES ITEMS LOCATED IN THE CONTROL CONSOLE

ITEM	PART NUMBER	ORDER DESC	DESCRIPTION	MATERIAL	UNIT QTY
14	5600702		FILTER, SUCTION - 150 MICRON		1
13	567367	1	BRAKE- MULTI DISK		REF
12	5602084		TEST POINT, 1/4"		4
11	690414		MANIFOLD BLOCK		1
10	5004077		CHECK VALVE 12 SAE		1
9	566369	1	COOLER- HYDRAULIC		REF
8					
7	560331	1	VALVE- RF 9150 4600 ORB-04		REF
6	537350	1	GAUGE- 2-1/2" 0-5000 PSI/BAR		REF
5	5603562		MANIFOLD, DUAL RVPL - W/ SHUTTLE		1
4	560320	1	VALVE, DIRECTIONAL, 3W2P		REF
3	561198	1	GAUGE- 2-1/2" 0-600 PSI/BAR		REF
2	533678	1	MOTOR- HYDRAULIC 5.04 CI		REF
1	567168	1	PUMP, HYD. 90R055 SERIES		REF

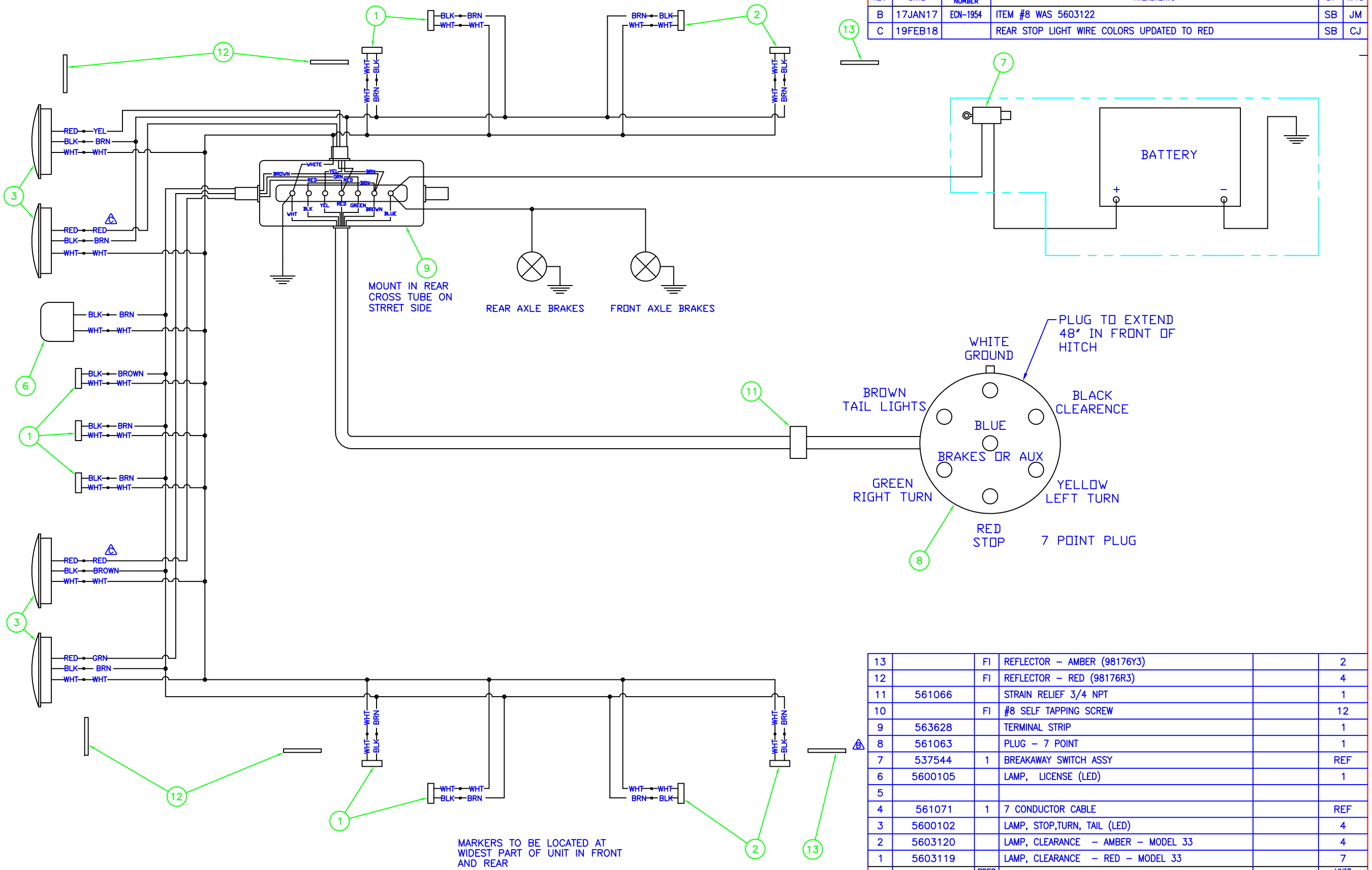
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE INCHES
DIMENSIONS IN ( ) ARE MM
-TOLERANCES-
AD ANGULAR ± 1/2°
BD DECIMAL (ONE) X ± .06
(TWO) .XX ± .02
(THREE) .XXX ± .01
CD FRACTIONAL
1. GENERAL ± 1/32
2. SAWING, FLAME CUTTING, SHEARING & BREAKING ± 1/16
3. WELDING ± 1/8

TSE INTERNATIONAL INC
Shreveport, Louisiana, United States of America

MATL CERT N/R
MATL TEST N/R
WELD TEST N/R
EST LBS N/A
ACT LBS N/A

TITLE HYDRAULIC SCHEMATIC DPT-40B FT4
NEXT ASSEMBLY 8602060
SERVICED FROM 8602064
FIRST USED ON NO 4713
SHEET 1 OF 1
BRANCH ACL | CHECKED | APPROVED JM
DATE 16DEC15 | SCALE 1/1
8602068 | REV D

REV	DATE	CHANGE NUMBER	AMENDMENTS	BY	APPD
B	17JAN17	ECN-1954	ITEM #8 WAS 5603122	SB	JM
C	19FEB18		REAR STOP LIGHT WIRE COLORS UPDATED TO RED	SB	CJ



ITEM	PART NUMBER	OPER DESC	DESCRIPTION	MATERIAL	UNIT QTY
13		FI	REFLECTOR – AMBER (98176Y3)		2
12		FI	REFLECTOR – RED (98176R3)		4
11	561066		STRAIN RELIEF 3/4 NPT		1
10		FI	#8 SELF TAPPING SCREW		12
9	563628		TERMINAL STRIP		1
8	561063		PLUG – 7 POINT		1
7	537544	1	BREAKAWAY SWITCH ASSY		REF
6	5600105		LAMP, LICENSE (LED)		1
5					
4	561071	1	7 CONDUCTOR CABLE		REF
3	5600102		LAMP, STOP,TURN, TAIL (LED)		4
2	5603120		LAMP, CLEARANCE – AMBER – MODEL 33		4
1	5603119		LAMP, CLEARANCE – RED – MODEL 33		7

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE INCHES
DIMENSIONS IN [ ] ARE MM
-TOLERANCES-

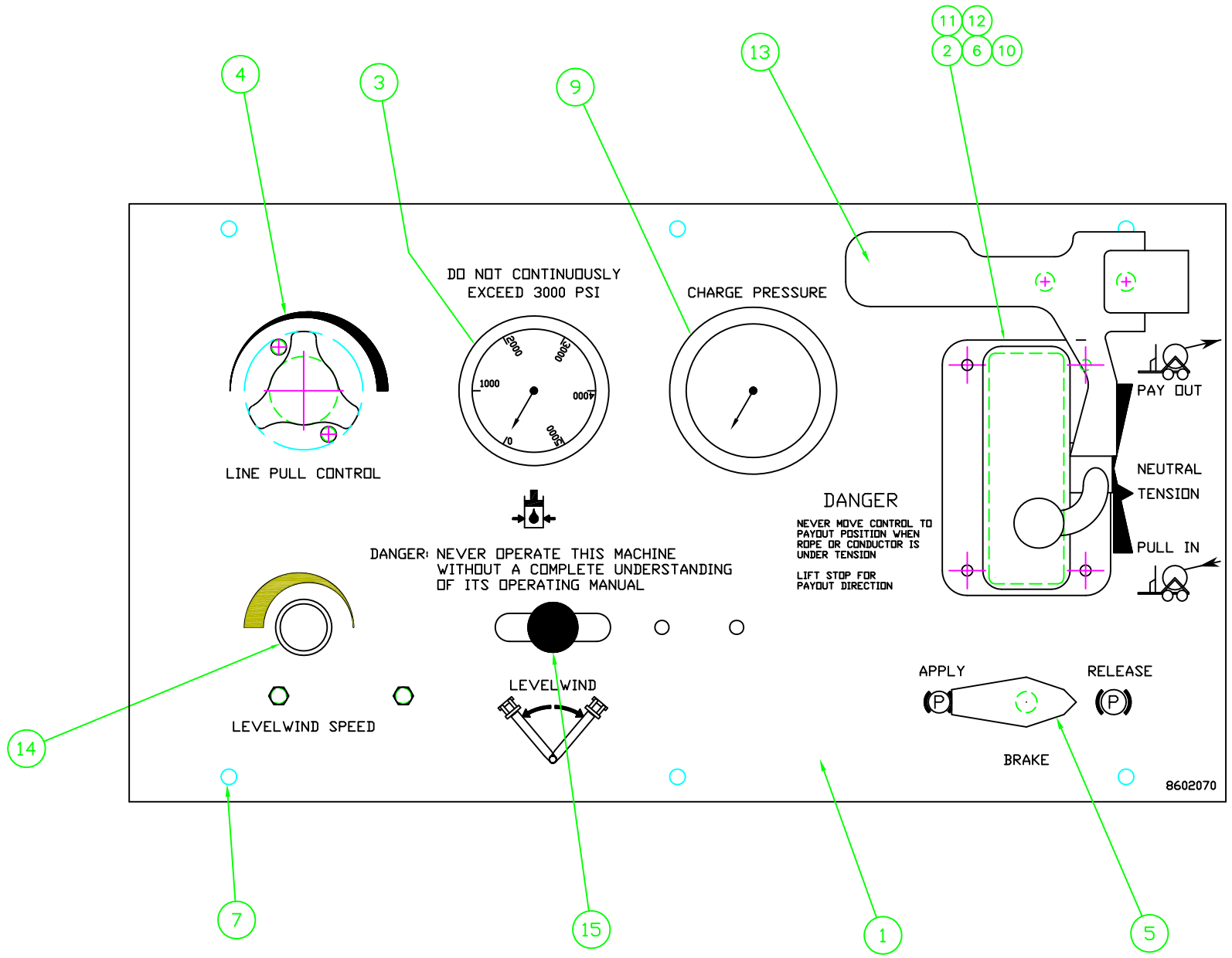
A) ANGULAR		± 1/2°
B) DECIMAL	(ONE) .X	± .06
	(TWO) .XX	± .02
	(THREE) .XXX	± .01
C) FRACTIONAL		
1. GENERAL		± 1/32
2. SAWING, FLAME CUTTING, SHEARING & BREAKING		± 1/16
3. WELDING		± 1/8

TSE INTERNATIONAL INC
Shreveport, Louisiana, United States of America

MATL CERT	N/R	TITLE	LIGHTING DIAGRAM, 7 PT LED
MATL TEST	N/R	NEXT ASSEMBLY	36-00048-000
WELD TEST	N/R	FIRST USED ON WO	4666
EST LBS	N/A	DRAWN	SB
ACT LBS	N/A	CHECKED	
		APPROVED	
		DATE	10NOV15
		SCALE	1/4

DERIVED FROM 7601106
SHEET 1 OF 1
7601116 REV C

REV	DATE	CHANGE NUMBER	AMENDMENTS	BY	APPD



ITEM	PART NUMBER	OPER DESC	DESCRIPTION	MATERIAL	UNIT QTY
15	563299	1	BECKETT VALVE		REF
14	562109	1	VALVE- FR 3000 ORB-06 AL		REF
13	811853		SAFETY LATCH		1
12	561180		CABLE CLAMP		1
11	561171		COLLAR- STOP		1
10	561114		DETENT KIT		1
9	561198		GAUGE- 2-1/2" 0-600 PSI/BAR		1
8	531185		BALL JOINT		1
7		FI	HHCS 1/4-20NC X 1 LG; C/W LW, NUT	GR 5	6
6	561147		CABLE, CONTROL - 8FT		1
5	560320		VALVE- BL 3W2P 2500 NPT-04 BRS		1
4	560331		VALVE- RF 9150 4600 ORB-04		1
3	537350		GAUGE- 2-1/2" 0-5000 PSI/BAR		1
2	561111		MORSE CONTROL, SINGLE		1
1	8602070		PANEL ENGRAVING DPT 40B FT4		1

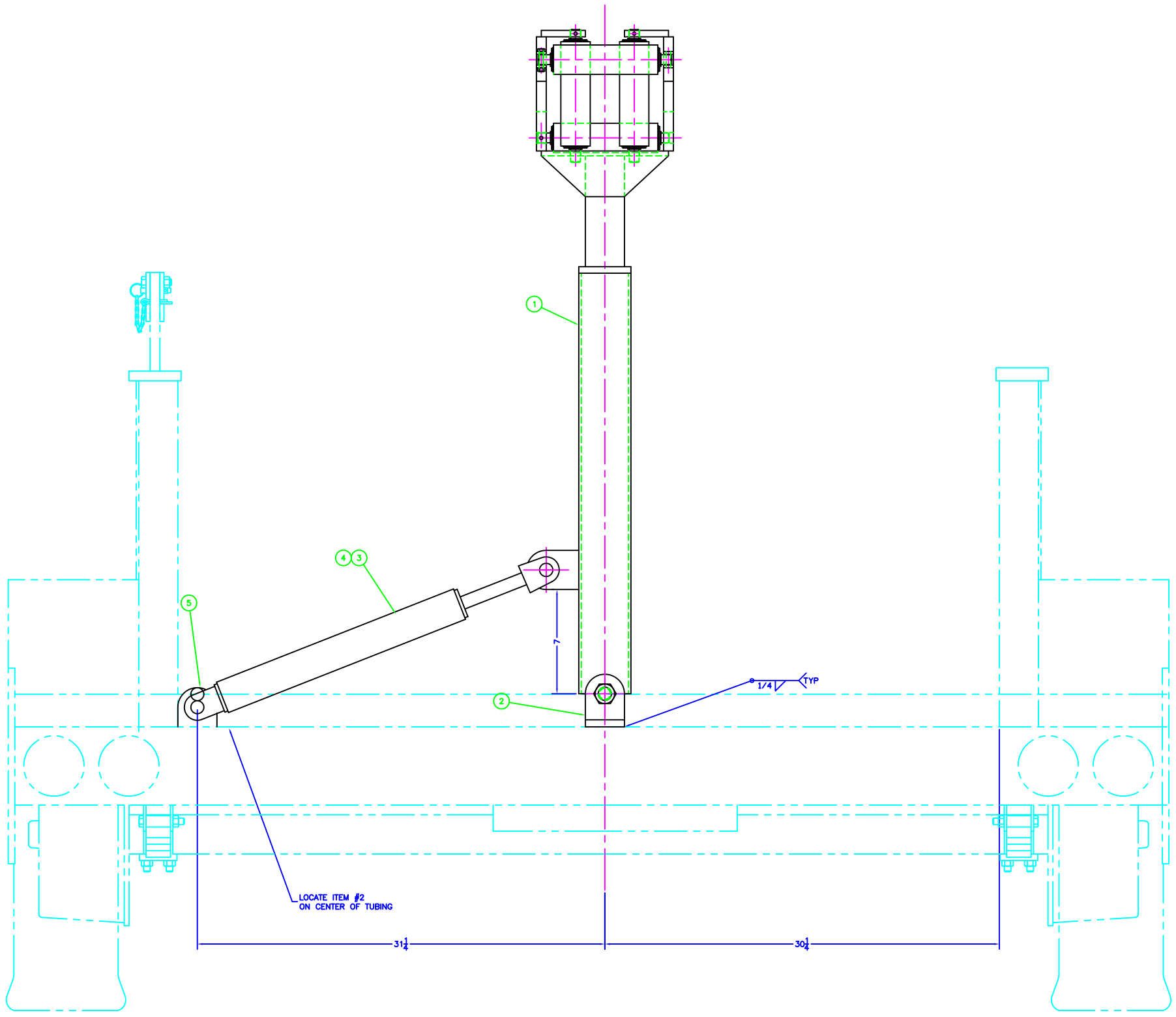
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE INCHES
DIMENSIONS IN [ ] ARE MM
-TOLERANCES-

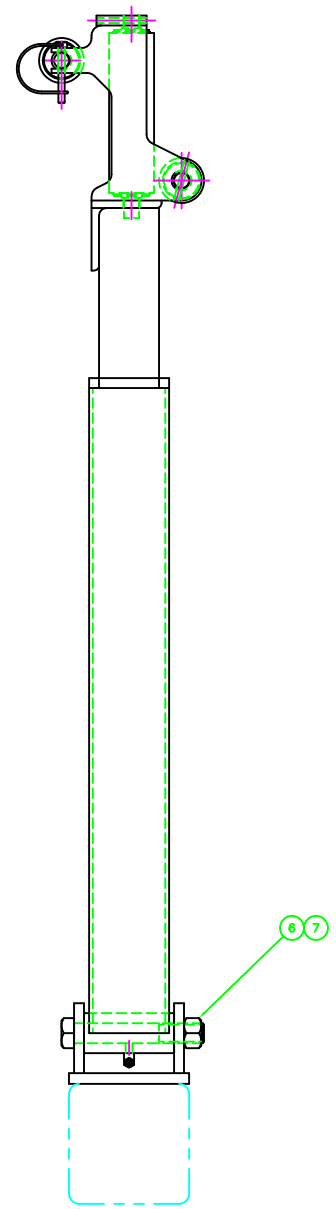
A) ANGULAR		± 1/2°
B) DECIMAL	(ONE) .X	± .06
	(TWO) .XX	± .02
	(THREE) .XXX	± .01
C) FRACTIONAL		
1. GENERAL		± 1/32
2. SAWING, FLAME CUTTING, SHEARING & BREAKING		± 1/16
3. WELDING		± 1/8

TSE INTERNATIONAL INC
Shreveport, Louisiana, United States of America

MATL CERT	N/R	TITLE	CONTROL CONSOLE ASSEMBLY
MATL TEST	N/R	NEXT ASSEMBLY	8602060
WELD TEST	N/R	FIRST USED ON WO	4713
EST LBS	N/A	DRAWN	ACL
ACT LBS	N/A	CHECKED	
		APPROVED	JM
		DATE	15DEC15
		SCALE	1/2
		DERIVED FROM	
		SHEET	1 OF 1
		7601128	REV

REV	DATE	CHANGE NUMBER	AMENDMENTS	BY	APPD





ITEM	PART NUMBER	QPER ASSY	DESCRIPTION	MATERIAL	UNIT QTY
7	200311	1	LOCK NUT- 1-8NC	ESNA	REF.
6	196279	1	HHCS 1-8NC X 6-1/2 LG	GR 5	REF.
5	561741		CYLINDER EAR		1
4	560500		CYLINDER, HYDRAULIC LEVELWIND		1
3	7600250		LEVELWIND PLUMBING, DPT 30 & 40		1
2	660347		LEVELWIND MOUNTING BRACKET		1
1	760188		LEVELWIND ASSEMBLY		1

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE INCHES
DIMENSIONS IN [ ] ARE MM
-TOLERANCES-

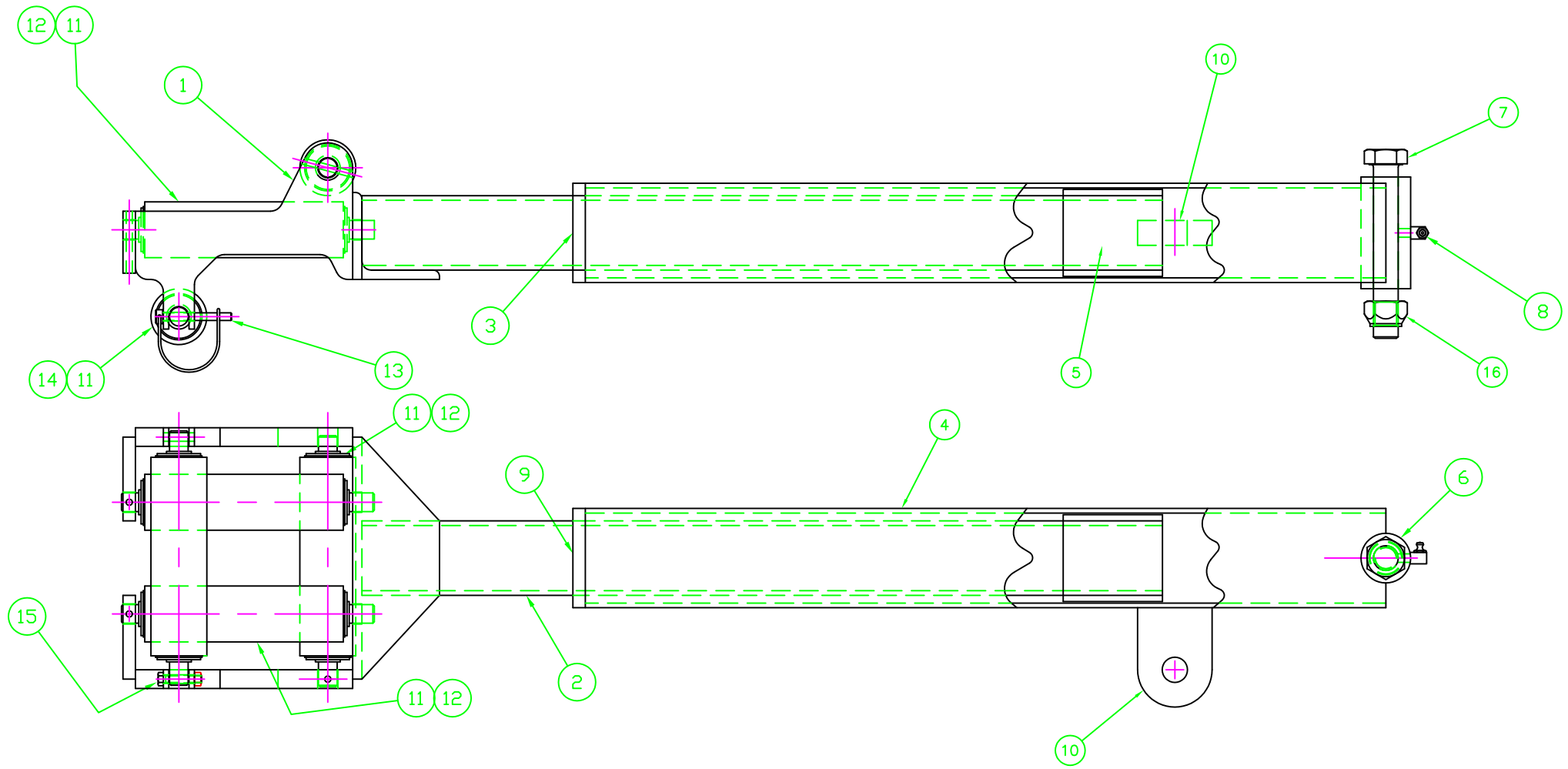
A) ANGULAR ± 1/2°
B) DECIMAL (ONE) X ± .06
(TWO) .XX ± .02
(THREE) .XXX ± .01
C) FRACTIONAL
1. GENERAL ± 1/32
2. SAWING, FLAME CUTTING, SHEARING ± 1/16
3. MACHINING
3. WELDING ± 1/8

MATL CERT N/R
MATL TEST N/R
YIELD TEST N/R
EST LBS N/A
ACT LBS N/A

TSE INTERNATIONAL INC
Shreveport, Louisiana, United States of America

TITLE LEVELWIND ASSY, OVERHEAD
NEXT ASSEMBLY
SERVICED FROM
FIRST USED ON VO 3017
SHEET 1 OF 1
DRAWN SB
CHECKED RJB
APPROVED
DATE 17MAY04
SCALE 1/4

8600484 REV A



ITEM	PART NO.	OPER DESC	DESCRIPTION	MATERIAL	UNIT QTY	
16	200311		LOCKNUT- 1-8NC ESNA		1	A
15		FI	5/16-18 NC HHCS X 1 3/4"L C/W LW,N	GR-2	REF	
14	563391	1	PIN (3/4" DIA X 10 1/4"LONG)	---	REF	
13	561264	1	5/16" P.T.O. PIN	---	REF	
12	563390	3	PIN ASSY (3/4" DIA X 10 1/8"L)	---	REF	
11	660035	4	HARD ROLLER ASSY	---	REF	
10	561741	S	CYLINDER EAR	---	1	A
9	120006	2	KEYSTOCK 1/2" X 1/2" X 4" LONG	C1018	0.7FT	
8		FI	1/8"-27 NPT GREASE FITTING (90')	---	1	
7	196280		1"-8 NC HHCS X 7 LG	GR-5	1	A A
6	145023	1	ROUND 2" DIA X 4 1/2" LONG	C1018	0.4FT	
5	105112	4	FLAT 1/4" X 3" X 4"LONG	A-36	1.4FT	
4	158139	1	TUBE 4" X 4" X 3/16"W X 32 1/4"LG	GR-50	2.7FT	
3	120006	2	KEYSTOCK 1/2" X 1/2" X 3" LONG	C1018	.5FT	
2	158351	1	TUBE 3" X 3" X 3/16"W X 32 1/4"LG	GR-50	2.7FT	
1	760097	S	LEVELWIND HEAD ASY	---	1	

REV.	DATE	CHANGE NUMBER	AMENDMENTS	BY	APP'D
N	05JAN15	RFC-4641	1-1/2 & 7 DIMENSIONS ADDED	SB	JM
M	18OCT12		ITEM 7 WAS #196279 & 6-1/2 LG	BMF	DSR
L	23OCT01	RFC#1319	IT. #10 WAS REF.	DY	RB
K	15SEP00		RFC-A284 IT 7 WAS FI, IT 16 ADDED	WJW	ARD
J	05MAY00		REVERSE REV I	WJW	ARD
I	01OCT99		9-1/2 WAS 8-1/2	WJW	JF
H	12/1/93		ITEM #7 WAS NOT SHOWN	RCT	
G	7/12/92		ITEM #8 WAS STRT,NOW 90° ELBOW	RCT	MG
			DWG. REV'D TO "AS BUILT" BY TSE		
F	30/9/92		REMOVED HOLES FROM IT.#2 & 4	RCT	MG
			REMOVED IT.#17 &18		
E	16/JU/91		IT.#17 WAS 511788	RCT	MG
			HEAD REDESIGNED, REDRAWN ON CAD		
D	22/8/90		DRILL SIZE WAS 7/8"	JVK	DS
C	14/2/90		2 1/2" WAS 3 1/2",5 3/4" WAS 4"	JVK	DS

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE INCHES
DIMENSIONS IN [ ] ARE MM
-TOLERANCES-

A) ANGULAR ± 1/2°
B) DECIMAL (ONE) .X ± .06
(TWO) .XX ± .02
(THREE) .XXX ± .01
C) FRACTIONAL
1. GENERAL ± 1/32
2. SAWING, FLAME CUTTING, SHEARING & BREAKING ± 1/16
3. WELDING ± 1/8

TIMBERLAND EQUIPMENT LIMITED
Woodstock, Ontario, Canada

TITLE: LEVELWIND ASSY DPT 30B

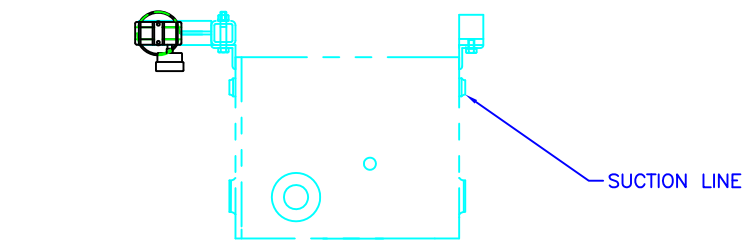
NEXT ASSEMBLY | DERIVED FROM | EST LBS N/A | ACT LBS N/A

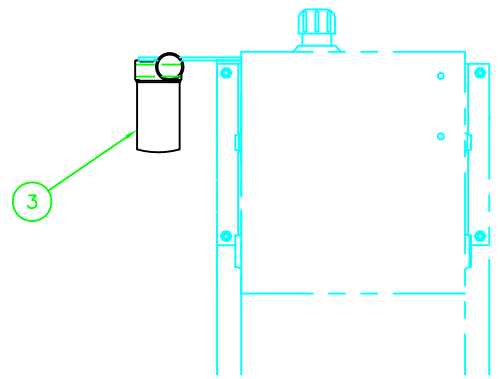
FIRST USED ON W.O. | DATE 5/JU/91 | SCALE 1=4 | REV. N

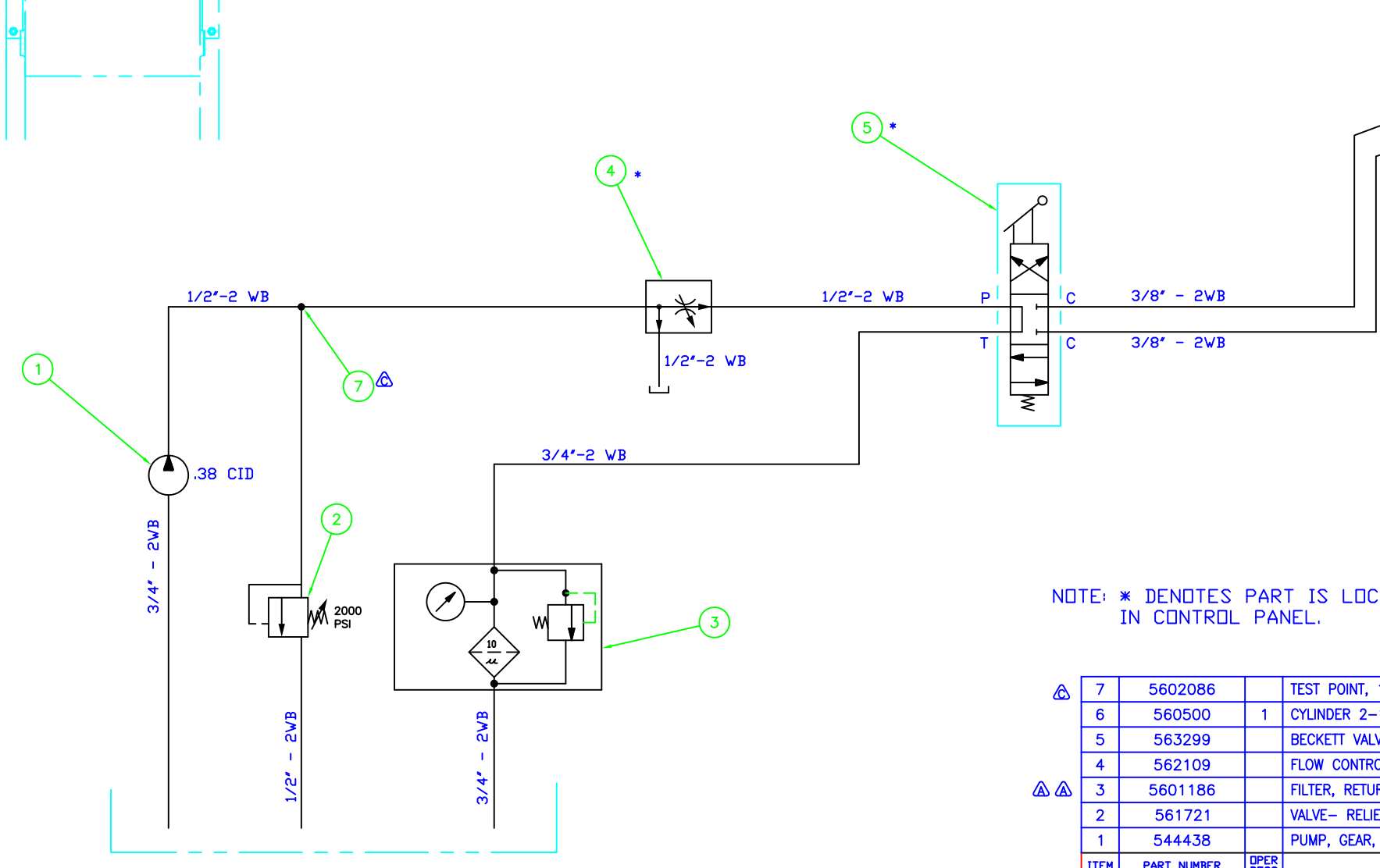
DRAWN RCT | CHECKED | APPROVED | SHEET 1 OF 1

760188

REV	DATE	CHANGE NUMBER	AMENDMENTS	BY	APPD
A	25MAY04		ITEM 3 WAS 533764 IN ERROR; ADDED TANK DETAIL	SB	
B	30MAY06		ITEM 3 WAS 534867	SB	JM
C	22JUN10		ITEM #7 ADDED	SB	JM
D	20AUG10		ITEM #8 ADDED	SB	JM
E	21MAR13		ITEM #8 WAS 6600323; DELETED	SB	JM







NOTE: * DENOTES PART IS LOCATED IN CONTROL PANEL.

ITEM	PART NUMBER	OPER DESC	DESCRIPTION	MATERIAL	UNIT QTY
7	5602086		TEST POINT, 1/2"		1
6	560500	1	CYLINDER 2-1/2 BORE X 12 STROKE		REF
5	563299		BECKETT VALVE		1
4	562109		FLOW CONTROL		1
3	5601186		FILTER, RETURN (10 MICRON)		1
2	561721		VALVE- RELIEF		1
1	544438		PUMP, GEAR, .38 CID		1

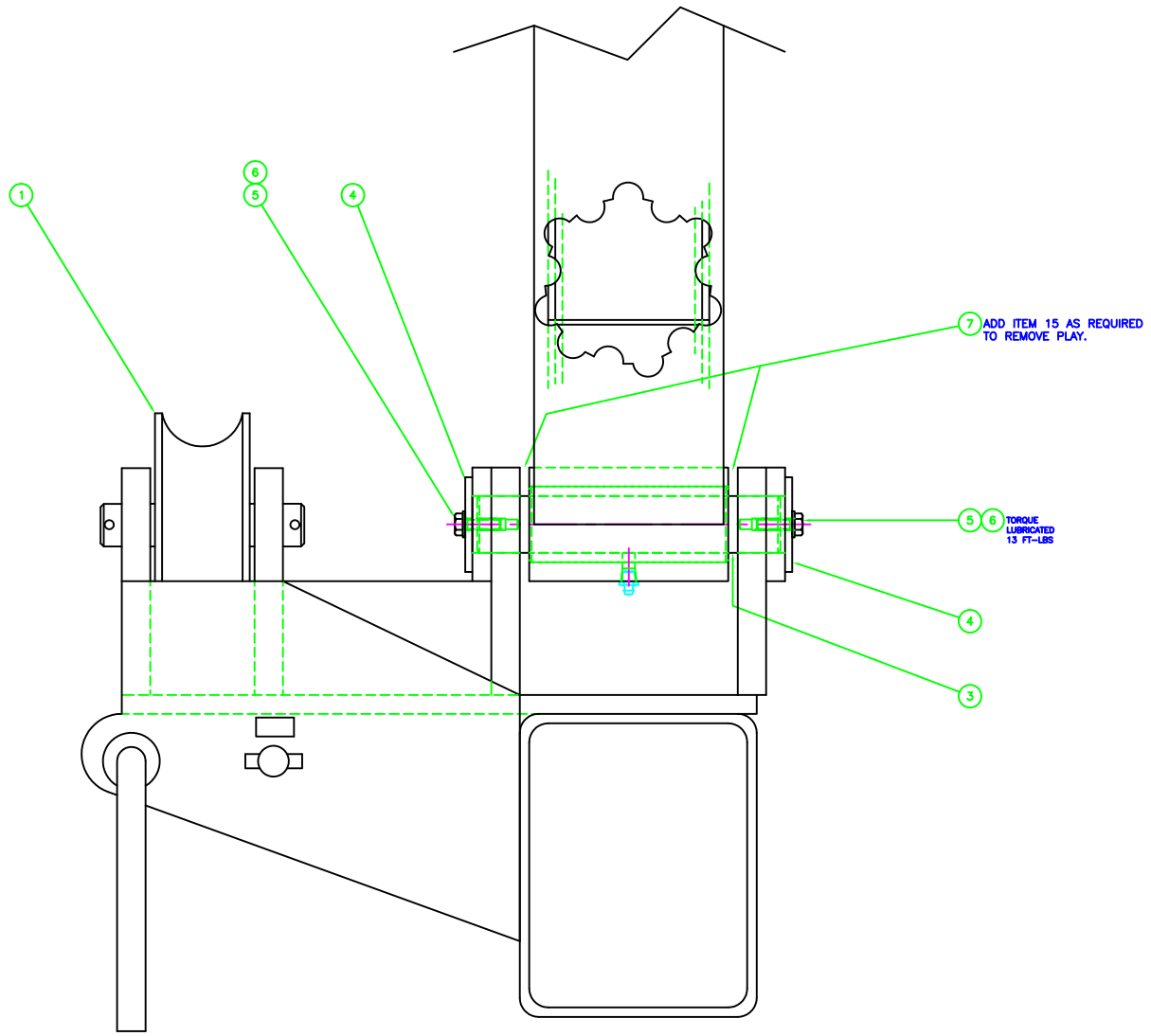
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE INCHES
DIMENSIONS IN [ ] ARE MM
-TOLERANCES-

A) ANGULAR		± 1/2°
B) DECIMAL	(ONE) .X	± .06
	(TWO) .XX	± .02
	(THREE) .XXX	± .01
C) FRACTIONAL		
1. GENERAL		± 1/32
2. SAWING, FLAME CUTTING, SHEARING & BREAKING		± 1/16
3. WELDING		± 1/8

TSE INTERNATIONAL INC
Shreveport, Louisiana, United States of America

MATL CERT	N/R	TITLE	LEVELWIND PLUMBING, DPT 30 & 40
MATL TEST	N/R	NEXT ASSEMBLY	DERIVED FROM
WELD TEST	N/R	FIRST USED ON WO	3017
EST LBS	N/A	DRAWN SB / CHECKED RJB / APPROVED	SHEET 1 OF 1
ACT LBS	N/A	DATE 17MAY04 / SCALE 1/1	7600250 REV E

REV	DATE	CHANGE NUMBER	AMENDMENTS	BY	APPD



ITEM	PART NUMBER	QPER DESC	DESCRIPTION	MATERIAL	UNIT QTY
12	100051	2	P 1/2 PL 5 5/8 X 17	A-36	1.4SF
11	100051	4	P 1/2 PL 7 1/2 X 11 3/16	A-36	2.4SF
10	159392	1	63 LG - 4X3X1/4 W RECT TUBE	A500B	5.3FT
9	100014	1	P 3/16 PL 16 13/16 X 68 1/2	CHKR	8.0SF
8	159492	1	D 88 LG - 8X6X3/8 W RECT TUBE	A500B	7.4FT
7	181016		FLATWASHER- 1-1/2 HARDENED	STL	2
6		FI	FLATWASHER- 5/16	STL	2
5		FI	HHCS 5/16-18NC X 1 LG	GR 5	2
4	100011	2	P 3/16 PL 2 1/2 OD	A-36	0.1SF
3	140018	1	8 LG - 1-1/2 DIA ROUND	C1045GND&PL	0.7FT
2	155223	1	5 1/4 LG - 2 ODX1/4 W RND TUBE	A513DOM	0.5FT
1	860106		OVERHEAD/UNDERGROUND LEVELWIND ASSY		1

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE INCHES
DIMENSIONS IN [ ] ARE MM
-TOLERANCES-

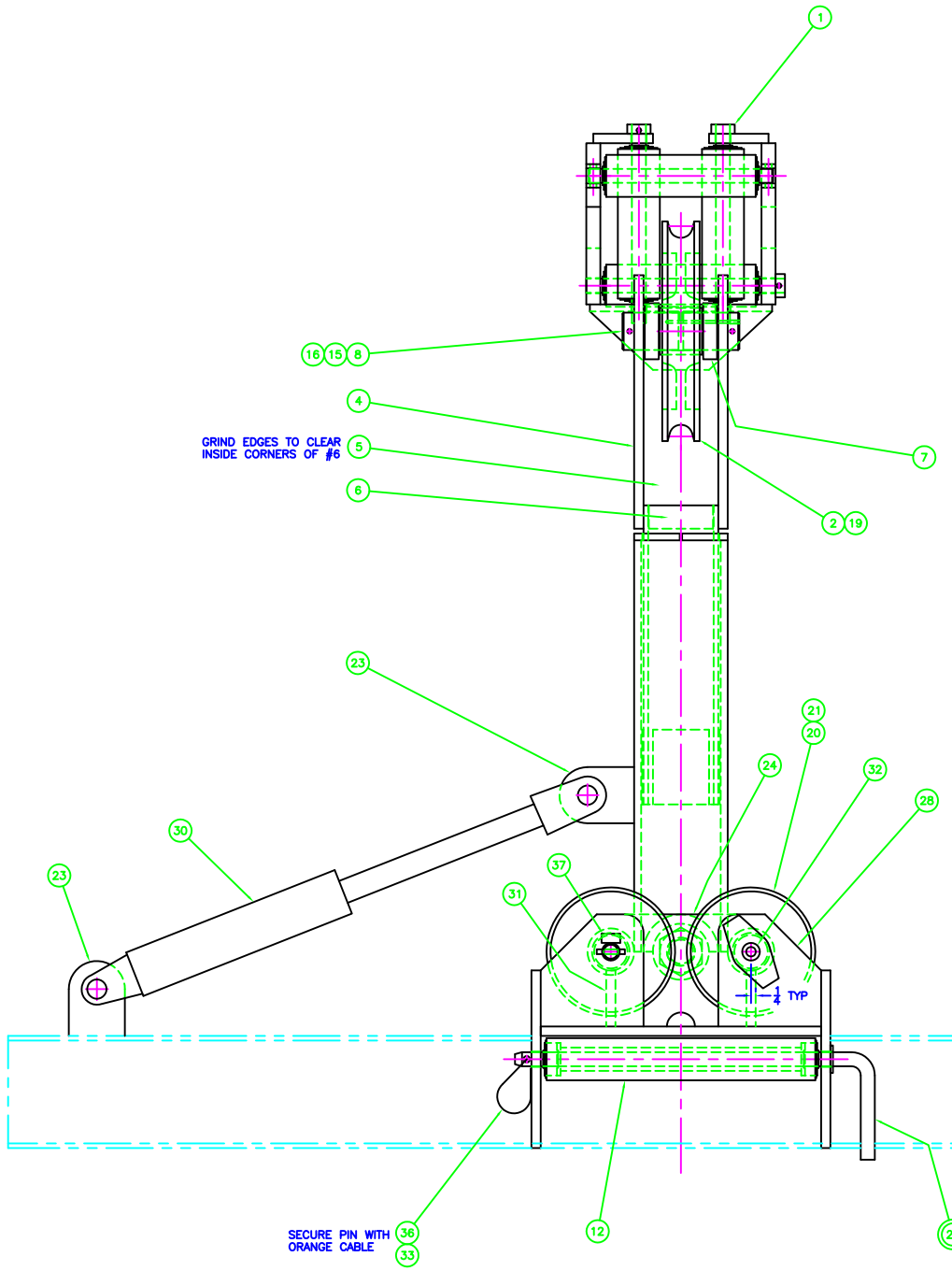
A) ANGULAR ± 1/2°
B) DECIMAL (ONE) X ± .06
(TWO) XX ± .02
(THREE) XXX ± .01
C) FRACTIONAL ± 1/32
1. GENERAL
2. SAWING, FLAME CUTTING, SHEARING ± 1/16
3. MACHINING ± 1/10
4. WELDING

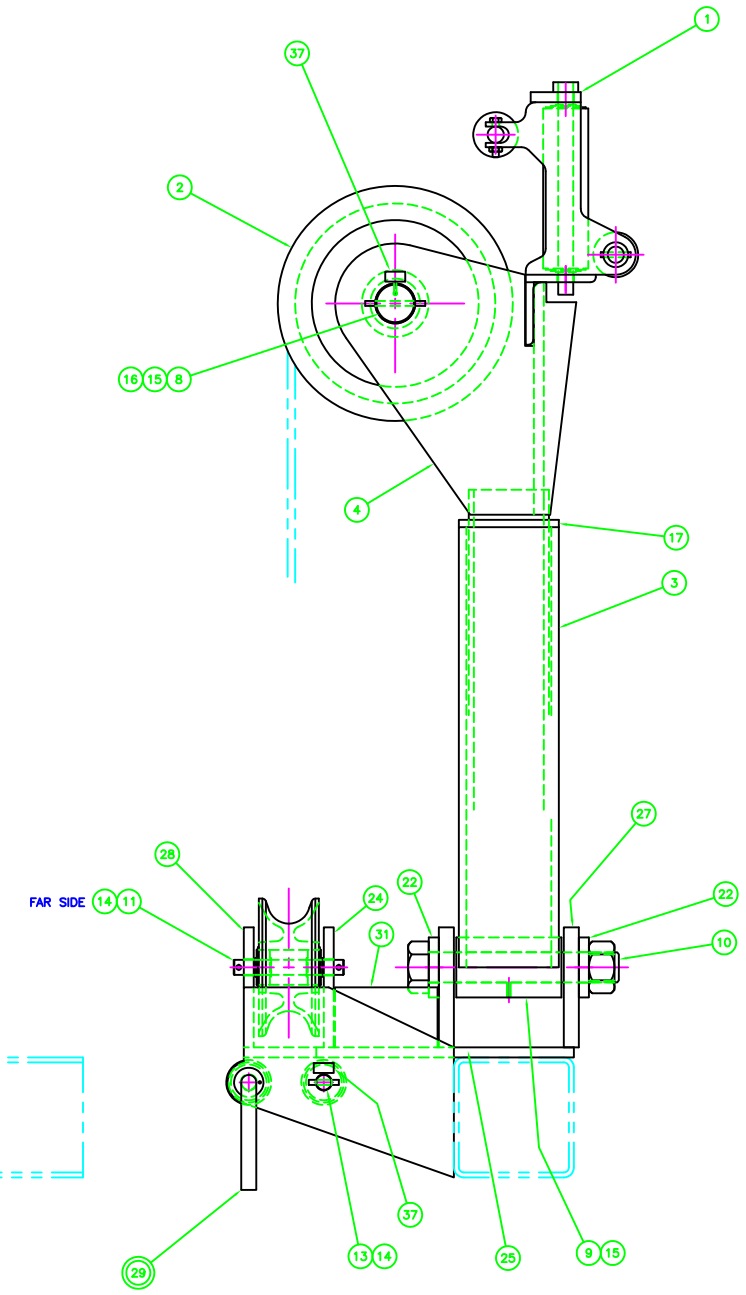
TSE INTERNATIONAL INC
Shreveport, Louisiana, United States of America

MATL CERT N/R
MATL TEST N/R
WELD TEST N/R
EST LBS N/A
ACT LBS N/A

TITLE LEVELWIND, OVER/UNDER - DPT40-B
NEXT ASSEMBLY F602474
SERVED FROM 8601832
FIRST USED ON VO 5201
SHEET 1 OF 2
DRAWN SB
CHECKED
APPROVED JM
DATE 16JAN19
SCALE 1/2
8602493
REV

REV	DATE	CHANGE NUMBER	AMENDMENTS	BY	APPD
M	12MAR15	RFC-4691	UPDATED & REDRAWN; ∯25 & 28 DETAILS UPDATED	SB	JM
N	13JUN16	RFC-4725	IT. 38 MATERIAL WAS 105280	ACL	JM
O	09FEB17	RFC-4863	ITEM ∯18 WAS 105110; 0.7FT	SB	JM





ITEM	PART NUMBER	OPCH DESC	DESCRIPTION	MATERIAL	UNIT QTY
38	100008	2	R SHEET, 14 GA 2 1/4 X 4	A-36	0.2SF
37	110006	3	1 LG - 1/2 SQUARE	A-36	0.3FT
36		FI	8 LG - ORANGE CABLE	STD	1
35		FI	3/4 LARGE FLAT WASHER	STD	1
34	130107	1	D 24 LG - 3/4 DIA ROUND	C1144	2.0FT
33	561265		PIN- LOCK		1
32	511788		PIN- BALL-LOC 3/4 DIA X 5 GRIP		1
31	105116	2	5 1/8 LG - 1/2 X 3 FLAT	A-36	0.9FT
30	560500	1	CYLINDER 2-1/2 BORE X 12 STROKE		REF
29		1	CONSIST OF ITEMS 34 & 35		1
28	100051	2	P 1/2 PL 5 1/2 X 6	A-36	0.5SF
27	100071	2	P 3/4 PL 6 X 4	A-36	0.4SF
26	100051	2	P 1/2 PL 11 5/16 X 9 1/2	A-36	1.6SF
25	100051	1	P 1/2 PL 16 1/2 X 15	A-36	1.8SF
24	100051	1	P 1/2 PL 15 X 6	A-36	0.7SF
23	561741		EAR, CYLINDER		2
22	155935	2	1/2 LG - 3 ODX3/4 W RND TUBE	A513DOM	0.09FT
21	560818		BEARING,RADIAL BALL 3/4 BORE		4
20	566362		SHEAVE MACHINING 6707		2
19	561576		BEARING, BRONZE - MACHINING		1
18	100008	2	R SHEET, 14 GA 3 X 4	A-36	0.2SF
17	100041	4	P 3/8 PL 5 X 2 1/2	A-36	0.4SF
16		FI	3 LG - 1/4 DIA ROLL PIN		2
15		FI	1/8 - 27NPT GREASE FITT		2
14		FI	D 1 1/2 LG - 1/4 DIA ROLL PIN		5
13	130107	1	D 16 3/4 LG - 3/4 DIA ROUND	C1144	1.4FT
12	660226		STEEL ROLLER ASSY X 14 3/8		2
11	130107	1	D 5 1/2 LG - 3/4 DIA ROUND	C1144	0.5FT
10	562617		9-1/2 LG, C/W LN X 1-1/2-6NC HHCS		1
9	145035	1	D 5 3/8 LG - 3 DIA ROUND	C1018	0.5FT
8	130121	1	D 6 1/4 LG - 2 DIA ROUND	C1144	0.6FT
7	155935	2	D 3/4 LG - 3 ODX3/4 W RND TUBE	A513DOM	0.13FT
6	159402	1	16 LG - 4 X 1/4 W SQ TUBE	A500B	1.4FT
5	100051	1	P 1/2 PL 4 X 11 5/8	A-36	0.4SF
4	100051	2	D 1/2 PL 12 X 12	A-36	2.0SF
3	158443	1	D 22 LG - 5 X 3/8 W SQ TUBE	A500B	1.9FT
2	100151	1	P 2 PL 11 3/4 OD X 2 ID	A-36	1.0SF
1	760097		LEVELWIND HEAD ASSEMBLY		1

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE INCHES
DIMENSIONS IN [ ] ARE MM
-TOLERANCES-

A) ANGULAR ± 1/2°
B) DECIMAL (ONE) X ± .06
(TWO) XX ± .02
(THREE) XXX ± .01
C) FRACTIONAL ± 1/32
1. GENERAL
2. SAWING, FLAME CUTTING, SHEARING & BREAKING ± 1/16
3. WELDING ± 1/8

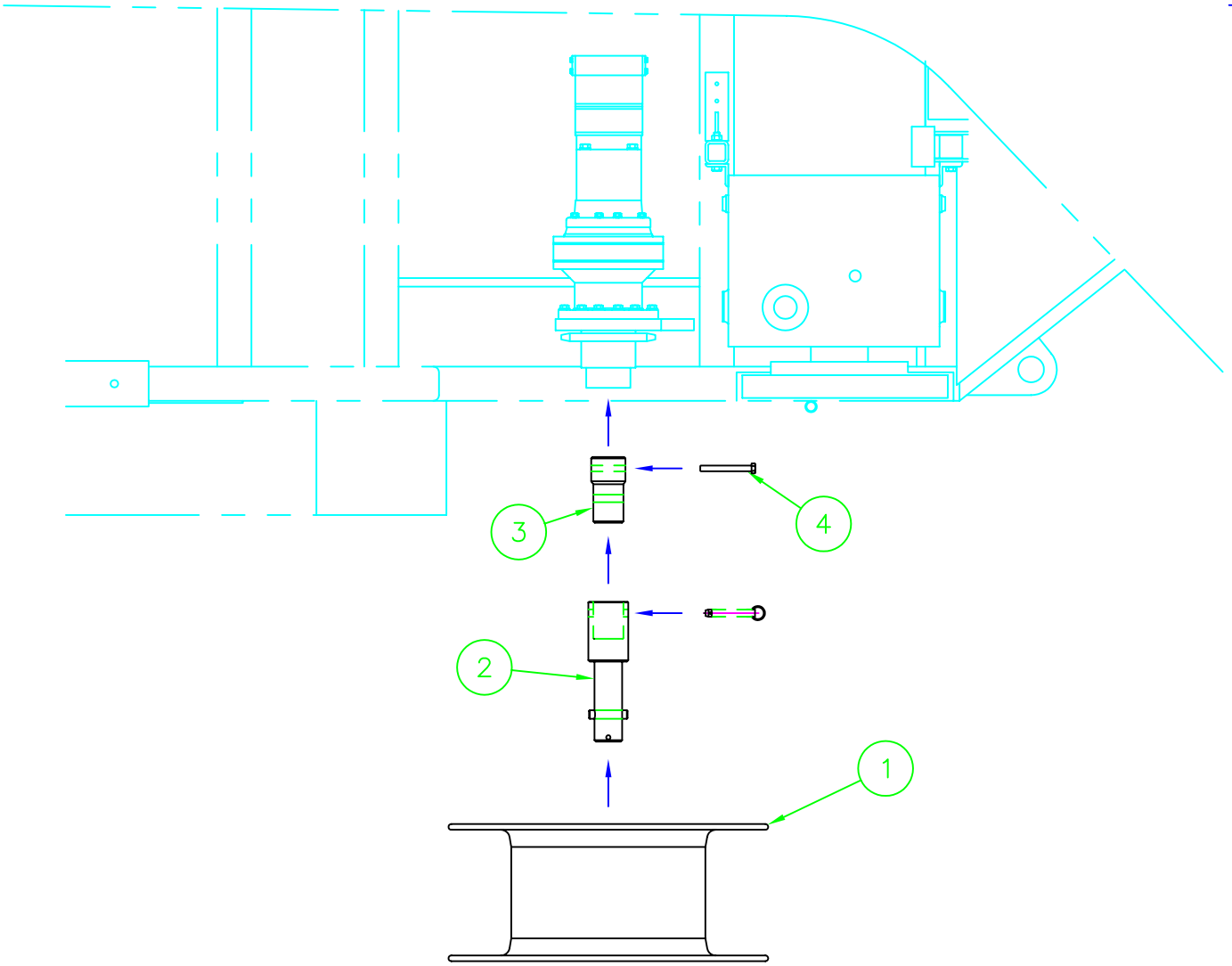
TSE INTERNATIONAL INC
Shreveport, Louisiana, United States of America

MATL CERT N/R
MATL TEST N/R
WELD TEST N/R
EST LBS N/A
ACT LBS N/A

TITLE UNDERGROUND/OVERHEAD L/W ASSY
NEXT ASSEMBLY 860104
SERVED FROM
FIRST USED ON MO
SHEET 1 OF 1
DRAWN JS
CHECKED
APPROVED RJB
DATE 18SEPT84
SCALE 1/4

860106 REV O

REV	DATE	CHANGE NUMBER	AMENDMENTS	BY	APPD
C	12MAR02		REDRAWN ON CAD	DY	RB



ITEM	PART NUMBER	OPER DESC	DESCRIPTION	MATERIAL	UNIT QTY
5	561265	1	PIN– LOCK		REF
4		FI	1/2–13NC HXHD X 4 1/2" LG. C/W LN		1
3	611146		SHAFT– DRIVE		1
2	713858		DRIVE ADAPTER, POLEMASTER		1
1		1	POLEMASTER REEL ASSEMBLY		REF.

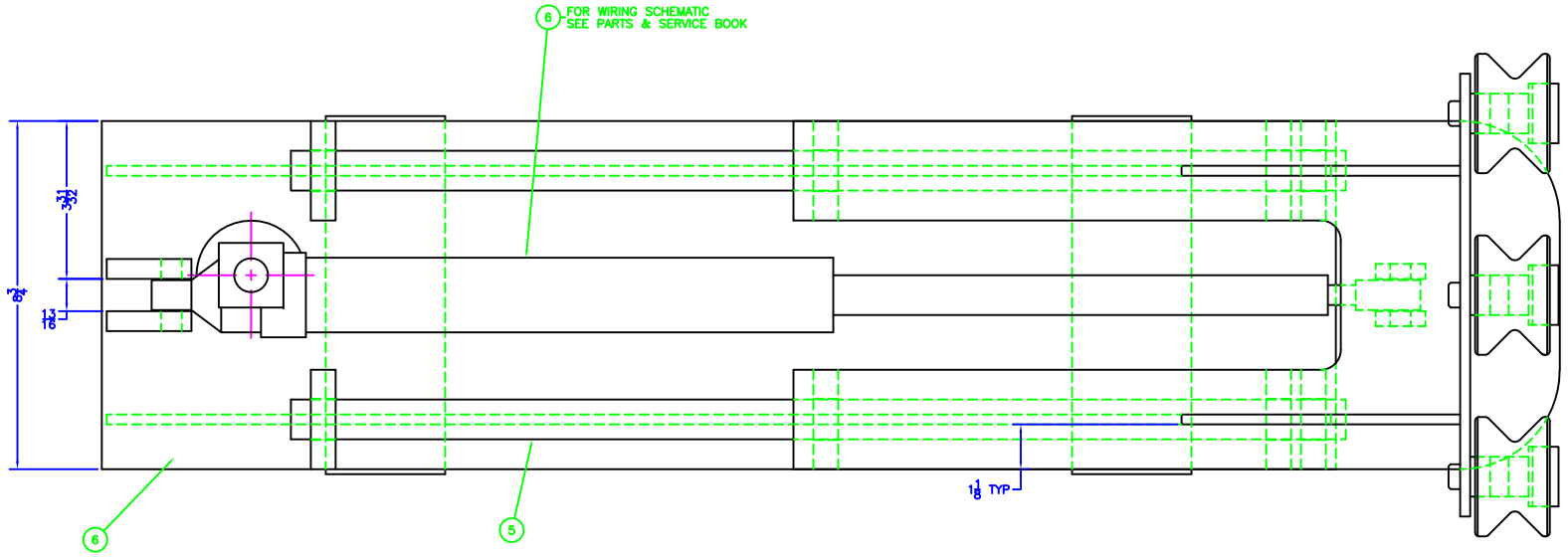
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE INCHES
DIMENSIONS IN [ ] ARE MM
–TOLERANCES–

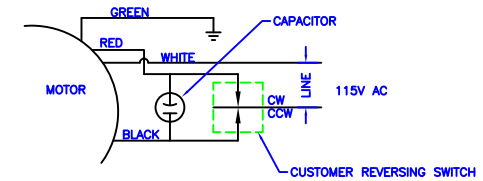
A) ANGULAR ± 1/2°
B) DECIMAL (ONE) .X ± .06
(TWO) .XX ± .02
(THREE) .XXX ± .01
C) FRACTIONAL
1. GENERAL ± 1/32
2. SAWING, FLAME CUTTING, SHEARING & BREAKING ± 1/16
3. WELDING ± 1/8

TSE INTERNATIONAL INC
Shreveport, Louisiana, United States of America

MATL CERT N/R	TITLE DRIVE , HIGH SPEED POLEMASTER		
MATL TEST N/R	NEXT ASSEMBLY	DERIVED FROM	
WELD TEST N/R	FIRST USED ON WO	SHEET 1	OF 1
EST LBS N/A	DRAWN SB / CHECKED / APPROVED	563016	REV C
ACT LBS N/A	DATE 7/18/89	SCALE 1/16	

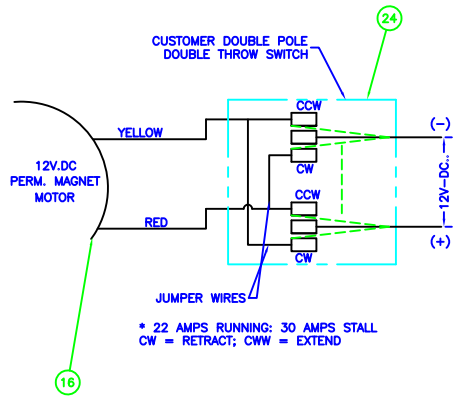
REV	DATE	CHANGE NUMBER	AMENDMENTS	BY	APP'D
C	12/23/93		ADDED IT. #24,25, & 26; AND WIRING SCHEMATIC	SB	
D	13MAY96		#14 WAS 5/8-11NC HXNUT, REVISED TO AS BUILT	SB	
E	24APR00		REDRAWN ON CAD	DY	RB
F	26FEB01		ITEM 16 WAS REF ONLY	SB	RB
G	09OCT17	ECC-4099	IT #14 WAS 125018, MACHINED TO 0.100" THICK	SB	ACL



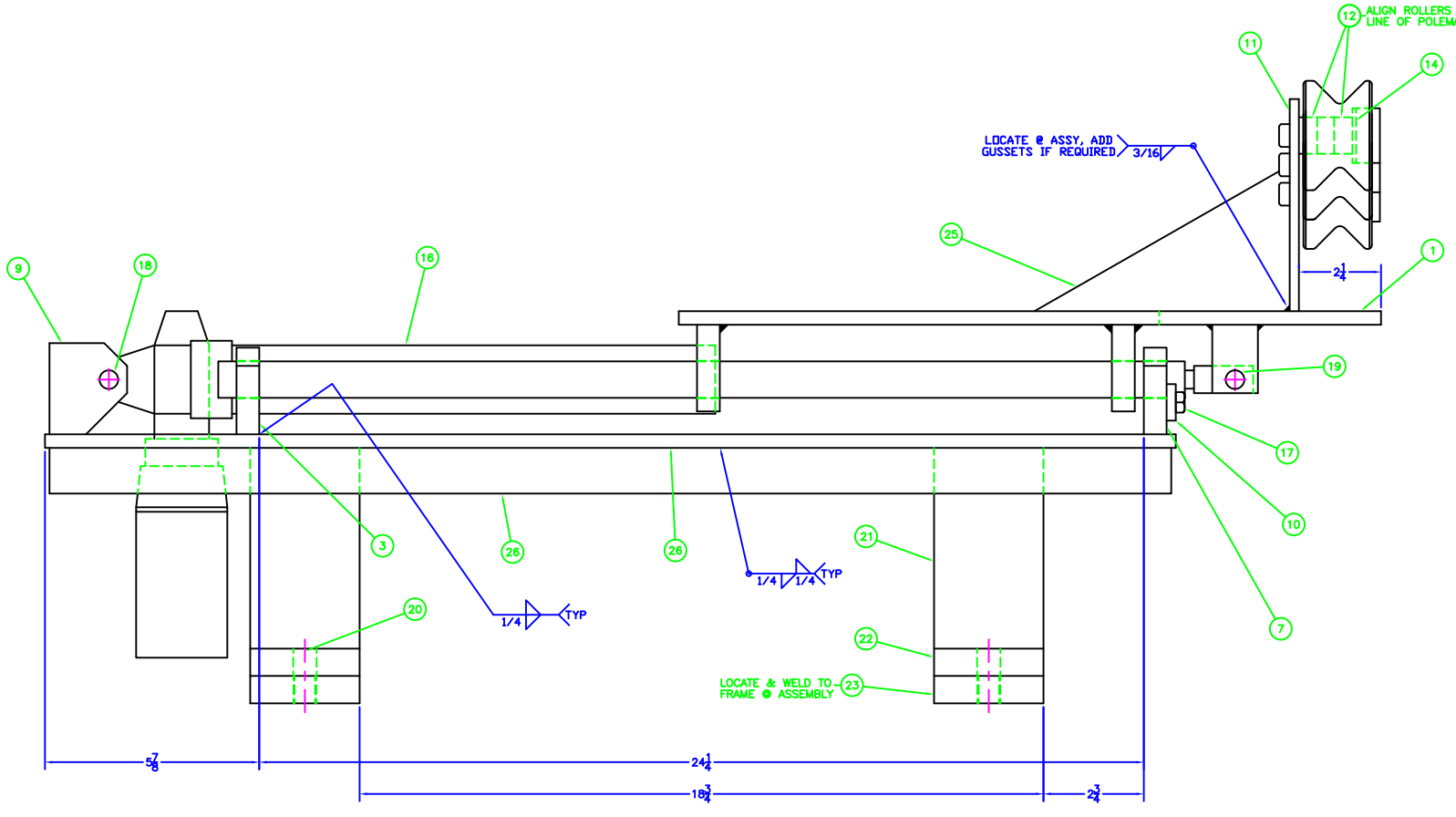


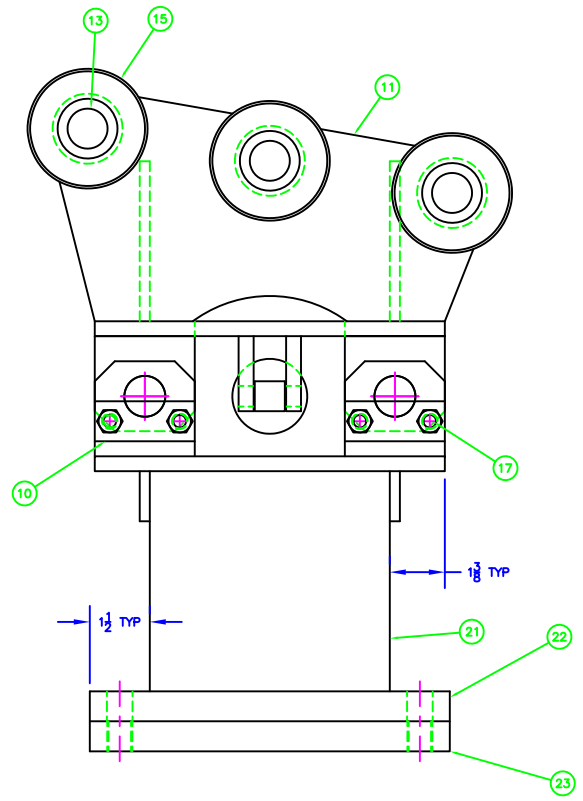
MINIMUM VOLTAGE: 103.5
CW = RETRACT; CCW = EXTEND

LOW VOLTAGES REDUCE THE
LOAD RATING OF THE ACTUATOR



* 22 AMPS RUNNING; 30 AMPS STALL
CW = RETRACT; CWW = EXTEND





	ITEM	PART NUMBER	UPPER DESC	DESCRIPTION	MATERIAL	UNIT QTY
	26	105042	2	30 3/4 LG - 1/4 X 1-1/4 FLAT	A-36	5.2FT
	25	100021	2	P 1/4 PL 4 X 7	A-36	0.4SF
	24	563838		TOGGLE SWITCH		1
	23	105119	2	D 9 LG - 3/4 X 3 FLAT	A-36	1.5FT
	22	105119	2	D 9 LG - 3/4 X 3 FLAT	A-36	1.5FT
	21	159470	2	5 1/2 LG - 6X3X1/4 W RECT TUBE	A500B	1.0FT
	20		FI	5/8-11NC BOLT X 1 1/2LG C/W LW	GR5	4
	19		FI	1/2-13NC BOLT X 2 1/2LG. C/W LN		1
	18		FI	1/2-13NC BOLT X 2 3/4LG C/W LN		1
	17		FI	3/8-16NC CPSC X 3/4LG. C/W LW	GR5	4
⚠	16	563408		MINI-PAC ACUATOR		1
	15	541444		3" ALUMINUM ROLLER		3
⚠	14		FI	FLATWASHER- 3/4	STL	3
	13	541446		SHOULDER BOLT		3
	12	509487		NEEDLE BEARING		6
PATT. #00633	11	100041	1	P 3/8 PL 5 13/16 X 11 1/8	A-36	0.5SF
	10	105032	2	D 2 1/2 LG - 1/4 X 1 FLAT	A-36	0.5FT
PATT. #00635	9	100051	2	P 1/2 PL 2 1/8 X 2 1/2	A-36	0.1SF
PATT. #00634	7	100061	2	P 5/8 PL 2 3/8 X 2 1/2	A-36	0.1SF
PATT. #00631	6	100041	1	P 3/8 PL 8 3/4 X 31	A-36	1.9SF
	5	135011	2	D 26 1/2 LG - 1 DIA ROUND	C4140HT&SR	4.5FT
	4	105044	2	1 7/8 LG - 3/8 X 1-1/4 FLAT	A-36	0.4FT
PATT. #00634	3	100061	6	P 5/8 PL 2 1/2 X 2 3/8	A-36	0.3SF
PATT. #00632	2	100041	1	P 3/8 PL 8 3/4 X 19 1/4	A-36	1.2SF
	1		1	CONSISTS OF IT. #2,3, & 4		1

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE INCHES
DIMENSIONS IN [ ] ARE MM
-TOLERANCES-
A) ANGULAR ± 1/2°
B) DECIMAL (ONE) X ± .06
(TWO) XX ± .02
(THREE) XXX ± .01
C) FRACTIONAL ± 1/32
1. GENERAL
2. SAWING, FLAME CUTTING, SHEARING & BREAKING ± 1/16
3. WELDING ± 1/8

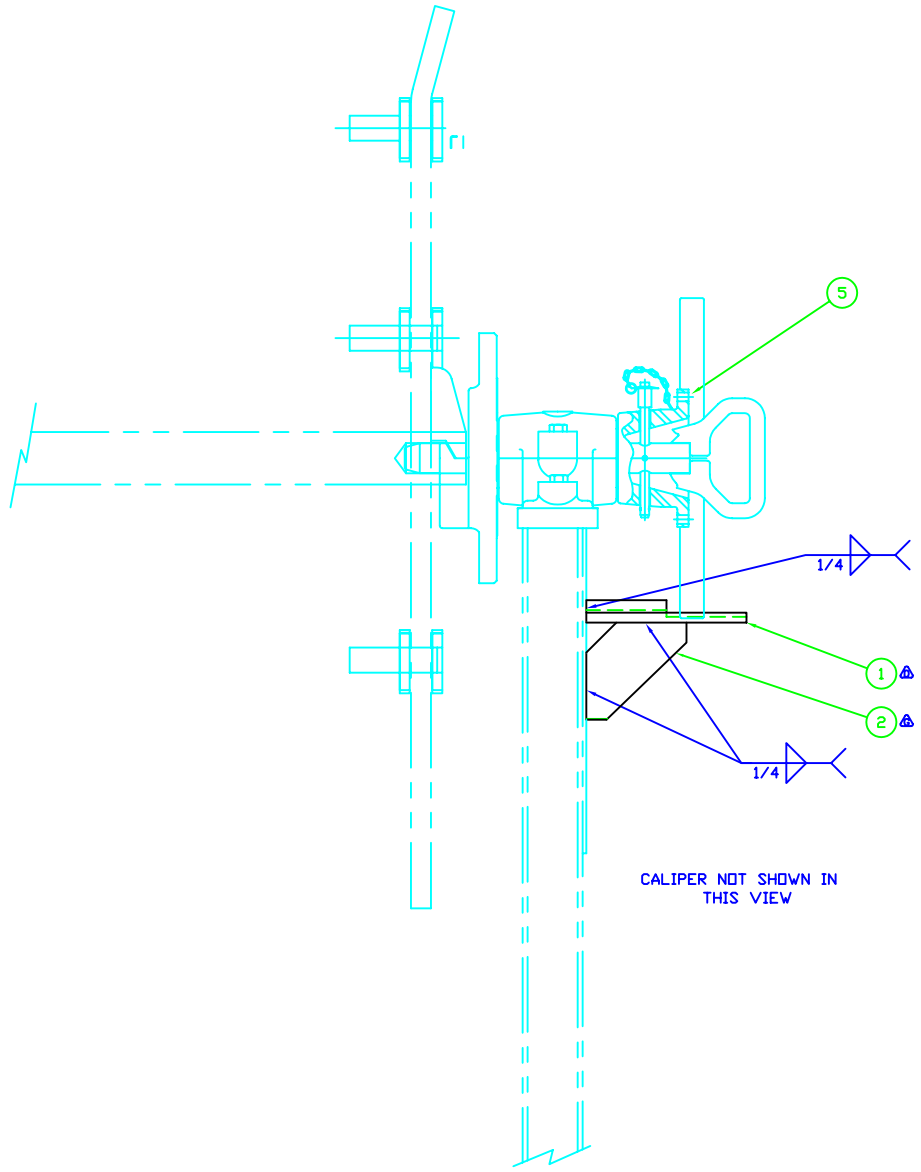
TSE INTERNATIONAL INC
Shreveport, Louisiana, United States of America

MATL COND N/R
MATL TEST N/R
WELD TEST N/R
EST LBR PCT LBR N/A N/A

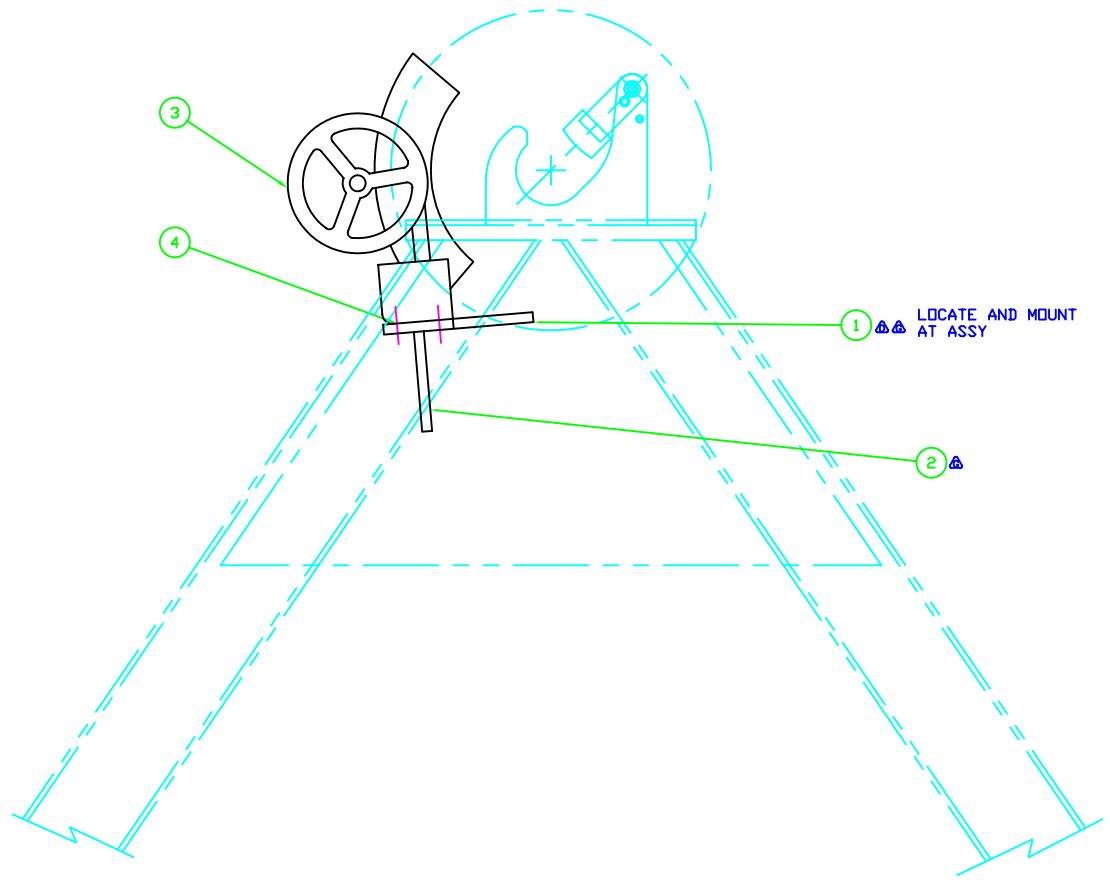
TITLE LEVELWIND ASSY - HIGH SPEED POLEMASTER
NEXT ASSEMBLY
REVISED FROM
FIRST USED ON NO 1152
SHEET 1 OF 2
DRAWN SJB
CHECKED
APPROVED
DATE 12NOV91
SCALE 1/2
860952
REV G

REV.	DATE	CHANGE NUMBER	AMENDMENTS	BY	APP'D
A	22/6/95		DIM. 5" WAS 4"	RCT	
B	10/JL/95		ADDED ITEM # 5	RCT	
C	23OCT95		4 5/16" WAS 4"	RCT	
D	29NOV99		IT 1 WAS 100051, IT 2 WAS 100051	WJW	PVK
E	09JUL01		IT. #1 WAS 613052; ADD ITEM 2	SB	JF
F	08NOV01	RFC#1336	IT. #4 WAS 270406, GR-8 BOLT	DY	RB
G	24FEB10	RFC-X2247	ADDED BALLOON FOR ITEM 2	GHN	PvK

ITEM	PART NO.	SPEC DESC	DESCRIPTION	MATERIAL	UNIT QTY.
1,2	566191		BRAKE CALIPER MOUNT		1
1,2	566192		BRAKE CALIPER MOUNT BRACE		1
3	564784	S	BRAKE CALIPER 16" DISC		1
4		F1	1/2"-13 NC HHCS X 1 1/2"(C/W LW	GR-5	3
5		F1	3/8"-16 NC HHCS X 1 3/4"L C/W LWJM	GR-5	8



CALIPER NOT SHOWN IN THIS VIEW



1 LOCATE AND MOUNT AT ASSY

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE INCHES
DIMENSIONS IN [ ] ARE MM
-TOLERANCES-
A) ANGULAR ± 1/2°
B) DECIMAL (ONE) .X ± .06
(TWO) .XX ± .02
(THREE) .XXX ± .01
C) FRACTIONAL
1. GENERAL ± 1/32
2. SAWING, FLAME CUTTING, SHEARING & BREAKING ± 1/16
3. WELDING ± 1/8

TSE INTERNATIONAL INC
Shreveport, Louisiana, United States of America

TITLE: BRAKE INSTN.

NEXT ASSEMBLY	DERIVED FROM	EST LBS	N/A	ACT LBS	N/A
880250	DATE 28/5/92	SCALE 1=4			REV. G
FIRST USED ON W.O.	DRAWN RCT	CHECKED	APPROVED	SHEET 1 OF 1	880256

2.9 L OEM Diesel Engines (Final Tier 4/Stage IV Platform)

OPERATOR'S MANUAL

2.9 L OEM Diesel Engines (Final Tier 4/Stage IV Platform)

OMRG39496 ISSUE 25MAR15 (ENGLISH)

CALIFORNIA

Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

If this product contains a gasoline engine:

⚠ WARNING

The engine exhaust from this product contains chemicals known to the State of California to cause cancer, birth defects or other reproductive harm.

The State of California requires the above two warnings.

Additional Proposition 65 Warnings can be found in this manual.

John Deere Power Systems

PRINTED IN U.S.A.

OEM Engine and Drivetrain Warranty Registration

Why registering your OEM engine or drivetrain product is a really smart idea:[1]

Get faster service. Registering your engine or drivetrain product gives us the information we need to meet your service needs promptly and completely.

Protect your investment. You'll be kept up-to-date on engine or drivetrain product updates.

Extend your warranty. You'll be given the option to extend your coverage before your standard warranty term expires.

Stay informed. Be the first to know about new products and money-saving offers from John Deere.

NOTE: A mail-in registration form is located at the back of this manual.

You're Covered

When you buy a John Deere engine or drivetrain product you aren't just buying pistons and crankshafts and gear drives. You're buying the ability to get work done. Without downtime, without worries, and without hassles. And you're buying the assurance that if you do need help, a strong support network will be there — ready to step in.

Confidence. That's what John Deere engines, John Deere drivetrains, and John Deere Warranties are all about.

Long durations. Warranties designed to give you confidence in your engine or drivetrain product.

Worldwide support. Get service when and where you need it. John Deere has 4,000+ service locations worldwide.

Genuine John Deere parts and service. Authorized service outlets will use only new or remanufactured parts or components furnished by John Deere.

Warranty Duration

[1]*Register your OEM engine or drivetrain product online and select an authorized John Deere service location. If available in your region, you'll receive information regarding new products and current money-saving offers from John Deere. Limit one money-saving offer per engine warranty registration. Not transferable. Not valid with any other offer. Offer ends 90 days from the date of issue. Some restrictions apply. See your John Deere service location for complete details.*

RG24614 —UN—21OCT13

Scan this code to register your OEM engine online now and learn of current money-saving offers available to you.[1] You can also visit us directly at JohnDeere.com/warranty.

Equipment operators can't afford downtime or unexpected repairs. That's why we offer a 2-year/2,000-hour warranty, with unlimited hours in the first year, on our OEM industrial and marine engines. This warranty takes effect the date that the engine is delivered to the first retail purchaser. In addition, extended warranties are available under certain conditions. John Deere offers a variety of purchased warranties to extend the warranty period for your engine. You'll be given the option to extend your coverage before your standard warranty term expires. Be sure to register your engine or drivetrain product and take full advantage of the John Deere service and support network.

Obtaining Warranty Service

Warranty service must be requested through an authorized John Deere service outlet before the expiration of the warranty. Evidence of the engine's or drivetrain product's delivery date to the first retail purchaser must be presented when requesting warranty service. Authorized service outlets include:

- John Deere distributor
- John Deere OEM service dealer
- John Deere equipment dealer
- John Deere marine dealer

Worldwide Support Network

Visit JohnDeere.com/dealer to find the authorized engine or drivetrain service location nearest you. For complete warranty details visit JohnDeere.com/warrantystatements to view, download, or print the warranty statement for your engine or drivetrain product.

ZE59858,000025E -19-02DEC13-1/1

Foreword

READ THIS MANUAL carefully to learn how to operate and service your engine correctly. Failure to do so could result in personal injury or equipment damage.

THIS MANUAL SHOULD BE CONSIDERED a permanent part of your engine and should remain with the engine when you sell it.

MEASUREMENTS IN THIS MANUAL are given in both metric and customary U.S. unit equivalents. Use only correct replacement parts and fasteners. Metric and inch fasteners may require a specific metric or inch wrench.

RIGHT-HAND AND LEFT-HAND sides are determined by standing at the drive or flywheel end (rear) of the engine and facing toward the front of the engine.

WRITE ENGINE SERIAL NUMBERS and option codes in the spaces indicated in the Record Keeping Section. Accurately record all the numbers. Your dealer also needs these numbers when you order parts. File the identification numbers in a secure place off the engine.

SETTING FUEL DELIVERY beyond published factory specifications or otherwise overpowering will result in loss of warranty protection for this engine.

CERTAIN ENGINE ACCESSORIES such as radiator, air cleaner, and instruments are optional equipment on John Deere OEM Engines. These accessories may be provided by the equipment manufacturer instead of John Deere. This operator's manual applies only to the engine and those options available through the John Deere distribution network.

NOTE: This operator's manual covers only engines provided to OEM (Original Equipment Manufacturers). For engines in Deere machines, refer to the machine operators manual.

ZE59858,000028E -19-14NOV13-1/1

Engine Owner

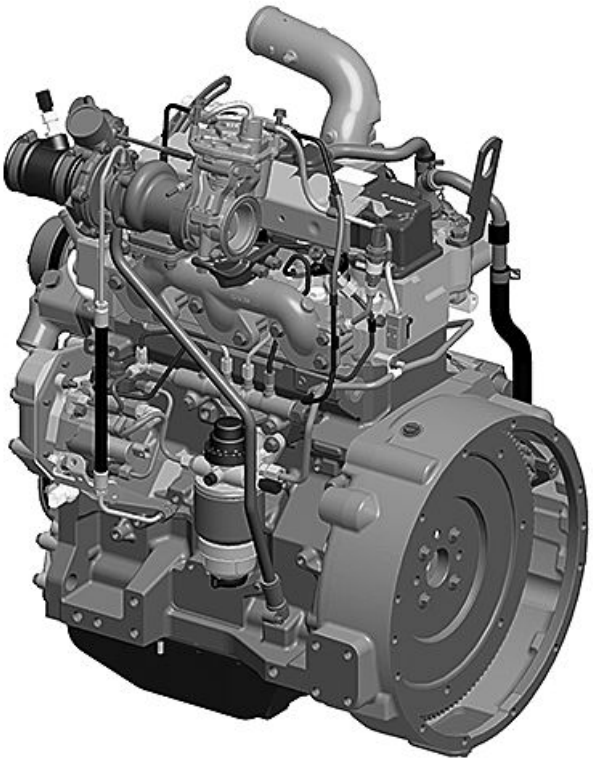
John Deere Engine Owner:

It is important for you to register your new engine for factory warranty. Registering your engine will allow your Service Dealer to verify that your warranty status should a repair be needed. The easiest way to register your engine is via the internet. To register your engine for warranty via the internet, please use the following URL: http://www.johndeere.com/enginewarranty

Your John Deere Engine Distributor or local John Deere Service Dealer will also be happy to provide this service. Engine service can be done by all Ag, C&FD, and JDPS branded dealers. To view the John Deere Service Dealer network or locate your nearest Dealer, use the following URL: http://www.johndeere.com/dealer

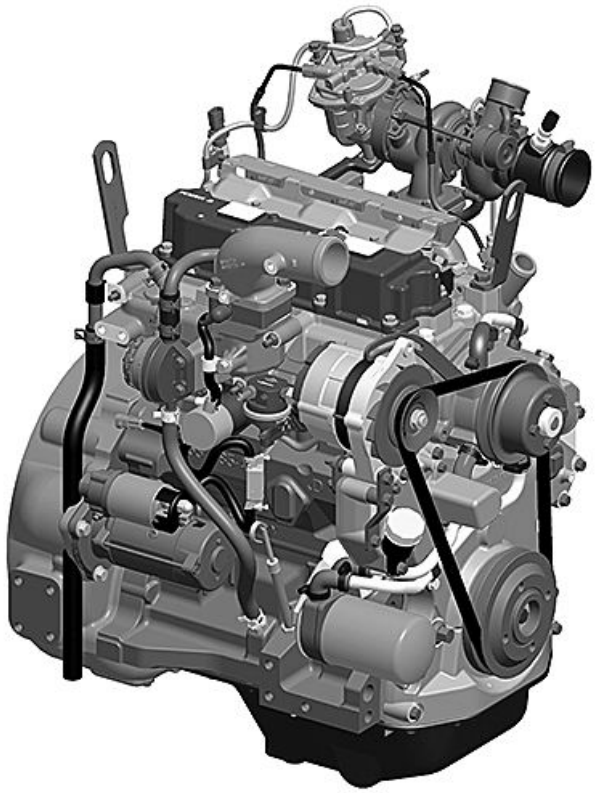
JR74534,000026F -19-21JUN12-1/1

Identification Views



RG25479 —UN—11APR14

3029HFC03 Left Rear View



RG25478 —UN—11APR14

3029HFC03 Right Front View

ZE59858,0000048 -19-15SEP14-1/1

Trademarks

Trademarks	
AdBlue®	AdBlue is a trademark of VDA, the German Association of the Automotive Industry.
AMP®	AMP is a trademark of Tyco Electronics
BIO-GREASE-GARD™	BIO-GREASE-GARD is a trademark of Deere & Company
Bio Hy-Gard™	Bio Hy-Gard is a trademark of Deere & Company
Bluetooth®	Bluetooth is a trademark of Bluetooth SIG
Break-In Plus™	Break-In Plus is a trademark of Deere & Company
CINCH™	CINCH is a trademark of Cinch Inc.
COOL-GARD™ PLUS	COOL-GARD is a trademark of Deere & Company
CoolScan™	CoolScan is a trademark of Deere & Company
COOLSCAN PLUS™	COOLSCAN PLUS is a trademark of Deere & Company
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PowerTech™ M	PowerTech is a trademark of Deere & Company
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Scotch-Grip®	Scotch-Grip is a trademark of 3M Co.
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SERVICEGARD™	SERVICEGARD is a trademark of Deere & Company
TACH-N-TIME™	TACH-N-TIME is a trademark of SPX Corp.
TeamMate™	TeamMate is a trademark of Deere & Company
TEFLON®	TEFLON is a trademark of Du Pont Co.
TMIII™	TMIII is a trademark of Deere & Company

Continued on next page

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WEATHER PACK®	WEATHER PACK is a trademark of Packard Electric
WINDOWS®	WINDOWS is a trademark of Microsoft Corporation

ZE59858,0000006 -19-13FEB14-2/2

Contents

Continued on next page

Original Instructions. All information, illustrations and specifications in this manual are based on the latest information available at the time of publication. The right is reserved to make changes at any time without notice.

Continued on next page

Page

Record Engine Serial Number

Each engine has a 13-digit John Deere engine serial number. The first two digits identify the factory that produced the engine:

- "CD" = Saran, France

The engine serial number plate (C) is located on the right-hand side of cylinder block.

Record all of the numbers and letters found on your engine serial number plate in the spaces provided below.

This information is very important for repair parts or warranty information. Use all 13 digits when providing engine serial number.

Engine Serial Number (A)

_____

Engine Model Number (B)

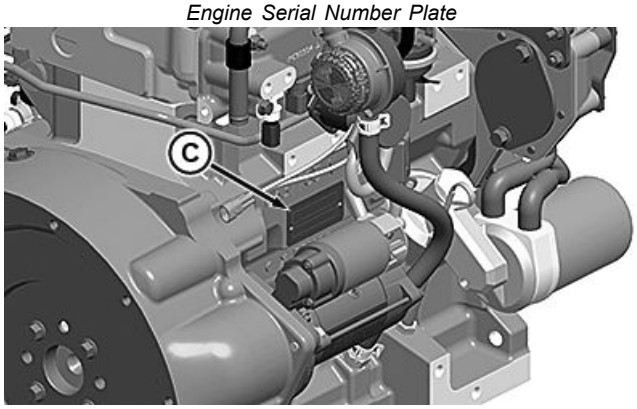
_____

NOTE: On engine serial number (A) the seventh digit shows the emission level as follows:

- *"U" for Final Tier 4/Stage IV*

RG26211 —UN—17JUL14

Engine Serial Number Plate



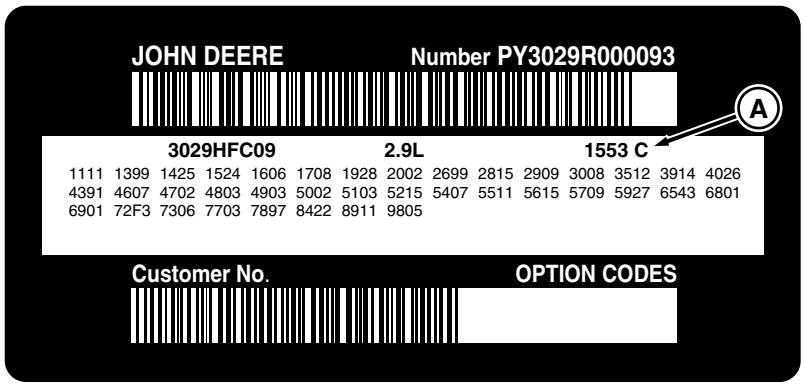
RG26212 —UN—17JUL14

Engine Serial Number Plate Location

A—Engine Serial Number
B—Engine Model Number
C—Serial Number Plate

ZE59858,0000049 -19-17JUL14-1/1

Engine Option Codes



RG26191 —UN—14JUL14

Engine Option Codes

A—Engine Base Code

In addition to the serial number plate, OEM engines have an engine option code label affixed to the rocker arm cover. These codes indicate which of the engine options were installed on your engine at the factory. When in need of parts or service, furnish your authorized servicing dealer or engine distributor with these numbers.

The engine option code label includes an engine base code (A). This base code must also be recorded along with the option codes.

The first two digits of each code identify a specific group, such as alternators. The last two digits of each code identify one specific option provided on your engine, such as a 12-volt, 55-amp alternator.

NOTE: These option codes are based on the latest information available at the time of publication. The right is reserved to make changes at any time without notice.

If an engine is ordered without a particular component, the last two digits of that functional group option code will be 99, 00, or XX. The list on the next page shows only the first two digits of the code numbers. For future reference such as ordering repair parts, it is important to have these code numbers available. To ensure this availability, enter the third and fourth digits shown on your engine option code label in the spaces provided on the following page.

NOTE: Your engine option code label may not contain all option codes if an option has been added after the engine left the producing factory.

If option code label is lost or destroyed, consult your servicing dealer or engine distributor selling the engine for a replacement.

Option Codes	Description
11	Rocker Arm Cover
12	Oil Fill Inlet
13	Crankshaft Pulley/Damper
14	Flywheel Housing
15	Flywheel
16	High-Pressure Fuel Pump
17	Air Inlet
19	Oil Pan
20	Coolant Pump
21	Thermostat Cover
22	Thermostat
23	Fan Drive
24	Fan Belt
26	Engine Coolant Heater
28	Exhaust Manifold
29	Crankcase Ventilation System
30	Starter Motor
31	Alternator
33	Aftertreatment Temperature Sensors
35	Fuel Filters

Option Codes	Description
49	Rocker Arm Assembly
50	Oil Pump
51	Cylinder Head With Valves
52	Auxiliary Gear Drive
53	Fuel Heater
54	Turbocharger Air Inlet
55	Shipping Stand
56	Paint
57	Coolant Pump Inlet
59	Oil Cooler and Filter
60	Add-on Auxiliary Drive Pulley
61	Aftertreatment
62	Alternator Mounting Bracket
63	Low Pressure Fuel Line
64	Exhaust Elbow
65	Turbocharger
67	Electronic Sensors (Base Engine)
69	Engine Serial Number Plate
7A	ECU Electronic Software Option
74	Air Conditioning Refrigerant Compressor

Continued on next page

Option Codes	Description	Option Codes	Description
36_____	Front Plate	76_____	Switches and Sensors
37_____	Fuel Transfer Pump	78_____	Air Compressor
39_____	Thermostat Housing	83_____	Electronic Software (Vehicle Option)
40_____	Oil Dipstick	84_____	Electrical Wiring Harness
41_____	Belt-Driven Front Auxiliary Drive	86_____	Fan Pulley
43_____	Starting Aid	87_____	Belt Tensioner
44_____	Timing Gear Cover	89_____	Exhaust Gas Recirculating (EGR) System
45_____	Balancer Shafts	90_____	Software
46_____	Cylinder Block With Liners and Camshaft	91_____	Wiring Harness Kit/Engine Installation Kit
47_____	Crankshaft and Bearings	93_____	Emission Label
48_____	Connecting Rods and Pistons	98_____	Shipping (Engine Hanger Straps)

Engine Base Code_____

ZE59858,000004A -19-15SEP14-2/2

Record Aftertreatment Serial Numbers

Record the numbers from your aftertreatment device as shown on DPF (A) (B) and DOC (C) (D) serial number plates. Having these numbers recorded and kept in a safe location can aid in part ordering and assist in locating stolen items in case of theft.

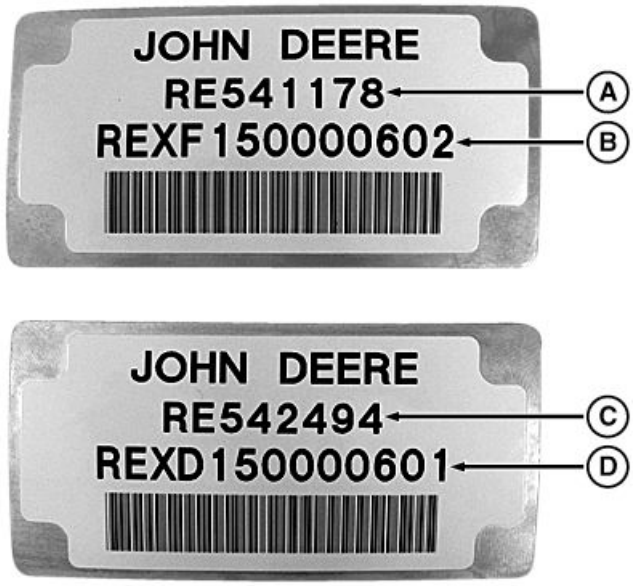
DPF Part Number._____

DPF Serial Number._____

DOC Part Number._____

DOC Serial Number._____

A—Diesel Particulate Filter Part Number
B—Diesel Particulate Filter Serial Number
C—Diesel Oxidation Catalyst Part Number
D—Diesel Oxidation Catalyst Serial Number



RG20010 —UN—11FEB11

Serial Number Plates for Aftertreatment

ZE59858,0000293 -19-14NOV13-1/1

Record High-Pressure Fuel Pump Model Number

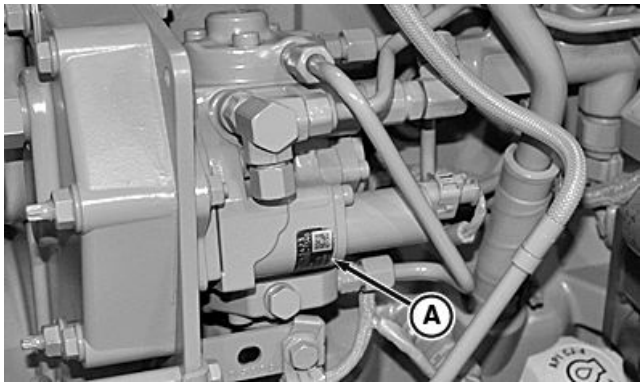
Record the high-pressure fuel pump model and serial number information found on the serial number plate (A).

Model No._____

Manufacturer's No._____

Serial No._____

A—Serial Number Plate



RG20108 —UN—15MAR11

Record High-Pressure Fuel Pump Serial Number

ZE59858,0000294 -19-04SEP14-1/1

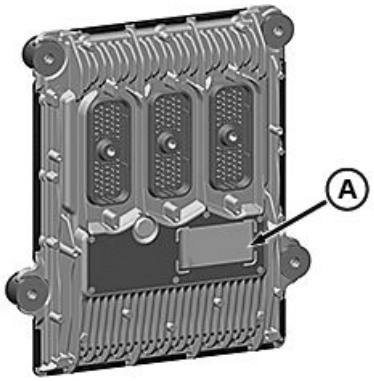
Record Engine Control Unit (ECU) Serial Number

Record the part number and serial number information found on the serial number label (A) on the Engine Control Unit (ECU) mounted on or near the engine.

Part No._____

Serial No._____

A—Serial Number Label



RG24819 —UN—04DEC13

Record Engine Control Unit (ECU) Serial Number

ZE59858,0000295 -19-04DEC13-1/1

Understand Signal Words

A signal word—DANGER, WARNING, or CAUTION—is used with the safety-alert symbol. DANGER identifies the most serious hazards.

DANGER or WARNING safety signs are located near specific hazards. General precautions are listed on CAUTION safety signs. CAUTION also calls attention to safety messages in this manual.

TS187 —19—30SEP88

DX,SIGNAL -19-03MAR93-1/1

Recognize Safety Information

This is a safety-alert symbol. When you see this symbol on your machine or in this manual, be alert to the potential for personal injury.

Follow recommended precautions and safe operating practices.

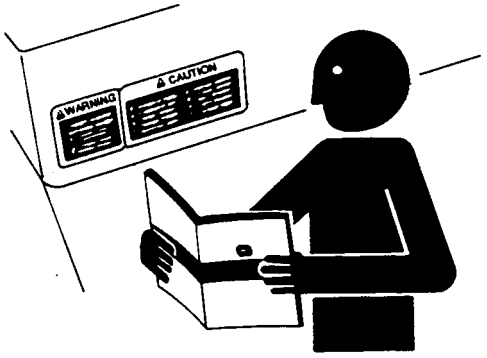
T81389 —UN—28JUN13

DX,ALERT -19-29SEP98-1/1

Replace Safety Signs

Replace missing or damaged safety signs. Use this operator's manual for correct safety sign placement.

There can be additional safety information contained on parts and components sourced from suppliers that is not reproduced in this operator's manual.



TS201 —UN—15APR13

DX,SIGNS -19-18AUG09-1/1

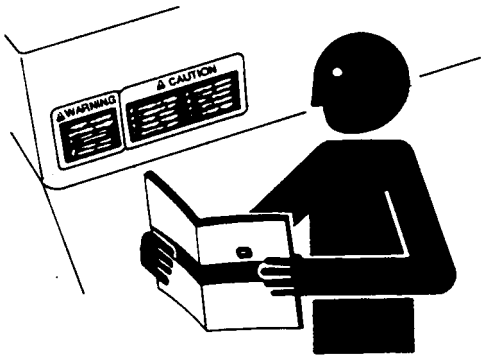
Follow Safety Instructions

Carefully read all safety messages in this manual and on your machine safety signs. Keep safety signs in good condition. Replace missing or damaged safety signs. Be sure new equipment components and repair parts include the current safety signs. Replacement safety signs are available from your John Deere dealer.

There can be additional safety information contained on parts and components sourced from suppliers that is not reproduced in this operator's manual.

Learn how to operate the machine and how to use controls properly. Do not let anyone operate without instruction.

Keep your machine in proper working condition. Unauthorized modifications to the machine may impair the function and/or safety and affect machine life.



TS201 —UN—15APR13

If you do not understand any part of this manual and need assistance, contact your John Deere dealer.

DX,READ -19-16JUN09-1/1

California Proposition 65 Warning

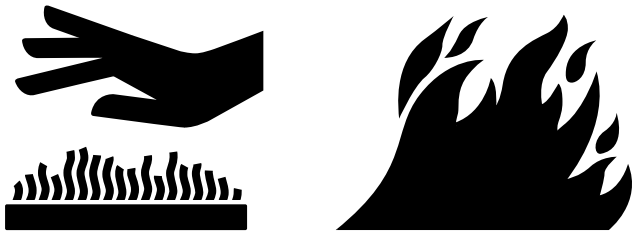
Diesel engine exhaust, some of its constituents, along with certain machine components contain or emit chemicals known to the State of California to cause cancer and birth defects or other reproductive harm. In addition, certain fluids contained in the machine and certain products of component wear contain or emit chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

RG41061,000001F -19-12JAN10-1/1

Exhaust Filter Cleaning

Servicing machine or attachments during exhaust filter cleaning can result in serious personal injury. Avoid exposure and skin contact with hot exhaust gases and components.

During auto or manual/stationary exhaust filter cleaning operations, the engine will run at elevated idle and hot temperatures for an extended period of time. Exhaust gases and exhaust filter components reach temperatures hot enough to burn people, or ignite, or melt common materials.



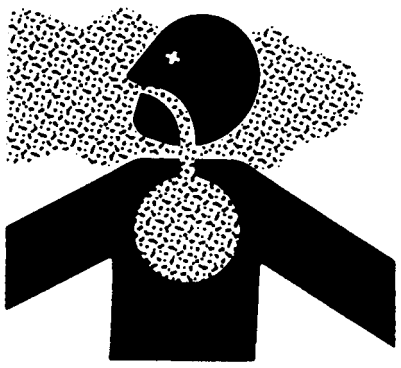
RG17488 —UN—21AUG09

DX,FILTER -19-20JAN10-1/1

Work In Ventilated Area

Engine exhaust fumes can cause sickness or death. If it is necessary to run an engine in an enclosed area, remove the exhaust fumes from the area with an exhaust pipe extension.

If you do not have an exhaust pipe extension, open the doors and get outside air into the area.



TS220 —UN—15APR13

DX,AIR -19-17FEB99-1/1

Dispose of Waste Properly

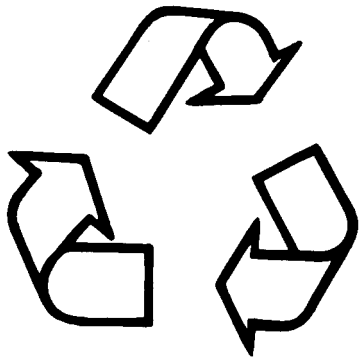
Improperly disposing of waste can threaten the environment and ecology. Potentially harmful waste used with John Deere equipment include such items as oil, fuel, coolant, brake fluid, filters, and batteries.

Use leakproof containers when draining fluids. Do not use food or beverage containers that may mislead someone into drinking from them.

Do not pour waste onto the ground, down a drain, or into any water source.

Air conditioning refrigerants escaping into the air can damage the Earth's atmosphere. Government regulations may require a certified air conditioning service center to recover and recycle used air conditioning refrigerants.

Inquire on the proper way to recycle or dispose of waste from your local environmental or recycling center, or from your John Deere dealer.



TS1133 —UN—15APR13

DX,DRAIN -19-03MAR93-1/1

Prevent Machine Runaway

Avoid possible injury or death from machinery runaway.

Do not start engine by shorting across starter terminals. Machine will start in gear if normal circuitry is bypassed.

NEVER start engine while standing on ground. Start engine only from operator's seat, with transmission in neutral or park.

TS177 —UN—11JAN89

DX,BYPAS1 -19-29SEP98-1/1

Practice Safe Maintenance

Understand service procedure before doing work. Keep area clean and dry.

Never lubricate, service, or adjust machine while it is moving. Keep hands, feet , and clothing from power-driven parts. Disengage all power and operate controls to relieve pressure. Lower equipment to the ground. Stop the engine. Remove the key. Allow machine to cool.

Securely support any machine elements that must be raised for service work.

Keep all parts in good condition and properly installed. Fix damage immediately. Replace worn or broken parts. Remove any buildup of grease, oil, or debris.

On self-propelled equipment, disconnect battery ground cable (-) before making adjustments on electrical systems or welding on machine.

On towed implements, disconnect wiring harnesses from tractor before servicing electrical system components or welding on machine.

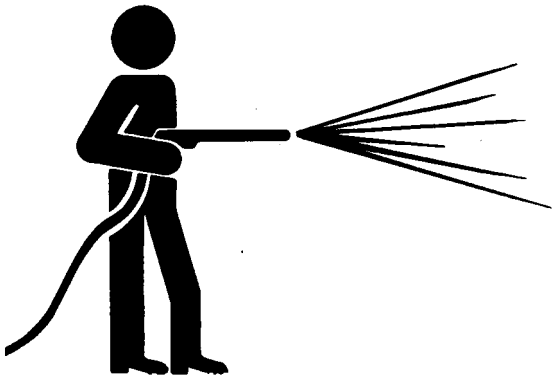
TS218 —UN—23AUG88

DX,SERV -19-17FEB99-1/1

Work in Clean Area

Before starting a job:

- Clean work area and machine.
- Make sure you have all necessary tools to do your job.
- Have the right parts on hand.
- Read all instructions thoroughly; do not attempt shortcuts.



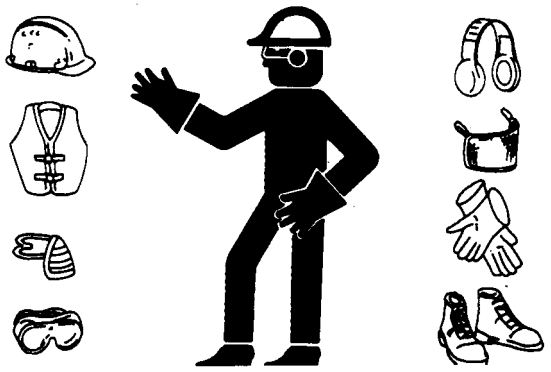
T6642EJ —UN—18OCT88

DX,CLEAN -19-04JUN90-1/1

Wear Protective Clothing

Wear close fitting clothing and safety equipment appropriate to the job.

Operating equipment safely requires the full attention of the operator. Do not wear radio or music headphones while operating machine.



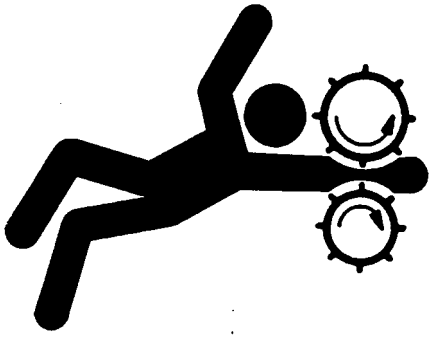
TS206 —UN—15APR13

DX,WEAR2 -19-03MAR93-1/1

Service Machines Safely

Tie long hair behind your head. Do not wear a necktie, scarf, loose clothing, or necklace when you work near machine tools or moving parts. If these items were to get caught, severe injury could result.

Remove rings and other jewelry to prevent electrical shorts and entanglement in moving parts.



TS228 —UN—23AUG88

DX,LOOSE -19-04JUN90-1/1

Use Proper Tools

Use tools appropriate to the work. Makeshift tools and procedures can create safety hazards.

Use power tools only to loosen threaded parts and fasenters.

For loosening and tightening hardware, use the correct size tools. DO NOT use U.S. measurement tools on metric fasteners. Avoid bodily injury caused by slipping wrenches.

Use only service parts meeting John Deere specifications.

TS779 —UN—08NOV89

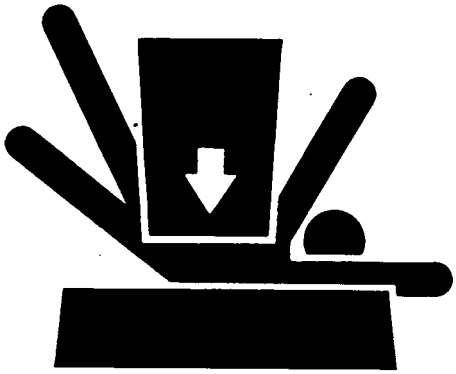
DX,REPAIR -19-17FEB99-1/1

Support Machine Properly

Always lower the attachment or implement to the ground before you work on the machine. If the work requires that the machine or attachment be lifted, provide secure support for them. If left in a raised position, hydraulically supported devices can settle or leak down.

Do not support the machine on cinder blocks, hollow tiles, or props that may crumble under continuous load. Do not work under a machine that is supported solely by a jack. Follow recommended procedures in this manual.

When implements or attachments are used with a machine, always follow safety precautions listed in the implement or attachment operator's manual.



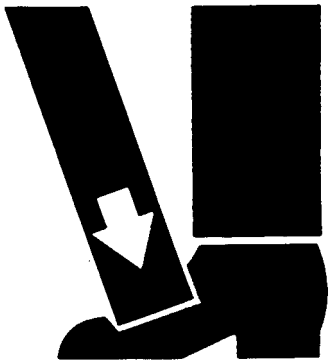
TS229 —UN—23AUG88

DX,LOWER -19-24FEB00-1/1

Use Proper Lifting Equipment

Lifting heavy components incorrectly can cause severe injury or machine damage.

Follow recommended procedure for removal and installation of components in the manual.



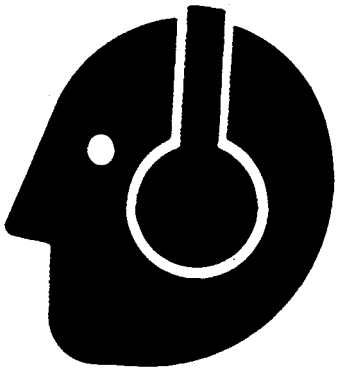
TS226 —UN—23AUG88

DX,LIFT -19-04JUN90-1/1

Protect Against Noise

Prolonged exposure to loud noise can cause impairment or loss of hearing.

Wear a suitable hearing protective device such as earmuffs or earplugs to protect against objectionable or uncomfortable loud noises.

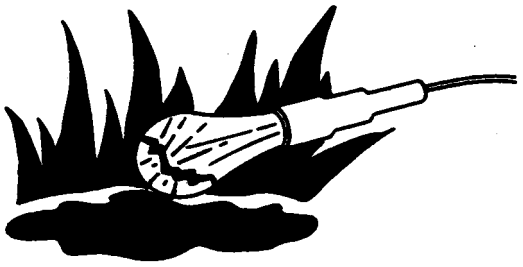


TS207 —UN—23AUG88

DX,NOISE -19-03MAR93-1/1

Illuminate Work Area Safely

Illuminate your work area adequately but safely. Use a portable safety light for working inside or under the machine. Make sure the bulb is enclosed by a wire cage. The hot filament of an accidentally broken bulb can ignite spilled fuel or oil.



TS223 —UN—23AUG88

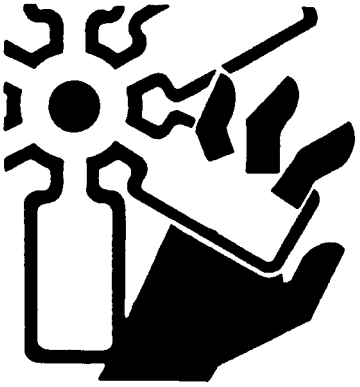
DX,LIGHT -19-04JUN90-1/1

Install All Guards

Rotating cooling system fans, belts, pulleys, and drives can cause serious injury.

Keep all guards in place at at all times during engine operation.

Wear close-fitting clothes. Stop the engine and be sure fans, belts, pulleys, and drives are stopped before making adjustments, connections, or cleaning near fans and their drive components.



TS677 —UN—21SEP89

DX,GUARDS -19-18AUG09-1/1

Stay Clear of Rotating Drivelines

Entanglement in rotating driveline can cause serious injury or death.

Keep all shields in place at all times. Make sure rotating shields turn freely.

Wear close-fitting clothing. Stop the engine and be sure that all rotating parts and drivelines are stopped before making adjustments, connections, or performing any type of service on engine or machine driven equipment.

TS1644 —UN—22AUG95

DX,ROTATING -19-18AUG09-1/1

Protect Against High Pressure Spray

Spray from high pressure nozzles can penetrate the skin and cause serious injury. Keep spray from contacting hands or body.

If an accident occurs, see a doctor immediately. Any high pressure spray injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available from Deere & Company Medical Department in Moline, Illinois, U.S.A.

TS1343 —UN—18MAR92

DX,SPRAY -19-16APR92-1/1

Service Cooling System Safely

Explosive release of fluids from pressurized cooling system can cause serious burns.

Shut off engine. Only remove filler cap when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing completely.

TS281 —UN—15APR13

DX,RCAP -19-04JUN90-1/1

Remove Paint Before Welding or Heating

Avoid potentially toxic fumes and dust.

Hazardous fumes can be generated when paint is heated by welding, soldering, or using a torch.

Remove paint before heating:

- Remove paint a minimum of 100 mm (4 in.) from area to be affected by heating. If paint cannot be removed, wear an approved respirator before heating or welding.
- If you sand or grind paint, avoid breathing the dust. Wear an approved respirator.
- If you use solvent or paint stripper, remove stripper with soap and water before welding. Remove solvent or paint stripper containers and other flammable material from area. Allow fumes to disperse at least 15 minutes before welding or heating.

Do not use a chlorinated solvent in areas where welding will take place.

TS220 —UN—15APR13

Do all work in an area that is well ventilated to carry toxic fumes and dust away.

Dispose of paint and solvent properly.

DX,PAINT -19-24JUL02-1/1

Do Not Open High-Pressure Fuel System

High-pressure fluid remaining in fuel lines can cause serious injury. Do not disconnect or attempt repair of fuel lines, sensors, or any other components between the high-pressure fuel pump and nozzles on engines with High Pressure Common Rail (HPCR) fuel system.

Only technicians familiar with this type of system can perform repairs. (See your John Deere dealer.)

TS1343 —UN—18MAR92

DX,WW,HPCR1 -19-07JAN03-1/1

Avoid High-Pressure Fluids

Inspect hydraulic hoses periodically – at least once per year – for leakage, kinking, cuts, cracks, abrasion, blisters, corrosion, exposed wire braid or any other signs of wear or damage.

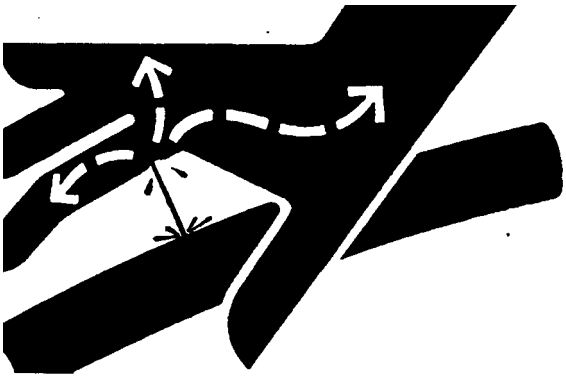
Replace worn or damaged hose assemblies immediately with John Deere approved replacement parts.

Escaping fluid under pressure can penetrate the skin causing serious injury.

Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure.

Search for leaks with a piece of cardboard. Protect hands and body from high-pressure fluids.

If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available in English from Deere & Company Medical Department in Moline, Illinois, U.S.A., by calling 1-800-822-8262 or +1 309-748-5636.



X9811 —UN—23AUG88

DX,FLUID -19-12OCT11-1/1

Avoid Heating Near Pressurized Fluid Lines

Flammable spray can be generated by heating near pressurized fluid lines, resulting in severe burns to yourself and bystanders. Do not heat by welding, soldering, or using a torch near pressurized fluid lines or other flammable materials. Pressurized lines can accidentally burst when heat goes beyond the immediate flame area.

TS953 —UN—15MAY90

DX,TORCH -19-10DEC04-1/1

Avoid Static Electricity Risk When Refueling

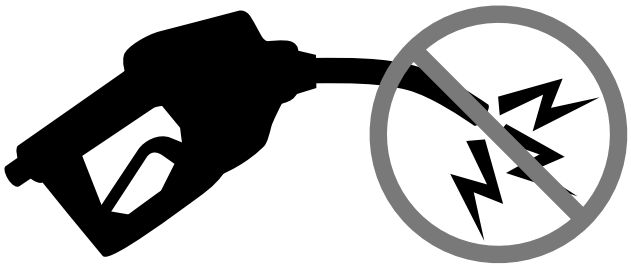
The removal of sulfur and other compounds in Ultra-Low Sulfur Diesel (ULSD) fuel decreases its conductivity and increases its ability to store a static charge.

Refineries may have treated the fuel with a static dissipating additive. However, there are many factors that can reduce the effectiveness of the additive over time.

Static charges can build up in ULSD fuel while it is flowing through fuel delivery systems. Static electricity discharge when combustible vapors are present could result in a fire or explosion.

Therefore, it is important to ensure that the entire system used to refuel your machine (fuel supply tank, transfer pump, transfer hose, nozzle, and others) is properly grounded and bonded. Consult with your fuel or fuel system supplier to ensure that the delivery system is in compliance with fueling standards for proper grounding and bonding practices.

RG22142 —UN—17MAR14



RG21992 —UN—21AUG13

DX,FUEL,STATIC,ELEC -19-12JUL13-1/1

Handle Fuel Safely—Avoid Fires

Handle fuel with care: it is highly flammable. Do not refuel the machine while smoking or when near open flame or sparks.

Always stop engine before refueling machine. Fill fuel tank outdoors.

Prevent fires by keeping machine clean of accumulated trash, grease, and debris. Always clean up spilled fuel.

Use only an approved fuel container for transporting flammable liquids.

Never fill fuel container in pickup truck with plastic bed liner. Always place fuel container on ground before refueling. Touch fuel container with fuel dispenser nozzle before removing can lid. Keep fuel dispenser nozzle in contact with fuel container inlet when filling.

TS202 —UN—23AUG88

Do not store fuel container where there is an open flame, spark, or pilot light such as within a water heater or other appliance.

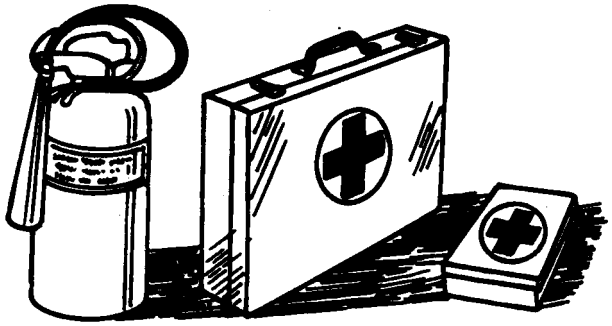
DX,FIRE1 -19-12OCT11-1/1

Prepare for Emergencies

Be prepared if a fire starts.

Keep a first aid kit and fire extinguisher handy.

Keep emergency numbers for doctors, ambulance service, hospital, and fire department near your telephone.



TS291 —UN—15APR13

DX,FIRE2 -19-03MAR93-1/1

Handle Starting Fluid Safely

Starting fluid is highly flammable.

Keep all sparks and flame away when using it. Keep starting fluid away from batteries and cables.

To prevent accidental discharge when storing the pressurized can, keep the cap on the container, and store in a cool, protected location.

Do not incinerate or puncture a starting fluid container.

Do not use starting fluid on an engine equipped with glow plugs or an air intake heater.

TS1356 —UN—18MAR92

DX,FIRE3 -19-14MAR14-1/1

Handling Batteries Safely

Battery gas can explode. Keep sparks and flames away from batteries. Use a flashlight to check battery electrolyte level.

Never check battery charge by placing a metal object across the posts. Use a voltmeter or hydrometer.

Always remove grounded (-) battery clamp first and replace grounded clamp last.

Sulfuric acid in battery electrolyte is poisonous and strong enough to burn skin, eat holes in clothing, and cause blindness if splashed into eyes.

Avoid hazards by:

- Filling batteries in a well-ventilated area
- Wearing eye protection and rubber gloves
- Avoiding use of air pressure to clean batteries
- Avoiding breathing fumes when electrolyte is added
- Avoiding spilling or dripping electrolyte
- Using correct battery booster or charger procedure.

If acid is spilled on skin or in eyes:

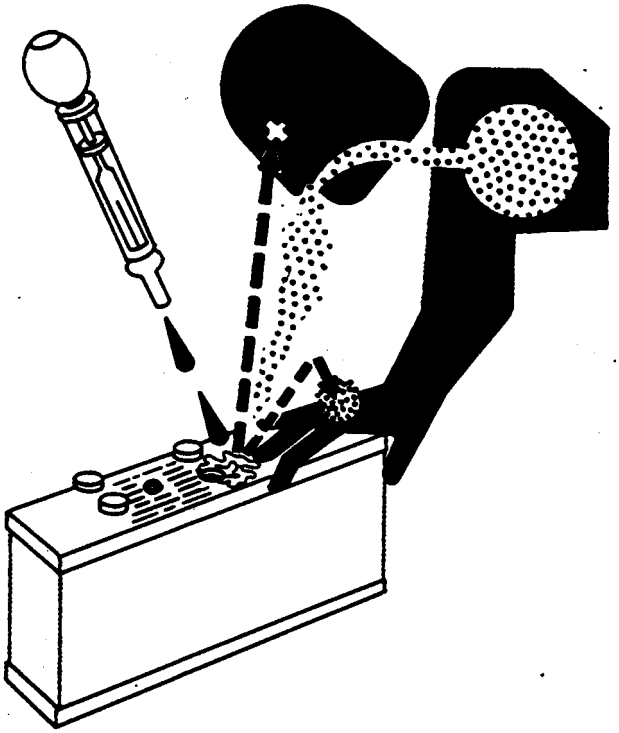
1. Flush skin with water.
2. Apply baking soda or lime to help neutralize the acid.
3. Flush eyes with water for 15—30 minutes. Get medical attention immediately.

If acid is swallowed:

1. Do not induce vomiting.
2. Drink large amounts of water or milk, but do not exceed 2 L (2 qt.).
3. Get medical attention immediately.

WARNING: Battery posts, terminals, and related accessories contain lead and lead compounds, chemicals known to the State of California to cause cancer and reproductive harm. **Wash hands after handling.**

TS204 —UN—15APR13



TS203 —UN—23AUG88

DX,WW,BATTERIES -19-02DEC10-1/1

Prevent Acid Burns

Sulfuric acid in battery electrolyte is poisonous. It is strong enough to burn skin, eat holes in clothing, and cause blindness if splashed into eyes.

Avoid the hazard by:

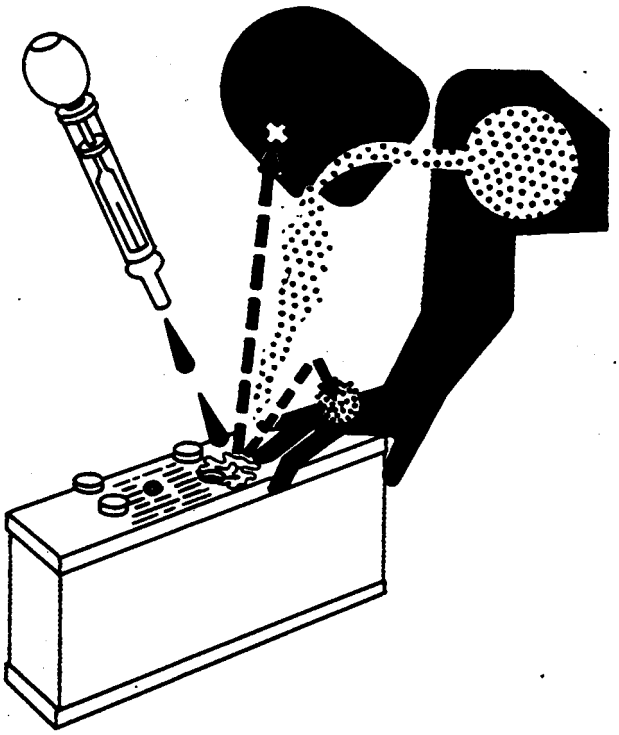
1. Filling batteries in a well-ventilated area.
2. Wearing eye protection and rubber gloves.
3. Avoiding breathing fumes when electrolyte is added.
4. Avoiding spilling or dripping electrolyte.
5. Use proper jump start procedure.

If you spill acid on yourself:

1. Flush your skin with water.
2. Apply baking soda or lime to help neutralize the acid.
3. Flush your eyes with water for 15—30 minutes. Get medical attention immediately.

If acid is swallowed:

1. Do not induce vomiting.
2. Drink large amounts of water or milk, but do not exceed 2 L (2 quarts).
3. Get medical attention immediately.



TS203 —UN—23AUG88

DX,POISON -19-21APR93-1/1

Prevent Battery Explosions

Keep sparks, lighted matches, and open flame away from the top of battery. Battery gas can explode.

Never check battery charge by placing a metal object across the posts. Use a volt-meter or hydrometer.

Do not charge a frozen battery; it may explode. Warm battery to 16°C (60°F).

TS204 —UN—15APR13

DX,SPARKS -19-03MAR93-1/1

Live With Safety

Before returning machine to customer, make sure machine is functioning properly, especially the safety systems. Install all guards and shields.

TS231 —19—07OCT88

DX,LIVE -19-25SEP92-1/1

Diesel Fuel

Consult your local fuel distributor for properties of the diesel fuel available in your area.

In general, diesel fuels are blended to satisfy the low temperature requirements of the geographical area in which they are marketed.

Diesel fuels specified to EN 590 or ASTM D975 are recommended. Renewable diesel fuel produced by hydrotreating animal fats and vegetable oils is basically identical to petroleum diesel fuel. Renewable diesel that meets EN 590 or ASTM D975 is acceptable for use at all percentage mixture levels.

Required Fuel Properties

In all cases, the fuel shall meet the following properties:

Cetane number of 40 minimum. Cetane number greater than 47 is preferred, especially for temperatures below –20 °C (–4 °F) or elevations above 1675 m (5500 ft.).

Cold Filter Plugging Point (CFPP) should be at least 5 °C (9 °F) below the expected lowest temperature or **Cloud Point** below the expected lowest ambient temperature.

Fuel lubricity should pass a maximum scar diameter of 0.52 mm as measured by ASTM D6079 or ISO 12156-1. A maximum scar diameter of 0.45 mm is preferred.

Diesel fuel quality and sulfur content must comply with all existing emissions regulations for the area in which the engine operates. DO NOT use diesel fuel with sulfur content greater than 10 000 mg/kg (10 000 ppm).

Sulfur content for Interim Tier 4, Final Tier 4, Stage III B, and Stage IV Engines

- Use ONLY ultra low sulfur diesel (ULSD) fuel with a maximum of 15 mg/kg (15 ppm) sulfur content.

Sulfur Content for Tier 3 and Stage III A Engines

- Use of diesel fuel with sulfur content less than 1000 mg/kg (1000 ppm) is RECOMMENDED.
- Use of diesel fuel with sulfur content 1000—2000 mg/kg (1000—2000 ppm) REDUCES the oil and filter change interval.
- BEFORE using diesel fuel with sulfur content greater than 2000 mg/kg (2000 ppm), contact your John Deere dealer.

Sulfur Content for Tier 2 and Stage II Engines

- Use of diesel fuel with sulfur content less than 2000 mg/kg (2000 ppm) is RECOMMENDED.
- Use of diesel fuel with sulfur content 2000—5000 mg/kg (2000—5000 ppm) REDUCES the oil and filter change interval.
- BEFORE using diesel fuel with sulfur content greater than 5000 mg/kg (5000 ppm), contact your John Deere dealer.

Sulfur Content for Other Engines

- Use of diesel fuel with sulfur content less than 5000 mg/kg (5000 ppm) is RECOMMENDED.
- Use of diesel fuel with sulfur content greater than 5000 mg/kg (5000 ppm) REDUCES the oil and filter change interval.

IMPORTANT: Do not mix used diesel engine oil or any other type of lubricating oil with diesel fuel.

Improper fuel additive usage may cause damage on fuel injection equipment of diesel engines.

DX,FUEL1 -19-24OCT14-1/1

Supplemental Diesel Fuel Additives

Diesel fuel can be the source of performance or other operational problems for many reasons. Some causes include poor lubricity, contaminants, low cetane number, and a variety of properties that cause fuel system deposits. These and others are referenced in other sections of this Operator's Manual.

To optimize engine performance and reliability, closely follow recommendations on fuel quality, storage, and handling, which are found elsewhere in this Operator's Manual.

To further aid in maintaining performance and reliability of the engine's fuel system, John Deere has developed a family of fuel additive products for most global markets. The primary products include Fuel-Protect Diesel Fuel Conditioner (full feature conditioner in winter and summer formulas) and Fuel-Protect Keep Clean (fuel injector deposit removal and prevention). Availability of these and other products varies by market. See your local John Deere dealer for availability and additional information about fuel additives that might be right for your needs.

DX,FUEL13 -19-07FEB14-1/1

Lubricity of Diesel Fuel

Most diesel fuels manufactured in the United States, Canada, and the European Union have adequate lubricity to ensure proper operation and durability of fuel injection system components. However, diesel fuels manufactured in some areas of the world may lack the necessary lubricity.

IMPORTANT: Make sure the diesel fuel used in your machine demonstrates good lubricity characteristics.

Fuel lubricity should pass a maximum scar diameter of 0.52 mm as measured by ASTM D6079 or ISO 12156-1. A maximum scar diameter of 0.45 mm is preferred.

If fuel of low or unknown lubricity is used, add John Deere Fuel-Protect Diesel Fuel Conditioner (or equivalent) at the specified concentration.

Lubricity of BioDiesel Fuel

Fuel lubricity can improve significantly with BioDiesel blends up to B20 (20% BioDiesel). Further increase in lubricity is limited for BioDiesel blends greater than B20.

DX,FUEL5 -19-07FEB14-1/1

Handling and Storing Diesel Fuel

CAUTION: Reduce the risk of fire. Handle fuel carefully. DO NOT fill the fuel tank when engine is running. DO NOT smoke while you fill the fuel tank or service the fuel system.

Fill the fuel tank at the end of each day's operation to prevent water condensation and freezing during cold weather.

Keep all storage tanks as full as practicable to minimize condensation.

Ensure that all fuel tank caps and covers are installed properly to prevent moisture from entering. Monitor water content of the fuel regularly.

When using BioDiesel fuel, the fuel filter may require more frequent replacement due to premature plugging.

Check engine oil level daily prior to starting engine. A rising oil level may indicate fuel dilution of the engine oil.

IMPORTANT: The fuel tank is vented through the filler cap. If a new filler cap is required, always replace it with an original vented cap.

When fuel is stored for an extended period or if there is a slow turnover of fuel, add a fuel conditioner to stabilize the fuel and prevent water condensation. Contact your fuel supplier or John Deere dealer for recommendations.

DX,FUEL4 -19-15FEB13-1/1

BioDiesel Fuel

BioDiesel fuel is comprised of mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats. BioDiesel blends are BioDiesel mixed with petroleum diesel fuel on a volume basis.

Before using fuel containing BioDiesel, review the BioDiesel Use Requirements and Recommendations in this Operator's Manual.

Environmental laws and regulations can encourage or prohibit the use of biofuels. Operators should consult with appropriate governmental authorities prior to using biofuels.

All John Deere Engines with Exhaust Filter (Released 2011 and After)

While 5% blends (B5) are preferred, BioDiesel concentrations up to a 20% blend (B20) in petroleum diesel fuel can be used. BioDiesel blends up to B20 can be used ONLY if the BioDiesel (100% BioDiesel or B100) meets ASTM D6751, EN 14214, or equivalent specification. Expect a 2% reduction in power and a 3% reduction in fuel economy when using B20.

BioDiesel concentrations above B20 can harm the engine's emission control systems and should not be used. Risks include, but are not limited to, more frequent stationary regeneration, soot accumulation, and increased intervals for ash removal.

John Deere approved fuel conditioners, which contain detergent and dispersant additives, are required when using BioDiesel blends from B10—B20, and are recommended when using lower BioDiesel blends.

All John Deere Engines Excluding Exhaust Filter (Primarily Released Prior to 2012)

While 5% blends (B5) are preferred, BioDiesel concentrations up to a 20% blend (B20) in petroleum diesel fuel can be used. BioDiesel blends up to B20 can be used ONLY if the BioDiesel (100% BioDiesel or B100) meets ASTM D6751, EN 14214, or equivalent specification. Expect a 2% reduction in power and a 3% reduction in fuel economy when using B20.

These John Deere engines can operate on BioDiesel blends above B20 (up to 100% BioDiesel). Operate at levels above B20 ONLY if the BioDiesel is permitted by law and meets the EN 14214 specification (primarily available in Europe). Engines operating on BioDiesel blends above B20 might not fully comply with or be permitted by all applicable emissions regulations. Expect up to a 12% reduction in power and an 18% reduction in fuel economy when using 100% BioDiesel.

John Deere approved fuel conditioners, which contain detergent and dispersant additives, are required when using BioDiesel blends from B10—B20, and are recommended when using lower BioDiesel blends.

BioDiesel Use Requirements and Recommendations

The petroleum diesel portion of all BioDiesel blends must meet the requirements of ASTM D975 (US) or EN 590 (EU) commercial standard.

BioDiesel users in the U.S. are strongly encouraged to purchase BioDiesel blends from a BQ-9000 Certified Marketer and sourced from a BQ-9000 Accredited Producer (as certified by the National BioDiesel Board). Certified Marketers and Accredited Producers can be found at the following website: http://www.bq9000.org.

BioDiesel contains residual ash. Ash levels exceeding the maximums allowed in either ASTM D6751 or EN14214 can result in more rapid ash loading and require more frequent cleaning of the Exhaust Filter (if present).

The fuel filter can require more frequent replacement, when using BioDiesel fuel, particularly if switching from diesel. Check engine oil level daily prior to starting engine. A rising oil level can indicate fuel dilution of the engine oil. BioDiesel blends up to B20 must be used within 90 days of the date of BioDiesel manufacture. BioDiesel blends above B20 must be used within 45 days from the date of BioDiesel manufacture.

When using BioDiesel blends up to B20, the following must be considered:

- Cold-weather flow degradation
- Stability and storage issues (moisture absorption, microbial growth)
- Possible filter restriction and plugging (usually a problem when first switching to BioDiesel on used engines)
- Possible fuel leakage through seals and hoses (primarily an issue with older engines)
- Possible reduction of service life of engine components

Request a certificate of analysis from your fuel distributor to ensure that the fuel is compliant with the specifications provided in this Operator's Manual.

Consult your John Deere dealer for approved fuel conditioners to improve storage and performance with BioDiesel fuels.

The following must also be considered if using BioDiesel blends above B20:

- Possible coking or blocked injector nozzles, resulting in power loss and engine misfire if John Deere approved fuel conditioners are not used
- Possible crankcase oil dilution (requiring more frequent oil changes)
- Possible lacquering or seizure of internal components
- Possible formation of sludge and sediments
- Possible thermal oxidation of fuel at elevated temperatures
- Possible compatibility issues with other materials (including copper, lead, zinc, tin, brass, and bronze) used in fuel handling equipment

Continued on next page

DX,FUEL7 -19-15MAY13-1/2

- Possible reduction in water separator efficiency
- Possible damage to paint if exposed to BioDiesel
- Possible corrosion of fuel injection equipment
- Possible elastomeric seal and gasket material degradation (primarily an issue with older engines)
- Possible high acid levels within fuel system
- Because BioDiesel blends above B20 contain more ash, using blends above B20 can result in more rapid ash loading and require more frequent cleaning of the Exhaust Filter (if present)

IMPORTANT: Raw pressed vegetable oils are NOT acceptable for use as fuel in any concentration in John Deere engines. Their use could cause engine failure.

DX,FUEL7 -19-15MAY13-2/2

Testing Diesel Fuel

A fuel analysis program can help to monitor the quality of diesel fuel. The fuel analysis can provide critical data such as cetane number, fuel type, sulfur content, water content, appearance, suitability for cold weather operations, bacteria, cloud point, acid number, particulate contamination, and whether the fuel meets specification.

Contact your John Deere dealer for more information on diesel fuel analysis.

DX,FUEL6 -19-14APR11-1/1

Fuel Filters

The importance of fuel filtration cannot be overemphasized with modern fuel systems. The combination of increasingly restrictive emission regulations and more efficient engines requires fuel system to operate at much higher pressures. Higher pressures can only be achieved using fuel injection components with very close tolerances. These close manufacturing tolerances have significantly reduced capacities for debris and water.

John Deere brand fuel filters have been designed and produced specifically for John Deere engines.

To protect the engine from debris and water, always change engine fuel filters as specified in this manual.

DX,FILT2 -19-14APR11-1/1

Minimizing the Effect of Cold Weather on Diesel Engines

John Deere diesel engines are designed to operate effectively in cold weather.

However, for effective starting and cold-weather operation, a little extra care is necessary. The following information outlines steps that can minimize the effect that cold weather may have on starting and operation of your engine. See your John Deere dealer for additional information and local availability of cold-weather aids.

Use Winter Grade Fuel

When temperatures fall below 0 °C (32 °F), winter grade fuel (No. 1-D in North America) is best suited for cold-weather operation. Winter grade fuel has a lower cloud point and a lower pour point.

Cloud point is the temperature at which wax begins to form in the fuel. This wax causes fuel filters to plug. **Pour point** is the lowest temperature at which movement of the fuel is observed.

NOTE: On average, winter grade diesel fuel has a lower Btu (heat content) rating. Using winter grade fuel may reduce power and fuel efficiency, but should not cause any other engine performance effects. Check the grade of fuel being used before troubleshooting for low-power complaints in cold-weather operation.

Air Intake Heater

An air intake heater is an available option for some engines to aid cold weather starting.

Ether

An ether port on the intake is available to aid cold weather starting.

CAUTION: Ether is highly flammable. Do not use ether when starting an engine equipped with glow plugs or an air intake heater.

Coolant Heater

An engine block heater (coolant heater) is an available option to aid cold weather starting.

Seasonal Viscosity Oil and Proper Coolant Concentration

Use seasonal grade viscosity engine oil based on the expected air temperature range between oil changes and a proper concentration of low silicate antifreeze as recommended. (See DIESEL ENGINE OIL and ENGINE COOLANT requirements in this section.)

Diesel Fuel Flow Additive

Use John Deere Fuel-Protect Diesel Fuel Conditioner (winter formula), which contains anti-gel chemistry, or equivalent fuel conditioner to treat non-winter grade fuel (No. 2-D in North America) during the cold-weather season. This generally extends operability to about 10 °C (18 °F) below the fuel cloud point. For operability at even lower temperatures, use winter grade fuel.

IMPORTANT: Treat fuel when outside temperature drops below 0 °C (32 °F). For best results, use with untreated fuel. Follow all recommended instructions on label.

BioDiesel

When operating with BioDiesel blends, wax formation can occur at warmer temperatures. Begin using John Deere Fuel-Protect Diesel Fuel Conditioner (winter formula) at 5 °C (41 °F) to treat BioDiesel fuels during the cold-weather season. Use B5 or lower blends at temperatures below 0 °C (32 °F). Use only winter grade petroleum diesel fuel at temperatures below -10 °C (14 °F).

Winterfronts

Use of fabric, cardboard, or solid winterfronts is not recommended with any John Deere engine. Their use can result in excessive engine coolant, oil, and charge air temperatures. This can lead to reduced engine life, loss of power and poor fuel economy. Winterfronts may also put abnormal stress on fan and fan drive components potentially causing premature failures.

If winterfronts are used, they should never totally close off the grill frontal area. Approximately 25% area in the center of the grill should remain open at all times. At no time should the air blockage device be applied directly to the radiator core.

Radiator Shutters

If equipped with a thermostatically controlled radiator shutter system, this system should be regulated in such a way that the shutters are completely open by the time the coolant reaches 93 °C (200 °F) to prevent excessive intake manifold temperatures. Manually controlled systems are not recommended.

If air-to-air aftercooling is used, the shutters must be completely open by the time the intake manifold air temperature reaches the maximum allowable temperature out of the charge air cooler.

For more information, see your John Deere dealer.

DX,FUEL10 -19-15MAY13-1/1

John Deere Break-In Plus™ Engine Oil — Interim Tier 4, Final Tier 4, Stage IIIB, and Stage IV

New engines are filled at the factory with John Deere Break-In Plus™ Engine Oil. During the break-in period, add John Deere Break-In Plus™ Engine Oil, as needed to maintain the specified oil level.

Operate the engine under various conditions, particularly heavy loads with minimal idling, to help seat engine components properly.

During the initial operation of a new or rebuilt engine, change the oil and filter between a minimum of 100 hours and maximum equal to the interval specified for John Deere Plus-50™ II oil.

After engine overhaul, fill the engine with John Deere Break-In Plus™ Engine Oil.

If John Deere Break-In Plus™ Engine Oil is not available, use an SAE 10W-30 viscosity grade diesel engine oil meeting one of the following:

- API Service Category CJ-4
- ACEA Oil Sequence E9
- ACEA Oil Sequence E6

If one of these oils is used during the initial operation of a new or rebuilt engine, change the oil and filter between a minimum of 100 hours and a maximum of 250 hours.

IMPORTANT: Do not use any other engine oils during the initial break-in of a new or rebuilt engine.

John Deere Break-In Plus™ Engine Oil can be used for all John Deere diesel engines at all emission certification levels.

After the break-in period, use John Deere Plus-50™ II or other diesel engine oil as recommended in this manual.

Break-In Plus is a trademark of Deere & Company
Plus-50 is a trademark of Deere & Company.

DX,ENOIL16 -19-15JUN10-1/1

Diesel Engine Oil — Interim Tier 4, Final Tier 4, Stage IIIB, and Stage IV

Use oil viscosity based on the expected air temperature range during the period between oil changes.

John Deere Plus-50™ II is the recommended engine oil.

Extended service intervals may apply when John Deere Plus-50™ II engine oil is used. Refer to the engine oil drain interval table and consult your John Deere dealer for more information.

If John Deere Plus-50™ II engine oil is not available, engine oil meeting one or more of the following may be used:

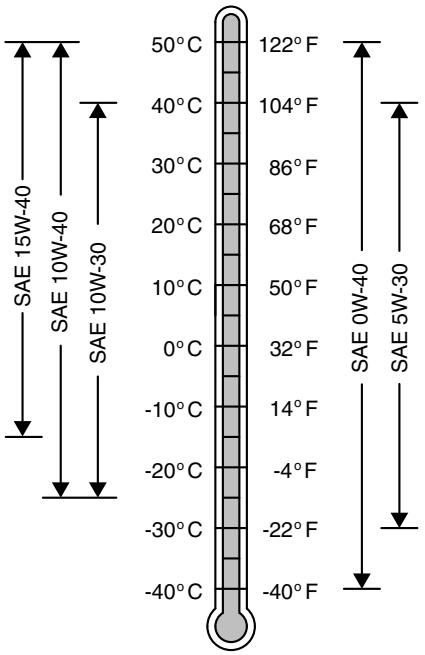
- API Service Category CJ-4
- ACEA Oil Sequence E9
- ACEA Oil Sequence E6

DO NOT use engine oil containing more than 1.0% sulfated ash, 0.12% phosphorus, or 0.4% sulfur.

Multi-viscosity diesel engine oils are preferred.

Diesel fuel quality and fuel sulfur content must comply with all existing emissions regulations for the area in which the engine operates.

IMPORTANT: Use only ultra low sulfur diesel (ULSD) fuel with a maximum sulfur content of 15 mg/kg (15 ppm).



Oil Viscosities for Air Temperature Ranges

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DX,ENOIL14 -19-15JUN10-1/1

Engine Oil and Filter Service Intervals — Interim Tier 4, Final Tier 4, Stage IIIB, and Stage IV — OEM Applications

Recommended oil and filter service intervals are based on a combination of oil pan capacity, type of engine oil and filter used, and sulfur content of the diesel fuel. Actual service intervals also depend on operation and maintenance practices.

Use oil analysis to evaluate the condition of the oil and to aid in selection of the proper oil and filter service interval. Contact your John Deere dealer for more information on engine oil analysis.

Change the oil and oil filter at least once every 12 months even if the hours of operation are fewer than the otherwise recommended service interval.

Diesel fuel sulfur content affects engine oil and filter service intervals. Higher fuel sulfur levels reduce oil and filter service intervals.

Use of diesel fuel with sulfur content less than 15 mg/kg (15 ppm) is REQUIRED.

IMPORTANT: To avoid engine damage:

- **Reduce oil and filter service intervals by 50% when using BioDiesel blends greater than B20. Oil analysis may allow longer service interval.**
- **Use only approved oil types.**

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Approved Oil Types

- John Deere Plus-50™ II
- “Other Oils” include API CJ-4, ACEA E9, and ACEA E6.

NOTE: The 500 hour extended oil and filter change interval is only allowed if all of the following conditions are met:

- *Engine equipped with an extended drain interval oil pan*
- *Use of diesel fuel with sulfur content less than 15 mg/kg (15 ppm)*
- *Use of John Deere Plus-50™ II oil*
- *Use of an approved John Deere oil filter*

Engine Oil and Filter Service Intervals		
	Oil Pan Size (L/kW)	
	Greater than or equal to 0.10	Greater than or equal to 0.12
John Deere Plus-50™ II	375 hours	500 hours
Other Oils	250 hours	250 hours
Oil analysis may extend the service interval of “Other Oils” to a maximum not to exceed the interval of Plus-50™ II oils.		

DX,ENOIL15,IT4,OEM -19-07FEB14-1/1

Diesel Engine Oil and Filter Service Intervals

The oil and filter service intervals in the following table should be used as guidelines. Actual service intervals also depend on operation and maintenance practices. It is suggested to use oil analysis to determine the actual useful life of the oil and to aid in selection of the proper oil and filter service interval. Change the oil and filter at least once every 12 months even if the hours of operation are fewer than the otherwise recommended service interval. Oil and filter service intervals are based on a combination of oil pan capacity and the type of engine oil and filter used.

Diesel fuel sulfur level will affect engine oil and filter service intervals.

Use of diesel fuel with sulfur content less than 0.0015% (or 15 ppm) (or 15 mg/kg) maximum limit is required.

IMPORTANT: To avoid engine damage:

- **Reduce oil and filter service intervals by 50% when using biodiesel blends greater than B20. Oil analysis may allow longer service intervals.**
- **Use only approved oil types.**

Approved Oil Types

- John Deere Plus-50™ II
- "Other Oils" include oils meeting API CJ-4, ACEA E9, or ACEA E6.

Use of other specification oils in Final Tier 4/Stage IV engines can result in premature failure.

NOTE: The 500 hour extended oil and filter change interval is only allowed if all the following conditions are met:

- *Engine equipped with an extended drain interval oil pan*
- *Use of diesel fuel with sulfur content less than 0.0015% (15 ppm) (15 mg/kg) maximum limit*
- *Use of John Deere Plus-50™ II oil*
- *Use of an approved John Deere oil filter*

		Oil Pan Option Codes	
Power Rating	Fuel Sulfur Content	19GN 8.5 L	
kW (hp)		Other Oils	John Deere Plus-50 II
36 (48)	≤15 ppm	250 hours	500 hours
48 (64)	≤15 ppm	250 hours	500 hours
55 (74)	≤15 ppm	250 hours	500 hours

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Mixing of Lubricants

In general, avoid mixing different brands or types of oil. Oil manufacturers blend additives in their oils to meet certain specifications and performance requirements.

Mixing different oils can interfere with the proper functioning of these additives and degrade lubricant performance.

Consult your John Deere dealer to obtain specific information and recommendations.

DX,LUBMIX -19-18MAR96-1/1

Alternative and Synthetic Lubricants

Conditions in certain geographical areas may require lubricant recommendations different from those printed in this manual.

Some John Deere brand coolants and lubricants may not be available in your location.

Consult your John Deere dealer to obtain information and recommendations.

Synthetic lubricants may be used if they meet the performance requirements as shown in this manual.

The temperature limits and service intervals shown in this manual apply to both conventional and synthetic lubricants.

Re-refined base stock products may be used if the finished lubricant meets the performance requirements.

DX,ALTER -19-11APR11-1/1

Lubricant Storage

Your equipment can operate at top efficiency only when clean lubricants are used.

Use clean containers to handle all lubricants.

Store lubricants and containers in an area protected from dust, moisture, and other contamination. Store containers on their side to avoid water and dirt accumulation.

Make certain that all containers are properly marked to identify their contents.

Properly dispose of all old containers and any residual lubricant they may contain.

DX,LUBST -19-11APR11-1/1

Oil Filters

Filtration of oils is critically important for proper operation and lubrication. John Deere brand oil filters have been designed and produced specifically for John Deere applications.

John Deere filters adhere to engineering specifications for quality of the filter media, filter efficiency rating, strength of the bond between the filter media and the element end cap, fatigue life of the canister (if applicable), and pressure capability of the filter seal. Non-John Deere branded oil filters might not meet these key John Deere specifications.

Always change oil filters regularly as specified in this manual.

DX,FILT1 -19-11APR11-1/1

Diesel Engine Coolant (engine with wet sleeve cylinder liners)

Preferred Coolants

The following pre-mix engine coolants are preferred:

- **John Deere COOL-GARD™II**
- **John Deere COOL-GARD II PG**

COOL-GARD II pre-mix coolant is available in several concentrations with different freeze protection limits as shown in the following table.

COOL-GARD II pre-mix	Freeze Protection Limit
COOL-GARD II 20/80	-9 °C (16 °F)
COOL-GARD II 30/70	-16 °C (3 °F)
COOL-GARD II 50/50	-37 °C (-34 °F)
COOL-GARD II 55/45	-45 °C (-49 °F)
COOL-GARD II PG 60/40	-49 °C (-56 °F)
COOL-GARD II 60/40	-52 °C (-62 °F)

Not all COOL-GARD II pre-mix products are available in all countries.

Use COOL-GARD II PG when a non-toxic coolant formulation is required.

Additional Recommended Coolants

The following engine coolant is also recommended:

- John Deere COOL-GARD II Concentrate in a 40—60% mixture of concentrate with quality water.

IMPORTANT: When mixing coolant concentrate with water, do not use less than 40% or greater than 60% concentration of coolant. Less than 40% gives inadequate additives for corrosion protection. Greater than 60% can result in coolant gelation and cooling system problems.

Other Coolants

Other ethylene glycol or propylene glycol base coolants may be used if they meet the following specification:

- Pre-mix coolant meeting ASTM D6210 requirements
- Coolant concentrate meeting ASTM D6210 requirements in a 40—60% mixture of concentrate with quality water

If coolant meeting one of these specifications is unavailable, use a coolant concentrate or pre-mix coolant that has a minimum of the following chemical and physical properties:

- Provides cylinder liner cavitation protection according to either the John Deere Cavitation Test Method or a fleet study run at or above 60% load capacity
- Is formulated with a nitrite-free additive package
- Protects the cooling system metals (cast iron, aluminum alloys, and copper alloys such as brass) from corrosion

Water Quality

Water quality is important to the performance of the cooling system. Distilled, deionized, or demineralized water is recommended for mixing with ethylene glycol and propylene glycol base engine coolant concentrate.

Coolant Drain Intervals

Drain and flush the cooling system and refill with fresh coolant at the indicated interval, which varies with the coolant used.

When COOL-GARD II or COOL-GARD II PG is used, the drain interval is 6 years or 6000 hours of operation.

If a coolant other than COOL-GARD II or COOL-GARD II PG is used, reduce the drain interval to 2 years or 2000 hours of operation.

IMPORTANT: Do not use cooling system sealing additives or antifreeze that contains sealing additives.

Do not mix ethylene glycol and propylene glycol base coolants.

Do not use coolants that contain nitrites.

COOL-GARD is a trademark of Deere & Company

DX,COOL3 -19-15MAY13-1/1

Water Quality for Mixing with Coolant Concentrate

Engine coolants are a combination of three chemical components: ethylene glycol (EG) or propylene glycol (PG) antifreeze, inhibiting coolant additives, and quality water.

Water quality is important to the performance of the cooling system. Distilled, deionized, or demineralized water is recommended for mixing with ethylene glycol and propylene glycol base engine coolant concentrate.

All water used in the cooling system should meet the following minimum specifications for quality:

Chlorides	<40 mg/L
Sulfates	<100 mg/L
Total solids	<340 mg/L
Total dissolved I hardness	<170 mg/L
pH	5.5—9.0

IMPORTANT: Do not use bottled drinking water because it often contains higher concentrations of total dissolved solids.

Freeze Protection

The relative concentrations of glycol and water in the engine coolant determine its freeze protection limit.

Ethylene Glycol	Freeze Protection Limit
40%	-24 °C (-12 °F)
50%	-37 °C (-34 °F)
60%	-52 °C (-62 °F)
Propylene Glycol	**Freeze Protection Limit**
40%	-21 °C (-6 °F)
50%	-33 °C (-27 °F)
60%	-49 °C (-56 °F)

DO NOT use a coolant-water mixture greater than 60% ethylene glycol or 60% propylene glycol.

DX,COOL19 -19-15MAY13-1/1

Operating in Warm Temperature Climates

John Deere engines are designed to operate using recommended engine coolants.

Always use a recommended engine coolant, even when operating in geographical areas where freeze protection is not required.

IMPORTANT: Water may be used as coolant *in emergency situations only.*

Foaming, hot surface aluminum and iron corrosion, scaling, and cavitation occur when water is used as the coolant, even when coolant conditioners are added.

Drain cooling system and refill with recommended engine coolant as soon as possible.

DX,COOL6 -19-15MAY13-1/1

Testing Coolant Freeze Point

The use of a handheld coolant refractometer is the quickest, easiest, and most accurate method to determine coolant freeze point. This method is more accurate than a test strip or a float-type hydrometer which can produce poor results.

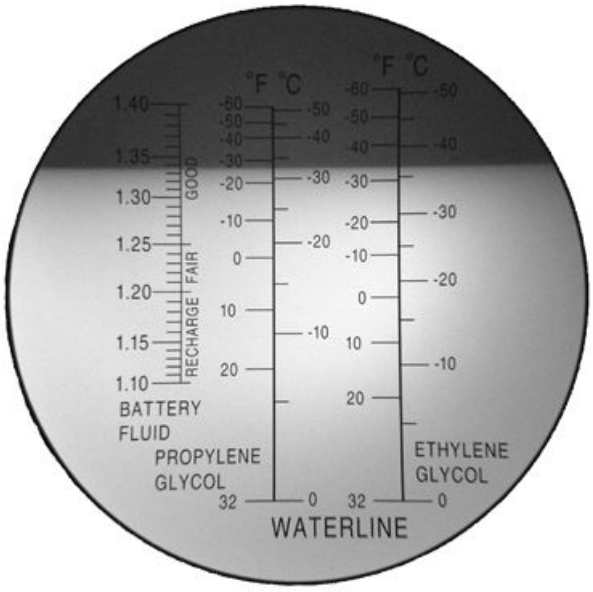
A coolant refractometer is available through your John Deere dealer under the SERVICEGARD™ tool program. Part number 75240 provides an economical solution to accurate freeze point determination in the field.

To use this tool:

1. Allow cooling system to cool to ambient temperatures.
2. Open radiator cap to expose coolant.
3. With the included dropper, collect a small coolant sample.
4. Open the lid of the refractometer, place one drop of coolant on the window and close the lid.
5. Look through the eyepiece and focus as necessary.
6. Record the listed freeze point for the type of coolant (ethylene glycol coolant or propylene glycol) being tested.

TS1732 —UN—04SEP13

SERVICEGARD™ Part Number 75240



TS1733 —UN—04SEP13

Image with a Drop of 50/50 Coolant Placed on the Refractometer Window

SERVICEGARD is a trademark of Deere & Company

DX,COOL,TEST -19-13JUN13-1/1

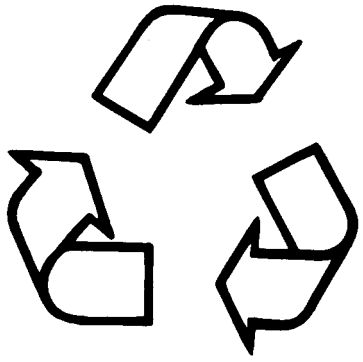
Disposing of Coolant

Improperly disposing of engine coolant can threaten the environment and ecology.

Use leakproof containers when draining fluids. Do not use food or beverage containers that may mislead someone into drinking from them.

Do not pour waste onto the ground, down a drain, or into any water source.

Inquire on the proper way to recycle or dispose of waste from your local environmental or recycling center, or from your John Deere engine distributor or servicing dealer.



TS1133 —UN—15APR13

Recycle Waste

RG,RG34710,7543 -19-09JAN07-1/1

Instrument Panels

Final Tier 4/Stage IV John Deere PowerTech™ OEM Engines have an electronic control system, which has the following controls and gauges as shown. The following information applies only to those controls and gauges supplied by John Deere. Refer to your engine application manual for specific guidelines if John Deere-sourced controls and instrumentation are not used.

NOTE: This manual only covers operation of engine with a John Deere control system.

Following is a brief description of the available optional electronic controls and gauges found on John Deere provided instrument panels. Refer to manufacturer's literature for information on controls not provided by Deere.

Instrument Panel

A—Diagnostic Gauge/Hour Meter

The diagnostic gauge (A) displays diagnostic trouble codes (DTCs) as they are accessed. Other information on the engine can be accessed using the touch keys (N, O and P). The hour meter feature shows the operating hours of the engine and should be used as a guide for scheduling periodic maintenance. If the diagnostic gauge receives a trouble code from an engine control unit, the current display will switch to a warning or shutdown (depending on the severity of the code) screen that will display the trouble code number, the description of the code and the corrective action needed.

B—Tachometer

The tachometer (B) indicates engine speed in hundreds of revolutions per minute (rpm).

C—Voltmeter (Optional)

The voltmeter (C) indicates system battery voltage. The amber "Warning" light (Q) will illuminate when battery voltage is too low for proper operation of the fuel injection system.

D—Audible Alarm (Optional)

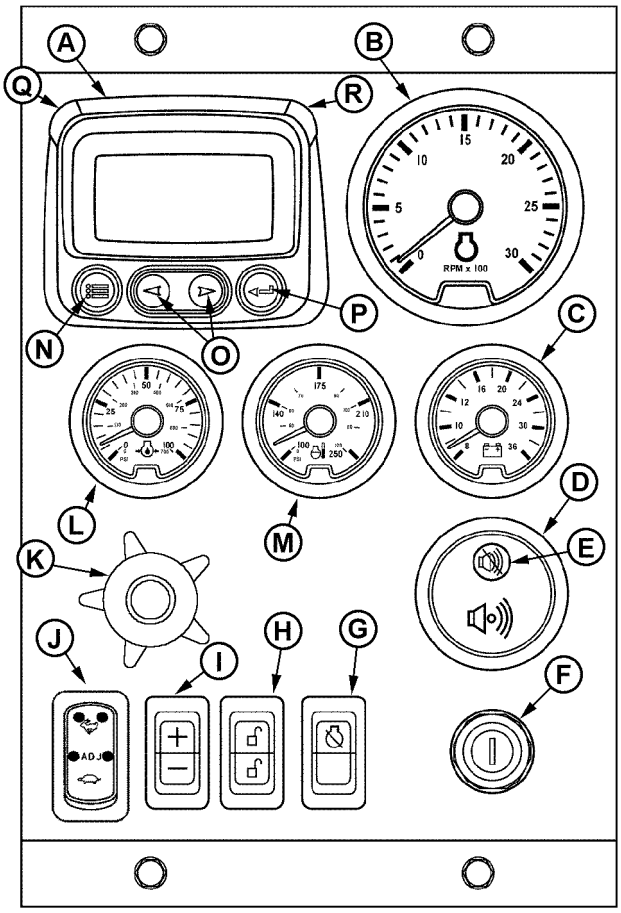
The audible alarm (D) will sound whenever low oil pressure, high coolant temperature, or water-in-fuel conditions exist. This includes all signals that light up the amber "warning" indicator (intermittent alarm) or the red "stop engine" indicator (steady alarm).

E—Audible Alarm Override Button

The optional audible alarm has an override button (E) that silences the audible alarm for approximately two minutes when pressed.

F—Key Start Switch

The three-position key start switch (F) controls the engine electrical system. When the key switch is turned clockwise to "START", the engine will crank. When the engine starts, the key is released and returns to the "ON" (RUN) position.



RG13276 —UN—28OCT03

Full-Featured Instrument Panel

A—Diagnostic Gauge/Hour Meter
B—Tachometer
C—Voltmeter (Optional)
D—Audible Alarm (Optional)
E—Audible Alarm Override Button
F—Key Switch
G—Override Shutdown Rocker Switch
H—Bump Enable Rocker Switch
I— Speed Select Rocker Switch
J— High-Low Speed Select Rocker Switch
K—Analog Throttle Control (Optional)
L—Oil Pressure Gauge
M—Coolant Temperature Gauge
N—Menu Key
O—Arrow Keys
P—Enter Key
Q—Amber "WARNING" Indicator Light
R—Red "STOP ENGINE" Indicator Light

G—Override Shutdown Rocker Switch

Switch will be present, but may not be active, depending on engine control unit (ECU) options originally selected. If switch is active, pressing the upper half of the override shutdown switch (G) will override an engine shutdown signal. The switch must be pressed within 30 seconds to prevent undesired shutdown of engine. Pressing this switch will override the engine shutdown for 30 seconds at a time to move vehicle to a safe location.

Continued on next page

H—Bump Speed Enable Rocker Switch

This is a three-position switch (H) with the center position as “OFF” (locked). With this switch in the “OFF” position, the speed select switch (I) is also locked, to prevent accidental changes in operating speed. Pressing upper or lower half of switch (H) will unlock or enable the bump speed switch to take effect using speed select switch (I).

I—Speed Select Rocker Switch

The speed select switch (I) is used to bump engine speed up (+) or down (-) in small increments during operation. This switch must be used with the bump speed enable switch (H) in the unlocked position (top or bottom half of button depressed).

J—High-Low Speed Select Rocker Switch

The high-low speed select switch (J) is used to set the engine operating speeds at slow (turtle) or fast (rabbit). Factory preset idle speeds can also be adjusted using bump speed enable switch (H) with speed select switch (I).

The basic instrument panel will have the high-low speed select switch only. Press and hold up (+) or down (-) to adjust engine speed as desired. The engine speed selected will not be held in the memory. To adjust engine speeds, See Changing Engine Speeds in Section 20.

How To Select Preset Operating Speeds (Bump Speeds)

First select Turtle (Slow) or Adj by pressing speed select switch (J) to “Turtle” (slow) or “Adj”(center). Then you can press either the upper or lower portion of the bump speed enable switch (H) to unlock the setting. The bump speed enable must be held down as the speed select switch (J) is used to change the setting by pressing (+) to increase speed or (-) to decrease speed.

Once the slow idle speed has been set, the bump speed enable **switch must be pressed and released three times within two seconds to commit the new operating speed to memory.** If not done, the engine's new speed will only be effective until the key switch is shut off. Then the speed will revert back to the previous setting.

The fast idle speed is not adjustable. It will always go back to the factory preset fast idle speed.

K—Analog Throttle Control (Optional)

The throttle control (K) is used to control engine speed. This control is available only on engines with analog throttle.

L—Engine Oil Pressure Gauge

The oil pressure gauge (L) indicates engine oil pressure. An audible alarm (D) warns the operator if engine oil pressure falls below a safe operating pressure.

M—Engine Coolant Temperature Gauge

The engine coolant temperature gauge (M) indicates engine coolant temperature. An audible alarm (D) warns the operator if coolant temperature rises above the preset safe operating temperature.

N—Menu Key

The menu key is pressed to either enter or exit the menu screens on the diagnostic gauge.

O—Arrow Keys

Use the arrow keys (O) to change the display on the window of the diagnostic gauge and to access engine performance data.

Pressing the left arrow to scroll to the left or upward or the right arrow to scroll to the right or downward. This will allow you to view various engine parameters and any diagnostic trouble codes that occur.

Refer to the following story for accessing engine information on the diagnostic gauge using the touch keys.

P—Enter Key

The enter key is pressed to select the parameter that is highlighted on the screen.

Q—Amber “WARNING” Indicator Light

When light comes on, an abnormal condition exists. It is not necessary to shut down the engine immediately, but the problem should be corrected as soon as possible.

R—Red “STOP ENGINE” Indicator Light

When light comes on, stop engine immediately or as soon as safely possible to prevent engine damage. Correct problem before restarting.

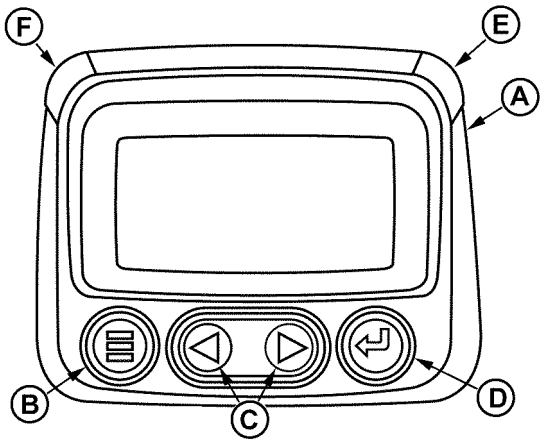
Using Diagnostic Gauge to Access Engine Information

The diagnostic gauge (A) allows the operator to view many readouts of engine functions and trouble codes (DTCs). The gauge is linked to the electronic control system and its sensors. This allows the operator to monitor engine functions and to troubleshoot the engine systems when needed.

Press the menu key (B) to access the various engine functions in sequence. The displays can be selected as either customary English or metric units.

The following menu of engine parameters can be displayed on the diagnostic gauge window:

- Intake Temperature
- Air Filter Diff. Pressure
- Battery Potential Voltage
- Fan Drive
- Engine Desired Op Speed
- Machine Hours
- Exhaust System High Temp Lamp
- Exhaust Filter Clean Status
- % Soot
- Last Exhaust Filter Clean
- Compressor Inlet Temperature
- CAC Outlet Temperature
- Exhaust Filter Outlet Temp
- Fan Drive State
- Fuel Level
- Fuel Temperature
- Fuel Delivery Pressure
- Engine Oil Pressure
- Coolant Pressure
- Coolant Level
- Fuel Rate
- Barometric Pressure
- Boost Pressure
- Intake Temperature
- Accelerator Pedal Position
- Percent Load at Current RPM
- Actual Engine Torque
- Engine Speed
- Total Engine Hours
- Trip Fuel



RG13132 —UN—09SEP03

Diagnostic Gauge

A—Diagnostic Gauge
B—Menu Key
C—Arrow Keys
D—Enter Key
E—Red "STOP ENGINE" Indicator Light
F—Amber "WARNING" Indicator Light

- Total Fuel Used
- Engine Coolant Temperature
- Fuel Temperature
- % Ash

NOTE: Engine parameters which can be accessed will vary with the engine application. Diagnostic gauge can be set to display readouts in one of the following languages; English, French, German, Italian, and Spanish. Contact your engine distributor or dealer.

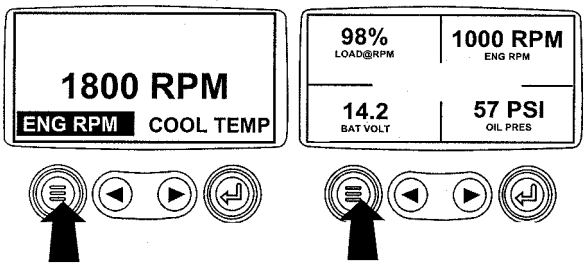
The diagnostic gauge includes a graphical backlit Liquid Crystal Display (LCD) screen. The display can show either a single parameter or a quadrant display showing four parameters simultaneously. The diagnostic gauge uses two arrow keys (C) for scrolling through the engine parameter list and viewing the menu list and an enter key (D) for selecting highlighted items. The red (E) and amber (F) lights are used to signal active trouble code received by the diagnostic gauge.

JR74534,00002C8 -19-23AUG10-1/1

Main Menu Navigation

NOTE: The engine does not need to be running to navigate the diagnostic gauge screens. If engine start up is desired, See Starting The Engine. All of the engine values illustrated on the diagnostic gauge indicate the engine is running.

1. Turn the key switch to the ON position. Starting at the single or four engine parameter display, press the "Menu" key.



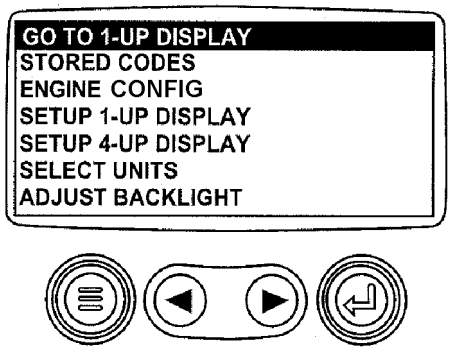
RG13159 —UN—26SEP03

Menu Key

Continued on next page

OURGP11,00000A9 -19-11OCT06-1/5

2. The first seven items of the "Main Menu" will be displayed.

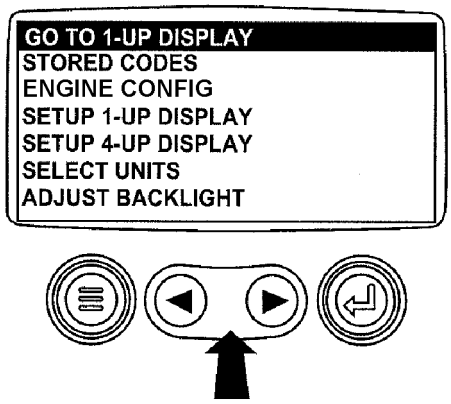


RG13160 —UN—02OCT03

Menu Display

OURGP11,00000A9 -19-11OCT06-2/5

3. Pressing the "Arrow" keys will scroll through the menu selections.

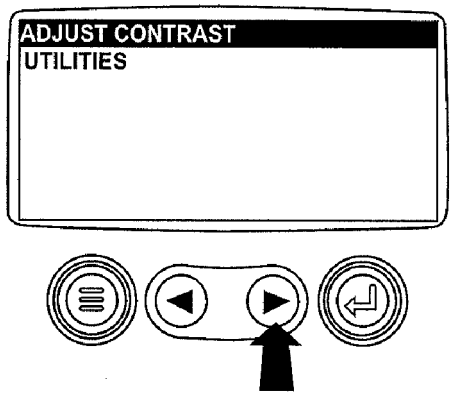


RG13161 —UN—02OCT03

Main Menu Items

OURGP11,00000A9 -19-11OCT06-3/5

4. Pressing the right arrow key will scroll down to reveal the last items of "Main Menu" screen, highlighting the next item down.



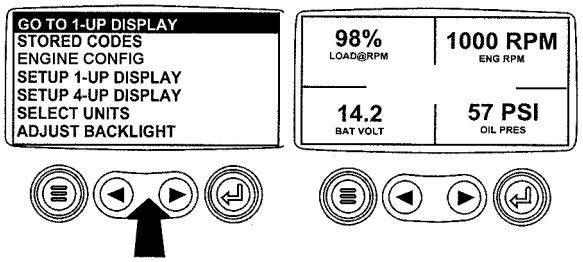
RG13162 —UN—26SEP03

Last Items On Main Menu

Continued on next page

OURGP11,00000A9 -19-11OCT06-4/5

5. Use the arrow keys to scroll to the desired menu item or press the "Menu Button" to exit the main menu and return to the engine parameter display.



RG13163 —UN—02OCT03

Use Arrow Buttons To Scroll / Quadrant Display

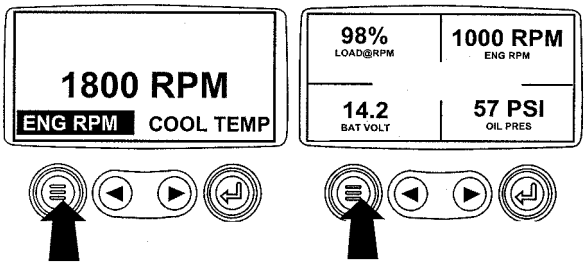
OURGP11,00000A9 -19-11OCT06-5/5

Engine Configuration Data

NOTE: The engine configuration data is a read only function.

NOTE: The engine does not need to be running to navigate the diagnostic gauge screens. If engine start up is desired, See Starting The Engine. All of the engine values illustrated on the diagnostic gauge indicate the engine is running.

1. Turn the key switch to the ON position. Starting at the single or four engine parameter display, press the "Menu" key.

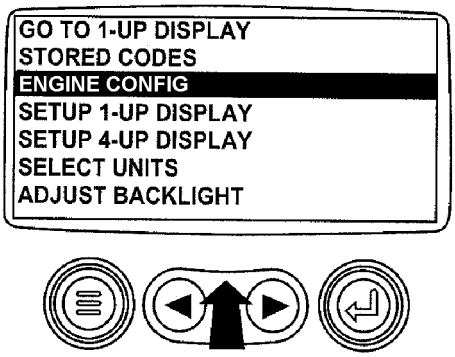


RG13159 —UN—26SEP03

Menu Key

OURGP11,00000AB -19-11OCT06-1/6

2. The main menu will be displayed. Use the "Arrow" keys to scroll through the menu until "Engine Config" is highlighted.



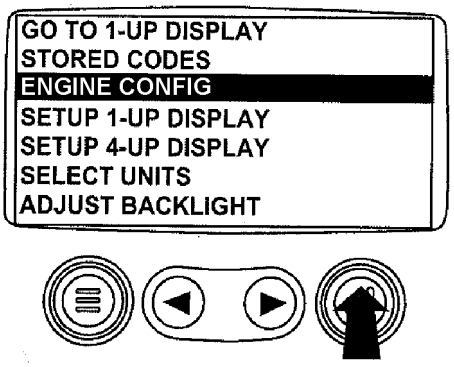
RG13164 —UN—07OCT03

Select Engine Configuration

Continued on next page

OURGP11,00000AB -19-11OCT06-2/6

3. Once "Engine Config" menu item has been highlighted, press the "Enter" key to view the engine configuration data.

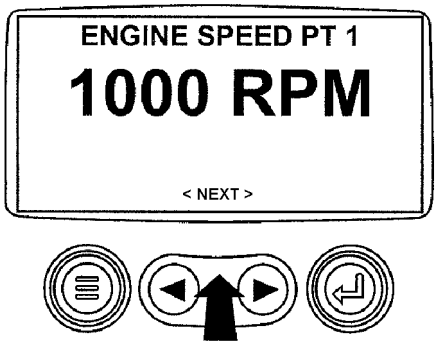


RG13165 —UN—02OCT03

Enter Key

OURGP11,00000AB -19-11OCT06-3/6

4. Use the "Arrow" keys to scroll through the engine configuration data.

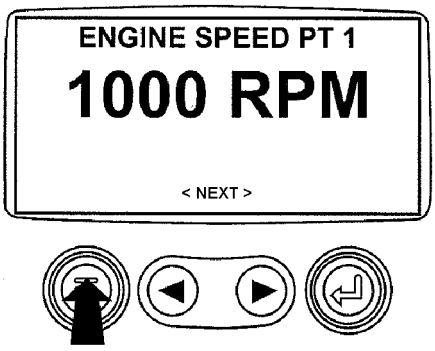


RG13166 —UN—29SEP03

Use Arrow Keys To Scroll

OURGP11,00000AB -19-11OCT06-4/6

5. Press the "Menu" key to return to the main menu.



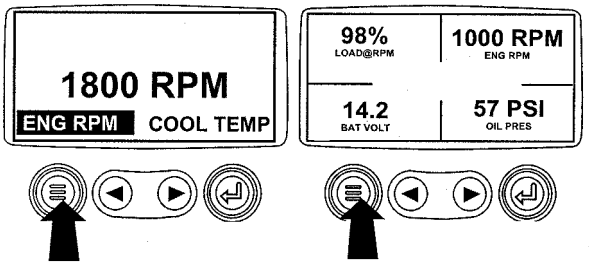
RG13167 —UN—29SEP03

Return To Main Menu

Continued on next page

OURGP11,00000AB -19-11OCT06-5/6

6. Press the "Menu" key to exit the main menu and return to the engine parameter display.



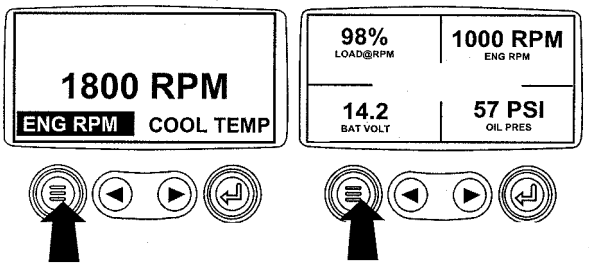
Exit Main Menu

OURGP11,00000AB -19-11OCT06-6/6

Accessing Stored Trouble Codes

NOTE: The engine does not need to be running to navigate the diagnostic gauge screens. If engine start up is desired, See Starting The Engine. All of the engine values illustrated on the diagnostic gauge indicate the engine is running.

For description of trouble codes, see chart in Troubleshooting Section.

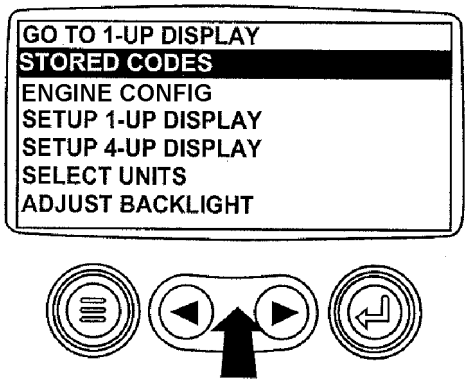


Menu Key

1. Turn the key switch to the ON position. Starting at the single or four engine parameter display, press the "Menu" key.

OURGP11,00000AC -19-11OCT06-1/6

2. The main menu will be displayed. Use the "Arrow" keys to scroll through the menu until "Stored Codes" is highlighted.

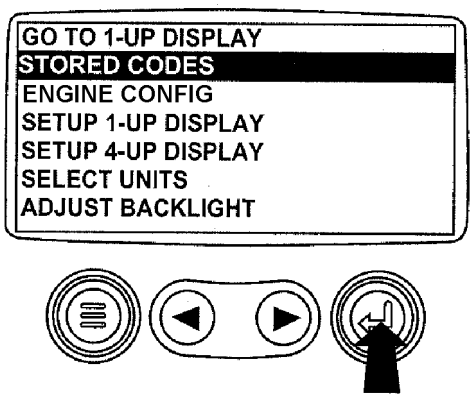


Select Stored Codes

Continued on next page

OURGP11,00000AC -19-11OCT06-2/6

3. Once the "Stored Codes" menu item has been highlighted press the "Enter" key to view the stored codes.

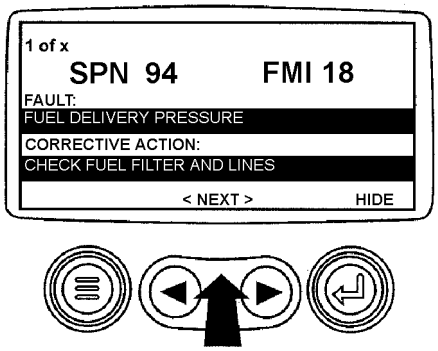


RG13169 —UN—02OCT03

Enter Key

OURGP11,00000AC -19-11OCT06-3/6

4. If the word "Next" appears above the "Arrow" keys, there are more stored codes that may be viewed. Use the "Arrow" key to scroll to the next stored code.

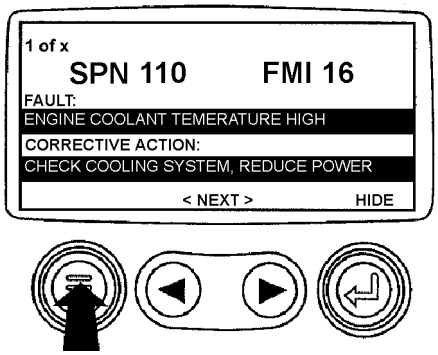


RG13245 —UN—02OCT03

Use Arrow Keys To Scroll

OURGP11,00000AC -19-11OCT06-4/6

5. Press the "Menu" key to return to the main menu.



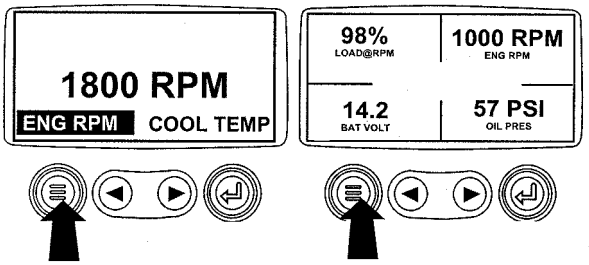
RG13246 —UN—02OCT03

Return To Main Menu

Continued on next page

OURGP11,00000AC -19-11OCT06-5/6

6. Press the "Menu" key to exit the main menu and return to the engine parameter display.



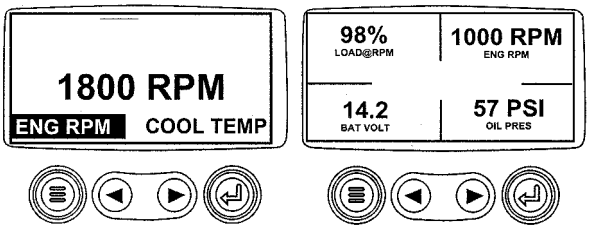
Exit Main Menu

OURGP11,00000AC -19-11OCT06-6/6

Accessing Active Trouble Codes

NOTE: The engine does not need to be running to navigate the diagnostic gauge screens. If engine start up is desired, See Starting The Engine. All of the engine values illustrated on the diagnostic gauge indicate the engine is running.

For description of trouble codes, see chart in Troubleshooting Section.



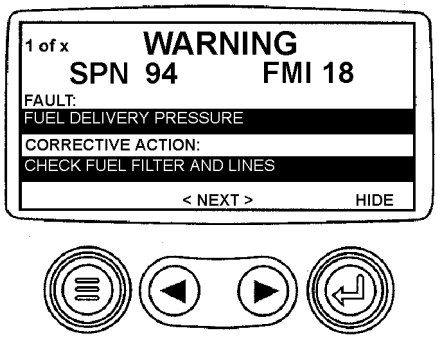
Normal Operation

1. During normal operation the single or four parameter screen will be displayed.

OURGP11,00000AD -19-11OCT06-1/7

2. When the diagnostic gauge receives a trouble code from an engine control unit, the single or four parameter screen will be replaced with the "Warning" message. The SPN and FMI number will be displayed along with a description of the problem and the corrective action needed.

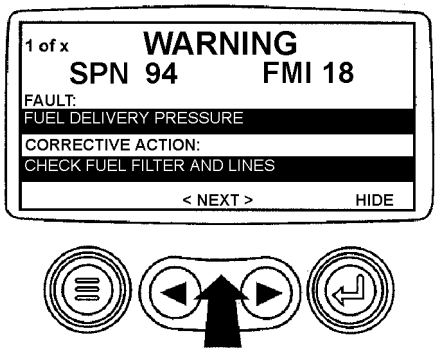
IMPORTANT: Ignoring active trouble codes can result in severe engine damage.



Active Trouble Codes Displayed

OURGP11,00000AD -19-11OCT06-2/7

3. If the word "Next" appears above the arrow keys, there are more trouble codes that can be viewed by using the arrow keys to scroll to the next trouble code.



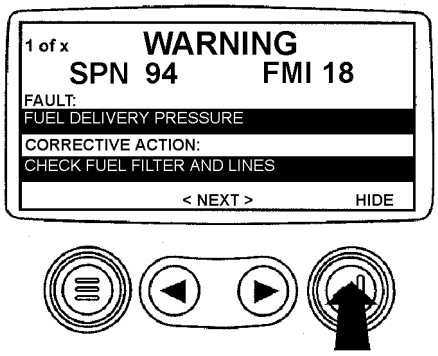
Use Arrow Keys To Scroll

Continued on next page

OURGP11,00000AD -19-11OCT06-3/7

IMPORTANT: Ignoring active trouble codes can result in severe engine damage.

4. To acknowledge and hide the code and return to the single or four parameter display, press the "Enter" Key.

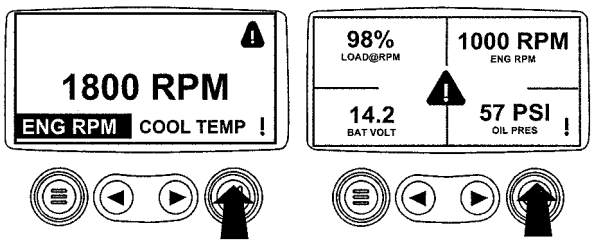


RG13242 —UN—30SEP03

Hide Trouble Codes

OURGP11,00000AD -19-11OCT06-4/7

5. The display will return to the single or four parameter display, but the display will contain the warning icon. Pressing the "Enter" key will redisplay the hidden trouble code.



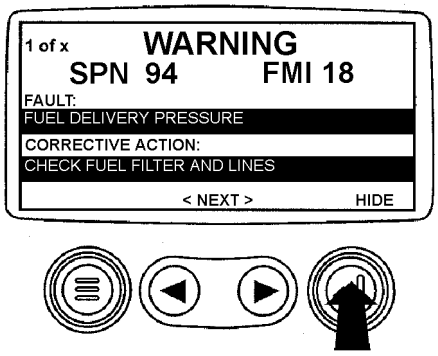
RG13176 —UN—26SEP03

Active Trouble Code Icon

OURGP11,00000AD -19-11OCT06-5/7

IMPORTANT: Ignoring active trouble codes can result in severe engine damage.

6. Pressing the "Enter" key once again will hide the trouble code and return the screen to the single or four parameter display.

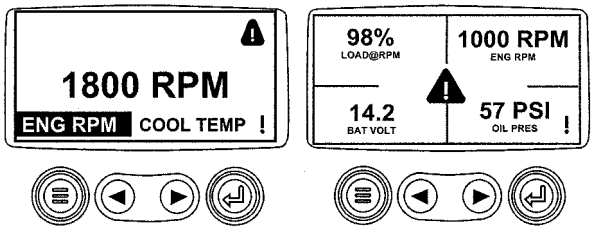


RG13242 —UN—30SEP03

Enter Key

OURGP11,00000AD -19-11OCT06-6/7

7. The single or four parameter screen will display the warning icon until the trouble code condition is corrected.



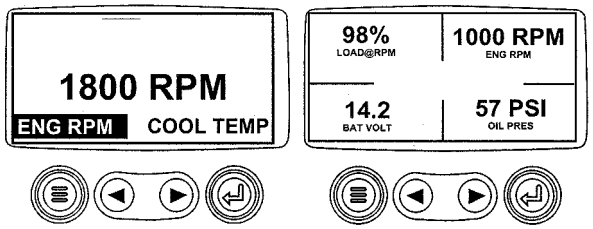
RG13243 —UN—01OCT03

Active Trouble Code Condition

OURGP11,00000AD -19-11OCT06-7/7

Engine Shutdown Codes

1. During normal operation the single or four parameter screen will be displayed.



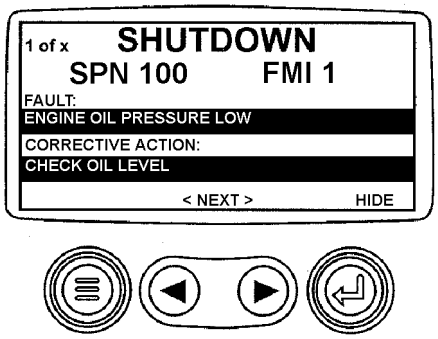
RG13172 —UN—26SEP03

Normal Operation

OURGP11,00000AE -19-11OCT06-1/6

2. When the diagnostic gauge receives a severe trouble code from an engine control unit, the single or four parameter screen will be replaced with the "Shutdown" message. The SPN and FMI number will be displayed along with a description of the problem and the corrective action needed.

   If the word "Next" appears above the arrow keys, there are more trouble codes that can be viewed by using the arrow keys to scroll to the next trouble code.



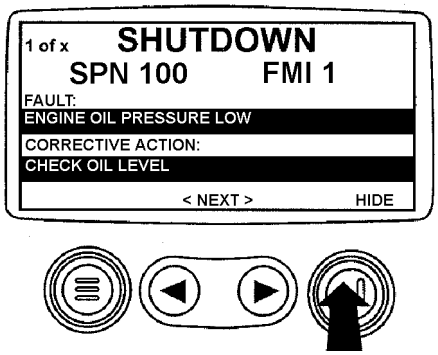
RG13238 —UN—29SEP03

Shutdown Message

OURGP11,00000AE -19-11OCT06-2/6

3. To acknowledge and hide the trouble code and return to the single or four parameter display, press the "Enter" key".

IMPORTANT: Ignoring the shutdown message can result in severe engine damage.



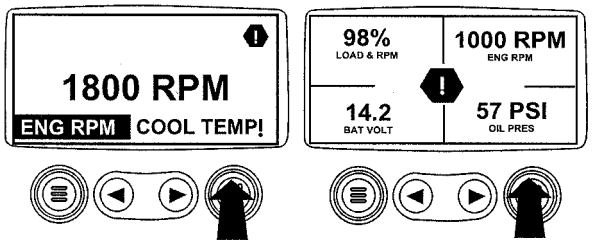
RG13239 —UN—29SEP03

Hide Trouble Code

OURGP11,00000AE -19-11OCT06-3/6

4. The display will return to the single or four parameter display, but the display will contain the "Shutdown" icon. Pressing the "Enter" key will redisplay the hidden trouble code.

IMPORTANT: Ignoring the shutdown message can result in severe engine damage.



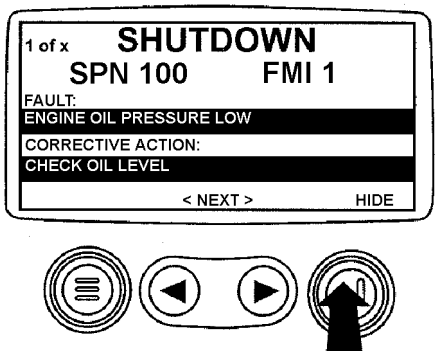
RG13179 —UN—26SEP03

Flashing Shutdown Icon

Continued on next page

OURGP11,00000AE -19-11OCT06-4/6

5. Pressing the "Enter" key once again will hide the trouble code and return the screen to the single or four parameter display.



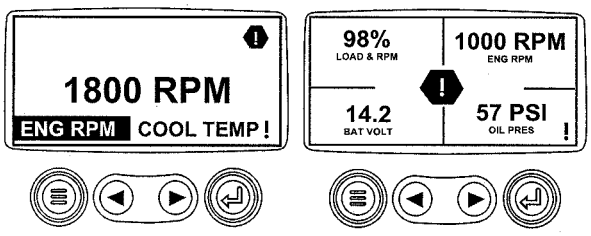
RG13239 —UN—29SEP03

Redisplay Trouble Code

OURGP11,00000AE -19-11OCT06-5/6

6. The single or four parameter screen will display the shutdown icon until the trouble code condition is corrected.

IMPORTANT: Ignoring the shutdown message can result in severe engine damage.



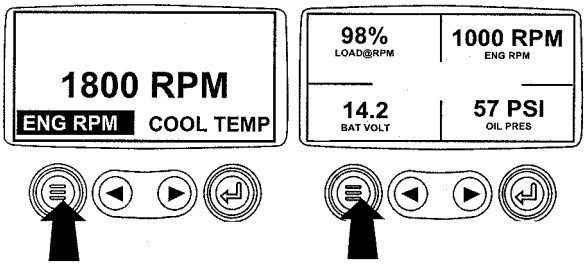
RG13180 —UN—26SEP03

Shutdown Icon

OURGP11,00000AE -19-11OCT06-6/6

Adjusting Backlighting

1. Turn the key switch to the ON position. Starting at the single or four engine parameter display, press the "Menu" key.

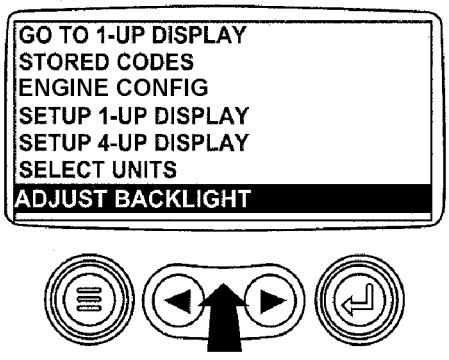


RG13159 —UN—26SEP03

Menu Key

OURGP11,0000237 -19-23AUG10-1/6

2. The main menu will be displayed. Use the "Arrow" keys to scroll through the menu until "Adjust Backlight" is highlighted.



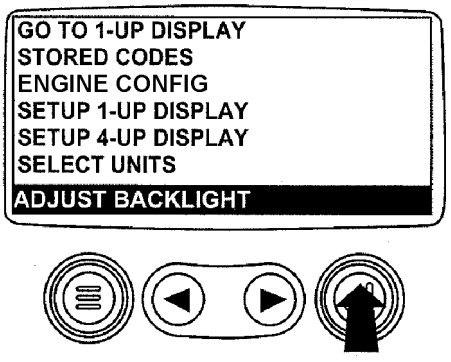
RG13181 —UN—02OCT03

Select Adjust Backlight

Continued on next page

OURGP11,0000237 -19-23AUG10-2/6

3. Once the "Adjust Backlight" menu item has been highlighted, press the "Enter" key to activate the "Adjust Backlight" function.

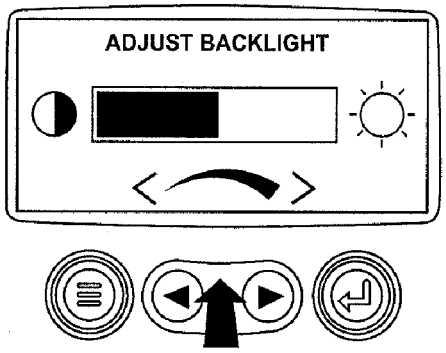


RG13182 —UN—02OCT03

Press Enter Key

OURGP11,0000237 -19-23AUG10-3/6

4. Use the "Arrow" keys to select the desired backlight intensity.

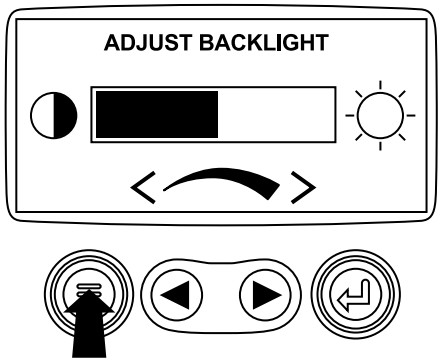


RG13183 —UN—29SEP03

Adjust Backlight Intensity

OURGP11,0000237 -19-23AUG10-4/6

5. Press the "Menu" key to return to the main menu.



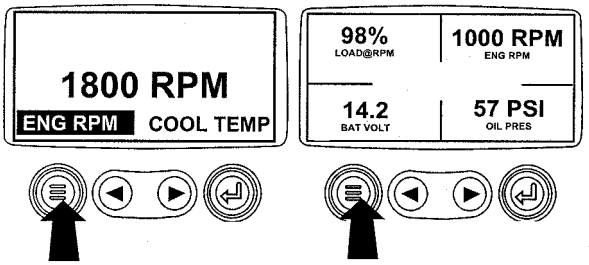
RG19048 —UN—23AUG10

Return to Main Menu

Continued on next page

OURGP11,0000237 -19-23AUG10-5/6

6. Press the "Menu" key to exit the main menu and return to the engine parameter display.

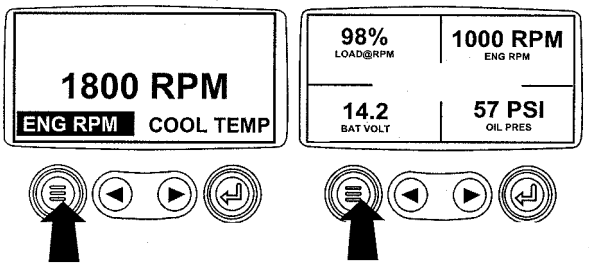


Exit Main Menu

OURGP11,0000237 -19-23AUG10-6/6

Adjusting Contrast

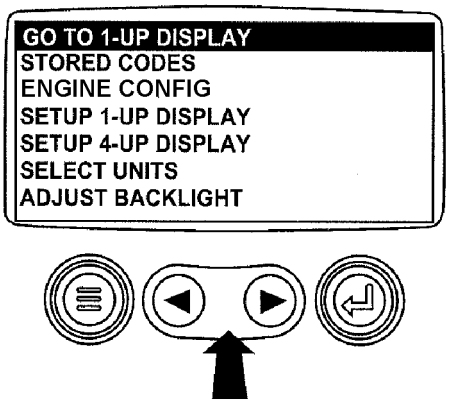
1. Turn the key switch to the ON position. Starting at the single or four engine parameter display press the "Menu" key.



Menu Key

OURGP11,00000AF -19-11OCT06-1/6

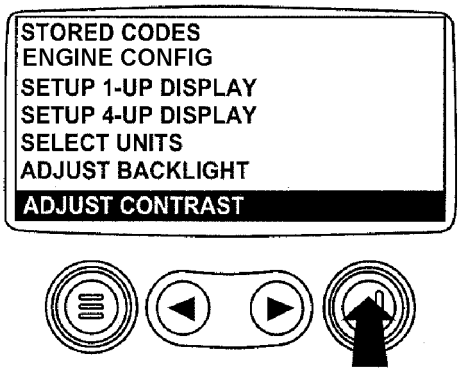
2. The main menu will be displayed. Use the "Arrow" keys to scroll through the menu until "Adjust Contrast" is highlighted.



Select Adjust Contrast

OURGP11,00000AF -19-11OCT06-2/6

3. Once the "Adjust Contrast" menu item has been highlighted, press the "Enter" key to activate the "Adjust Contrast" function.

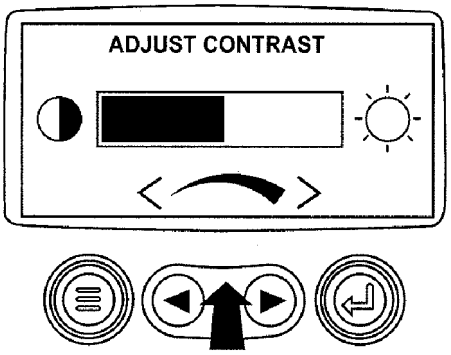


Press Enter Key

Continued on next page

OURGP11,00000AF -19-11OCT06-3/6

4. Use the "Arrow" keys to select the desired contrast intensity.

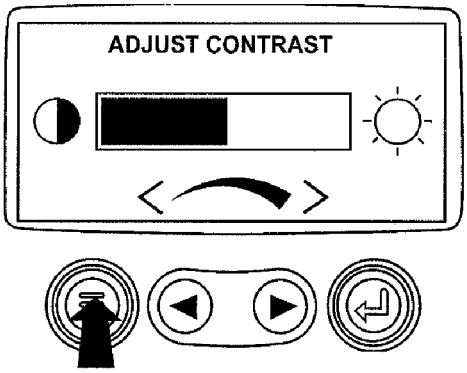


RG13186 —UN—29SEP03

Adjust Contrast Intensity

OURGP11,00000AF -19-11OCT06-4/6

5. Press the "Menu" key to return to the main menu.

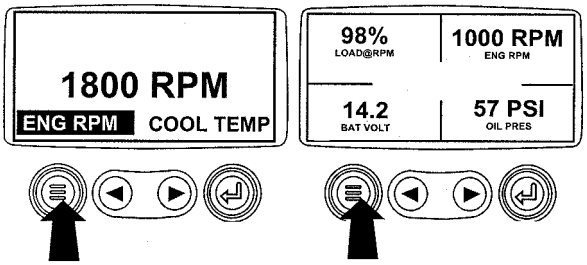


RG13187 —UN—26SEP03

Return To Main Menu

OURGP11,00000AF -19-11OCT06-5/6

6. Press the "Menu" key to exit the main menu and return to the engine parameter display.



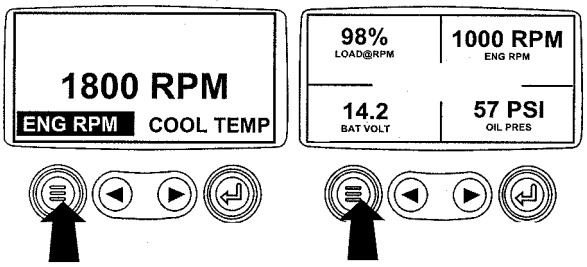
RG13159 —UN—26SEP03

Exit Main Menu

OURGP11,00000AF -19-11OCT06-6/6

Selecting Units Of Measurement

1. Turn the key switch to the ON position. Starting at the single or four engine parameter display, press the "Menu" key.



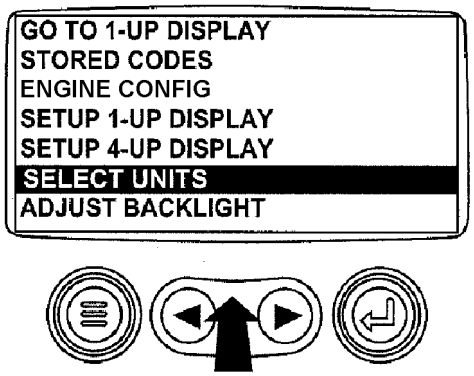
RG13159 —UN—26SEP03

Menu Key

Continued on next page

OURGP11,00000B0 -19-11OCT06-1/7

2. The main menu will be displayed. Use the "Arrow" keys to scroll through the menu until "Select Units" is highlighted.

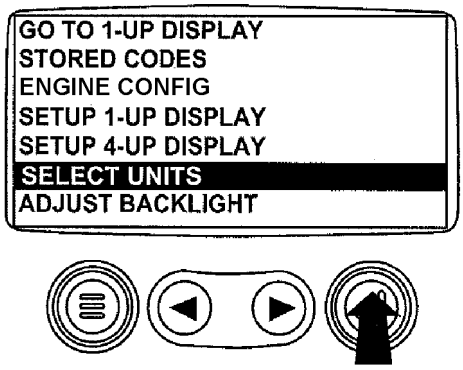


RG13188 —UN—02OCT03

Select Units

OURGP11,00000B0 -19-11OCT06-2/7

3. Once the "Select Units" menu item has been highlighted press the "Enter" key to access the "Select Units" function.



RG13189 —UN—02OCT03

Press Enter Key

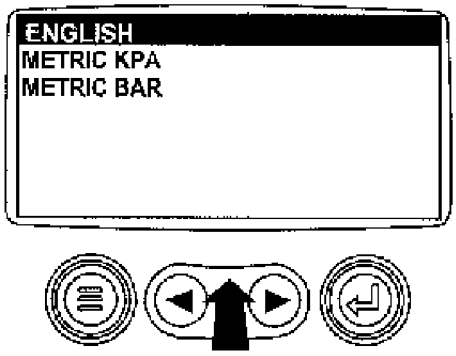
OURGP11,00000B0 -19-11OCT06-3/7

4. There are three choices for units of measurement, English, Metric kPa or Metric Bar.

   English is for Imperial units, with pressures displayed in PSI and temperatures in °F.

   Metric kPa and Metric bar are for IS units, with pressures displayed in kPa and bar respectively, and temperatures in °C.

   Use the "Arrow" keys to highlight the desired units of measurement.



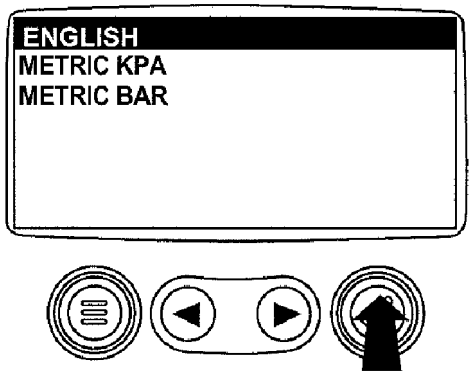
RG13190 —UN—26SEP03

Select Desired Units

Continued on next page

OURGP11,00000B0 -19-11OCT06-4/7

5. Press the "Enter" key to select the highlighted units.

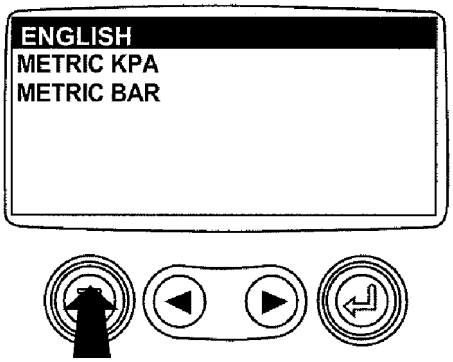


RG13191 —UN—30SEP03

Press Enter Key to Select

OURGP11,00000B0 -19-11OCT06-5/7

6. Press the "Menu" key to return to the main menu.

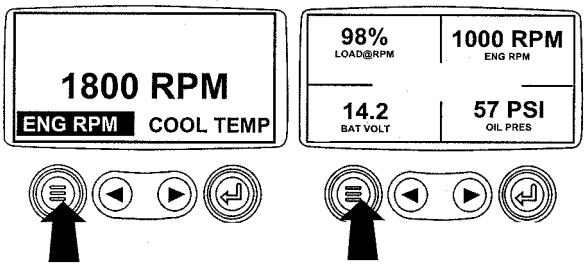


RG13192 —UN—26SEP03

Return To Main Menu

OURGP11,00000B0 -19-11OCT06-6/7

7. Press the "Menu" key to return to the engine parameter display.



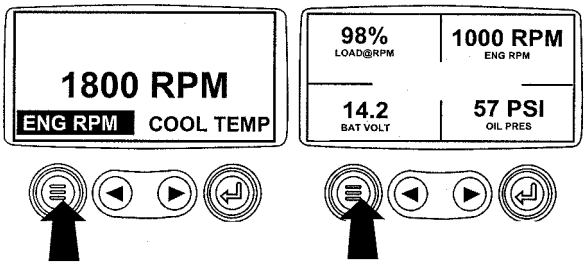
RG13159 —UN—26SEP03

Press Menu Key

OURGP11,00000B0 -19-11OCT06-7/7

Setup 1-Up Display

1. Turn the key switch to the ON position. Starting at the single engine parameter display, press the "Menu" key.



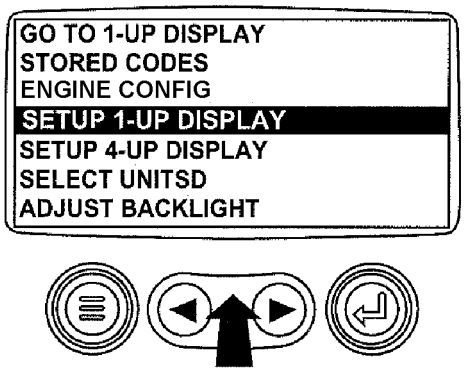
RG13159 —UN—26SEP03

Menu Key

Continued on next page

OURGP11,00000B1 -19-11OCT06-1/18

2. Use the "Arrow" keys to scroll through the menu until "Setup 1-Up Display" is highlighted.

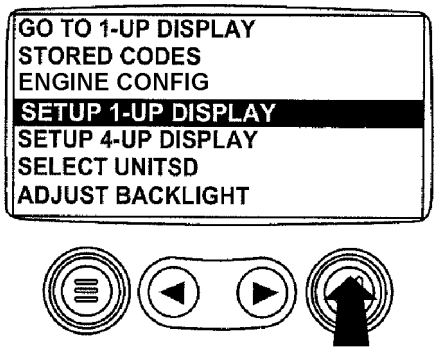


RG13193 —UN—02OCT03

Setup 1-Up Display

OURGP11,00000B1 -19-11OCT06-2/18

3. Once "Setup 1-Up Display" menu item has been highlighted press the "Enter" key to access the "Setup 1-Up Display" function.

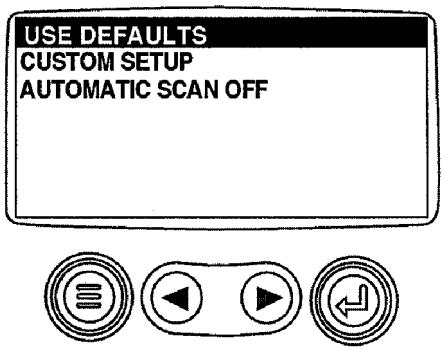


RG13194 —UN—02OCT03

Press Enter Key

OURGP11,00000B1 -19-11OCT06-3/18

4. Three options are available for modification of the 1-Up Display.
   a. **Use Defaults** – This option contains the following engine parameters for display: Engine Hours, Engine Speed, Battery Voltage, % Load, Coolant Temperature and Oil Pressure.
   b. **Custom Setup** – This option contains a list of engine parameters. Engine parameters from this list can be selected to replace any or all of the default parameters. This option can be used to add parameters available for scrolling in the 1-Up Display.
   c. **Automatic Scan** – Selecting the scan function will allow the 1-Up Display to scroll through the selected set of parameters one at a time, momentarily pausing at each.



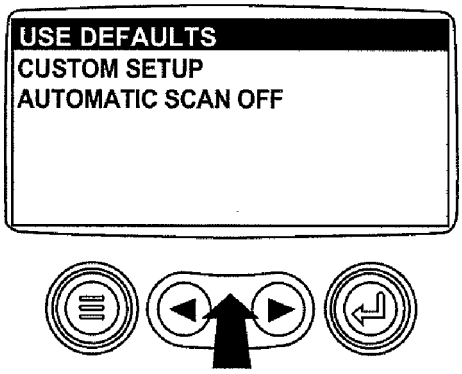
RG13196 —UN—26SEP03

1-Up Display Options

Continued on next page

OURGP11,00000B1 -19-11OCT06-4/18

5. **Use Defaults** - To select "Use Defaults" use the Arrow keys to scroll to and highlight "Use Defaults" in the menu display.

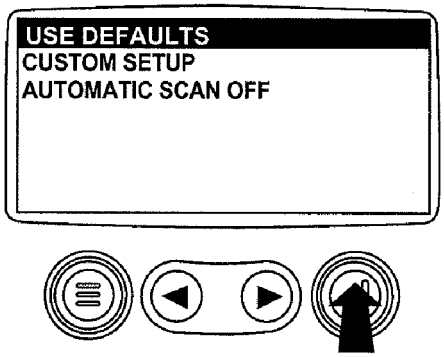


RG13195 —UN—26SEP03

Select Defaults

OURGP11,00000B1 -19-11OCT06-5/18

6. Press the "Enter" key to activate the "Use Defaults" function.

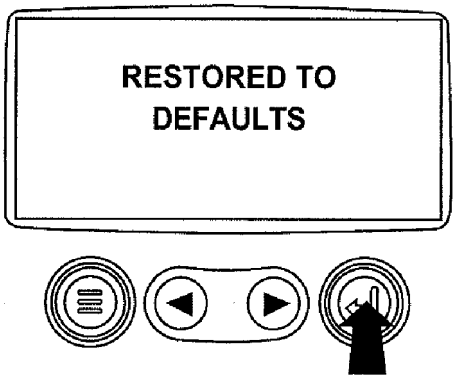


RG13197 —UN—29SEP03

Defaults Selected

OURGP11,00000B1 -19-11OCT06-6/18

7. The display parameters are reset to the factory defaults, then the display will return to the "Setup 1-Up Display" menu.



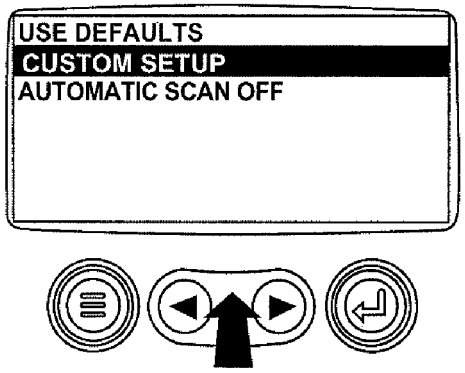
RG13149 —UN—24SEP03

Restored To Defaults

Continued on next page

OURGP11,00000B1 -19-11OCT06-7/18

8. **Custom Setup** - To perform a custom setup of the 1-Up Display, use the arrow buttons to scroll to and highlight "Custom Setup" on the display.

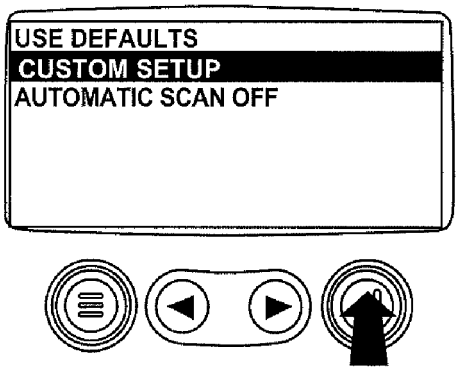


RG13198 —UN—26SEP03

Select Custom Setup

OURGP11,00000B1 -19-11OCT06-8/18

9. Press the "Enter" key to display a list of engine parameters.

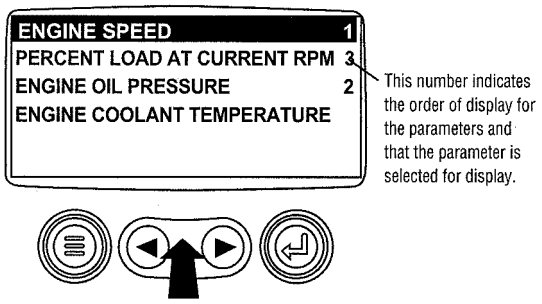


RG13199 —UN—26SEP03

Engine Parameters

OURGP11,00000B1 -19-11OCT06-9/18

10. Use the "Arrow" keys to scroll to and highlight a selected parameter (parameter with a number to right of it).



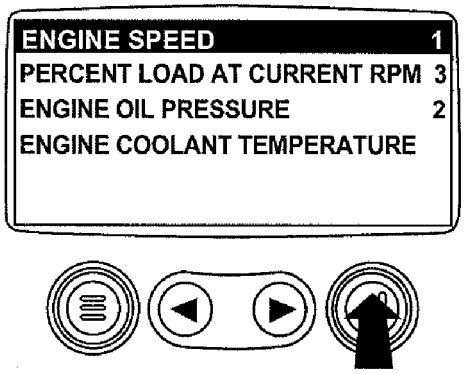
RG13150 —UN—24SEP03

Select Parameters

Continued on next page

OURGP11,00000B1 -19-11OCT06-10/18

11. Press the "Enter" key to deselect the selected parameter, removing it from the list of parameters being displayed on the 1-Up Display.

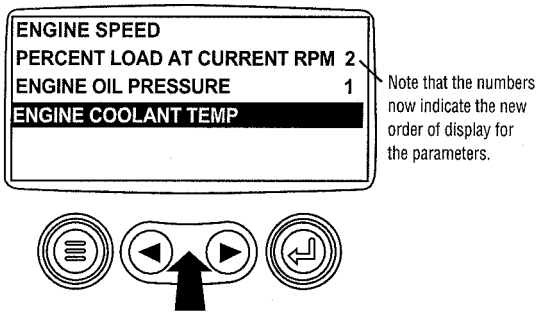


RG13219 —UN—26SEP03

Deselect Parameters

OURGP11,00000B1 -19-11OCT06-11/18

12. Use the "Arrow" keys to scroll and highlight the desired parameter that has not been selected for display (parameter without a number to right of it).

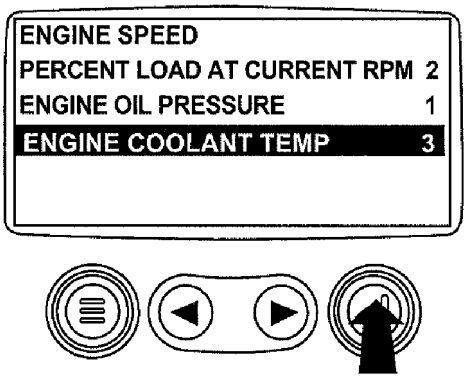


RG13151 —UN—24SEP03

Select Desired Parameters

OURGP11,00000B1 -19-11OCT06-12/18

13. Press the "Enter" key to select the parameter for inclusion in the Single Engine Parameter Display.
14. Continue to scroll through and select additional parameters for the custom 1-Up Display. Press the "Menu" key at any time to return to the "Custom Setup" menu.



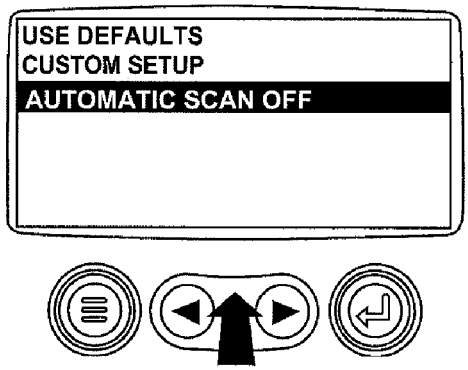
RG13220 —UN—26SEP03

Select Parameters For Display

Continued on next page

OURGP11,00000B1 -19-11OCT06-13/18

15. **Automatic Scan** - Selecting the scan function will allow the 1- Up Display to scroll through the selected set of parameters one at a time. Use the "Arrow" keys to scroll to the "Automatic Scan" function.

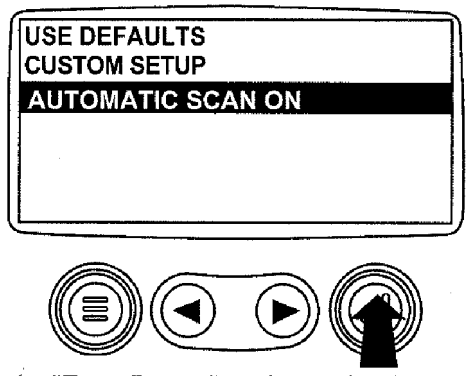


RG13221 —UN—26SEP03

Automatic Scan Off

OURGP11,00000B1 -19-11OCT06-14/18

16. Press the "Enter" key to toggle the "Automatic Scan" function on.

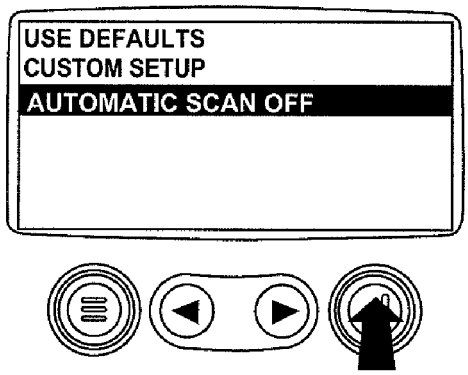


RG13222 —UN—26SEP03

Automatic Scan On

OURGP11,00000B1 -19-11OCT06-15/18

17. Press the "Enter" key again to toggle the "Automatic Scan" function off.



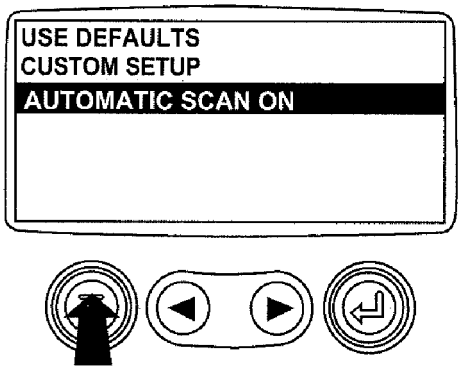
RG13223 —UN—26SEP03

Automatic Scan Off

Continued on next page

OURGP11,00000B1 -19-11OCT06-16/18

18. Once the "Use Defaults", "Custom Setup" and "Automatic Scan" functions have been set, press the "Menu" key to return to the main menu.

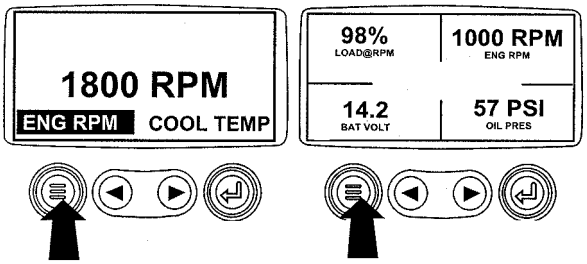


RG13224 —UN—26SEP03

Menu Key

OURGP11,00000B1 -19-11OCT06-17/18

19. Press the "Menu" key to exit the main menu and return to the engine parameter display.



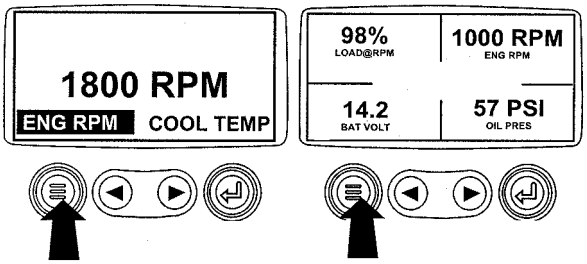
RG13159 —UN—26SEP03

Exit Main Menu

OURGP11,00000B1 -19-11OCT06-18/18

Setup 4-Up Display

1. Turn the key switch to the ON position. From the single or four engine parameter display, press the "Menu" key.

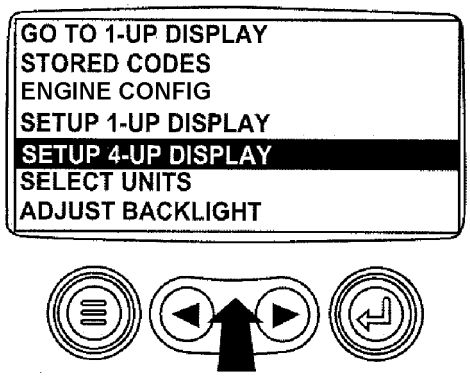


RG13159 —UN—26SEP03

Menu Key

OURGP11,00000B2 -19-11OCT06-1/14

2. The main menu will be displayed. Use the "Arrow" keys to scroll through the menu until "Setup 4-Up Display" is highlighted.



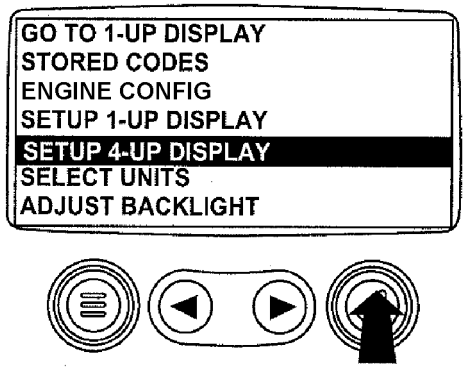
RG13225 —UN—02OCT03

Select Setup 4-Up Display

Continued on next page

OURGP11,00000B2 -19-11OCT06-2/14

3. Once the "Setup 4-Up Display" menu item has been highlighted, press the "Enter" key to activate the "Setup 4-Up Display" menu.

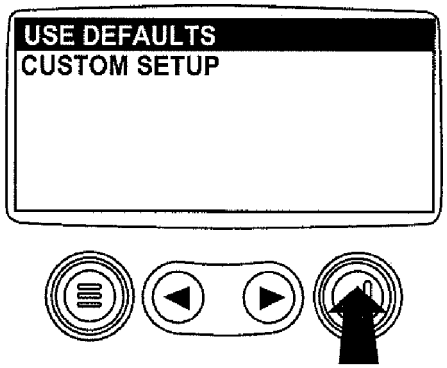


RG13226 —UN—02OCT03

Press Enter Key

OURGP11,00000B2 -19-11OCT06-3/14

4. Two options are available for the 4-Up Display.
   a. **Use Defaults** – This option contains the following engine parameters for display: Engine Speed, Battery Voltage, Coolant Temperature and Oil Pressure.
   b. **Custom Setup** – This option contains a list of engine parameters. Engine parameters from this list can be selected to replace any or all of the default parameters.

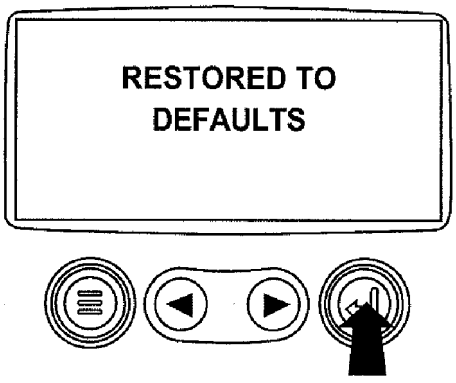


RG13244 —UN—02OCT03

Select Factory Defaults

OURGP11,00000B2 -19-11OCT06-4/14

5. To reset the display parameters to the factory defaults, scroll to and highlight "Use Defaults". Press the "Enter" key to activate the "Use Defaults" function. A message indicating the display parameters are reset to the factory defaults will be displayed, then the display will return to the "Setup 4-Up Display" menu.



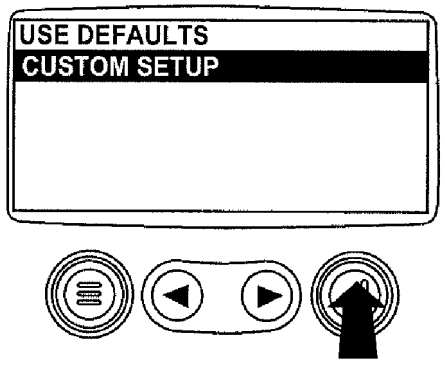
RG13149 —UN—24SEP03

Restored To Defaults

Continued on next page

OURGP11,00000B2 -19-11OCT06-5/14

6. **Custom Setup** - To perform a custom setup of the 4-Up Display, use the arrow buttons to scroll to and highlight "Custom Setup" on the display.

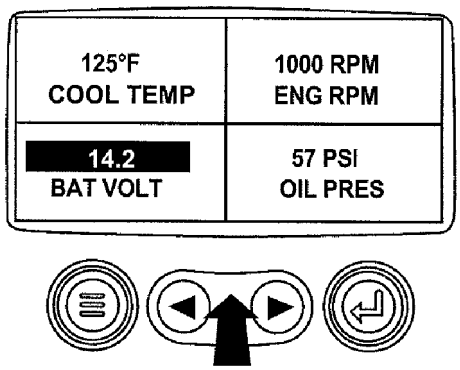


RG13227 —UN—26SEP03

Custom Setup

OURGP11,00000B2 -19-11OCT06-6/14

7. The quadrant with the highlighted parameter value is the current selected parameter. Use the "Arrow" keys to highlight the value in the quadrant you wish to change to a new parameter.

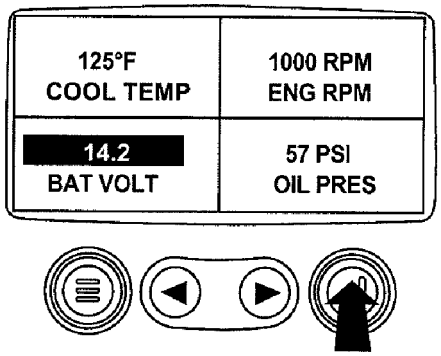


RG13228 —UN—26SEP03

Select Parameters

OURGP11,00000B2 -19-11OCT06-7/14

8. Press the "Enter" key and a list of engine parameters will be displayed.



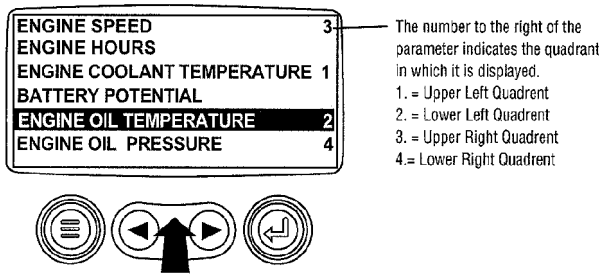
RG13229 —UN—26SEP03

List Of Engine Parameters

Continued on next page

OURGP11,00000B2 -19-11OCT06-8/14

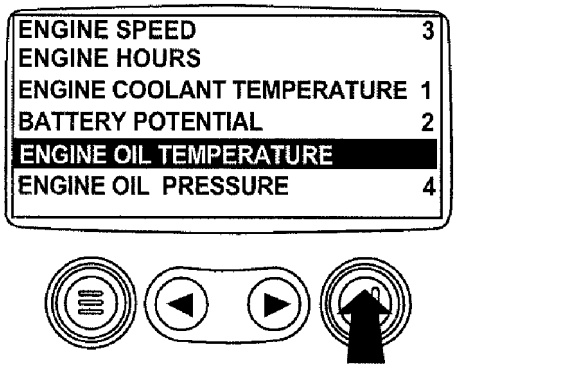
9. The parameter that is highlighted is the selected parameter for the screen. Use the "arrow" keys to highlight the new parameter to be placed in the "4-Up Display".



Select Desired Engine Parameter

OURGP11,00000B2 -19-11OCT06-9/14

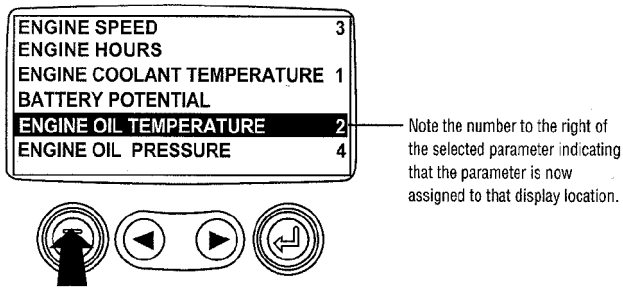
10. Press the "Enter" key to change the selected parameter in the quadrant to the new parameter.



Enter Selected Parameter

OURGP11,00000B2 -19-11OCT06-10/14

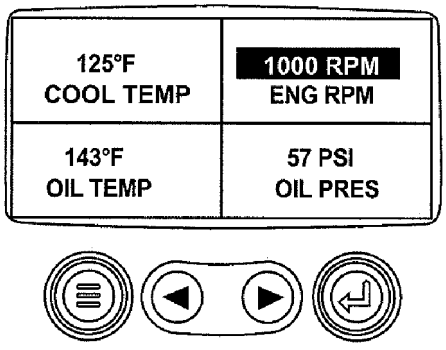
11. Use the "Menu" keys to return to the "4-Up Custom Setup" screen.



Return To 4-Up Custom Setup

OURGP11,00000B2 -19-11OCT06-11/14

12. The selected quadrant has now changed to the new selected parameter.

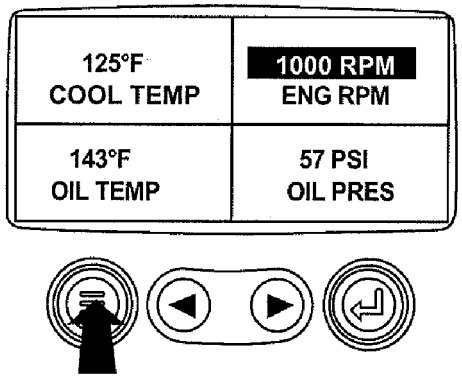


4-Up Display

Continued on next page

OURGP11,00000B2 -19-11OCT06-12/14

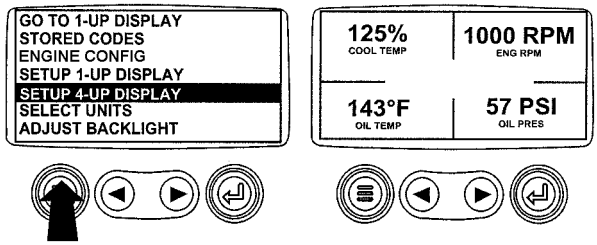
13. Repeat the parameter selection process until all spaces are as desired.
14. Press the "Menu" key to return to the main menu.



Return To Main Menu

OURGP11,00000B2 -19-11OCT06-13/14

15. Press the "Menu" key to exit the main menu and return to the engine parameter display.



Select Remaining Parameters

OURGP11,00000B2 -19-11OCT06-14/14

John Deere PowerSight

John Deere PowerSight is a web based service that allows remote access to machine data. John Deere PowerSight is accessible from a laptop, desktop or mobile device.

John Deere PowerSight works by combining a controller that includes cellular communication and GPS antennas. Machine data is collected by the controller and wirelessly transferred to a data server, where it is made available on a website.

John Deere PowerSight allows you to:

- Stay informed on machine location and hours
- Protect assets with Geofence and Curfew alerts
- Keep assets running with maintenance tracking and preventive maintenance plans
- Track and analyze machine and fuel usage
- Conduct remote machine diagnostics and programming

For more information and availability, contact an authorized John Deere dealer or servicing dealer.

BL90236,0000031 -19-13FEB14-1/1

Break-In Service

1. This engine is factory-filled with John Deere Break-In Plus oil. Operate the engine at heavy loads with minimal idling during the break-in period.
2. If the engine has significant operating time at idle, constant speeds, and light load usage, or make-up oil is required in the first 100 hour period, a longer break-in period may be required. In these situations, there are two acceptable options. 1. Drain the oil and replace with fresh Break-In Plus oil and a new John Deere oil filter (recommended). 2. Continue running the engine with the same oil and filter for up to a maximum of 500 hours.
3. Check engine oil by pulling out the oil dipstick located the right side of engine. Check oil more frequently during engine break-in period. If oil must be added during this period, John Deere Break-In Plus Oil is preferred. See John Deere Break-In™ Plus Engine Oil in the Fuels, Lubricants, and Coolants Section for other oils allowed.

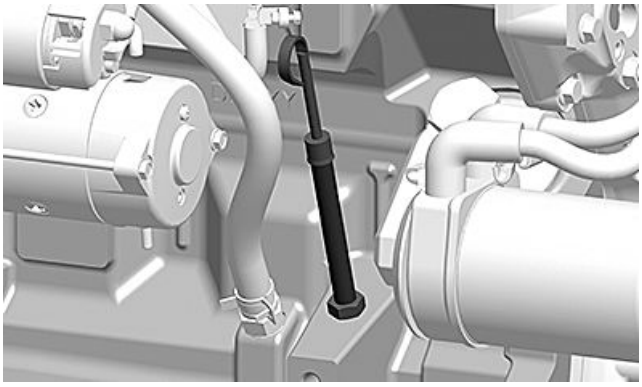
IMPORTANT: DO NOT fill above the top of the crosshatch pattern or the FULL mark, whichever is present. Oil levels anywhere within crosshatch are considered in the acceptable operating range.

4. During the first 20 hours, avoid prolonged periods of engine idling or sustained maximum load operation.
5. If engine idles longer than 5 minutes, stop engine.
6. During the initial operation of a new or rebuilt engine with Break-In Plus, change the oil and filter between a minimum of 100 hours and a maximum of up to 500 hours. See Changing Engine Oil and Replacing Filter in the Lubrication & Maintenance — 500 Hours/12 Months Section. Fill crankcase with seasonal viscosity grade oil. See Diesel Engine Oil in the Fuels, Lubricants, and Coolants Section.

NOTE: Some increase in oil consumption may be expected when low viscosity oils are used. Check oil levels more frequently.

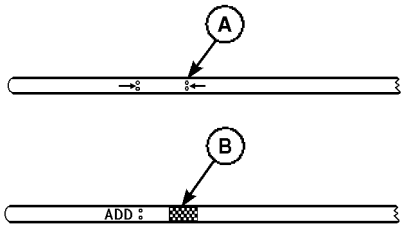
If air temperature is less than 0°C (32°F), use cold weather starting aids. See Cold Weather Operation in the Engine Operation Section.

If air temperature is less than 0°C (32°F), use an engine block heater.



RG26396 —UN—16SEP14

Check Engine Oil Level



RG11528 —UN—01DEC00

Dipstick Markings

A—Full Mark **B—Crosshatch**

7. Watch coolant temperature and oil pressure gauges closely during engine operation. If gauge does not indicate more than minimum oil pressure specification, stop the engine and determine the cause. If coolant temperature rises above 113°C (235°F), the engine reduces power automatically. Unless temperature drops quickly, stop the engine and determine the cause before resuming operation.

   Monitor oil pressure and coolant temperature specifications.

	Specification
Engine —Oil Pressure at Rated Speed	357 kPa (3.57 bar) (52 psi)
Minimum Oil Pressure at Low Idle	254 kPa (2.54 bar) (37 psi)
Coolant Temperature Range	83—95°C (181—203°F)

8. Check belt for proper alignment and seating in pulley grooves.

ZE59858,000004C -19-16SEP14-1/1

Generator Set (Standby) Applications

To assure that your engine will deliver efficient standby generator operation when needed, start engine and run at rated speed (with 50%—70% load) for 30 minutes every 2 weeks. DO NOT allow engine to run for an extended period of time with no load.

Biodiesel fuel is not recommended for standby equipment that can have minimal fuel consumption (such as standby generators, fire protection, etc.). For standby applications, use only petroleum based diesel fuel with John Deere approved fuel conditioners and additives. For fuel conditioners and additives, check with your local John Deere dealer.

Petroleum diesel fuel should not be stored in service tanks longer than two years even when using fuel additives. See your fuel distributor or John Deere dealer for more information.

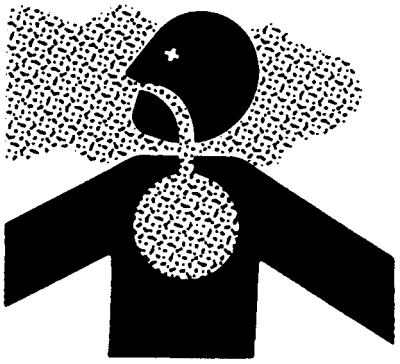
RK80614,0000009 -19-16OCT12-1/1

Starting the Engine

NOTE: The controls and instruments for your engine may be different from those shown here; always follow manufacturer's instructions.

The following instructions apply to the optional controls and instruments available through the John Deere Parts Distribution Network.

CAUTION: Before starting engine in a confined building, install proper outlet exhaust ventilation equipment. Always use safety approved fuel storage and piping.



TS220 —UN—15APR13

Use Proper Ventilation

NOTE: If temperature is below 0 °C (32 °F), it may be necessary to use cold weather starting aids. See Cold Weather Operation in the Engine Operation Section.

1. Perform all prestarting checks. See Daily Prestarting Checks in the Lubrication & Maintenance - Daily Section.
2. Open the fuel supply shutoff valve, if equipped.
3. Disengage power (or clutch if equipped) to any engine drive lines.

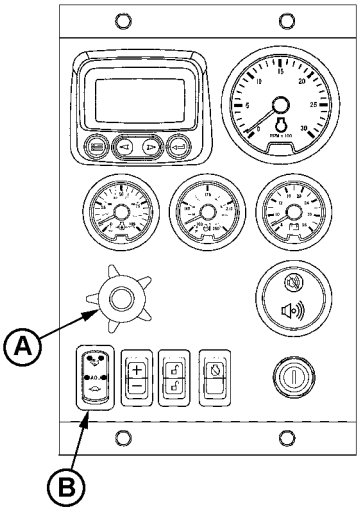
ZE59858,0000297 -19-15SEP14-1/3

4. Set slow idle as follows:

   Panels with high-low speed select rocker switch (B) only: Set slow speed by pressing lower half of switch.

   Panels with optional analog throttle(s) (A) : Set high-low speed select rocker switch to slow (turtle), then push in on analog throttle handle or turn full counterclockwise to set analog throttle(s) to slow speed.

IMPORTANT: Do not operate the starter for more than 30 seconds at a time. To do so may overheat the starter. If the engine does not start the first time, wait at least 2 minutes before trying again. If engine does not start after four attempts, see Troubleshooting Section.



RG13722 —UN—11NOV04

A—Analog Throttle Control (Optional)

B—Speed Select Rocker Switch

Analog Throttle Control and Speed Select Switch

Continued on next page

ZE59858,0000297 -19-15SEP14-2/3

5. Turn the key start switch (A) clockwise to the “ON” position. Wait until the Engine Preheater Indicator light turns off, then turn the key start switch clockwise “START” position to crank the engine. (In cold weather, preheater indicator light remains on longer while engine is warmed. See Cold Weather Operation in the Engine Operation Section.) When the engine starts, release the key switch so that it returns to the “ON” position.

IMPORTANT: If the key switch is released before the engine starts, wait until the starter and the engine stop turning before trying again. This will prevent possible damage to the starter and/or flywheel.

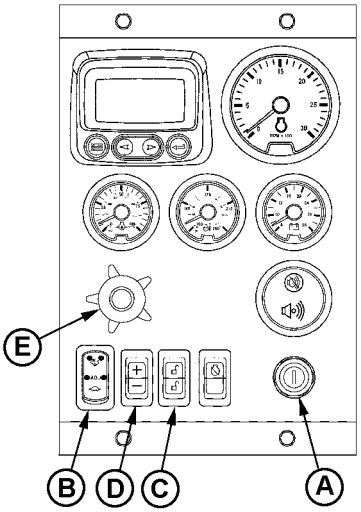
6. After engine starts, idle engine at not more than 1200 rpm until warm. See Warming Engine in the Engine Operation Section.

   Panels with high-low speed select rocker switch (B) only: Set rpm using bump speed enable switch (C) with speed select rocker switch (D).

   Panels with optional analog throttle (E): Set either high-low speed select switch (B) or analog throttle (E) to slow speed, and set desired speed with remaining control. See Changing Engine Speed in the Engine Operation Section.

NOTE: Engine Control Unit (ECU) reads the higher of the high-low speed select rocker switch or the analog throttle speed settings.

7. Check all gauges for normal engine operation. If operation is not normal, stop the engine and determine the cause. For normal gauge pressures and temperatures, see Break-In Service in the Engine Operation Section.



RG13723 —UN—11NOV04

Start And Idle Engine Controls On Instrument Panel

A—Key Start Switch
B—High-Low Speed Select Rocker Switch
C—Bump Speed Enable Rocker Switch
D—Speed Select Rocker Switch
E—Analog Throttle Control (Optional)

ZE59858,0000297 -19-15SEP14-3/3

Normal Engine Operation

Observe engine coolant temperature and engine oil pressure. Temperatures and pressures vary between engines and with changing operating conditions, temperatures, and loads.

Normal engine coolant operating temperature range is 83°—95°C (181°—203°F). If coolant temperature rises above 113°C (235°F), reduce load on engine. Unless temperature drops quickly, stop engine and determine cause before resuming operation.

Normal engine oil pressure at slow idle should be at least 254 kPa (2.54 bar) (37 psi) and should rise to at least 357 kPa (3.57 bar) (52 psi) at rated RPM.

Operate the engine under a lighter load and at slower than normal speed for first 15 minutes after start-up. DO NOT run engine at slow idle.

IMPORTANT: Should the engine die while operating under load, immediately remove load and restart the engine. Overheating of the turbocharger parts may occur when oil flow is stopped.

Stop engine immediately if there are any signs of part failure. Some early signs of engine problems are:

- Sudden drop in oil pressure
- Abnormal coolant temperatures
- Unusual noise or vibration
- Sudden loss of power
- Excessive fuel consumption
- Excessive oil consumption
- Fluid leaks

ZE59858,000004D -19-15SEP14-1/1

Warming Engine

IMPORTANT: To assure proper lubrication, operate engine at or below 1200 rpm with no load for 1–2 minutes. Extend this period 2–4 minutes when operating at temperatures below freezing.

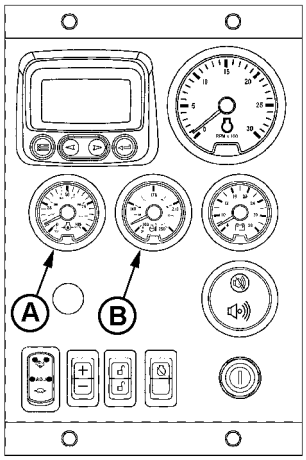
Engines used in generator set applications where the governor is locked at a specified speed may not have a slow idle function. Operate these engines at fast idle for 1—2 minutes before applying the load. This procedure does not apply to standby generator sets where the engine is loaded immediately upon reaching rated speed.

1. Check oil pressure gauge (A) as soon as engine starts. If oil pressure gauge does not increase to more than minimum oil pressure specification, 254 kPa (2.54 bar) (37 psi) within 5 seconds, stop the engine and determine the cause. Normal engine oil pressure is measured at slow idle (850 rpm) and rated full load speed (1800–2500 rpm).

Specification

Oil Pressure—Pressure.....254—357 kPa (2.54—3.57 bar) (37—52 psi)

2. Watch coolant temperature gauge (B). Do not place engine under full load until it is properly warmed up. The normal engine coolant temperature range is 83°–95°C (181°–203°F).



RG13724 —UN—11NOV04

Oil Pressure and Coolant Temperature Gauges On Panel

A—Engine Oil Pressure Gauge **B—Engine Coolant Temperature Gauge**

NOTE: It is a good practice to operate the engine under a lighter load and at lower speeds than normal for the first few minutes after start-up.

ZE59858,000004E -19-15SEP14-1/1

Idling Engine

Avoid excessive engine idling. Prolonged idling may cause the engine coolant temperature to fall below its normal range. This in turn, causes crankcase oil dilution, due to incomplete fuel combustion and permits formation of gummy deposits on valves, pistons and piston rings. It also promotes rapid accumulation of engine sludge and unburned fuel in the exhaust system.

Once an engine is warmed to normal operating temperatures, engine should be idled at slow idle speed. If an engine will be idling for more than five minutes, stop and restart later.

NOTE: Generator set application engines will idle at no load governed speed (high idle).

ZE59858,0000304 -19-07JAN14-1/1

Changing Engine Speed

NOTE: On engines with **2-position** *throttles, speeds are not adjustable. These throttles allows operation only at the preset rated speed or at idle using the single switch (A).*

Changing from slow to fast speed using Standard High-Low Speed Select Rocker Switch (A) (If Equipped):

- For slow speed, press lower half of switch (indicated by turtle symbol).
- For fast speed, press upper half of switch (indicated by rabbit symbol).

NOTE: To adjust preset fast or slow speeds for High-Low Speed Select Rocker Switch:

1. *Select fast (rabbit) or slow (turtle) position on High-Low Speed Select Rocker Switch (A).*
2. *Press and hold top or bottom half of Bump Speed Enable Rocker Switch (B) while using Speed Select Rocker Switch (C).*
3. *Use Speed Select Rocker Switch (C) to bump engine speed up (+) or down (-).*

NOTE: Once the speed has been set, the Bump Speed Enable Switch (B) must be pressed and released three times within two seconds to commit the new slow or fast speed to memory. If not done, the engine's new slow or fast speed will only be effective until the key switch is shut off. Then the speed will revert to its previous setting.

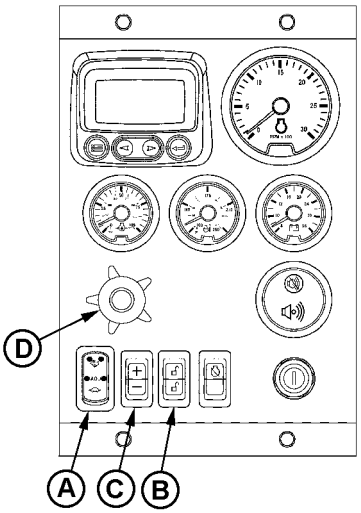
Changing from slow to fast speed using Adjustable High-Low Speed Select Rocker Switch (A) (If Equipped):

Panels have an adjustable **three-position** rocker switch (A) that can be used to select slow idle, fast idle, or an adjustable (“ADJ”) intermediate speed.

- For slow speed, press lower half of rocker switch (indicated by turtle symbol).
- For fast speed, press upper half of rocker switch (indicated by rabbit symbol).

NOTE: To adjust preset fast or slow speeds with adjustable High-Low Speed Select Rocker Switch:

1. *Select middle position (ADJ) or slow (turtle) position on the optional Adjustable Three-State Speed Select Rocker Switch (A).*
2. *Press and hold top or bottom half of Bump Speed Enable Rocker Switch (B) while using Speed Select Rocker Switch (C).*
3. *Use Speed Select Rocker Switch (C) to bump engine speed up (+) or down (-).*



RG13725 —UN—11NOV04

Changing Engine Speed On Panel

A— High-Low Speed Select Rocker Switch
B— Bump Speed Enable Rocker Switch
C— Speed Select Rocker Switch
D— Analog Throttle Control (Optional)

NOTE: Slow (turtle) position is factory preset at low engine idle, while middle (ADJ) position is factory set at high engine idle.

NOTE: Once the speed has been set, the Bump Speed Enable Switch (B) must be pressed and released three times within two seconds to commit the new slow or fast speed to memory. If not done, the engine's new slow or fast speed will only be effective until the key is shut off. Then the speed will revert to its previous setting.

Changing engine speed using optional analog throttle (D)

NOTE: Pushing in on analog throttle will immediately take engine to slow idle speed.

1. Set High-Low Speed Select Rocker Switch (A) to low speed “turtle” position.

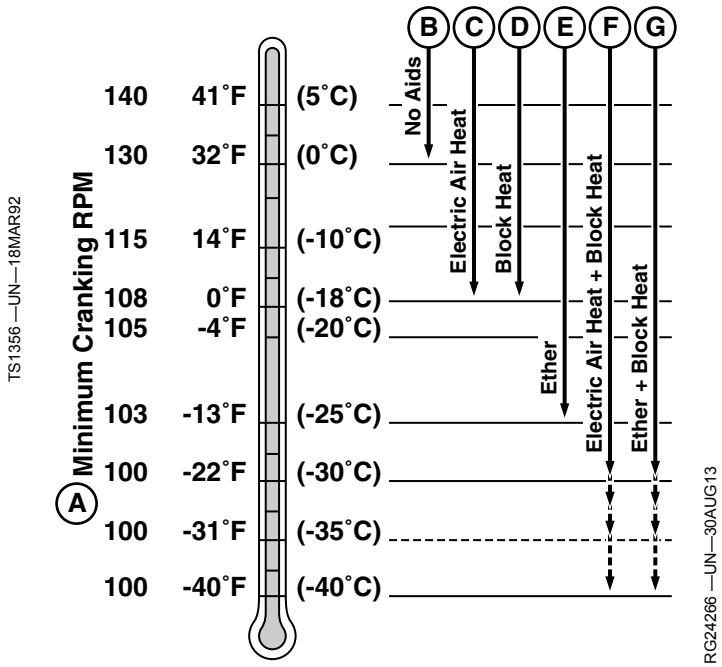
2. Turn analog throttle (D) clockwise to increase speed or counterclockwise to decrease speed.

NOTE: Engine Control Unit (ECU) reads the higher of the High-Low Speed Select Rocker Switch or the Analog Throttle(s) Speed Settings. With High-Low switch at low speed, Analog Throttle(s) will control speed higher than slow idle setting.

ZE59858,000029A -19-14NOV13-1/1

Cold Weather Operation

Starting Fluid is Flammable



Cold Weather Starting Guidelines

A— Minimum Cranking RPM
B— No Aids
C— Electric Air Heat
D— Block Heat
E— Ether
F— Electric Air Heat and Block Heat
G— Ether and Block Heat

CAUTION: Ether is highly flammable. DO NOT use ether when starting an engine equipped with glow plugs or an air intake heater.

DO NOT use starting fluid near fire, sparks, or flames. DO NOT incinerate or puncture a starting fluid container.

IMPORTANT: Engines with Rear PTO -Turn off or unload all pumps, auxiliary drives, and compressors before cold weather starting to reduce drag on engine.

Engines may be equipped with a block heater, coolant heater, or fuel heater as cold weather starting aids.

Starting aids are required below 0 °C (32 °F). They will enhance starting performance above these temperatures and may be needed to start applications that have high parasitic loads during cranking and/or start acceleration to idle.

Using correct grade oil (per engine and machine operators manual) is critical to achieving adequate cold-weather cranking speed. Synthetic oils have improved flow at low temperatures

Other cold weather starting aids are required at temperatures below -25 °C (-13 °F) or at altitudes above 1500 m (5000 ft).

1. Follow steps 1—4 as listed under Starting the Engine in the Engine Operation Section, then proceed as follows according to the instrument (control) panel on your engine.

2. Use cold weather starting aids as needed. Follow supplier instructions for starting aid provided on your engine. A booster battery can be connected if needed (see Using a Booster Battery or Charger in the Engine Operation Section).

3. Engines with air intake heaters or glow plugs: Turn key ON but do not crank engine until Engine Preheat Indicator goes off.

4. Follow remaining steps 5—7 as listed under Starting the Engine in the Engine Operation Section.

Additional information on cold-weather operation is available from your authorized servicing dealer.

RK80614,000000C -19-25MAR14-1/1

Stopping the Engine

1. Pull PTO clutch lever rearward (away from engine) to disengage clutch, if equipped.

IMPORTANT: Before stopping an engine that has been operating at working load, idle engine at least 2 minutes at 1000—1200 rpm to cool hot engine parts. If an Exhaust Filter Cleaning has just been performed, increase engine idle time to 4 minutes. If service work is going to be performed on the Exhaust Filter, increase engine idle time to 10 minutes.

Engines in generator set applications, run engine for at least 2 minutes at fast idle and no load. If an Exhaust Filter Cleaning has just been performed, increase engine idle time to 4 minutes. If service work is going to be performed on the Exhaust Filter, increase engine idle time to 10 minutes

2. Run engine at 1000—1200 rpm for at least 2 minutes to cool. If an Exhaust Filter Cleaning has just been performed, increase engine idle time to 4 minutes. If service work is going to be performed on the Exhaust Filter, increase engine idle time to 10 minutes

   Panels with high-low speed select rocker switch (B) only: Set rpm using bump speed enable switch (C) with speed select rocker switch (D).

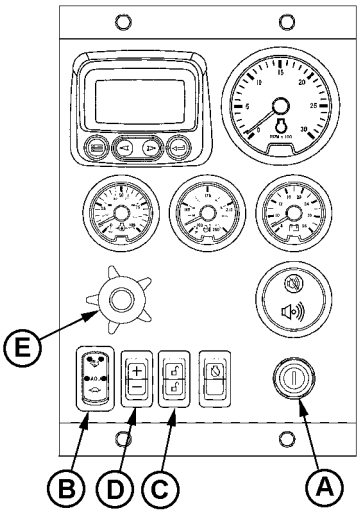
   Panels with optional analog throttle (E): Set either high-low speed select switch (B) or analog throttle control (E) to slow idle, and set desired speed with remaining control.

NOTE: Engine control unit (ECU) reads the higher of the high-low speed select rocker switch or the analog throttle speed settings.

3. Push in on analog throttle control handle (if equipped) so that engine goes to slow idle, or set slow speed with high-low speed select rocker switch.

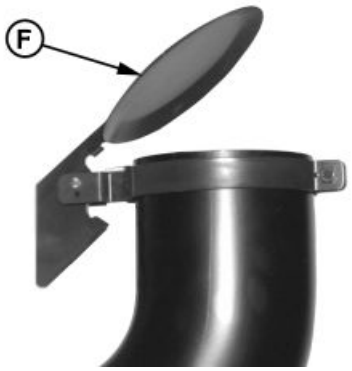
4. Turn key start switch (A) to “OFF” position to stop the engine. Remove ignition key.

IMPORTANT: Make sure that exhaust stack rain cap (F) is installed when engine is not running. This will prevent water and dirt from entering engine.



RG13723 —UN—11NOV04

Stopping the Engine Using Panel Controls (Full-Featured Panel Shown)



RG19047 —UN—23AUG10

Exhaust Stack Rain Cap

A—Key Start Switch
B—High-Low Speed Select Rocker Switch
C—Bump Speed Enable Rocker Switch
D—Speed Select Rocker Switch
E—Analog Throttle Control (Optional)
F—Exhaust Stack Rain Cap

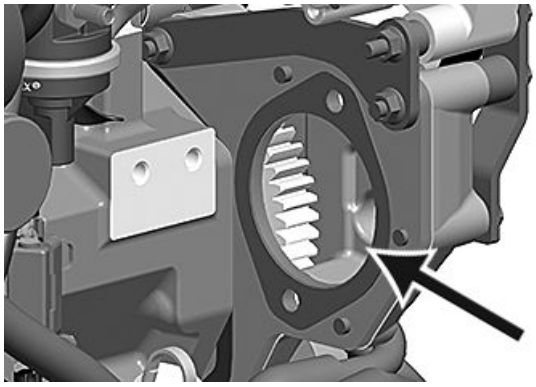
ZE59858,0000305 -19-07JAN14-1/1

Auxiliary Gear Drive Limitations

IMPORTANT: See OEM engine distributor for more information to prevent overloading the auxiliary drive. Severe engine damage could result.

IMPORTANT: When attaching an air compressor, hydraulic pump, or other accessory to be driven by the auxiliary gear drive (engine timing gear train at front of engine), power requirements of the accessory must be limited to values listed:

- 11 kW (15 hp) Continuous Operation at 2400 rpm
- 18 kW (24 hp) Intermittent Operation at 2400 rpm
- 10 kW (13 hp) Continuous Operation at 2200 rpm
- 16.5 kW (22 hp) Intermittent Operation at 2200 rpm



RG26397 —UN—16SEP14

Auxiliary Gear Drive

ZE59858,000004F -19-23SEP14-1/1

Using a Booster Battery or Charger

A 12 volt booster battery or charger can be connected in parallel with battery(ies) on the unit to aid in cold weather starting. ALWAYS use heavy-duty jumper cables.

CAUTION: Gas given off by battery is explosive. Keep sparks and flames away from battery. Before connecting or disconnecting a battery charger, turn off charger. Make last connection and first disconnection at a point away from battery. Always connect NEGATIVE (–) cable last and disconnect this cable first.

WARNING: Battery posts, terminals, and related accessories contain lead and lead compounds, chemicals known to the State of California to cause cancer and reproductive harm. **Wash hands after handling.**

IMPORTANT: Be sure that polarity is correct before making connections. Reversed polarity damages electrical system. Always connect positive to positive and negative to ground. Always use 12 volt booster battery for 12 volt electrical systems and 24 volt booster battery(ies) for 24 volt electrical systems.

1. Connect booster battery or batteries to produce the required system voltage for your engine application.

NOTE: To avoid sparks, DO NOT allow the free ends of jumper cables to touch the engine.

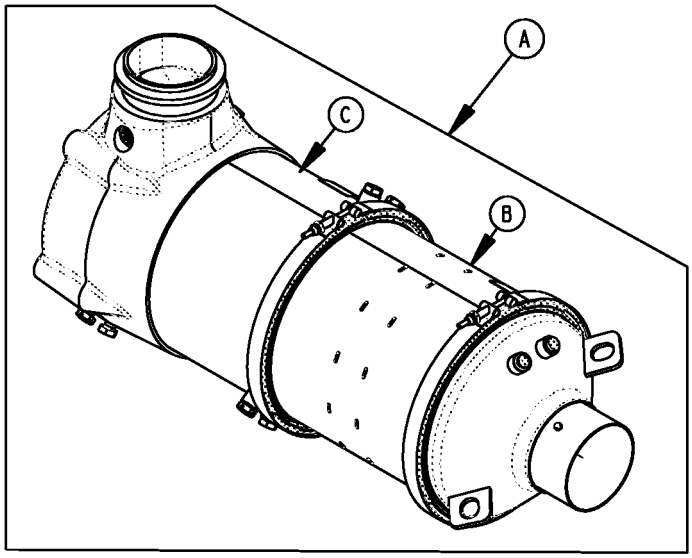
TS204 —UN—15APR13

Exploding Battery

2. Connect one end of jumper cable to the POSITIVE (+) post of the booster battery.
3. Connect the other end of the jumper cable to the POSITIVE (+) post of battery connected to starter.
4. Connect one end of the other jumper cable to the NEGATIVE (–) post of the booster battery.
5. ALWAYS complete the hookup by making the last connection of the NEGATIVE (–) cable to a good ground on the engine frame and away from the battery(ies).
6. Start the engine. Disconnect jumper cables immediately after engine starts. Always disconnect NEGATIVE (–) cable first.

ZE59858,0000011 -19-18AUG14-1/1

Exhaust Filter Cleaning and Maintenance



RE537721TMDA02 —UN—04MAR10

Exhaust Filter

A—Exhaust Filter
B—Diesel Particulate Filter (DPF)
C—Diesel Oxidation Catalyst (DOC)

The purpose of these instructions is to provide proper management of ash generated by the exhaust filter (or “filter”) along with its proper disposal.

RK80614,0000013 -19-16OCT12-1/1

Exhaust Filter — Cleaning

The Exhaust Filter, which includes the Diesel Oxidation Catalyst (DOC) and Diesel Particulate Filter (DPF), is a critical component in the engine’s emissions control system, which is required to meet governmental emissions regulations. The Exhaust Filter captures diesel particulate matter or “soot” to prevent its release into the atmosphere. This soot must be eliminated from the DPF to keep it functioning properly. The process of eliminating collected soot is carefully controlled by the Engine Control Unit (ECU) and is called “exhaust filter cleaning” or “regeneration”. During this process, a rise in exhaust temperature occurs and allows the soot to be oxidized within the DPF.

RK80614,0000014 -19-04JUN13-1/1

Diesel Particulate Filter Maintenance and Service

The Exhaust Filter includes the Diesel Oxidation Catalyst (DOC) and Diesel Particulate Filter (DPF). The DPF is designed to retain residual ash, which is a noncombustible result of additives used in crankcase lubrication oils and the fuel. The DPF provides many hours of maintenance free operation. At some point the DPF will require professional service to remove the accumulated ash. The exact number of hours of operation before service is required will vary depending upon the engine power category, duty cycle and operating conditions, engine oil ash content, and fuel quality. Adhering to John Deere's recommended oil and fuel specifications will maximize the hours of operation before professional DPF service is required.

As the engine owner, you are responsible for performing the required maintenance described in your Operator's manual. Generally, the ash removal service interval will far exceed the EPA required minimums of 3,000 hours for engines below 175hp/130kW and 4,500 hours for engines at or above 175hp/130kW. The use of recommended John Deere fluids will extend the life of the aftertreatment system and extend the maintenance intervals of the DPF. When the exhaust filter requires service, the Engine Control Unit (ECU) will alert the operator with a Diagnostic Trouble Code (DTC)

The removal of DPF ash must be done by removing the DPF from the machine and placing it into specialized equipment. Do not remove ash by using water or other chemicals. Removing ash by these methods may damage the material securing the DPF in its canister, resulting in the loosening of the DPF element in the canister and subjecting it to damage from vibration.

Failure to follow the approved ash removal methods may violate your Governing Bodies Regulations along with damage the DPF, resulting in potential denial of the Diesel Exhaust Filter emissions warranty. It is recommended that you take the DPF to an authorized John Deere service location or other qualified service provider for servicing.

RK80614,0000015 -19-16DEC13-1/1

Exhaust Filter — Diesel Particulate Filter Ash Handling and Disposal

CAUTION: Your Governing Bodies Regulations may classify diesel particulate filter ash as a hazardous waste. Hazardous wastes therefore must be disposed of in accordance with all applicable Governing Bodies Regulations governing hazardous waste disposal. Only a qualified service provider should remove ash from the DPF. Personal protective equipment and clothing, maintained in a sanitary and reliable condition, should be used when handling and cleaning a DPF. See your John Deere dealer or qualified service provider for assistance.

RK80614,0000016 -19-05JUN13-1/1

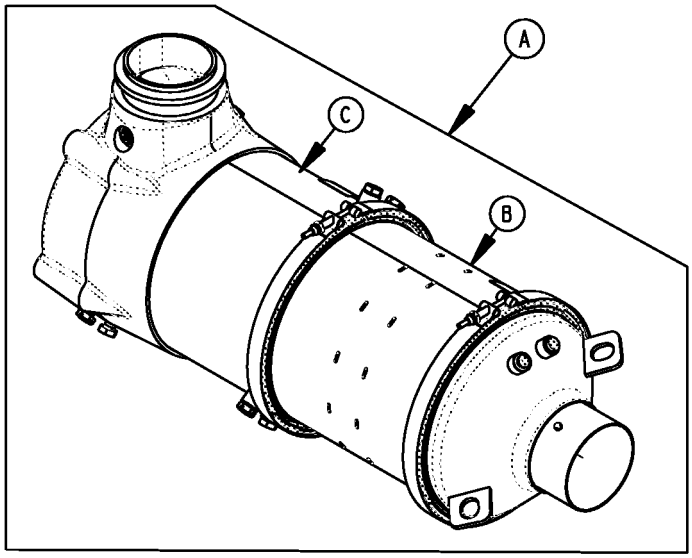
Exhaust Filter — Disposal

CAUTION: Proper management of an Exhaust Filter that has reached the end of its useful life is required, since the ash or catalyst material in the device may be classified as hazardous waste under federal, state, and/or local laws or regulations. See your John Deere dealer or qualified service provider for assistance.

RK80614,0000017 -19-21OCT13-1/1

Exhaust Filter System Overview

NOTE: Operator display icons and procedures can vary in other applications. The information contained in this section specifically applies to only OEM engines using the diagnostic gauge. If you are operating a John Deere vehicle, please see the vehicle operator manual for all exhaust filter cleaning operation information and procedures.



RE537721TMDA02 —UN—04MAR10

Diesel Exhaust Filter

A—Diesel Exhaust Filter **B—Diesel Particulate Filter (DPF)** **C—Diesel Oxidation Catalyst (DOC)**

John Deere has developed an exhaust filter consisting of a diesel oxidation catalyst (DOC) and a diesel particulate filter (DPF) specifically to meet the demands of off-highway applications. The DOC reduces carbon monoxide, hydrocarbons, and some particulate matter. The downstream DPF traps and holds particulates remaining in the exhaust stream. Trapped particles are eventually oxidized within the DPF through a process known as regeneration or exhaust filter cleaning.

Under normal machine operation and with the system in AUTO mode, the exhaust filter system requires minimal operator interaction.

To avoid unnecessary buildup of diesel particulates or soot in the exhaust filter system;

1 — Utilize the Automatic (AUTO) Exhaust Filter Cleaning mode.

2 — Avoid unnecessary idling.

3 — Use proper engine oil (See Fuels, Lubricants, and Coolants Section for recommendations).

4 — Use only ultra low sulfur fuel (See Fuels, Lubricants, and Coolants Section for recommendations).

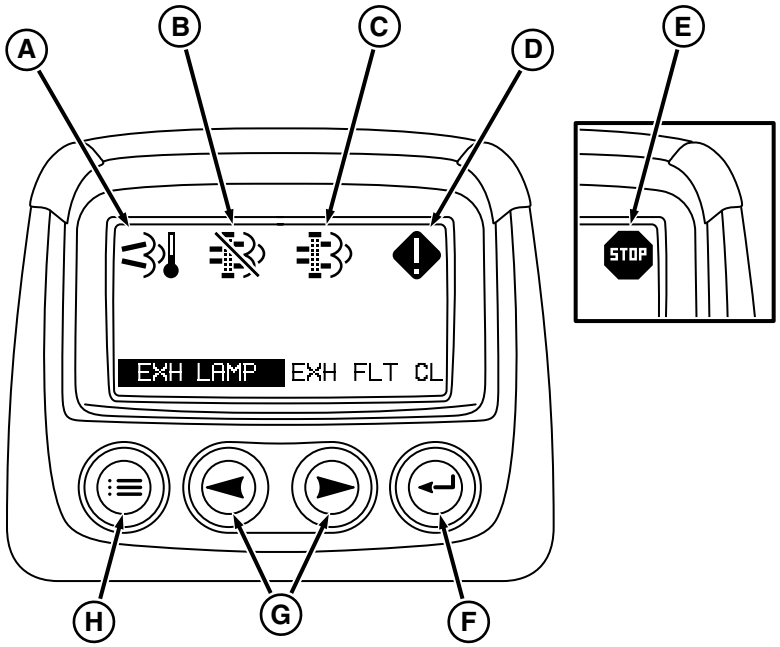
In addition to soot, ash deposits will also slowly build up in the DPF and cannot be removed through the engine exhaust filter cleaning process. To clean the ash deposits from the DPF see Diesel Particulate Filter Maintenance and Service in the Aftertreatment Section.

CAUTION: Do not power wash the filter assembly when external skin temperature of assembly exceeds 50 °C (120 °F).

RK80614,0000018 -19-28JAN13-1/1

Diagnostic Gauge Keys and Indicators Overview

The image below shows all the keys and indicators you will see and use through the operator initiated or auto exhaust filter cleaning and disable processes.



RG17926 —UN—13JAN10

Diagnostic Gauge Indicators and Keys

A—Exhaust Filter Cleaning Indicator
B—Auto Cleaning Disabled Indicator
C—Exhaust Filter Indicator
D—Caution Indicator
E—Warning Indicator
F—Enter Key
G—Arrow Keys
H—Menu Key

NOTE: You will never see the diagnostic gauge with all indicators illuminated at the same time (as shown). This image is only to illustrate the indicators you may see during operation.

The exhaust filter cleaning indicator (A) will illuminate when exhaust gas temperature is at optimal regeneration temperature, elevated idle is active, or exhaust filter cleaning is in process.

When this indicator (A) is illuminated, the machine can be operated as normal unless the operator determines the machine is not in a safe location for high exhaust temperatures and disables auto cleaning.

The auto cleaning disabled indicator (B) will illuminate when the operator has engaged the request to disable the auto exhaust filter cleaning function from the diagnostic gauge. This icon will remain illuminated until the operator reengages automatic exhaust filter cleaning from the diagnostic gauge. Disabling auto mode is not recommended for any situation unless it is safety related or if the fuel tank lacks the required fuel to complete the cleaning process.

The exhaust filter indicator (C) will illuminate when the exhaust filter is in need of cleaning and the operator has disabled auto exhaust filter cleaning. DTC 3719.15 will be present on the diagnostic gauge (see Listing of Diagnostic Trouble Codes in the Troubleshooting section for more information). If conditions are safe, the operator should enable the auto exhaust filter clean setting or perform manual service regeneration or follow DTC procedure.

If the exhaust filter indicator (C) is combined with the caution indicator (D), the engine performance will be reduced by the ECU because the soot level of the exhaust filter is moderately high. DTC 3719.16 will be present on the diagnostic gauge (see Listing of Diagnostic Trouble Codes in the Troubleshooting section for more information) and the amber indicator light on the diagnostic gauge will turn on. If conditions are safe, the operator should enable the auto exhaust filter clean function. If conditions are not safe, the operator should move the machine to a safe location and engage the auto exhaust filter cleaning mode. Perform manual service regeneration or follow DTC procedure

If the exhaust filter indicator (C) is combined with the stop engine warning indicator (E), the engine performance will be further reduced by the ECU because the soot level of the exhaust filter is extremely high. DTC 3719.00 will be present on the diagnostic gauge (see Listing of Diagnostic Trouble Codes in the Troubleshooting section for more information) and the red indicator light on the diagnostic gauge will turn on. If this combination is present, see your authorized servicing dealer.

Continued on next page

JR74534,00001E5 -19-04JAN11-1/2

The instructions in this section refer to the keys on the diagnostic gauge. The Enter key (F) is used when selecting an option on the diagnostic gauge. The Arrow keys (G) are used to scroll up or down between options on the diagnostic gauge screen. The Menu key (H) is used to access the main menu of options from which the operator can choose.

JR74534,00001E5 -19-04JAN11-2/2

Passive Regeneration/Natural Cleaning

Periodically, the exhaust filter will experience higher heat levels simply through the engine operating at higher loads. During these times, the higher exhaust heat will naturally clean a small amount of soot build up in the exhaust filter. Conversely, unnecessary idling can cause additional exhaust filter soot to accumulate. For the best possible engine operation which requires the least amount of operator interaction, the engine should be worked at higher load conditions whenever possible and idling should be kept to a minimum.

RK80614,000001A -19-16OCT12-1/1

Automatic (AUTO) Exhaust Filter Cleaning

NOTE: Operator display icons and procedures can vary in other applications. The information contained in this section specifically applies to only OEM engines. If you are operating a John Deere vehicle, please see the vehicle operator manual for all exhaust filter cleaning and handling information and procedures.

NOTE: When Auto or Parked exhaust filter cleaning is enabled, the exhaust temperature may be high under no load or light load conditions at certain times during the exhaust filter cleaning cycle.

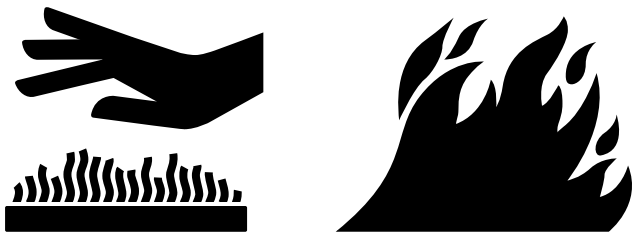
Operating the engine in AUTO Mode allows the ECU to perform intelligent exhaust filter cleaning as required. The Exhaust Filter Cleaning Indicator will illuminate when the system is actively performing an exhaust filter cleaning. During this process, the injector will inject small amounts of fuel into the exhaust stream to assist in cleaning the exhaust filter. When the exhaust filter cleaning process has completed its cycle, the cleaning indicator will automatically turn off.

CAUTION:

Servicing machine or attachments during exhaust filter cleaning can result in serious personal injury. Avoid exposure and skin contact with hot exhaust gases and components.

During auto or manual/stationary exhaust filter cleaning operations, the engine will run at elevated idle and hot temperatures for approximately 20—50 minutes. Exhaust gases and exhaust filter components reach temperatures hot enough to burn people, ignite, or melt common materials.

CAUTION: If the machine is not in a safe location for elevated exhaust temperatures, move the machine to a safe location and check for adequate fuel level before beginning the exhaust filter cleaning process. Any PTO driven devices (if equipped) should be powered off or disconnected.



RG17488 —UN—21AUG09

If the machine is not able to be moved into a safe location, the operator should temporarily disable auto exhaust filter cleaning (see Disable Exhaust Filter Cleaning in the Aftertreatment System Section). If the machine is located in a safe location, the auto mode should always be engaged.

To engage the auto exhaust filter cleaning mode:

1 — Press the Menu key on the diagnostic gauge.
2 — Press the Arrow keys to scroll up or down to EXHAUST FILTER.
3 — Press the Select key.
4 — Press the Arrow keys to scroll up or down to AUTO EXH FLT CLEAN.
5 — Press the Select key to enable auto exhaust filter cleaning.

RK80614,000001B -19-24JUL13-1/1

Manual/Parked Exhaust Filter Cleaning

NOTE: Operator display icons and procedures can vary in other applications. The information contained in this section specifically applies to only OEM engines. If you are operating a John Deere vehicle, please see the vehicle operator manual for all exhaust filter cleaning and handling information and procedures.

Manual/Parked Exhaust Filter Cleaning is an automated process initiated at the request of the operator. This process allows the system to clean the exhaust filter when the operator previously needed to engage the disable exhaust filter cleaning because of specific conditions. During the process the engine speed will be controlled by the ECU and the machine must remain parked to complete the procedure. Time required for the manual/Parked Exhaust Filter Cleaning process is dependent upon the level of exhaust filter restriction, ambient temperatures, and current exhaust gas temperature.

Complete cleaning times will very on several criteria including fuel type, oil type, duty cycle, and the number of previously aborted exhaust filter cleaning requests. Average time for a standard cleaning can range from 20-50 minutes.

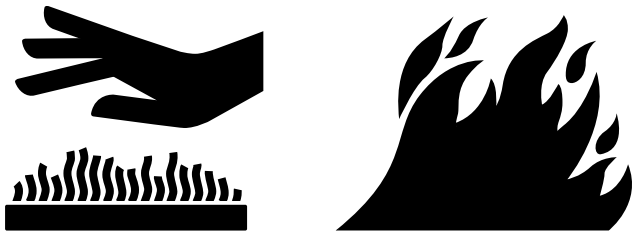
CAUTION:

Servicing machine or attachments during exhaust filter cleaning can result in serious personal injury. Avoid exposure and skin contact with hot exhaust gases and components.

During auto or manual/parked exhaust filter cleaning operations, the engine will run at elevated idle and hot temperatures for approximately 20-50 minutes. Exhaust gases and exhaust filter components reach temperatures hot enough to burn people, ignite, or melt common materials.

CAUTION: Always park the machine in a safe location and check for adequate fuel level before beginning the exhaust filter cleaning process. Any PTO driven devices (if equipped) should be powered off or disconnected.

To request a manual/parked exhaust filter cleaning:



RG17488 —UN—21AUG09

1 — Reduce engine speed to slow idle.
2 — Press the Menu key.
3 — Press the Arrow keys to scroll up or down to EXHAUST FILTER.
4 — Press the Select key.
5 — Press the Arrow keys to scroll up or down to REQUEST EXH FLT CLEAN.
6 — Press the Select key to request a manual/parked exhaust filter cleaning.
7 — Follow the directions on the display and ensure all conditions are met.
8 — Press the Select key to CONFIRM all conditions are met.

NOTE: Engine speed will be controlled by the ECU during filter cleaning.

The Exhaust filter indicator will remain off when Filter Cleaning is complete. If you are not returning the machine to service immediately after the procedure, allow the engine and the exhaust filter time to return to normal operating temperature before stopping engine. At any time during the parked procedure, the process can be canceled.

Avoid disabling the cleaning procedure unless absolutely necessary. Repeated disabling or ignoring prompts to perform a manual/parked cleaning procedure will cause additional engine power limitations and can eventually lead to dealer required service.

Utilize Exhaust Filter Cleaning AUTO mode to avoid additional service.

RK80614,000001C -19-24JUL13-1/1

Disable Exhaust Filter Cleaning

NOTE: Operator display icons and procedures can vary in other applications. The information contained in this section specifically applies to only OEM engines. If you are operating a John Deere vehicle, please see the vehicle operator manual for all exhaust filter cleaning and handling information and procedures.

NOTE: Disabling the exhaust filter cleaning request is not preferred. Disable the automatic exhaust filter cleaning only when necessary. Whenever possible, cleaning should be allowed and the diagnostic gauge should be left in the auto mode. When left in auto mode, soot buildup in the exhaust filter system will be at a minimum.

NOTE: When AUTO or PARKED/MANUAL cleaning is enabled, the exhaust temperature may be high under no load or light load conditions at certain times during the exhaust filter cleaning cycle. Disable exhaust filter cleaning in conditions where it may be unsafe for elevated exhaust temperatures.

To disable the auto exhaust filter cleaning mode:

1 — Press the Menu key on the diagnostic gauge.
2 — Press the Arrow keys to scroll up or down to select EXHAUST FILTER.
3 — Press the Enter key.
4 — Press the Arrow keys to scroll up or down and select DISABLE EXH FLT CLEAN to disable auto exhaust filter cleaning.
5 — Press the Enter key.

JR74534,00001E9 -19-04JAN11-1/1

Exhaust Filter Service Required

The exhaust filter cleaning procedures listed earlier in this section clean the soot from your exhaust filter. The exhaust filter also traps ash deposits over time which are not removed during an exhaust filter cleaning. When the exhaust filter has run several thousand hours, these ash deposits can restrict engine performance due to increased back pressure. To correct this situation, replace the exhaust filter or have the exhaust filter cleaned in specialized equipment. See Diesel Particulate Filter Maintenance and Service in the Aftertreatment Section.

RK80614,000001E -19-11JUL13-1/1

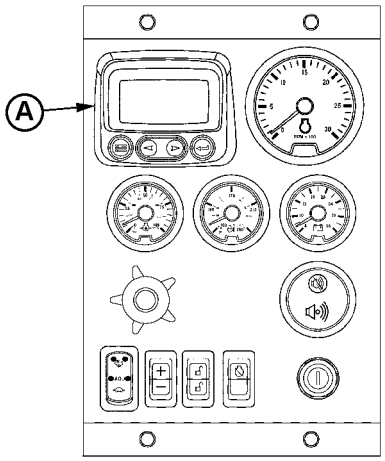
Observe Service Intervals

A repair shop or person of the owner's choosing may maintain, replace, or repair emission control devices and systems. However, warranty service must be performed by an authorized John Deere service facility except in the case of emergency.

In an emergency, where an authorized John Deere service location is not available, repairs may be performed at any available service establishment, or by the owner, using any replacement part, provided such parts are warranted by their manufacturer to be the equivalent of John Deere parts in performance and durability and the failure does not arise from the owner's failure to perform required maintenance.

Using hour meter (A) as a guide, perform all services at the hourly intervals indicated on following pages. At each scheduled maintenance interval, perform all previous maintenance operations in addition to the ones specified. Keep a record of hourly intervals and services performed, using charts provided in Lubrication and Maintenance Records section.

IMPORTANT: Recommended service intervals are for normal operating conditions. Perform maintenance at interval which occurs first, for example, either at 500 hours of operation or every 12 months. Service more often if engine operated under adverse conditions. Neglecting maintenance can result in failures or permanent damage to the engine.



RG13728 —UN—11NOV04

Hour Meter On Instrument Panel

A—Hour Meter

Perform all services at the hourly intervals. Record the services performed in the Lubrication and Maintenance Records Section. When scheduled service at any hourly level is performed, also perform all subordinate hourly level services.

ZE59858,0000050 -19-23SEP14-1/1

Use Correct Fuels, Lubricants, and Coolant

IMPORTANT: Use only fuels, lubricants, and coolants meeting specifications outlined in Fuels, Lubricants, and Coolant Section when servicing your John Deere Engine.

Consult your John Deere Servicing Distributor or your nearest John Deere Parts Network for recommended fuels, lubricants, and coolant. Also available are necessary additives for use when operating engines in tropical, arctic, or any other adverse conditions.

RG17133 —UN—18MAY09

JR74534,000027F -19-18MAY09-1/1

Lubrication and Maintenance Service Interval Chart

	Lubrication and Maintenance Service Intervals						
Item	Daily	250 Hours of Operation or Every 12 Months	500 Hours of Operation or Every 12 Months	1200 Hours of Operation	1500 Hours of Operation or Every 24 Months	6000 Hours of Operation or Every 72 Months	Service as Required
Check Engine Oil Level	•						
Check Engine Coolant Level	•						
Check Fan, Alternator, and Accessory Drive Belts	•						
Drain Water From Fuel Filter	•						
Check Air Cleaner Dust Unloader Valve and Restriction Indicator Gauge	•						
Visual Walk Around Inspection	•						
Replace Fuel Filter Elements		•					
Service Fire Extinguisher			•				
Service Battery			•				
Change Engine Oil And Replace Oil Filter [a] [b]			•				
Visually Inspect Coolant Pump			•				
Check Open Crankcase Ventilation (OCV) System			•				
Check Engine Mounts			•				
Check Belt and Belt Wear			•				
Check Air Intake Hoses, Connections, & System			•				
Check Engine Ground Connection			•				
Check Cooling System			•				
Pressure Test Cooling System			•				
Check Engine Speeds			•				
Check and Adjust Engine Valve Clearance				•			
Changing Open Crankcase Ventilation (OCV) Filter					•		
Flush and Refill Cooling System						•	
Test Thermostats						•	
Drain Water From Fuel Filters							•
Bleed Fuel System							•
Add Coolant							•
Pre-Start Cleaning Guide							•
Replace Air Cleaner Elements							•
Clean Diesel Particulate Filter[c]							•
Replace Fan Belt							•
Check Fuses							•
Check Electrical Wiring and Connections							•
Check Air Compressor (If Equipped)							•

[a] During the initial operation of a new or rebuilt engine with Break-In Plus, change the oil and filter between a minimum of 100 hours and a maximum of up to 500 hours.
[b] Service intervals depend on sulfur content of the diesel fuel, oil pan capacity, and the oil and filter used. (See Diesel Engine Oil and Filter Service Intervals in the Fuels, Lubricants, and Coolants Section.)
[c] Actual service should take place when the dash indicator light comes on or as indicated by the diagnostic gauge.

RK80614,0000534 -19-12DEC14-1/1

Daily Prestarting Checks

Check the following items BEFORE STARTING THE ENGINE for the first time each day:

- Check engine oil level on dipstick. Fill cap/dipstick may be located on left or right side, depending on application. Add as required, using seasonal viscosity grade oil. (See Diesel Engine Oil — Interim Tier 4, Final Tier 4, Stage IIIB, and Stage IV in the Fuels, Lubricants, and Coolants Section for oil specifications.)

  NOTE: Wipe all fittings, caps, and plugs before performing any maintenance to reduce the chance of system contamination.

- Check the coolant level when engine is cold. Fill radiator or surge tank with proper coolant if level is low. (See Adding Coolant in the Service As Required Section.) Check overall cooling system for leaks.
- Check radiator for leaks and trash buildup.

  NOTE: It is normal for a small amount of coolant to weep from the coolant pump weep hole, especially as the engine cools down and parts contract. If enough coolant weeps from the engine where coolant drips from the engine, this may indicate the need to replace the coolant pump seal. Contact your engine distributor or servicing dealer for repairs.

- Check fan, alternator, and accessory drive belts for cracks, breaks or other damage.
- Loosen water drain valve on each fuel filter all the way so that the valve opens to drain water and debris as needed. Retighten valves securely.

  NOTE: Any water in fuel is drained into the bottom of the fuel filters. The operator is signaled by an amber indicator on the instrument panel. To service, see Drain Water From Fuel Filters in the Service As Required Section.

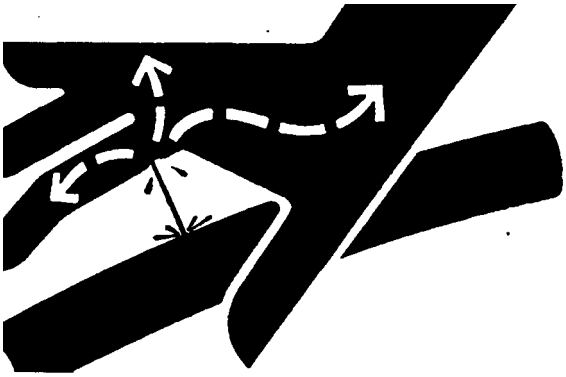
- Squeeze the automatic dust unloader valve (if equipped) on air cleaner assembly to clear away any dust buildup.
- Check air intake restriction indicator gauge and service air cleaner as required (if equipped).
- Check air intake system hoses and connections for cracks and loose clamps.
- Inspect the engine compartment. Look for fluid leaks, worn fan and accessory drive belts, loose connections, and trash buildup. Remove trash buildup and have repairs made as needed.

RK80614,0000023 -19-05FEB14-1/1

Removing and Installing Fuel Filter

CAUTION: Escaping fluid under pressure can penetrate the skin causing serious injury. Relieve pressure before disconnecting fuel or other lines. Tighten all connections before applying pressure. Keep hands and body away from pinholes and nozzles which eject fluids under high pressure. Use a piece of cardboard or paper to search for leaks. Do not use your hand.

If any fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type injury or gangrene may result. Doctors unfamiliar with this type of injury may call the Deere & Company Medical Department in Moline, Illinois, or other knowledgeable medical source.



X9811 —UN—23AUG88

High-Pressure Fluids

IMPORTANT: Replace fuel filter elements anytime audible alarm sounds and trouble codes indicate plugged fuel filters (low fuel pressure). If no alarm sounds during the 12 month service interval, replace elements at that time, or after 250 hours operation, whichever comes first.

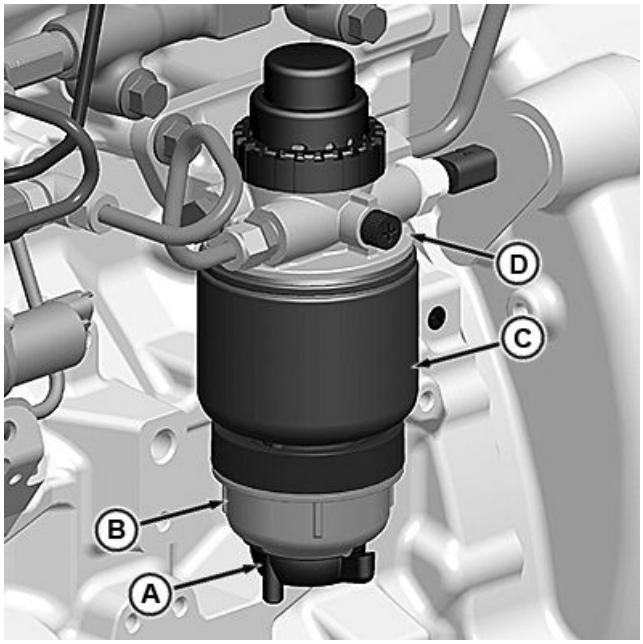
RK80614,0000535 -19-12DEC14-1/2

Remove and Install Primary Fuel Filter Element

1. Thoroughly clean filter header and surrounding area to prevent dirt and debris from entering fuel system.
2. Connect a hose to filter drain valve (A) on bottom of filter and drain all fuel from filter canister.
3. Disconnect water-in-fuel sensor connector if equipped.
4. Remove fuel filter canister (C).
5. Place new O-ring on filter canister.
6. Apply a thin film of fuel on O-ring.

IMPORTANT: Do not fill the new filter with fuel before installing. This could contaminate the fuel system with unfiltered fuel.

7. Install new filter and tighten until the top portion of the filter contacts the filter header assembly.
8. Reconnect water-in-fuel sensor connector if equipped.
9. Prime the fuel system. See Bleeding Fuel System in the Service As Required Section.



RG25271 —UN—18MAR14

Replace primary fuel filter

A—Drain Valve
B—Water Separator
C—Primary Fuel Filter Element
D—Primary Fuel Filter Header

RK80614,0000535 -19-12DEC14-2/2

Servicing Fire Extinguisher

A fire extinguisher (A) is available from your authorized servicing dealer or engine distributor.

Read and follow the instructions which are packaged with it. The extinguisher should be inspected at least every 500 hours of engine operation or every 12 months. Once extinguisher is operated, no matter how long, it must be recharged. Keep record of inspections on the tag which comes with the extinguisher instruction booklet.

A—Fire Extinguisher

RW4918 —UN—15DEC88

Fire Extinguisher

RK80614,0000024 -19-16OCT12-1/1

Servicing Battery

CAUTION: Battery gas can explode. Keep sparks and flames away from batteries. Use a flashlight to check battery electrolyte level.

Never check battery charge by placing a metal object across the posts. Use a voltmeter or hydrometer.

Always remove grounded NEGATIVE (—) battery clamp first and replace it last.

TS204 —UN—15APR13

Exploding Battery

WARNING: Battery posts, terminals, and related accessories contain lead and lead compounds, chemicals known to the State of California to cause cancer and reproductive harm. **Wash hands after handling.**

IMPORTANT: Wear personal Protective Equipment while doing any type of Battery check or replacement.

1. On regular batteries, check electrolyte level. Fill each cell to bottom of filler neck with distilled water.

NOTE: Low-maintenance or maintenance-free batteries should require little additional service. However, electrolyte level can be checked by cutting the center section of decal on dash-line, and removing cell plugs. Fill each cell to bottom of filler neck with distilled water.

2. Keep batteries clean by wiping them with a damp cloth. Keep all connections clean and tight. Remove any corrosion, and wash terminals with a solution of 1 part baking soda and 4 parts water. Tighten all connections securely.

NOTE: Coat battery terminals and connectors with a mixture of petroleum jelly and baking soda to retard corrosion.

3. Keep battery fully charged, especially during cold weather. If a battery charger is used, turn off charger before connecting charger to battery(ies). Attach POSITIVE (+) battery charger lead to POSITIVE (+) battery post. Then attach NEGATIVE (—) battery charger lead to a good ground.

Continued on next page

ZE59858,0000052 -19-16APR14-1/2

CAUTION: Sulfuric acid in battery electrolyte is poisonous. It is strong enough to burn skin, eat holes in clothing, and cause blindness if splashed into eyes.

Avoid the hazard by:

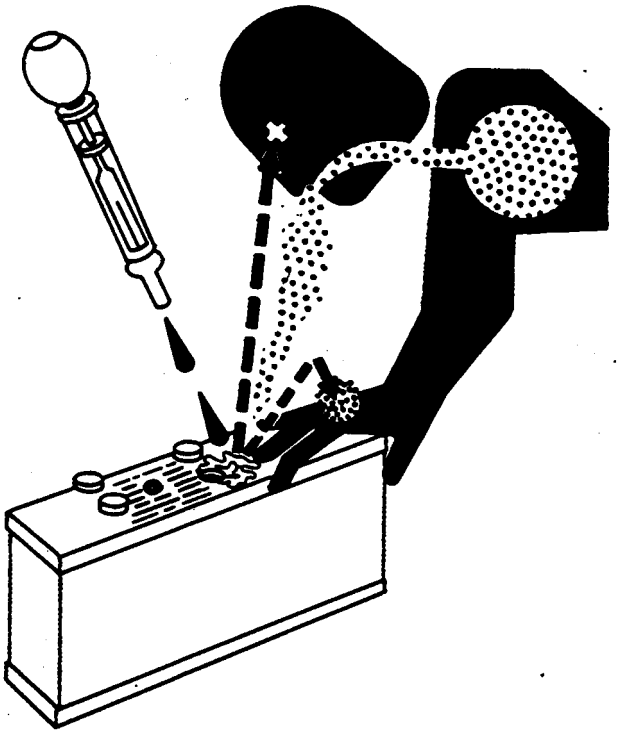
1. **Filling batteries in a well-ventilated area.**
2. **Wearing eye protection and rubber gloves.**
3. **Avoiding breathing fumes when electrolyte is added.**
4. **Avoiding spilling or dripping electrolyte.**
5. **Using proper jump start procedure.**

If you spill acid on yourself:

1. **Flush your skin with water.**
2. **Apply baking soda or lime to help neutralize the acid.**
3. **Flush your eyes with water for 10—15 minutes. Get medical attention immediately.**

If acid is swallowed:

1. **Drink large amounts of water or milk.**
2. **Then drink milk of magnesia, beaten eggs, or vegetable oil.**
3. **Get medical attention immediately.**



TS203 —UN—23AUG88

Sulfuric Acid

In freezing weather, run engine at least 30 minutes to ensure thorough mixing after adding water to battery.

Replacement battery(ies) must meet or exceed the following recommended capacities[1] at -18 °C (0 °F):

Specification	
12-Volt System—Minimum Battery Capacity—Cold Cranking Amps	640 Minimum
Reserve Capacity (Minutes)	285 Minimum
24-Volt System—Minimum Battery Capacity—Cold Cranking Amps	570 Minimum
Reserve Capacity (Minutes)	275 Minimum

[1] Total recommended capacity based on batteries connected in series or parallel.

ZE59858,0000052 -19-16APR14-2/2

Changing Engine Oil and Replacing Filter

NOTE: During the initial operation of a new or rebuilt engine with Break-In Plus, change the oil and filter between a minimum of 100 hours and a maximum of up to 500 hours.

OILSCAN or OILSCAN PLUS is a John Deere sampling program to help you monitor machine performance and identify potential problems before they cause serious damage. OILSCAN and OILSCAN PLUS kits are available from your John Deere engine distributor or servicing dealer. Oil samples should be taken prior to the oil change. Refer to instructions provided with kit.

1. Run engine approximately 5 minutes to warm up oil. Shut engine off.
2. Remove oil pan drain plug (D).

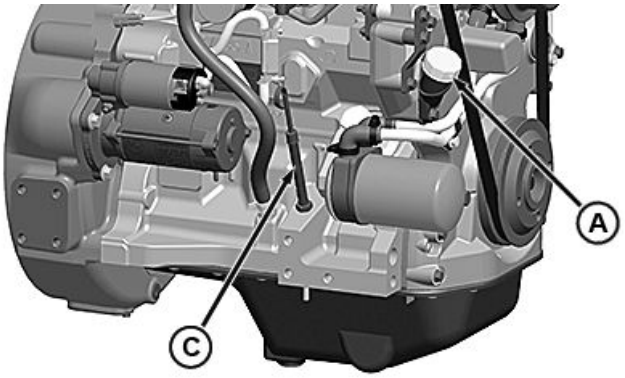
NOTE: Inspect copper washer for damage, replace if necessary.

3. Drain crankcase oil from engine while warm.
4. Install drain plug (D)and copper washer (E)and tighten to specification.

Specification

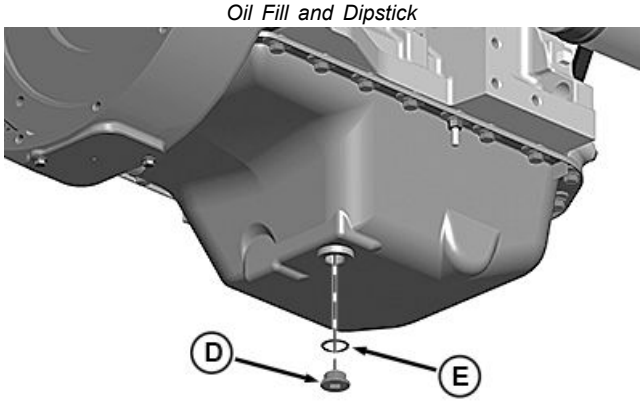
Oil Pan Drain Plug—Torque..... 70 N·m (52 lb.-ft.)

A—Oil Filler Cap
B—Crosshatch MARKS on Dipstick
C—Dipstick
D—Drain Plug
E—Copper Washer



RG25826 —UN—16MAY14

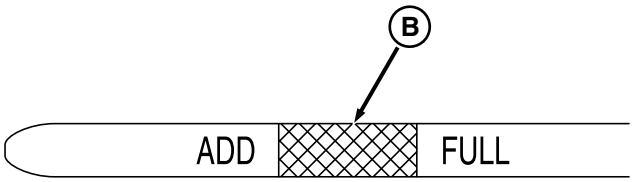
Oil Fill and Dipstick



RG25827 —UN—16MAY14

Oil Drain Pug or Valve

RG18611 —UN—28MAY10



Dipstick Oil Level

Continued on next page

ZE59858,0000053 -19-16SEP14-1/2

5. Remove filter element (A) using a suitable filter wrench. Remove inner seal (B). Discard oil filter element and seal.

NOTE: Depending on engine application, oil filter is mounted in the vertical or horizontal position.

IMPORTANT: Filtration of oils is critical to proper lubrication. Always change filter regularly. Use filter meeting John Deere performance specifications.

6. Clean oil filter sealing surface.
7. Apply clean engine oil to the new filter inner seal (B) and to filter threads.
8. Thread new oil filter onto oil filter header until the oil filter seal contacts the oil filter header.
9. Hand tighten oil filter to specification. DO NOT overtighten oil filter.

Specification	
Oil Filter—Turn After Contact	3/4—1-1/4 turn

10. Fill engine crankcase with correct John Deere engine oil through oil filler cap. See Diesel Engine Oil — Interim Tier 4, Final Tier 4, Stage IIIB, and Stage IV in the Fuels, Lubricants, and Coolant Section for determining correct engine oil.

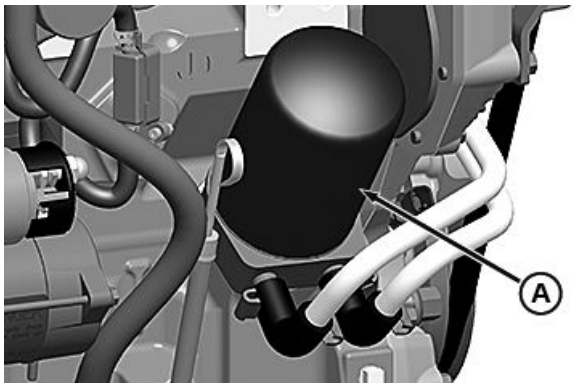
    To determine the correct oil fill quantity for your engine, see Engine Crankcase Oil Fill Quantities in the Specifications Section.

IMPORTANT: Immediately after completing any oil change, crank engine for 30 seconds without permitting engine to start. This helps insure adequate lubrication to engine components before engine starts.

NOTE: Crankcase oil capacity may vary slightly. ALWAYS fill crankcase within crosshatch marks on dipstick. DO NOT overfill.

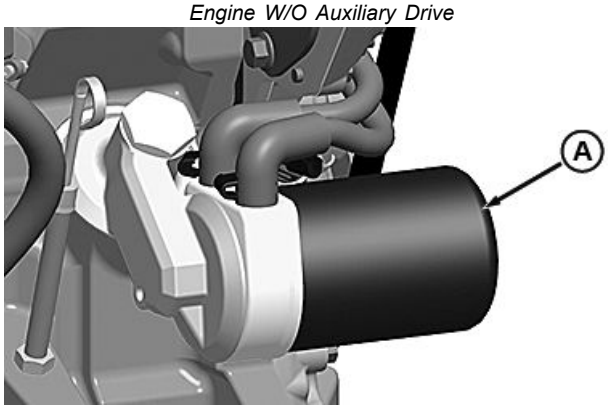
11. Start engine and run to check for possible leaks.
12. Stop engine and check oil level after 10 minutes. Oil level reading should be within crosshatch marks on dipstick.

A—Oil Filter Element **B—Inner Seal**



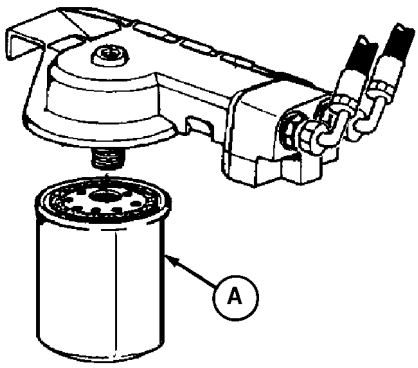
Engine W/O Auxiliary Drive

RG26398 —UN—16SEP14



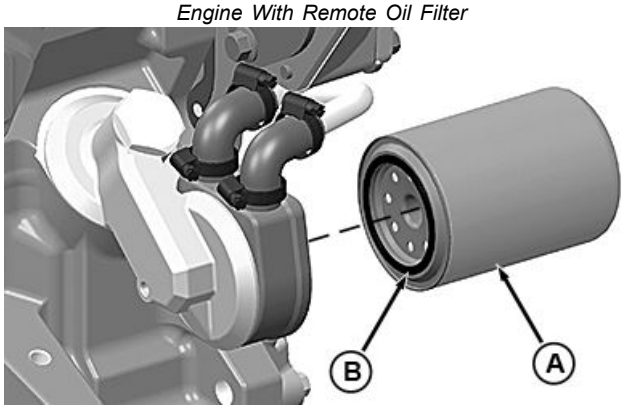
Engine With Auxiliary Drive

RG26399 —UN—16SEP14



Engine With Remote Oil Filter

RG11549 —UN—06DEC00



Remove Oil Filter

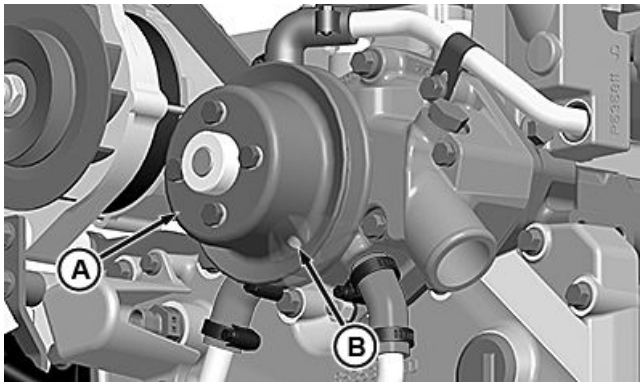
RG25563 —UN—17APR14

ZE59858,0000053 -19-16SEP14-2/2

Visually Inspecting Coolant Pump

NOTE: Cooling pump drive pulley is transparent for clarity purposes.

1. Inspect coolant weep hole (B). Clean weep hole if blocked.
2. Coolant leakage indicates a damaged seal.
3. A slight weeping of coolant is normal. If enough coolant leaks from the weep hole that it drips from the engine, the coolant pump assembly should be replaced or repaired.
4. Wiggle coolant pump pulley (A). There should only be slight radial movement in the bearing. If bearing is loose, repair or replace coolant pump.



RG25316 —UN—25MAR14

Inspect Coolant Pump

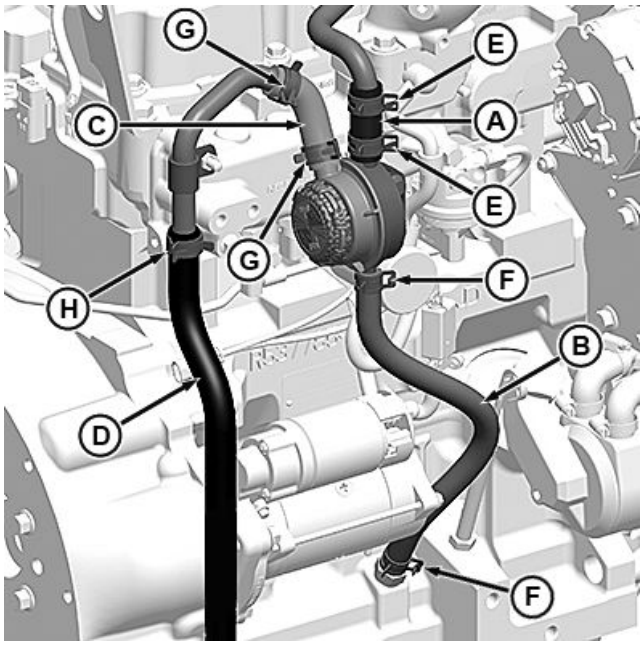
A—Pulley **B—Weep Hole**

ZE59858,0000054 -19-07MAY14-1/1

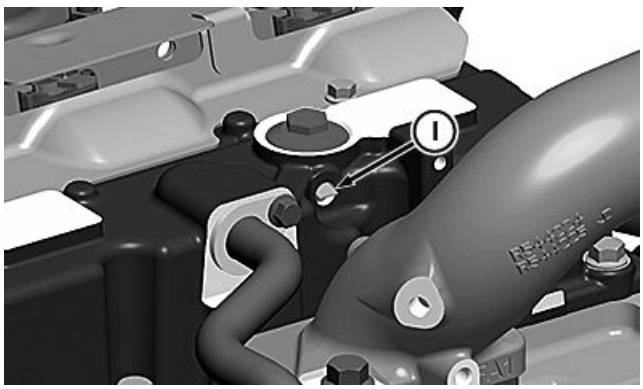
Checking Open Crankcase Vent (OCV)

1. Check all hoses (A), (B), (C), and (D) of open crankcase ventilation system for cracks, damage, and blockage.
2. Check all constant tension clamps (E), (F), (G), and (H) for its appropriate tension on the hoses.
3. Check filter housing for cracks and damage.
4. Inspect duckbill valve for leakage or blockage (I).

A—OCV Filter Inlet Hose
B—Oil Drain Hose
C—OCV Filter Outlet Hose
D—OCV Air Vent Hose
E—Constant Tension Clamp — Inlet Hose
F—Constant Tension Clamp — Oil Drain Hose
G—Constant Tension Clamp — Outlet Hose
H—Constant Tension Clamp — Air Vent Hose
I— Duckbill Valve



RG25188 —UN—28FEB14



RG26409 —UN—24SEP14

OCV System Hoses and Clamps

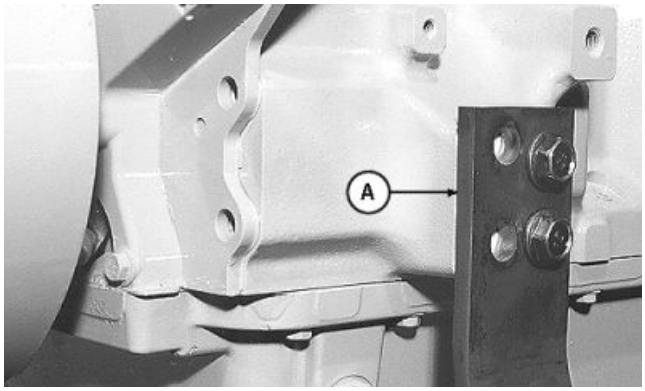
ZE59858,0000055 -19-24SEP14-1/1

Checking Engine Mounts

Engine mounting is the responsibility of the Original Equipment Manufacturer. Follow manufacturer's guidelines for mounting specifications.

IMPORTANT: Use only Grade SAE 8 or higher grade of hardware for engine mounting.

1. Check the engine mounting brackets (A), vibration isolators, and mounting bolts on support frame and engine block for tightness. Tighten as necessary.
2. Inspect overall condition of vibration isolators, if equipped. Replace isolators, as necessary, if rubber has deteriorated or mounts have collapsed.



RG9905 —UN—06JAN99

Engine Mounting

A—Mounting Bracket

ZE59858,00002A2 -19-14NOV13-1/1

Checking Fan And Alternator V-Belt Tension

Low belt tension causes slippage resulting in excessive cover wear, burn spots, overheating, or "slip and grab", causing belt breakage.

High belt tension causes belt heating and excessive stretch, as well as damage to drive components such as pulleys and shafts. V-belts should ride on the sides of standard pulleys not on the bottom of the groove.

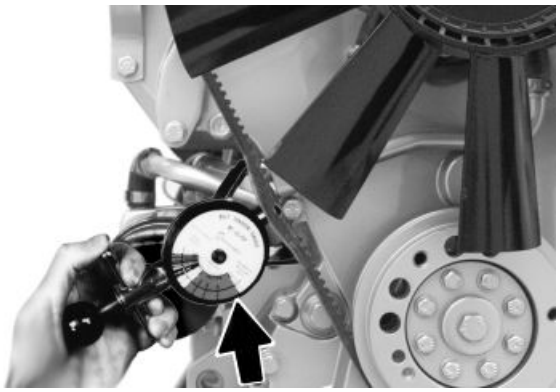
Standard V-belt tension can be checked with JDG529 Tension Gauge (bold arrow) or equivalent gauge. (Gauge is available from a John Deere Dealer or Distributor)

NOTE: On engines with dual belts, check tension of front belt only.

1. Inspect belts for cracks, fraying, or stretched out areas. Replace if necessary.
2. Using JDG529 Belt Tension Gauge, or belt tension tester (A) and straightedge (B), check tension of warm belts:
   a. When using JDG529 Belt Tension Gauge, measure belt tension and compare with specifications on next page.
   b. Belt deflection when using belt tension tester (A) with straightedge (B), with force applied halfway between pulleys.

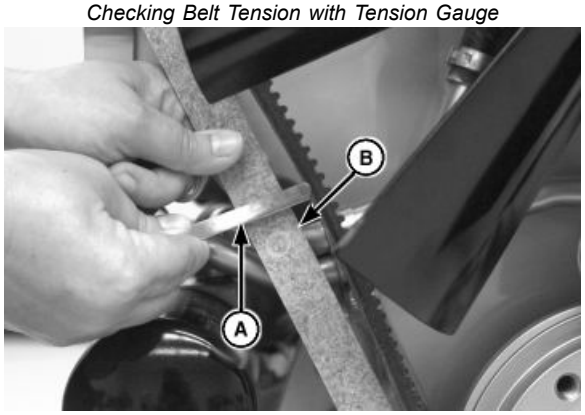
Specification

Standard V-Belt with 89 N (20 lb) force—Deflection..... 19 mm (3/4 in.)



RG7333 —UN—01DEC00

Checking Belt Tension with Tension Gauge



RG7334 —UN—01DEC00

Checking Belt Tension with Straightedge

A—Tension Tester **B—Straightedge**

Continued on next page

ZE59858,0000059 -19-18SEP14-1/2

3. If adjustment is necessary, loosen alternator bracket cap screw (C) and nut (D) on mounting bolt. Pull alternator frame outward until belts are correctly tensioned.
4. Tighten alternator bracket cap screw and nut to specification.

Specification	
Alternator Lower Bracket —Torque	30 N·m (22 lb.-ft.)
Alternator Upper Bracket —Torque	30 N·m (22 lb.-ft.)

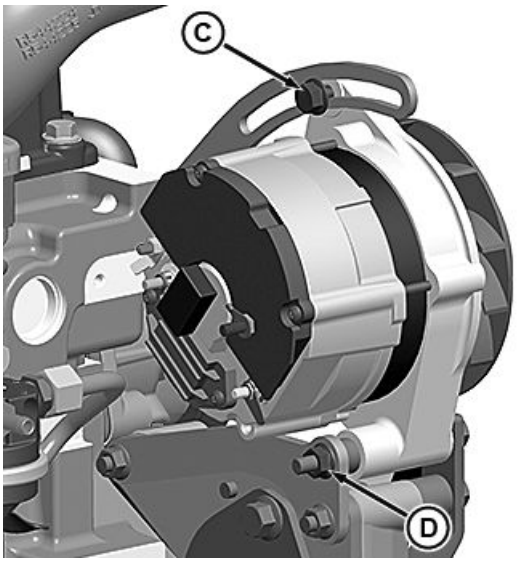
IMPORTANT: Do not pry against the alternator rear frame. Do not tighten or loosen belts while they are hot.

5. After a new or used belt has run for 10 minutes, recheck belt tension.

STANDARD V-BELTS

	New Belt Tension	Used Belt Tension[a]
Single Belt	578—623 N (130—140 lb force)	378—423 N (85—95 lb force)
Dual Belts	423—463 N (95—104 lb force)	378—423 N (85—95 lb force)

[a] *Belts are considered used after 10 minutes of operation.*



RG26400 —UN—16SEP14

Alternator Mounting Brackets

C—Cap Screw **D—Nut**

ZE59858,0000059 -19-18SEP14-2/2

Checking Air Intake System

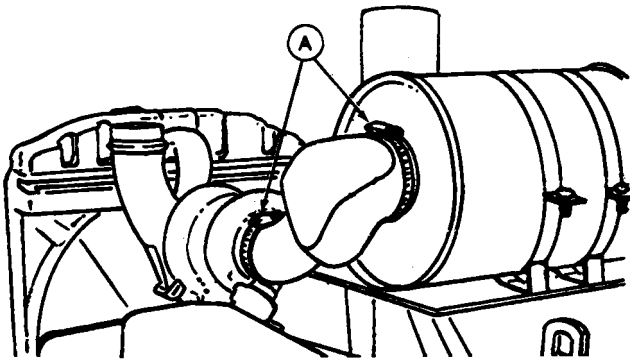
IMPORTANT: The air intake system must not leak. Any leak, no matter how small, may result in internal engine damage due to abrasive dirt and dust entering the intake system.

1. Inspect all intake hoses (piping) for cracks. Replace as necessary.
2. Check clamps (A) on piping which connect the air cleaner, engine and, if present, turbocharger. Tighten clamps as necessary. This will help prevent dirt from entering the air intake system through loose connections causing internal engine damage.
3. If engine has a rubber dust unloader valve (B), inspect the valve on bottom of air cleaner for cracks or plugging. Replace as necessary.

IMPORTANT: ALWAYS REPLACE primary air cleaner element when air restriction indicator shows a vacuum of 625 mm (25 in.) H_2O, is torn, or visibly dirty.

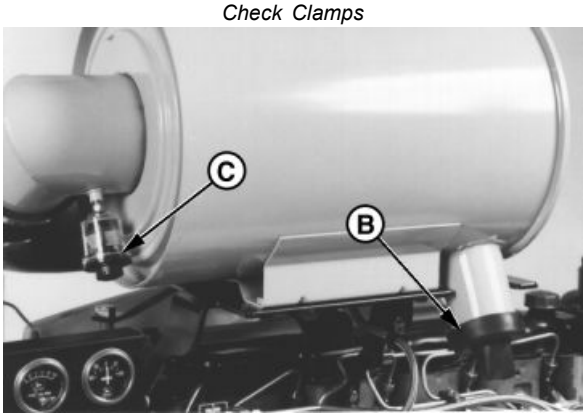
4. Test air restriction indicator (C) for proper operation. Replace indicator as necessary.

IMPORTANT: If not equipped with air restriction indicator, replace air cleaner elements at 500 Hours or at 12 Months, whichever occurs first.



RG4689 —UN—20DEC88

Check Clamps



RG7332B —UN—22JAN99

Unloader Valve and Air Restriction Indicator

A—Clamps
B—Dust Unloader Valve
C—Air Restriction Indicator

JR74534,000025D -19-26APR10-1/1

Checking Engine Ground Connection

Check engine ground connection to be sure that it is secure and clean. This will prevent electrical arcing which can damage engine.

Verify engine to frame ground.

Verify battery ground to frame.

Verify Engine Control Unit to ground (Remote Mount).

RK80614,0000033 -19-11JUL13-1/1

Checking Cooling System

CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns.

Shut off engine. Only remove filler cap when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing completely.

IMPORTANT: Air must be expelled from cooling system when system is refilled. Loosen temperature sending unit fitting at rear of cylinder head or plug in thermostat housing to allow air to escape when filling system. Retighten fitting or plug when all the air has been expelled. Cooling system must be free of air by time engine coolant temperature reaches 80 °C (176 °F).

1. Check entire cooling system for leaks. Tighten all clamps securely.

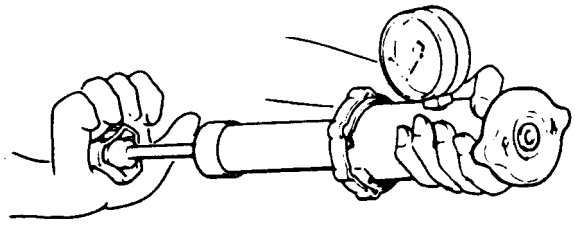
High Pressure Fluids

TS281 —UN—15APR13

2. Thoroughly inspect all cooling system hoses for hard, flimsy, or cracked conditions. Replace hoses if any of the above conditions are found.

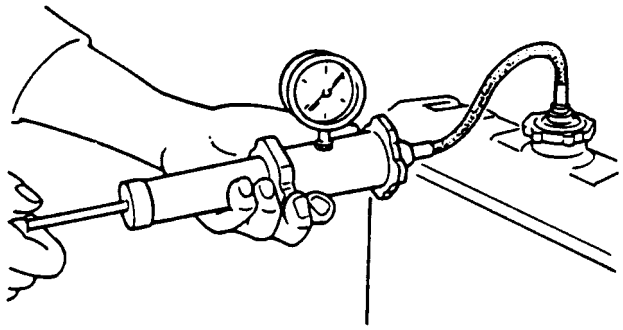
ZE59858,00002F0 -19-17DEC13-1/1

Pressure Testing Cooling System



Test Radiator Cap

RG6557 —UN—20JAN93



RG6558 —UN—20JAN93

Test Cooling System

⚠ CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns.

Shut off engine. Only remove filler cap when cool enough to touch with bare hands. To relieve pressure before completely removing, slowly remove pressure cap and allow pressure to relieve before completely removing cap.

Test Radiator Cap

1. Remove radiator cap and attach to D05104ST Tester, or similar, as shown.
2. Pressurize cap to following specifications. [1]. Gauge should hold pressure for 10 seconds within the normal range if cap is acceptable.

Specification	
Radiator Cap—Maximum Pressure	125 kPa (1.25 bar) (18 psi)

If gauge does not hold pressure, replace radiator cap.

3. Remove the cap from gauge, turn it 180°, and retest cap. This verifies that the first measurement was accurate.

Test Cooling System for Leaks

NOTE: Engine should be warmed up to test overall cooling system for leaks.

[1]Test pressures recommended are for all Deere OEM cooling systems. On specific vehicle applications, test cooling system and pressure cap according to the recommended pressure for that vehicle.

1. Allow engine to cool, then carefully remove radiator cap.
2. Fill radiator with coolant to the normal operating level.

IMPORTANT: DO NOT apply excessive pressure to cooling system; doing so may damage radiator and hoses.

3. Connect gauge and adapter to radiator filler neck, or expansion tank. Pressurize cooling system to the following specifications [1].

Specification	
Cooling System—Maximum Pressure	125 kPa (1.25 bar) (18 psi)

4. With pressure applied, check all cooling system hose connections, radiator, and overall engine for leaks.

If leakage is detected, correct as necessary and pressure test system again.

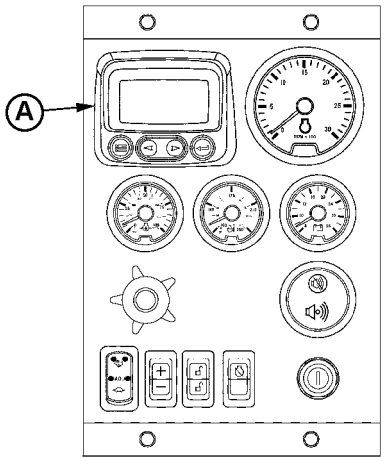
If no leakage is detected, but the gauge indicated a drop in pressure, coolant may be leaking internally within the system or at the block-to-head gasket. Have your servicing dealer or distributor correct this problem immediately.

DN28805,0001EF6 -19-23SEP14-1/1

Checking and Adjusting Engine Speeds

Use tachometer on the diagnostic gauge (A) to verify engine speeds. (See Engine Power and Speed Rating Specifications in the Specifications Section for engine speed specifications.) If engine speed adjustment is required, see your authorized servicing dealer or engine distributor.

A—Tachometer



RG13728 —UN—11NOV04

Using Tachometer to Check Engine Speeds

ZE59858,00002A6 -19-14NOV13-1/1

Checking and Adjusting Valve Clearance

CAUTION: To prevent accidental starting of engine while performing valve adjustments, always disconnect NEGATIVE (—) battery terminal.

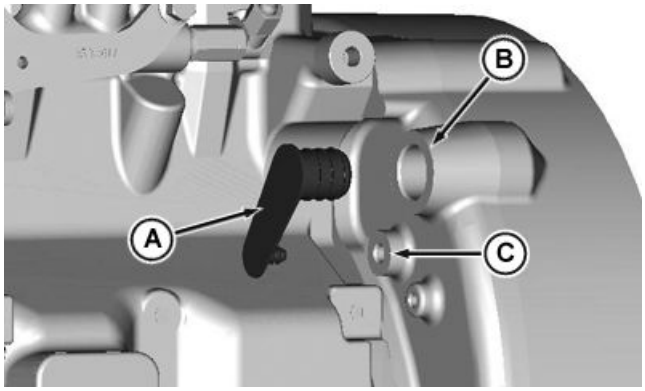
IMPORTANT: Valve clearance MUST BE checked and adjusted with engine COLD.

1. Remove fuel injector heat shield, crankcase ventilator tube, and rocker arm cover.
2. Remove plastic plug (A) from flywheel housing bores and install appropriate flywheel turning tool JDG820, or JDE83. Install JDG1571 or JDE81-4 flywheel timing pin.

IMPORTANT: Visually inspect contact surfaces of valve tips and rocker arm wear pads. Check all parts for excessive wear, breakage, or cracks. Replace parts that show visible damage.

Rocker arms that exhibit excessive valve clearance should be inspected more thoroughly to identify damaged parts.

3. Rotate engine in operating direction, with the flywheel turning tool until locking pin engages timing hole in flywheel.



RG20536 —UN—03JUN11

Bores to Insert Flywheel Turning Tool and Timing Pin

A—Plastic Plug
B—Flywheel Turning Tool Bore
C—Timing Pin Bore

NOTE: If the rocker arms for No. 1 (front) cylinder are loose, the engine is at No. 1 top dead center compression.

NOTE: If the rocker arms for No. 1 (front) cylinder are **NOT** *loose, the engine is at No. 1 top dead center exhaust. Rotate the engine one full revolution (360°) to No. 1 top dead center compression.*

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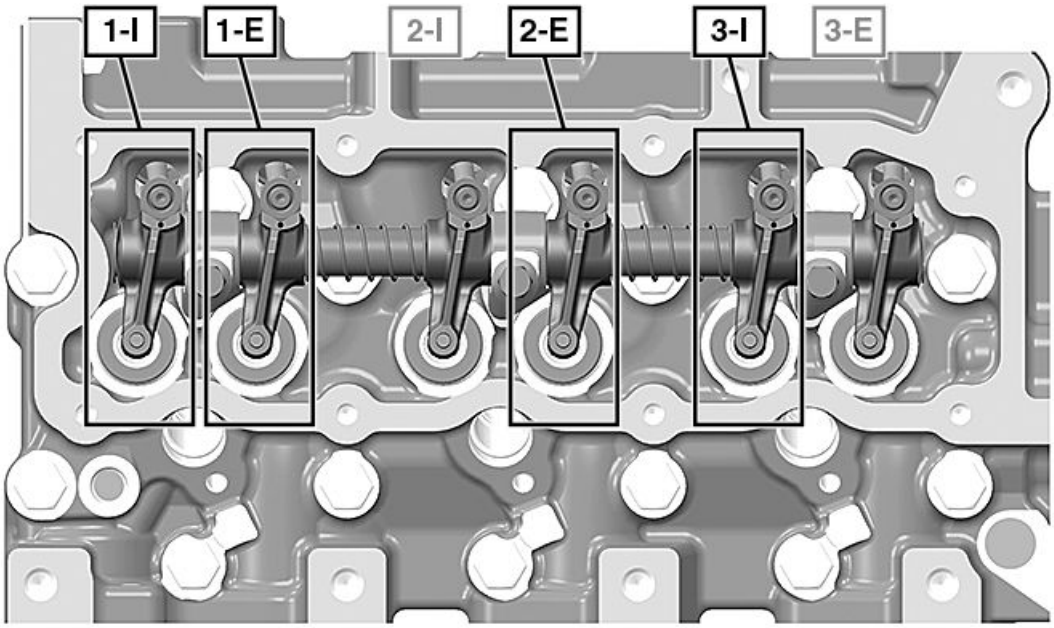
ZE59858,000005A -19-23SEP14-1/5

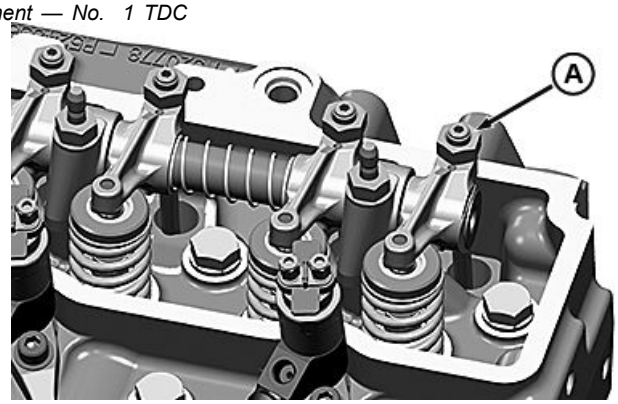


RG25055 —UN—12FEB14

Valve Clearance Adjustment — No. 1 TDC

4. With engine locked at TDC of No. 1 piston compression stroke, use a bent feeler gauge to check valve clearance on No. 1 and 2 exhaust and No. 1 and 3 intake valves. Loosen lock nut (A) on rocker arm adjusting screw. Turn adjusting screw with a 4 mm hex key wrench until feeler gauge slips with a slight drag. Hold the adjusting screw from turning and tighten lock nut to specifications.

Specification	
Intake Valve Clearance (Rocker Arm-to-Valve Tip With Engine Cold) —Clearance	0.35 mm (0.014 in.)
Exhaust Valve Clearance (Rocker Arm-to-Valve Tip With Engine Cold)—Clearance	0.45 mm (0.018 in.)
Valve Adjusting Screw Lock Nut—Torque	27 N·m (20 lb.-ft.)



RG24696 —UN—30OCT13

Rocker Arm Lock Nut

A—Lock Nut

Recheck clearance again after tightening lock nut. Readjust clearance as necessary.

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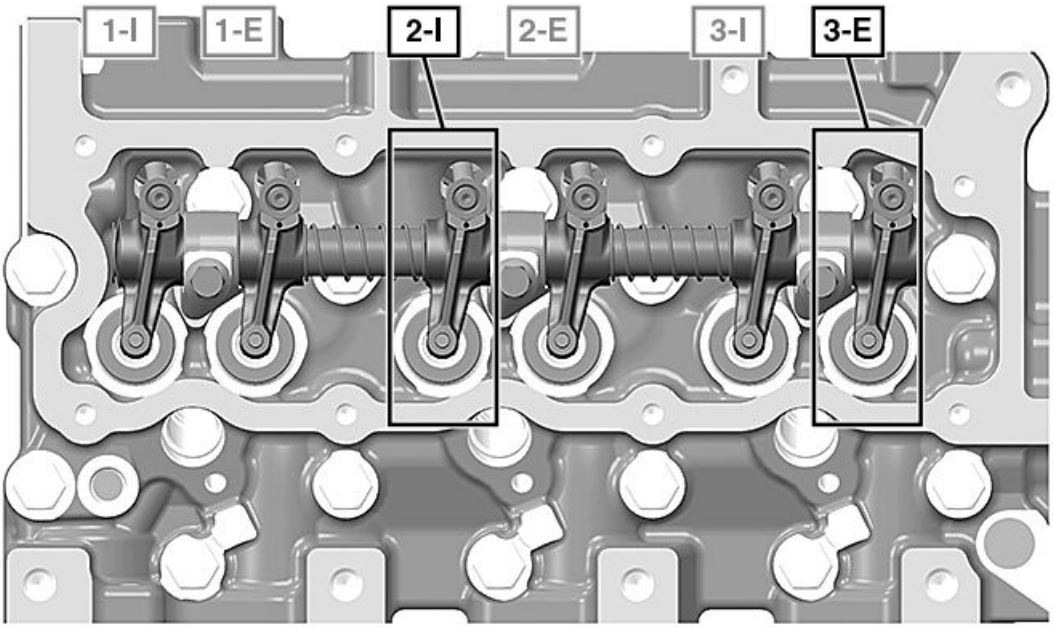
ZE59858,000005A -19-23SEP14-2/5



RG25056 —UN—12FEB14

Valve Clearance Adjustment — No. 1 TDC Exhaust

5. Using the flywheel turning tool, rotate engine in operating direction 360°, until locking pin engages timing hole in flywheel. No. 1 piston is at TDC of its exhaust stroke. Rocker arms for No. 1 piston should **NOT** be loose.
6. Check and adjust valve clearance to the same specifications on for No. 3 exhaust and No. 2 intake valves.
7. Remove timing pin and flywheel turning tool. Replace plug in flywheel housing.
8. Lubricate valve components with a generous amount of engine oil.

ZE59858,000005A -19-23SEP14-3/5

9. Install a new gasket (C) onto the cylinder head (D). Do not use sealant on gasket.

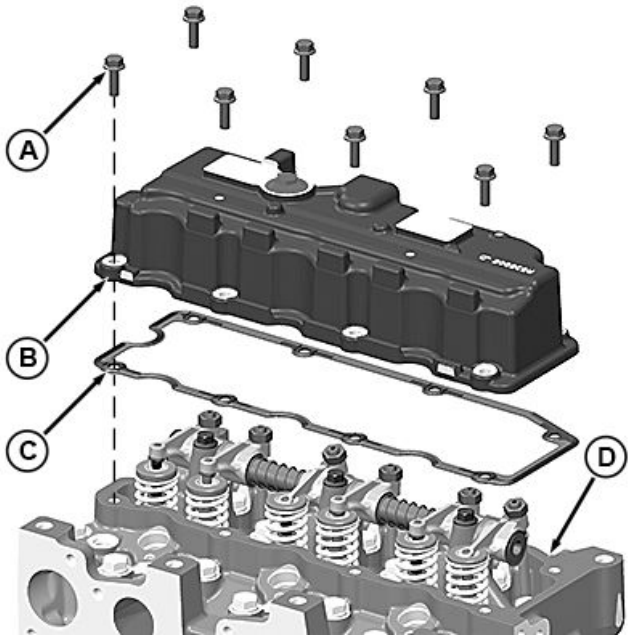
IMPORTANT: Replace gasket (C) every time the rocker arm cover is removed.

10. Install rocker arm cover (B) onto the cylinder head
11. Finger start cap screws (A) through the rocker arm cover and gasket into the cylinder head. Tighten cap screws to specification starting form the center and moving towards both the front and rear ends of the cover.

Specification	
Rocker Arm Cover Cap Screws —Torque	30 N·m (22 lb.-ft.)

12. Install Fuel Injector Heat Shield.

A—Cap Screws (8 used)
B—Rocker Arm Cover
C—Gasket
D—Cylinder Head



RG25053 —UN—12FEB14

Rocker Arm Cover Installation

Continued on next page

ZE59858,000005A -19-23SEP14-4/5

13. Engage the fuel injector heat shield (B) into the external groove (C) in the rocker arm cover.
14. Install cap screws (A) and tighten to specification.

Specification

Cap Screw —Torque.....11 N·m (97 lb.-in.)

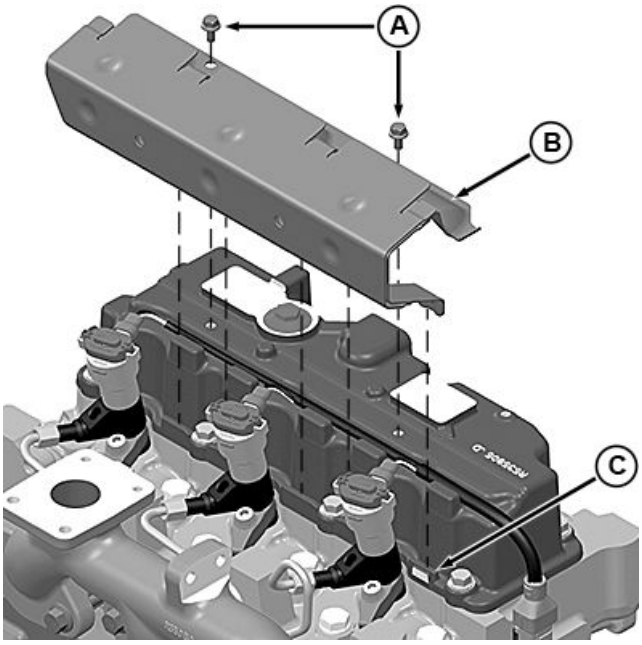
15. Install OCV inlet pipe. Lubricate new O-ring with engine oil and install OCV filter inlet tube into the rocker arm cover. Tighten M6 cap screw to specification.

Specification

M6 Cap Screw —Torque..... 15 N·m (133 lb.-in.)

16. Reconnect battery terminal.

A—Cap Screw (2 used)
B—Fuel Injector Heat Shield
C—External Groove



RG25052 —UN—12FEB14

Fuel Injector Heat Shield

ZE59858,000005A -19-23SEP14-5/5

Changing Open Crankcase Ventilation (OCV) Filter

Service checks of the OCV include checking and/or replacement of worn, cracked, leaking, or bulging hoses and for good clamp tension on all hose ends.

Expectation for minimal service interval will be at least 1500 hours.

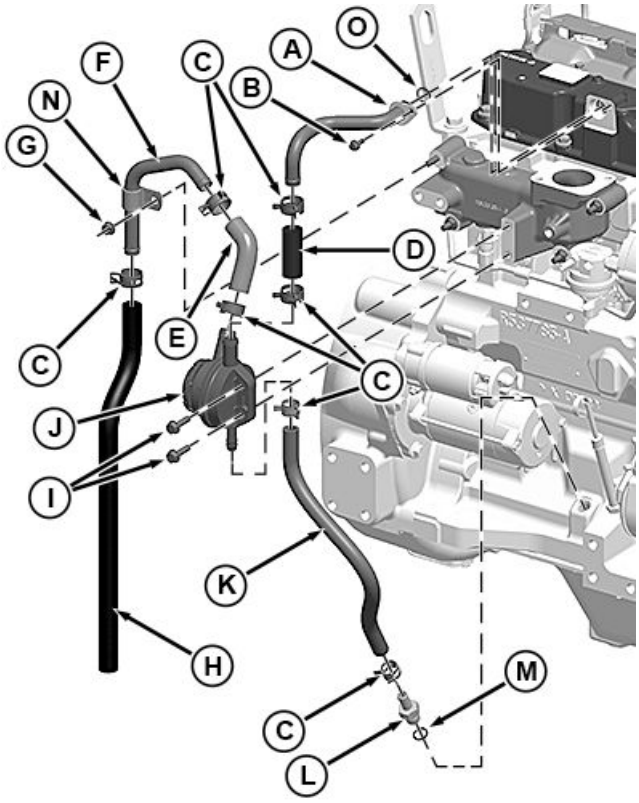
NOTE: OCV Filter must be replaced as an assembly, the filter inside is not serviceable.

Remove OCV Filter Assembly

1. Squeeze constant tension clamps (C) on both ends of the OCV filter outlet hose (E) with suitable tool and position clamps onto the OCV filter outlet tube (F). Remove the OCV filter outlet hose (E) from the OCV filter outlet hose barb and OCV filter outlet tube (F).
2. Squeeze constant tension clamps (C) on the OCV filter oil drain hose (K) with suitable tool and position clamp 50 mm (2.0 in.) from the end of the hose.

   Remove the OCV filter oil drain hose (K) from the OCV filter assembly (J), inspect for damage.
3. Squeeze constant tension clamps (C) on both ends of OCV filter inlet hose (D) with suitable tool and position clamps onto the OCV filter inlet tube (A).

   Remove the OCV filter inlet hose (D) from the hose barb of the OCV filter assembly (J) and the OCV filter inlet tube (A), inspect for damage.
4. Remove two cap screws (I) from the OCV filter assembly (J). Remove OCV filter assembly (J).



RG25157 —UN—03MAR14

OCV Filter Assembly

A—OCV Filter Inlet Tube
B—M6 x 16 mm Cap Screw
C—Constant Tension Clamp
D—OCV Filter Inlet Hose
E—OCV Filter Outlet Hose
F—OCV Filter Outlet Tube
G—M8 Flanged Head Nut
H—OCV Air Vent Hose
I— M8 x 30 mm Cap Screw (2 used)
J— OCV Filter Assembly
K—Oil Drain Hose
L— Oil Drain Check Valve
M—O-ring
N—P-Clamp
O—O-ring

Continued on next page

DN28805,0001EF7 -19-23SEP14-1/2

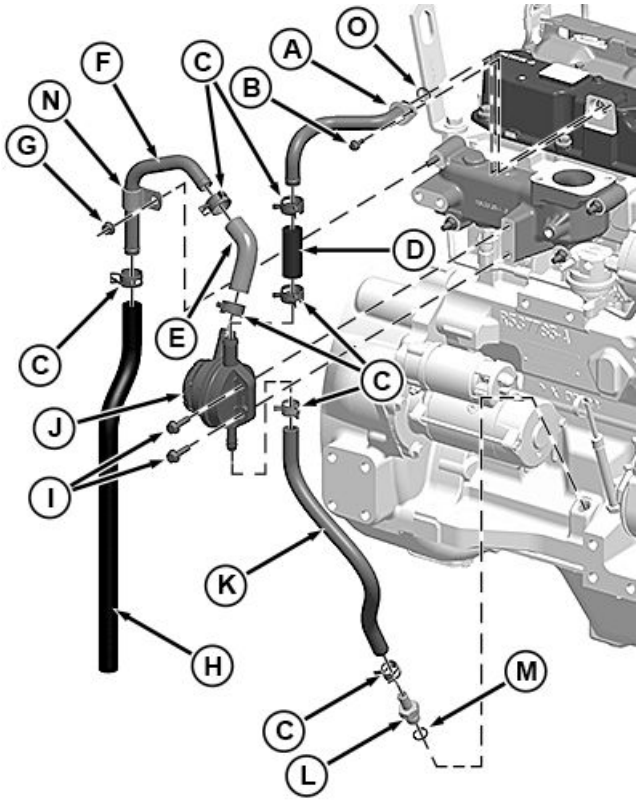
Install OCV Filter Assembly

1. Install two cap screws (I) through the OCV filter assembly (J) into the threaded holes in the intake manifold. Tighten cap screws to specification.

Specification

OCV Filter Assembly Mounting Cap Screws —Torque..... 40 N·m (30 lb.-ft.)

2. Install two constant tension clamps (C) onto the OCV filter inlet tube (A).
3. Lubricate ID of both ends of OCV filter inlet hose (D).
4. Insert one end of OCV filter inlet hose (D) onto the hose barb of the OCV filter inlet tube (A). Install the other end onto the inlet hose barb of the OCV filter assembly (J).
5. Squeeze constant tension clamps (C) with suitable tool and position clamps 2—5 mm (0.08—0.20 in.) from the end of the hose.
6. Lubricate ID of the OCV filter oil drain hose (K). Install the oil drain hose (K) onto the OCV filter assembly (J).
7. Squeeze constant tension clamp (C) with suitable tool and position clamps 2—5 mm (0.08—0.20 in.) from the end of the hose.
8. Lubricate ID of both ends of OCV filter outlet hose (E).
9. Insert one end of OCV filter outlet hose (E) onto the OCV filter outlet hose barb.
10. Install two constant tension clamps (C) onto the OCV filter outlet tube (F).
11. Install the OCV filter outlet hose (E) onto the OCV filter outlet tube(F).
12. Squeeze constant tension clamps (C) with suitable tool and position clamps 2—5 mm (0.08—0.20 in.) from the end of the hose.
13. If necessary, orient OCV filter outlet tube (F). Install P-Clamp (N) around tube onto the intake manifold mounting stud. Install flanged head nut (G) and tighten to specification.



RG25157 —UN—03MAR14

OCV Filter Assembly

A—OCV Filter Inlet Tube
B—M6 x 16 mm Cap Screw
C—Constant Tension Clamp
D—OCV Filter Inlet Hose
E—OCV Filter Outlet Hose
F—OCV Filter Outlet Tube
G—M8 Flanged Head Nut
H—OCV Air Vent Hose
I— M8 x 30 mm Cap Screw (2 used)
J— OCV Filter Assembly
K—Oil Drain Hose
L— Oil Drain Check Valve
M—O-ring
N—P-Clamp
O—O-ring

Specification

OCV Filter Outlet Tube P-Clamp M8 Flanged Head Nut —Torque..... 35 N·m (26 lb.-ft.)

IMPORTANT: Secure OCV Air Vent Hose out of the way to prevent pinching or blockage of the hose.

DN28805,0001EF7 -19-23SEP14-2/2

Flushing and Refilling Cooling System

CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns.

Shut off engine. Only remove filler cap when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing completely.

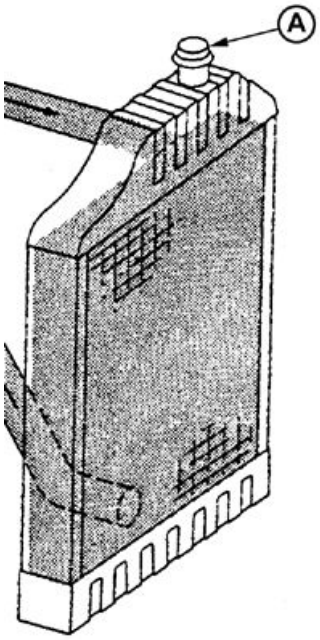
NOTE: If COOL-GARD II is not used, the drain interval is reduced to 2000 hours or 24 months of operation.

Drain old coolant, flush the entire cooling system, test thermostats, and fill with recommended clean coolant per the following procedure.

1. Pressure test entire cooling system and pressure cap if not previously done. See Pressure Testing Cooling System in the Lubrication & Maintenance — 500 Hours/12 Months Section.
2. Slowly open the engine cooling system filler cap or radiator cap (A) to relieve pressure and allow coolant to drain faster.

TS281 —UN—15APR13

High-Pressure Fluids



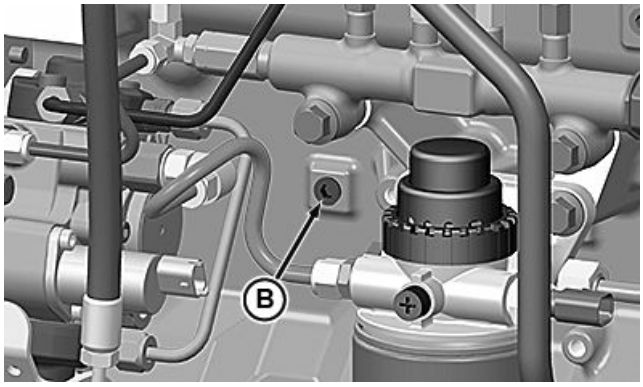
RG12833 —UN—13FEB03

Radiator Cap

ZE59858,000005B -19-24SEP14-1/3

3. Remove engine block drain plug (B). Drain all coolant from engine block.
4. Open radiator drain valve. Drain all coolant from radiator.
5. Close all drain valves and reinstall plug after coolant has drained.

B—Cylinder Block Coolant Drain Plug



RG26091 —UN—27JUN14

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ZE59858,000005B -19-24SEP14-2/3

6. Remove the coolant pump bypass tube from the thermostat housing (H). Remove cap screws (G), thermostat housing (H) and thermostat (I).
7. Reinstall thermostat housing (H) and gasket (J) without the thermostat. Tighten cap screws (G) to specification. Reinstall the coolant pump bypass tube.

Specification

Thermostat Housing Cap Screws—Torque..... 70 N·m (52 lb.-ft.)

8. Test thermostat opening temperature. See Testing Thermostat Opening Temperature in the Lubrication & Maintenance — 6000 Hours/72 Months Section.
9. Fill the cooling system with clean water. Run the engine 10 minutes to stir up possible rust or sediment.

CAUTION: Do not run engine longer than 10 minutes. Doing so may cause engine to overheat which may cause burns when radiator water is draining.

10. Stop engine. Remove lower radiator hose and radiator cap. Immediately drain the water from system before rust and sediment settles.
11. After draining water, reinstall radiator cap and radiator hose and clamp. Fill the cooling system with clean water and a heavy-duty cooling system cleaner such as Fleetguard® RESTORE™ and RESTORE PLUS™. Follow manufacturer's directions on label.
12. Remove radiator cap and engine coolant drain plugs as stated in steps (3 and 4).
13. Install drain plug on engine block. Close drain valve on radiator. Tighten plugs to specification.

Specification

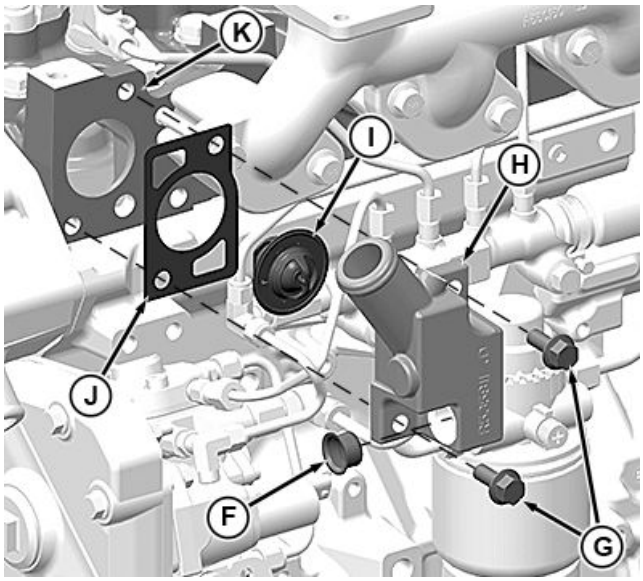
Cylinder Block Coolant Drain Plug—Torque..... 17 N·m (13 lb.-ft.)

14. Install thermostat and thermostat housing with new gasket. Tighten cap screws (G) to specification. Reinstall the coolant pump bypass tube.

Specification

Thermostat Housing Cap Screws—Torque..... 70 N·m (52 lb.-ft.)

Fleetguard is a trademark of Cummins Engine Company, Inc.
RESTORE is a trademark of Fleetguard.
RESTORE PLUS is a trademark of Fleetguard.



RG25318 —UN—26MAR14

Thermostat and Housing

F— Bypass Tube Seal
G—M10 x 25 mm Cap Screw (2 used)
H—Thermostat Housing
I— Thermostat
J— Gasket
K—Cylinder Head

15. Add coolant to surge tank. Coolant level should be at bottom of surge tank filler neck or radiator filler neck. If equipped with a translucent surge tank, coolant level should be at cool fill line indicator on surge tank. Install radiator cap. Coolant capacities can vary significantly, see your application operator's manual for coolant capacity.
16. Run engine until it reaches operating temperature. This mixes the solution uniformly and circulates it through the entire system. The normal engine coolant temperature range is 82°—95°C (180°—203°F).
17. After running engine, check coolant level and entire cooling system for leaks.

ZE59858,000005B -19-24SEP14-3/3

Testing Thermostat Opening Temperature

Removing Thermostat

1. Visually inspect area around thermostat housing for leaks.

CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns. DO NOT drain coolant until it has cooled below operating temperature. Always loosen radiator pressure cap or drain valve slowly to relieve pressure.

2. Remove radiator pressure cap and partially drain cooling system.

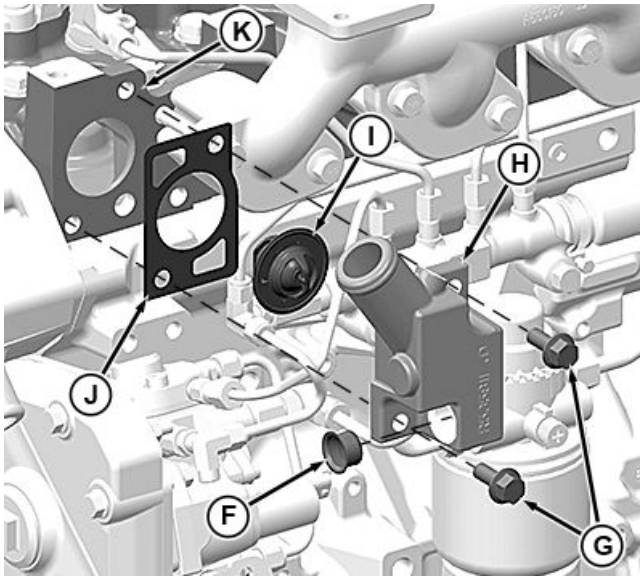
High-Pressure Fluids

TS281 —UN—15APR13

ZE59858,000005C -19-24SEP14-1/4

3. Remove coolant pump bypass tube from the thermostat housing (H). Remove cap screws (G) and thermostat housing (H). Clean and check housing for cracks or damage.
4. Remove thermostat (I) from the housing.

F—Bypass Tube Seal
G—M10 x 25 mm Cap Screw (2 used)
H—Thermostat Housing
I— Thermostat
J— Gasket
K—Cylinder Head



RG25318 —UN—26MAR14

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ZE59858,000005C -19-24SEP14-2/4

Testing Thermostat Opening Temperature

1. Visually inspect thermostat for corrosion or damage.

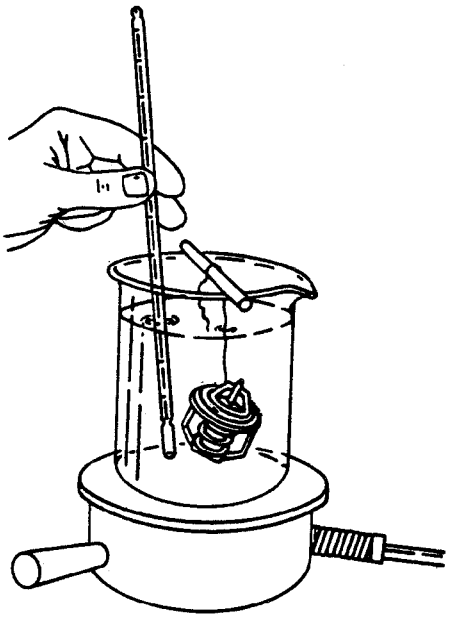
CAUTION: DO NOT allow thermostat or thermometer to rest against the side or bottom of container when heating water. Either may become damaged if overheated.

2. Suspend thermostat and a thermometer in a container of water.
3. Stir the water as it heats. Observe opening action of thermostat and compare with specifications.

Specification	
Thermostat — Start to Open—Temperature	83°C (181°F)
Thermostat — Fully Open—Temperature	95°C (203°F)

NOTE: Due to varying tolerances of different suppliers, initial opening and full open temperatures may vary slightly from specified temperatures.

4. Remove thermostat and observe its closing action as it cools. In ambient air the thermostat should close completely. Closing action should be smooth and slow.



RG5971 —UN—23NOV97

Testing Thermostat Opening Temperature

5. Replace thermostat if defective.

ZE59858,000005C -19-24SEP14-3/4

Installing Thermostat

1. If necessary, install seal (F) into the thermostat housing.
2. Remove gasket material from cylinder head (K) and thermostat housing (H) surfaces.
3. Place thermostat (I) into recess in thermostat housing with jiggle pin on top for proper deaeration.
4. Apply Loctite ® fast drying black weather strip adhesive to the thermostat housing side of gasket (J).
5. Place gasket (J) onto thermostat housing (H). Allow adhesive to set.

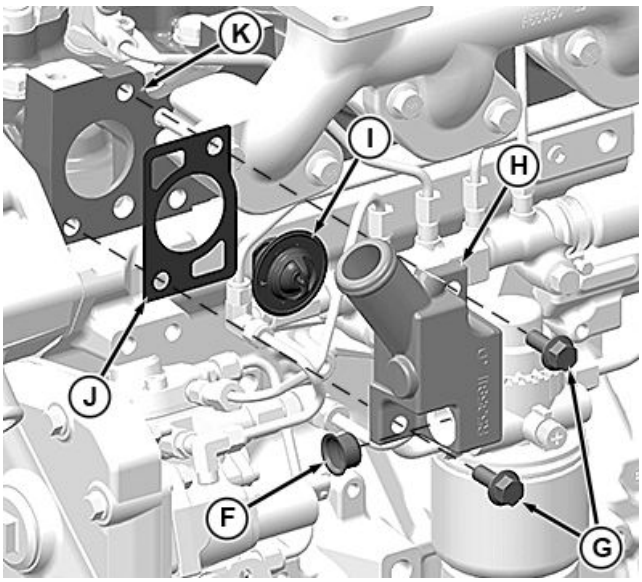
NOTE: Gasket holds thermostat in place during installation of thermostat housing onto the cylinder head.

6. Install cap screws (G) and tighten to specifications.

Specification	
Thermostat Housing Cap Screws —Torque	70 N·m (52 lb.-ft.)

7. Reinstall coolant pump bypass tube.
8. Fill cooling system and check for leaks.

IMPORTANT: Air must be expelled from cooling system when system is refilled. Loosen temperature sending unit fitting at rear of cylinder head to allow air to escape when filling system. Retighten fitting when all the air has been expelled.



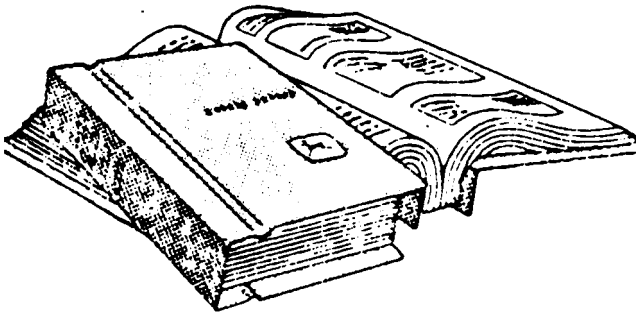
RG25318 —UN—26MAR14

F—Bypass Tube Seal
G—M10 x 25 mm Cap Screw (2 used)
H—Thermostat Housing
I— Thermostat
J— Gasket
K—Cylinder Head

ZE59858,000005C -19-24SEP14-4/4

Additional Service Information

This is not a detailed service manual. If you want more detailed service information, contact your John Deere dealer or engine distributor.



RG4624 —UN—15DEC88

Component Technical Manuals

OURGP11,0000048 -19-23AUG10-1/1

Do Not Modify Fuel System

CAUTION: Do not open high-pressure fuel system.

High-pressure fluid remaining in fuel lines can cause serious injury. Do not disconnect or attempt repair of fuel lines, sensors, or any other components between the high-pressure fuel pump and nozzles on engines with High Pressure Common Rail (HPCR) fuel system.

Only technicians familiar with this type of system can perform repairs. (See your John Deere dealer.)

IMPORTANT: Never steam clean or pour cold water on a high-pressure fuel pump while it is still warm. To do so may cause seizure of pump parts.

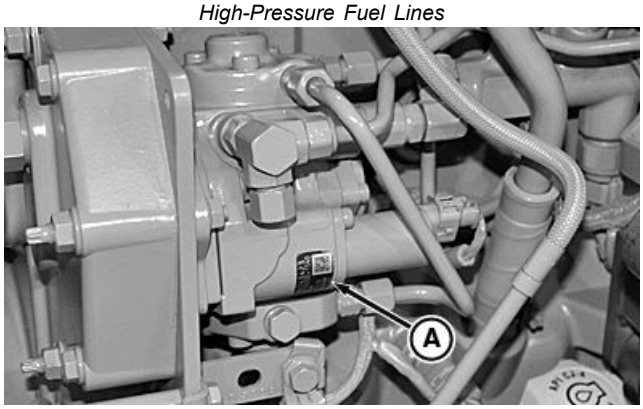
Modification or alteration of the high-pressure fuel pump (A), the injection timing, or the fuel injectors in ways not recommended by the manufacturer will terminate the warranty obligation to the purchaser.

In addition, tampering with fuel system which alters emission-related equipment on engines may result in fines or other penalties, per EPA regulations or other local emission laws.

Do not attempt to service fuel pump, fuel rail, or fuel injectors yourself. Special training and special tools are required. (See your authorized servicing dealer or engine distributor.)

TS1343 —UN—18MAR92

High-Pressure Fuel Lines



RG20108 —UN—15MAR11

High Pressure Fuel Pump

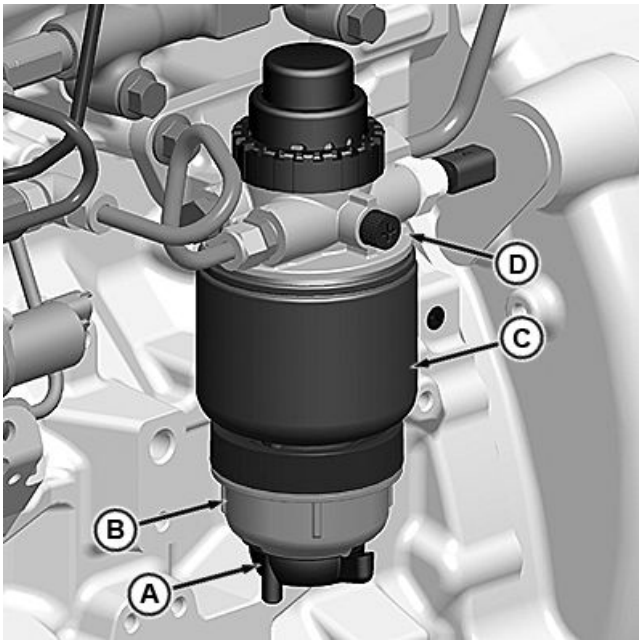
A—High-Pressure Fuel Pump

JR74534,0000368 -19-29MAR11-1/1

Drain Water From Fuel Filter

1. Loosen drain valve (A) to drain water and debris as needed. If necessary, open air bleed screw to allow water to drain from separator.
2. Retighten drain valve securely.
3. Bleed air from the fuel system as required. See Bleeding Fuel System in Service As Required section.

A—Drain Valve
B—Water Separator
C—Primary Fuel Filter
D—Air Bleed Screw



RG25271 —UN—18MAR14

ZE59858,000005D -19-23SEP14-1/1

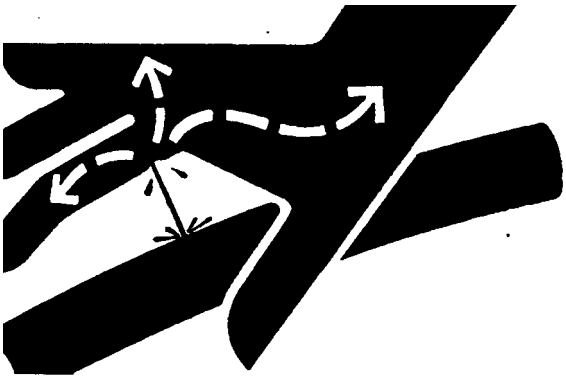
Bleeding Fuel System

CAUTION: Escaping fluid under pressure can penetrate the skin causing serious injury. Relieve pressure before disconnecting fuel or other lines. Tighten all connections before applying pressure. Keep hands and body away from pinholes and nozzles which eject fluids under high pressure. Use a piece of cardboard or paper to search for leaks. Do not use your hand.

If ANY fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type injury or gangrene may result. Doctors unfamiliar with this type of injury may call the Deere & Company Medical Department in Moline, Illinois, or other knowledgeable medical source.

IMPORTANT: Do not operate the engine at high speeds or full loads just before bleeding the fuel system as this may cause fuel injection pump failure.

Bleed the fuel system anytime the fuel system has been opened up. This includes:



X9811 —UN—23AUG88

Keep Skin Away from High-Pressure Fluids

- After fuel filter changes.
- After pump or nozzle replacement.
- Anytime fuel lines have been disconnected.
- After engine has run out of fuel.

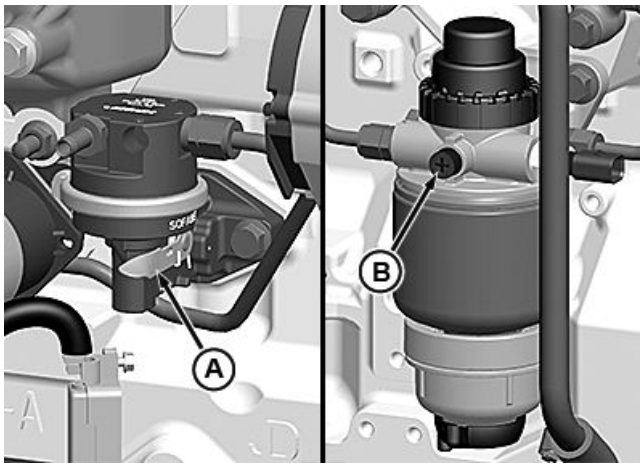
Bleed the fuel system using the following procedure:

Continued on next page

ZE59858,000005E -19-24SEP14-1/3

1. Loosen the air bleed vent screw (B) two full turns.
2. On mechanical supply pumps, operate supply pump primer lever (A) until fuel flow is free from air bubbles.
3. On electric supply pumps, turn key switch to “ON” position until fuel flow is free from air bubbles.
4. Tighten bleed screw securely by hand. Continue operating hand primer until pumping action is not felt. When finished, pull hand primer upward as far as it will go.
5. Start engine and check for leaks.

   If engine does not start, it may be necessary to bleed air from fuel system at the high-pressure fuel pump.



RG25136 —UN—19FEB14

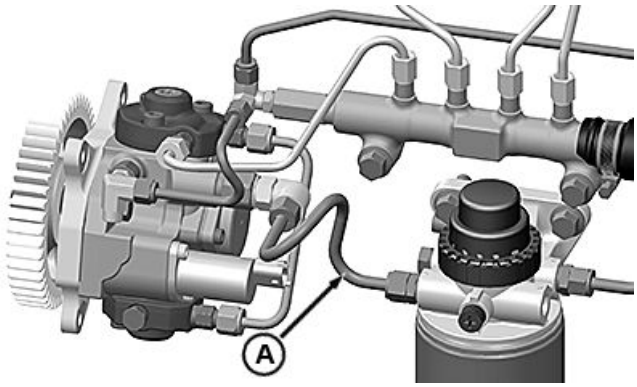
Air Bleed Screw and Fuel Supply Pump Primer Lever

A—Fuel Supply Pump Primer Lever

B—Air Bleed Screw

ZE59858,000005E -19-24SEP14-2/3

6. Disconnect high-pressure pump fuel inlet line (A).
7. Attach a fuel line to the fuel inlet line (A), and place other end in a 3.8 L (1.0 gal.) or larger container.
8. Manually prime the mechanical transfer pump until discharge stream of fuel into bucket is present without air bubbles.
9. Reinstall fuel inlet line and prime the high-pressure fuel pump.
10. With the ignition ON and the engine OFF, manually prime the mechanical transfer pump.
11. Crank the engine for 15 seconds. If engine does not start, perform step 6—10 as necessary. If engine does not start, see your John Deere dealer.



RG25141 —UN—19FEB14

High-Pressure Fuel Pump

A—Fuel Inlet Line

ZE59858,000005E -19-24SEP14-3/3

Adding Coolant

CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns.

Shut off engine. Only remove filler cap when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing completely.

IMPORTANT: Never pour cold liquid into a hot engine, as it may crack cylinder head or block. DO NOT operate engine without coolant for even a few minutes.

John Deere Cooling System Sealer may be added to the radiator to stop leaks. DO NOT use any other stop-leak additives in the cooling system.

Air must be expelled from cooling system when system is refilled and before running the engine is run at normal operating temperatures. Air will escape from the coolant system through an engine coolant vent line (if equipped) when the engine is idled. Allow approximately 30 minutes to ensure all air has escaped the system before returning the engine to normal service. If there is no engine coolant vent line installed on the engine (connected to the coolant surge tank) loosen the temperature sending unit fitting (rear of cylinder head) or a plug in thermostat housing to allow air to escape when filling the system. Retighten fitting or plug when all the air has been expelled.

Coolant level should be maintained to the bottom of the surge tank filler neck or radiator filler neck (A). If needed, add coolant as follows.

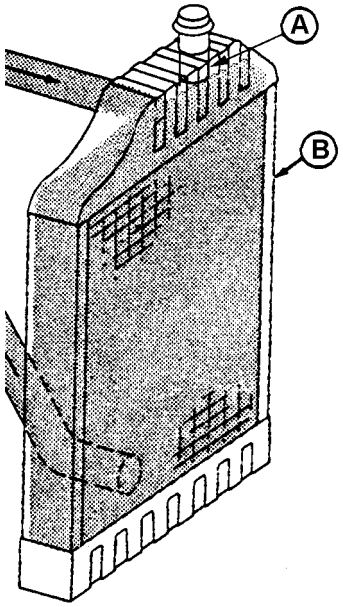
1. Loosen temperature sending unit fitting at rear of cylinder head to allow air to escape when filling system.

IMPORTANT: When adding coolant to the system, use the appropriate coolant solution. (See ENGINE COOLANT SPECIFICATIONS in Fuels, Lubricants, and Coolant Section for mixing of coolant ingredients before adding to cooling system.)

Do not overfill cooling system. A pressurized system needs space for heat expansion without overflowing at top of radiator.

TS281 —UN—15APR13

High-Pressure Fluids



RG13295 —UN—20NOV03

Radiator and Coolant

A—Radiator Filler Neck **B—Radiator**

2. Add coolant until level is at bottom of surge tank filler neck or radiator filler neck (A). If equipped with a translucent surge tank, coolant level should be at cool fill line indicator on surge tank.
3. Tighten plugs and fittings when air has been expelled from system.
4. Run engine until it reaches operating temperature.

JR74534,0000276 -19-07OCT10-1/1

Pre-Start Cleaning Guide

IMPORTANT: Before cleaning machine, allow ample time for hot surfaces to cool.

IMPORTANT: Do not direct high-pressure spray from hose output directly at or close to electrical connections and sensors.

Rigorous cleaning as needed is recommended. Clean more frequently during heavy machine use, and when weather conditions are dry.

- Check enclosed areas daily. Clean the engine and other enclosed areas of equipment to remove debris and any buildup of oil and grease. Keep the engine and engine compartment free of combustible material.
- Check for debris buildup daily on and around intake systems, exhaust systems, and intercooler piping systems. Verify that there are no holes or leaks in intake or exhaust systems. Do not allow debris to build up near hot exhaust components. Verify that hot exhaust components are cleaned as often as environmental conditions require.
- Inspect cooling system daily to determine whether cooling system needs cleaning. Visible buildup of residue that blocks airflow may degrade machine performance and requires more frequent cleaning depending on environmental conditions.
- Inspect difficult to observe areas daily as conditions may require additional cleaning care to remove debris.
- Check for oil and fuel leaks daily. Replace or repair any sources of leaks, including gaskets, seals, breather tubes, fittings, and fluid lines.

Maintenance and Service Reminders

- Keep surfaces free of grease and oil.
- Clean up after hydraulic and other fluid leaks.
- Fuel Lines — Check for leaks, cracks, and kinks that require service before use.
- Fuel Pumps — Check fittings, especially compression ring couplings, for cracks and leaks.
- Fuel Injectors — Check pressure and return lines for signs of leaks.
- When servicing fuel filter or draining water separator, avoid fuel spills. Immediately clean up any fuel spill.
- Handle transmission and power steering fluids with care. Immediately clean up any spills, especially around fill points.
- Check for transmission case venting system seepage, transmission case leakage, power steering cylinder leakage, or power steering line leakage.
- Check for loose electrical connectors, damaged wiring, corrosion, and poor connections.

ZE59858,0000009 -19-20MAY13-1/1

Replacing Single Stage Air Cleaner

IMPORTANT: ALWAYS REPLACE air cleaner when air filter restriction indicator shows a vacuum of 625 mm (25 in.) H_2O, is torn, or visibly dirty.

NOTE: This procedure applies to John Deere single stage air cleaner kits. Refer to manufacturers' instructions for servicing air cleaners not supplied by John Deere.

1. If equipped, loosen body clamp.
2. Loosen clamp around outlet neck (A).
3. Remove air cleaner.
4. Install new filter so that overlap (B) of air cleaner outlet neck and engine intake pipe is to specification below.

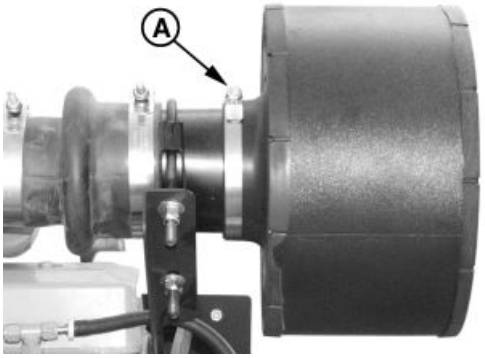
Specification	
Air Cleaner Neck to Engine Intake—Overlap	38 mm (1.5 in.)

5. Tighten neck clamp (A) to specification below.

Specification	
Air Cleaner Neck Clamp—Torque	6.8 N·m (60 lb.-in.)

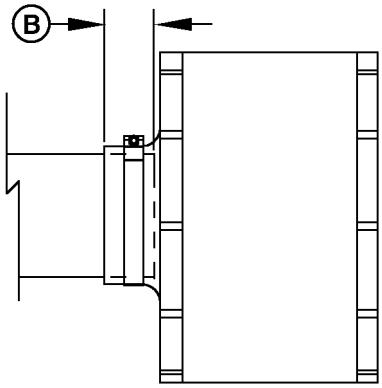
IMPORTANT: Do NOT overtighten body clamp. Overtightening may cause crushing of air cleaner body. Tighten body clamp only until snug.

6. If equipped, tighten body clamp until snug.



RG11319A —UN—06SEP00

Single Stage Air Filter



RG11320 —UN—07SEP00

Installation of Single Stage Air Cleaner

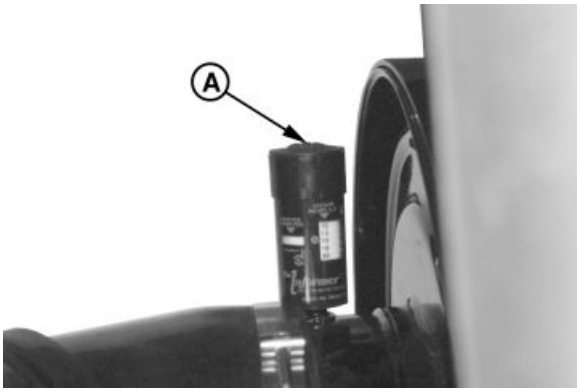
A—Outlet Neck Clamp **B—Filter to Engine Overlap**

RG,RG34710,5594 -19-18DEC13-1/2

IMPORTANT: Whenever the air cleaner has been serviced or removed, ALWAYS fully depress the air filter restriction indicator reset button (if equipped) to assure accurate readings.

7. If equipped, fully depress air filter restriction indicator reset button (A) and release to reset indicator.

A—Air Filter Restriction Indicator



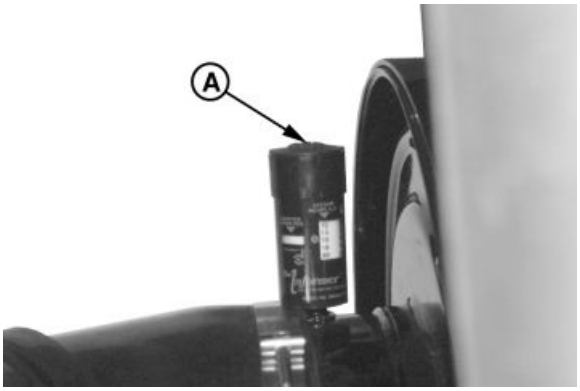
RG8719B —UN—03SEP99

RG,RG34710,5594 -19-18DEC13-2/2

Replacing Axial Seal Air Cleaner Filter Element

IMPORTANT: ALWAYS REPLACE primary air cleaner element when air restriction indicator (A) shows a vacuum of 625 mm (25 in.) H_2O, is torn, or visibly dirty.

NOTE: This procedure applies to John Deere 2-stage axial seal air cleaner kits. Refer to manufacturers' instructions for servicing air cleaners not supplied by John Deere.



RG8719B —UN—03SEP99

Air restriction Indicator

Continued on next page

OURGP11,000013A -19-24SEP14-1/2

1. Remove wing nut and remove canister cover shown in small illustration inset.
2. Remove wing nut (A) and remove primary element (B) from canister.
3. Thoroughly clean all dirt from inside canister.

NOTE: Some engines may have a dust unloader valve (C) on the air cleaner. If equipped, squeeze valve tip to release any trapped dirt particles.

IMPORTANT: Remove secondary (safety) element (E) ONLY for replacement. DO NOT attempt to clean, wash, or reuse secondary element. Replacement of secondary element is usually necessary ONLY when primary element has a hole in it.

4. To replace secondary element, remove retaining nut (D) and secondary element (E). Immediately replace secondary element with new element to prevent dust from entering air intake system.

Specification

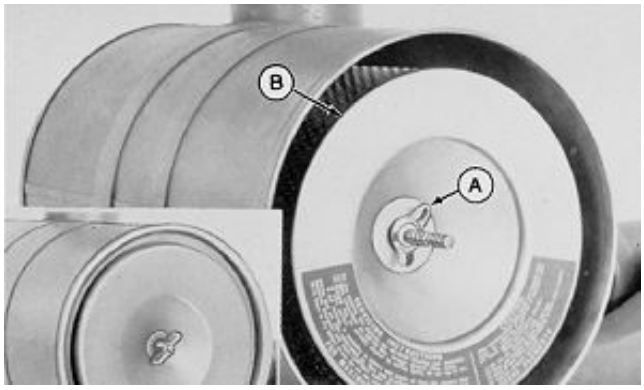
Retaining Nut—Torque..... 20 N·m (177 lb.-in.)

5. Install new primary element and tighten wing nut securely. Install cover assembly and tighten retaining wing nut securely.

IMPORTANT: Whenever the air cleaner has been serviced or had cover removed, ALWAYS fully depress the air restriction indicator reset button (if equipped) to assure accurate readings.

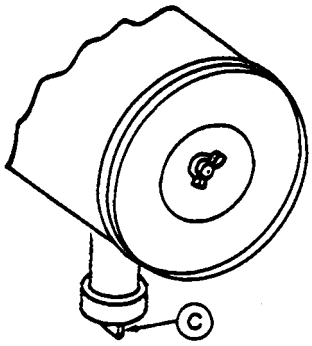
6. If equipped, fully depress air restriction indicator reset button and release to reset indicator.

A—Wing Nut
B—Primary Element
C—Dust Unloader Valve
D—Retaining Nut
E—Secondary Element



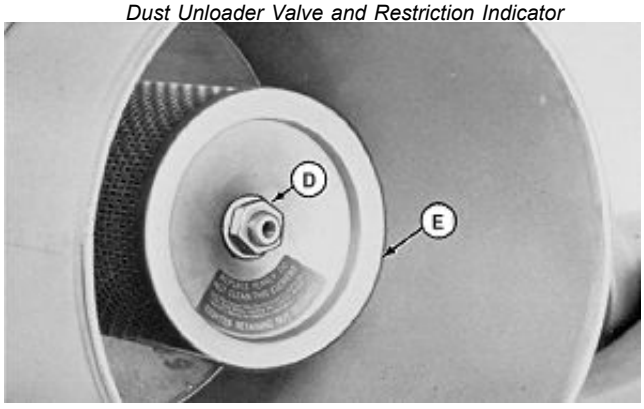
Wing Nut and Primary Element

RG4686 —UN—20DEC88



Dust Unloader Valve and Restriction Indicator

RG4687 —UN—20DEC88



Retaining Nut and Secondary Element

RG11068 —UN—26JUN00

OURGP11,000013A -19-24SEP14-2/2

Replacing Radial Seal Air Cleaner Filter Element

IMPORTANT: ALWAYS REPLACE primary air cleaner element when air restriction indicator shows a vacuum of 625 mm (25 in.) H_2O, is torn, or visibly dirty.

NOTE: This procedure applies to John Deere 2-stage radial seal air cleaner kits. Refer to manufacturers' instructions for servicing air cleaners not supplied by John Deere.

1. Unlatch and remove dust cap/cover (A) of air cleaner.
2. Move end of filter (B) back and forth gently to break seal.
3. Pull filter (B) off outlet tube and out of housing.
4. Thoroughly clean all dirt from inside housing and from outlet bore.

IMPORTANT: Remove secondary (safety) element (C) ONLY for replacement. DO NOT attempt to clean, wash, or reuse secondary element. Replacement of secondary element is usually necessary ONLY when primary element has a hole in it.

5. To replace secondary element (C), pull filter element out gently. Immediately replace secondary element with new element to prevent dust from entering air intake system.
6. Install new primary filter element. Apply pressure by hand at outer rim of filter.

IMPORTANT: Do NOT use latches on cover to force filter into air cleaner. Using cover to force filter will damage cleaner housing.

7. Close housing with dust unloader valve aimed down and latch latches.

IMPORTANT: Whenever the air cleaner has been serviced or cover has been removed, ALWAYS fully depress the air restriction indicator reset button (if equipped) to assure accurate readings.

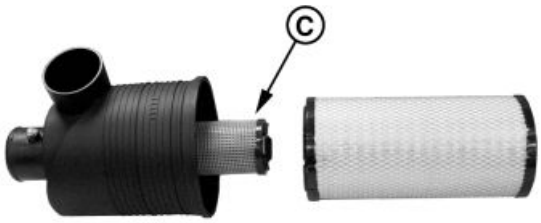
8. If equipped, fully depress air restriction indicator reset button and release to reset indicator.

RG11321A —UN—08SEP00

Dust Cap/Cover

RG11322A —UN—08SEP00

Primary Filter Element



RG11327A —UN—08SEP00

Secondary Filter Element

A—Dust Cap/Cover
B—Primary Filter Element
C—Secondary Filter Element

RG41165,000008B -19-07OCT10-1/1

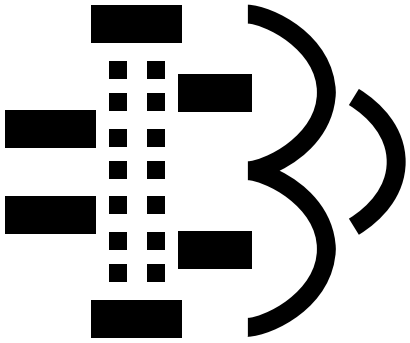
Cleaning the Exhaust Filter

The exhaust filter will require maintenance periodically. Some of the maintenance will be transparent to the operator. During continuous heavy loads and other conditions, the engine may create enough heat to naturally remove accumulated soot in the exhaust filter. When the exhaust filter has accumulated higher levels of soot, the display panel may request (depending on predefined user settings) an exhaust filter cleaning. During this request, the equipment is required to be located or moved to a suitable location with adequate ventilation.

To the right are symbols which may be seen on the operator interface.

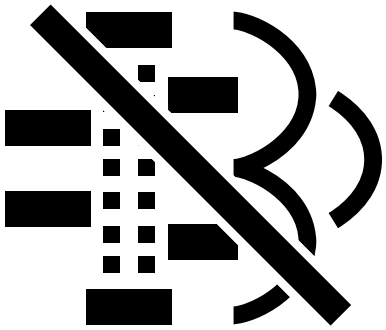
IMPORTANT: The area above and surrounding the engine during a manual exhaust filter cleaning should be free of any flammable objects as temperatures can reach as high as 550 °C (1022 °F).

NOTE: For more information on the operator interface icons or exhaust filter cleaning procedures, please see the Aftertreatment System Section of this Manual, or the corresponding Component Technical Manual (CTM).



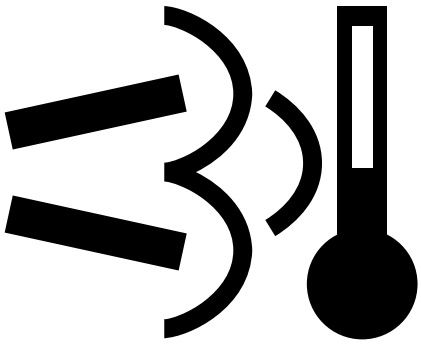
RG16860 —UN—01APR10

Exhaust Filter Cleaning is Needed



RG16861 —UN—01APR10

Exhaust Filter Cleaning is Disabled



RG16862 —UN—01APR10

Emission System Temperature is High or Exhaust Filter Cleaning is Underway

ZE59858,00002D4 -19-06DEC13-1/1

Replacing Fan Belt

1. Inspect belts for cracks, fraying, or stretched out areas. Replace if necessary.
2. Install new belt, making sure that belt is correctly seated in all pulley grooves. Text on belt (such as John Deere or part number) should be readable when standing at the front of the engine looking back toward the rear.

NOTE: While belt is removed, inspect pulleys and bearings. Rotate and feel for hard turning or any unusual sounds. If pulleys or bearings need replacement, see your John Deere dealer.

3. Adjust belt tension. See Checking Fan And Alternator V-Belt Tension in Lubrication & Maintenance - 500 Hours -12 Months section.
4. Install fan guard if removed.
5. Start engine and check belt alignment.

ZE59858,000005F -19-27JUN14-1/1

Checking Fuses

Check the following fuses located in the control panel wiring harness. Replace defective fuses.

- Control Panel fuse — 30 Amp
- JDLink fuse — 10 Amp
- ECU fuse — 20 Amp
- Transient Voltage Protection (TVP) fuse — 30 Amp

See 2.9 L Wiring Diagram 5 in the Troubleshooting Section.

ZE59858,0000060 -19-27JUN14-1/1

Checking Electrical Wiring And Connections

Check for loose or corroded wiring and connectors. Tighten connections or replace wiring as needed. See your authorized servicing dealer for repairs.

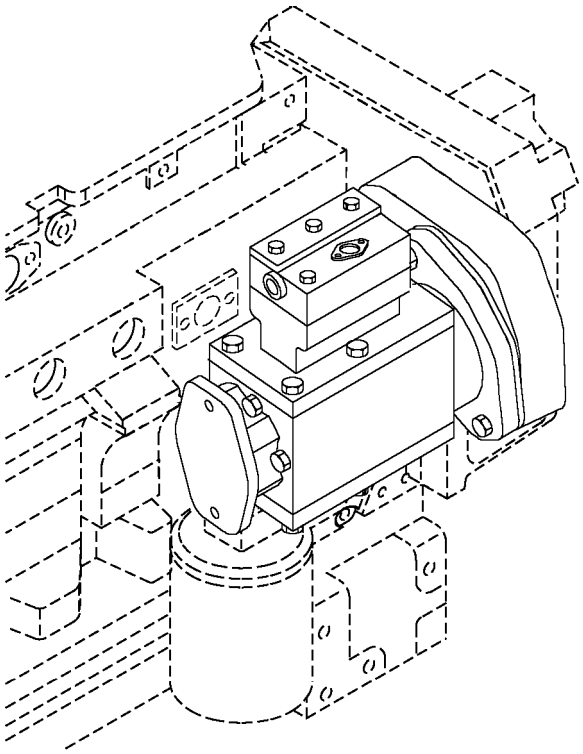
ZE59858,00002D6 -19-06DEC13-1/1

Checking Air Compressors (If Equipped)

Air compressors are offered as options with John Deere OEM engines to provide compressed air to operate air-powered devices like vehicle air brakes.

Air compressors are engine-driven piston types. They are either air cooled or cooled with engine coolant. The compressors are lubricated with engine oil. The compressor runs continuously as gear or spline driven by the auxiliary drive of the engine but has “loaded” and “unloaded” operating modes. This is controlled by the vehicle's air system (refer to vehicle technical manual for complete air system checks and services).

See your John Deere engine distributor or servicing dealer for diagnostic and troubleshooting information. If diagnosis leads to an internal fault in the compressor, replace the complete compressor as a new or remanufactured unit.



RG12836 —UN—27FEB03

Air Compressor (Optional)

OURGP12,00001E0 -19-27JUL06-1/1

General Troubleshooting Information

Troubleshooting engine problems can be difficult. An engine wiring diagram is provided in this section to help isolate electrical problems on power units using John Deere wiring harness and instrument (gauge) panel.

Later in this section is a list of possible engine problems that may be encountered accompanied by possible causes and corrections. The illustrated diagrams and troubleshooting information are of a general nature; final design of the overall system for your engine application may be different. See your engine distributor or servicing dealer if you are in doubt.

A reliable program for troubleshooting engine problems should include the following basic diagnostic thought process:

- Know the engine and all related systems.
- Study the problem thoroughly.
- Relate the symptoms to your knowledge of engine and systems.
- Diagnose the problem starting with the easiest things first.
- Double-check before beginning the disassembly.
- Determine cause and make a thorough repair.
- After making repairs, operate the engine under normal conditions to verify that the problem and cause was corrected.

NOTE: All engines have electronic control systems which may send diagnostic trouble codes to signal problems (see Diagnostic Trouble Codes (DTCs) — Operation in the Troubleshooting Section).

1. *If fault codes are present, perform the suggested corrective actions.*
2. *If this does not correct the engine problem, contact your servicing dealer.*
3. *If engine has problems but no fault codes are displayed, see Engine Troubleshooting in the Troubleshooting Section for problems and solutions.*

EP89502,0000001 -19-16SEP13-1/1

Diagnostic Trouble Codes (DTCs) — Listing

NOTE: Not all of these codes are used in all engine applications.

NOTE: Not all DTCs are listed below. See your application technical manual for more information.

There are several possible combinations of SPN and FMI codes. To use the table below, first write down the SPN and FMI codes you received from the engine diagnostic gauge. Locate each SPN and its associated definition. In the same way, locate the FMI and its associated definition.

FMI Code	FMI Name
0	Extremely High
1	Extremely Low
2	Invalid
3	Out of Range High
4	Out of Range Low
5	High Resistance
6	Low Resistance
7	Mismatch
8	Signal Missing
9	Loss of Communication
10	Change Abnormal
11	Activated
12	Error
13	Fault
14	Incorrect Message
15	Slightly High
16	Moderately High
17	Slightly Low
18	Moderately Low
19	Communication Error
31	Condition Exists

SPN Code	SPN Name
28	Digital Throttle Signal
29	Secondary Analog Throttle Signal
91	Primary Analog Throttle Signal
94	Low Pressure Fuel Signal
97	Water-in-fuel Signal
100	Engine Oil Pressure Signal
101	Crankcase Pressure Signal
102	Manifold Air Pressure Signal
105	Manifold Air Temperature Signal
108	Barometric Pressure Signal
110	Engine Coolant Temperature Signal
157	Fuel Rail Pressure Signal
158	ECU Power Down
168	Unswitched Battery Voltage
174	Fuel Temperature Signal
189	Engine Speed Derate
190	Engine Speed
237	VIN Security Data
611	Injector Drive #1
629	ECU EEPROM
636	Camshaft Position Signal
637	Crankshaft Position Signal
651	Injector #1
652	Injector #2
653	Injector #3
676	Cold Start Aid Drive Circuit
970	External Shutdown Commanded
971	External Derate Commanded
974	Remote Analog Throttle Signal Out of Range

Continued on next page

1136	ECU Temperature Signal
1180	Calculated Turbocharger Turbine Inlet Temperature
1209	Exhaust Manifold Pressure Signal
1347	Suction Control Valve Circuit
1569	Engine Power Derate
2002-2253	Source Address 2-253
2797	Injector High Voltage Supply #1
3246	DPF Outlet Temperature
3251	DPF Differential Pressure Signal
3465	Exhaust Throttle Actuator Drive Circuit
3509	Sensor Supply #1 Voltage
3510	Sensor Supply #2 Voltage
3511	Sensor Supply #3 Voltage
3512	Sensor Supply #4 Voltage
3513	Sensor Supply #5 Voltage
3514	Sensor Supply #6 Voltage
3597	Injector Power Supply Voltage
3711	DOC Inlet Temp
3719	Calculated Soot Level
3720	Calculated Ash Level
3936	DPF Fault Occurrences
4765	DOC Inlet Temp
4766	DOC Outlet Temp
4795	DPF Missing
5018	DOC Fault Occurrences
5125	Sensor Supply #7 Voltage
5126	Sensor Supply #8 Voltage
5127	Sensor Supply #9 Voltage
5298	DOC Efficiency Fault
520629	Illegal Operation
522495	Exhaust Filter Temp Module

NOTE: Diagnostic gauge on instrument panel may also display text for communication faults, such as “CAN Bus FAILURE”. Contact your servicing dealer.

ZE59858,000006B -19-17APR14-2/2

Diagnostic Trouble Codes (DTCs) — Operation

SPN/FMI CODES

Stored and active diagnostic trouble codes are output on the diagnostic gauge on the Deere electronic instrument panel according to the J1939 standard as a two-part code as shown on the tables on the following pages.

The first part is a Suspect Parameter Number (SPN) followed by a Failure Mode Identifier (FMI) code. In order to determine the exact failure, both parts (SPN and FMI) of the code are needed.

The SPN identifies the system or the component that has the failure; for example SPN 000110 indicates a failure in the engine coolant temperature circuit.

The FMI identifies the type of failure that has occurred; for example FMI 03 indicates value out of range high. Combining SPN 000110 with FMI 03 yields a fault code “engine coolant temperature input voltage too high”. A corrective action will also be displayed, “check sensor and wiring”. If this check does not solve the engine fault, contact your servicing dealer.

Always contact your servicing dealer for help in correcting unsolved diagnostic trouble codes which are displayed for your engine.

DN28805,0001E6B -19-07FEB14-1/1

Intermittent Fault Diagnostics

Intermittent faults are problems that periodically “go away”. A problem such as a terminal that intermittently doesn't make contact can cause an intermittent fault. Other intermittent faults may be set only under certain operating conditions such as heavy load, extended idle, etc. When diagnosing intermittent faults, take special note of the condition of wiring and connectors, since a high percentage of intermittent problems originates here. Check for loose, dirty, or disconnected connectors. Inspect the wiring routing, looking for possible shorts caused by contact with external parts (for example, rubbing against sharp sheet metal edges). Inspect the connector vicinity, looking for wires that have pulled out of connector terminals, damaged connectors, poorly positioned terminals, and corroded or damaged splices and terminals. Look for broken wires, damaged splices, and wire-to-wire shorts. Use good judgment if component replacement is thought to be required.

NOTE: The engine control unit (ECU) is the component LEAST likely to fail.

Suggestions for diagnosing intermittent faults:

- If diagnostic charts on preceding pages indicate that the problem is intermittent, try to reproduce the operating conditions that were present when the diagnostic trouble code (DTC) set.
- If a faulty connection or wire is suspected to be the cause of the intermittent problem: clear DTCs, then check the connection or wire by wiggling it while watching the diagnostic gauge to see if the fault resets.

Possible causes of intermittent faults:

- Faulty connection between sensor or actuator harness.
- Faulty contact between terminals in connector.
- Faulty terminal/wire connection.
- Electromagnetic interference (EMI) from an improperly installed 2-way radio, etc., can cause faulty signals to be sent to the ECU.

NOTE: Refer to wiring diagrams later in this section as a guide to connections and wiring.

RK80614,000004C -19-26AUG13-1/1

Engine Troubleshooting

NOTE: Before troubleshooting the engine, first retrieve any fault codes on the diagnostic gauge display and perform the corrective actions. (See earlier in this section.) If any problems remain, use the following charts to solve engine problems.

Symptom	Problem	Solution
Engine Will Not Crank	Low battery output voltage or discharged battery	Charge or replace batteries.
	Loose or corroded connections	Clean and tighten connections.
	Faulty start circuit relay	See your authorized John Deere engine distributor or servicing dealer.
	Blown fuse	Replace fuse.
	Defective main switch or start safety switch	Repair switch as required.
	Starter solenoid defective	Replace solenoid.
	Starter defective	Replace starter.
Starter Cranks Slowly	Low battery output voltage or discharged battery	Charge or replace batteries.
	Too high viscosity crankcase oil	Drain crankcase oil and replace with correct viscosity oil.
	Loose or corroded connections	Clean and tighten connections.
Hard to Start or Will Not Start	Engine starting under load	Disengage PTO.
	Improper starting procedure	Review starting procedure.
	Exhaust restricted	Check and correct exhaust restriction.
	No fuel	Check fuel tank.
	Air in fuel line	Bleed fuel lines.
	Poor fuel quality	Drain fuel and replace with proper grade and quality of fuel for operating condition.
	Water, dirt, or air in fuel system	Drain, flush, fill, and bleed fuel system.
	Fuel filter restricted or full of water	Replace fuel filter or drain water from fuel filter.
	Dirty or faulty fuel injectors	See your authorized John Deere engine distributor or servicing dealer.
	Electronic fuel system problem	See your authorized John Deere engine distributor or servicing dealer.

Continued on next page

Symptom	Problem	Solution
	Cold weather	Use cold weather starting aids. See Cold Weather Operation in the Engine Operation Section.
	Too high viscosity crankcase oil	Drain crankcase oil and replace with correct viscosity oil.
	Electronic Control System Problem or Basic Engine Problem	See your authorized John Deere engine distributor or servicing dealer.
Engine Misfiring or Runs Irregularly	Poor fuel quality	Incorrect fuel/dirty fuel
		Test fuel, drain water from fuel bowl.
	Restricted fuel filter	Replace fuel filter element.
	Water, dirt, or air in fuel system	Drain, flush, fill, and bleed fuel system.
	Low coolant temperature	Remove and check thermostat.
	Dirty or faulty fuel injectors	See your authorized John Deere engine distributor or servicing dealer.
	Electronic fuel system problem	See your authorized John Deere engine distributor or servicing dealer.
	Electronic Control System problem or basic engine problem	See your authorized John Deere engine distributor or servicing dealer.
Lack of Engine Power	Intake air restriction	Service air cleaner.
	Exhaust restricted	Check and correct exhaust restriction.
	Poor fuel quality	Drain fuel and replace with proper grade and quality of fuel for operating condition.
	Restricted fuel filter	Replace fuel filter elements.
	Engine overloaded	Reduce engine load.
	Improper crankcase oil	Drain crankcase oil and replace with correct viscosity oil.
	Low coolant temperature	Remove and check thermostat.
	Improper valve clearance	Adjust valve clearance. See Adjusting Valve Clearance in the Lubrication & Maintenance — 2000 Hours/24 Months.
	Dirty or faulty fuel injectors	See your authorized John Deere engine distributor or servicing dealer.

Continued on next page

Symptom	Problem	Solution
	Turbocharger not functioning properly	See your authorized John Deere engine distributor or servicing dealer.
	Air leak in engine intake or exhaust manifold	Check intake and exhaust manifold gaskets and manifolds; repair as required. See your authorized John Deere engine distributor or servicing dealer.
	Engine is in derate due to DTC	See your authorized John Deere engine distributor or servicing dealer.
	Electronic Control System problem or basic engine problem	See your authorized John Deere engine distributor or servicing dealer.
Engine Idles Poorly	Poor fuel quality	Drain fuel and replace with proper grade and quality of fuel for operating condition.
	Electronic control system problem or basic engine problem	See your authorized John Deere engine distributor or servicing dealer.
Excessive Fuel Consumption	Engine overloaded	Reduce engine load.
	Air cleaner restricted or dirty	Replace air cleaner element as required.
	Compression too low	Determine cause of low compression and repair as required.
	Leaks in fuel supply system	Locate source of leak and repair as required.
	Improper type of fuel	Drain fuel and replace with proper grade and quality of fuel for operating condition.
	Poor fuel quality	Drain fuel and replace with proper grade and quality of fuel for operating condition.
	Improper valve clearance	Adjust valve clearance. See Adjusting Valve Clearance in the Lubrication & Maintenance — 2000 Hours/24 Months.
	Dirty or faulty fuel injectors	See your authorized John Deere engine distributor or servicing dealer.
	Electronic fuel system problem	See your authorized John Deere engine distributor or servicing dealer.
	Electronic Control System problem or basic engine problem	See your authorized John Deere engine distributor or servicing dealer.

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Symptom	Problem	Solution
	Turbocharger not functioning properly	Inspect turbocharger. See your authorized John Deere engine distributor or servicing dealer.
	Low engine temperature	Remove and check thermostat.
Fuel in Oil	Restricted fuel return line	Check and fix fuel return lines.
	Engine load too light	Increase engine load
	Leaking fuel injectors	See your authorized John Deere engine distributor or servicing dealer.
Low-Pressure Fuel System — Fuel Pressure Low	Restricted fuel filter	Replace fuel filter.
	Restricted fuel line	Locate restriction, repair as required.
	Faulty transfer pump	See your authorized John Deere engine distributor or servicing dealer.
	Faulty high-pressure fuel pump	Remove fuel pump, repair/replace pump as required. See your authorized John Deere engine distributor or servicing dealer.
Abnormal Engine Noise	Worn main or connecting rod bearings	Determine bearing clearance. See your authorized John Deere engine distributor or servicing dealer.
	Excessive crankshaft end play	Check crankshaft end play. See your authorized John Deere engine distributor or servicing dealer.
	Loose main bearing caps	Check bearing clearance; replace bearings and bearing cap screws as required. See your authorized John Deere engine distributor or servicing dealer.
	Worn connecting rod bushings and piston pins	Inspect piston pins and bushings. See your authorized John Deere engine distributor or servicing dealer.
	Scored pistons	Inspect pistons. See your authorized John Deere engine distributor or servicing dealer.
	Worn timing gears or excess backlash	Check timing gear back lash. See your authorized John Deere engine distributor or servicing dealer.

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Symptom	Problem	Solution
	Excessive valve clearance	Check and adjust valve clearance. See Adjusting Valve Clearance in the Lubrication & Maintenance 2000 Hours/24 Months Section.
	Worn camshaft lobes	Inspect camshaft. See your authorized John Deere engine distributor or servicing dealer.
	Worn rocker arm shaft(s)	Inspect rocker arm shafts. See your authorized John Deere engine distributor or servicing dealer.
	Worn valve guides	Check valve guides for wear. See your authorized John Deere engine distributor or servicing dealer.
	Damaged valve retainers	Inspect retainer and retainer locks for excessive wear. See your authorized John Deere engine distributor or servicing dealer.
	Loose or worn rocker arms	Inspect rocker arms for wear. See your authorized John Deere engine distributor or servicing dealer.
	Bent pushrods	Inspect pushrods for straightness and check contact ends for wear and damage. See your authorized John Deere engine distributor or servicing dealer.
	Broken valve springs	Inspect valve springs. See your authorized John Deere engine distributor or servicing dealer.
	Bent connecting rods	Inspect connecting rod and cap for damage. See your authorized John Deere engine distributor or servicing dealer.
	Worn flywheel	Inspect flywheel and ring gear for damage. See your authorized John Deere engine distributor or servicing dealer.
	Loose flywheel	Check flywheel mounting screws. See your authorized John Deere engine distributor or servicing dealer.
	Excessive piston to liner clearance	Check and adjust piston liner clearance. See your authorized John Deere engine distributor or servicing dealer.

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Symptom	Problem	Solution
	Excessive thrust bearing clearance	Check and adjust thrust bearing clearance. See your authorized John Deere engine distributor or servicing dealer.
	High oil viscosity	Drain engine oil and refill with correct viscosity engine oil
Turbocharger "Screams"	Leak in intake air system	Check air system for loose clamps, damaged tubes, charged air cooler leaks, and intake manifold gasket leaks; repair as required. See your authorized John Deere engine distributor or servicing dealer.
Turbocharger Noise or Vibration *NOTE: Do not confuse the whine heard during run down with noise which indicates a bearing failure.* *The whine heard during turbocharger run down is normal.*	Bearings not lubricated (insufficient oil pressure)	Determine cause of lack of lubrication; repair as required. See your authorized John Deere engine distributor or servicing dealer.
	Air leak in engine intake or exhaust manifold	Check intake and exhaust manifold gaskets and manifolds; repair as required. See your authorized John Deere engine distributor or servicing dealer.
	Improper clearance between turbine wheel and turbine housing	Inspect turbocharger; repair/replace as required. See your authorized John Deere engine distributor or servicing dealer.
	Broken blades (or other wheel failures)	Inspect turbocharger; repair/replace as required. See your authorized John Deere engine distributor or servicing dealer.
Engine has reached Service Only Soot Level	Auto Filter cleaning is disabled for an extended period of time	Enable exhaust filter cleaning.
	Frequent engine shut downs occurred while auto cleaning was in process	Let engine run for 30 min to clean the exhaust filter.
	Interlock switches are not properly set to allow DPF recovery/Regeneration to occur	Machine must be stationary (Parked). Engine speed must be above the minimum setpoint. Any PTO driven device must be shut off. Engine load must be stable.
Engine Emits White Smoke	Engine compression too low	Determine cause of low compression and repair as required. See your authorized John Deere engine distributor or servicing dealer.

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Symptom	Problem	Solution
	Defective thermostat(s) (does not close)	Test thermostats; replace thermostats as required.
	Coolant entering combustion chamber (failed cylinder head gasket or cracked cylinder head)	Repair or replace as required. See your authorized John Deere engine distributor or servicing dealer.
	Electronic Control System problem or basic engine problem	See your authorized John Deere engine distributor or servicing dealer.
	Improper type of fuel	Drain fuel and replace with proper grade and quality of fuel for operating condition.
	Poor fuel quality	Drain fuel and replace with proper grade and quality of fuel for operating condition.
	Low engine temperature	Warm up engine to normal operating temperature.
	Defective thermostat.	Remove and check thermostat.
	Defective fuel injectors	See your authorized John Deere engine distributor or servicing dealer.
Engine Emits Black, Gray or Blue Smoke	Engine overloaded	Reduce engine load.
	Engine burning oil	See your authorized John Deere engine distributor or servicing dealer.
	Air cleaner restricted or dirty	Replace air cleaner element as required.
	Electronic control system problem or basic engine problem	See your authorized John Deere engine distributor or servicing dealer.
	Exhaust filter is cracked or damaged	See your authorized John Deere engine distributor or servicing dealer.
	Improper type of fuel	Use proper fuel.
	Fuel injectors dirty	See your authorized John Deere engine distributor or servicing dealer.
	Electronic Control System problem or basic engine problem	See your authorized John Deere engine distributor or servicing dealer.
	Turbocharger not functioning properly	See your authorized John Deere engine distributor or servicing dealer.
Engine Overheats	Air cleaner restricted or dirty	Replace air cleaner element as required.

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Symptom	Problem	Solution
	Lack of coolant in cooling system	Fill cooling system to proper level. Check radiator and hoses for loose connections or leaks.
	Low engine oil level	Check oil level. Add oil as required.
	Radiator core dirty	Clean cooling system as required.
	Cooling system needs flushing	Flush coolant system. (See Flushing And Refilling Cooling System in the Lubrication & Maintenance — 6000 Hours/72 Months Section.)
	Engine overloaded	Reduce engine load.
	Loose or defective fan belt	Check fan and alternator V-belt tension. Replace as required. (See Checking Fan And Alternator V-Belt Tension in the Lubrication & Maintenance — 500 Hours/12 Months Section.)
	Defective or wrong type of thermostat	Test thermostat opening temperature, replace thermostat as required.
	Damaged cylinder head gasket	Replace cylinder head gasket. See your authorized John Deere engine distributor or servicing dealer.
	Leak at cylinder head gasket	Replace cylinder head gasket. See your authorized John Deere engine distributor or servicing dealer.
	Defective coolant pump	Replace coolant pump. See your authorized John Deere engine distributor or servicing dealer.
	Defective radiator cap	Replace radiator cap as required.
	Defective temperature gauge or sender	Check coolant temperature with thermometer and replace, if necessary.
	Incorrect grade of fuel	Use correct grade of fuel.
Coolant Temperature Below Normal	Defective thermostat	Test thermostat, replace thermostat as required.
	Defective temperature gauge or temperature sender	Check gauge, sender, and connections.
Coolant in Crankcase	Cylinder head gasket defective	Replace cylinder head gasket. See your authorized John Deere engine distributor or servicing dealer.

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Symptom	Problem	Solution
	Cylinder head or block cracked	Locate crack, repair/replace components as required. See your authorized John Deere engine distributor or servicing dealer.
	Cylinder liner seals leaking	Remove and inspect cylinder liners. See your authorized John Deere engine distributor or servicing dealer.
	Pitted cylinder liners	Remove and inspect cylinder liners. See your authorized John Deere engine distributor or servicing dealer.
	Leaking oil cooler	Pressure test oil cooler, repair/replace as required. See your authorized John Deere engine distributor or servicing dealer.
Low Oil Pressure	Low crankcase oil level	Fill crankcase to proper oil level.
	High crankcase oil level	Fill crankcase to proper oil level.
	Faulty pressure sensor	Replace sensor. See your authorized John Deere engine distributor or servicing dealer.
	Restricted oil cooler or filter	Remove and inspect oil cooler. See your authorized John Deere engine distributor or servicing dealer.
	Excessive oil temperature	Remove and inspect oil cooler. See your authorized John Deere engine distributor or servicing dealer.
	Defective oil pump	Remove and inspect oil pump. See your authorized John Deere engine distributor or servicing dealer.
	Incorrect oil	Drain crankcase and refill with correct oil.
	Oil pressure regulating valve failure	Remove and inspect oil pressure regulating valve. See your authorized John Deere engine distributor or servicing dealer.
	Restricted oil pump screen or cracked pick-up tube	Remove oil pan and clean screen/replace pick-up tube.
	Excessive main or connecting rod bearing clearance	Determine bearing clearance. See your authorized John Deere engine distributor or servicing dealer.

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Symptom	Problem	Solution
	Crankcase oil level too high	Check engine oil level and drain as necessary.
High Oil Pressure	Improper oil classification	Drain crankcase and refill with correct oil.
	Faulty pressure sensor	Replace sensor. See your authorized John Deere engine distributor or servicing dealer.
	Oil pressure regulating valve failure	Remove and inspect oil pressure regulating valve. See your authorized John Deere engine distributor or servicing dealer.
	Stuck or damaged filter bypass valve	Remove and inspect filter bypass valve. See your authorized John Deere engine distributor or servicing dealer.
	Stuck or damaged oil cooler bypass valve	Remove and inspect oil cooler bypass valve. See your authorized John Deere engine distributor or servicing dealer.
Excessive Oil Consumption	Too low viscosity crankcase oil	Drain crankcase and refill with correct viscosity oil.
	Crankcase oil level too high	Drain oil until oil level is correct.
	External oil leak(s)	Determine source of oil leak(s) and repair as required.
	Excessive oil pressure	See **High Oil Pressure**
	Oil control rings not seated	See your authorized John Deere engine distributor or servicing dealer.
	Oil control rings worn or broken	Replace piston rings. See your authorized John Deere engine distributor or servicing dealer.
	Restricted crankcase vent tube or filter.	Clean vent tube and change crankcase ventilation filter, verify that crankcase oil level is not too high.
	Defective turbocharger	See your authorized John Deere engine distributor or servicing dealer.
	Scored cylinder liners or pistons	Remove and inspect cylinders and liners; replace as required. See your authorized John Deere engine distributor or servicing dealer.

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Symptom	Problem	Solution
	Worn valve guides or stems	Inspect and measure valve stems and valve guides; repair as required. See your authorized John Deere engine distributor or servicing dealer.
	Piston ring grooves excessively worn	Remove and inspect pistons. See your authorized John Deere engine distributor or servicing dealer.
	Piston rings sticking in ring grooves	Remove and inspect pistons. See your authorized John Deere engine distributor or servicing dealer.
	Insufficient piston ring tension	Remove and inspect pistons. See your authorized John Deere engine distributor or servicing dealer.
	Piston ring gaps not staggered	Remove and inspect pistons. See your authorized John Deere engine distributor or servicing dealer.
	Front and/or rear crankshaft oil seal faulty	Replace oil seals. See your authorized John Deere engine distributor or servicing dealer.
Undercharged Electrical System	Excessive electrical load from added accessories	Remove accessories or install higher output alternator. See your authorized John Deere engine distributor or servicing dealer.
	Excessive engine idling	Increase engine rpm when heavy electrical load is used.
	Poor electrical connections on battery, ground strap, starter, or alternator	Inspect and clean as necessary.
	Defective battery	Test batteries.
	Defective alternator	Test charging system.
Battery Used Too Much Water	Cracked battery case	Check for moisture and replace as necessary.
	Defective battery	Test battery.
	Battery charging rate too high	Test charging system.
Batteries Will Not Charge	Loose or corroded connections	Clean and tighten connections.
	Sulfated or worn-out batteries	Replace batteries.
	Stretched belt or defective belt tensioner	Adjust belt tension or replace belts.

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Symptom	Problem	Solution
Starter and Hourmeter Functions; Rest of Electrical System Does Not Function	Blown fuse	Replace fuse.
Entire Electrical System Does Not Function	Faulty battery connection	Clean and tighten connections.
	Sulfated or worn-out batteries	Replace batteries.
	Blown fuse	Replace fuse.

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Precautions for Electrical System When Steam Cleaning Engine

IMPORTANT: Do not steam clean any electrical or electronic components while steam cleaning the engine as it could damage sensitive parts.

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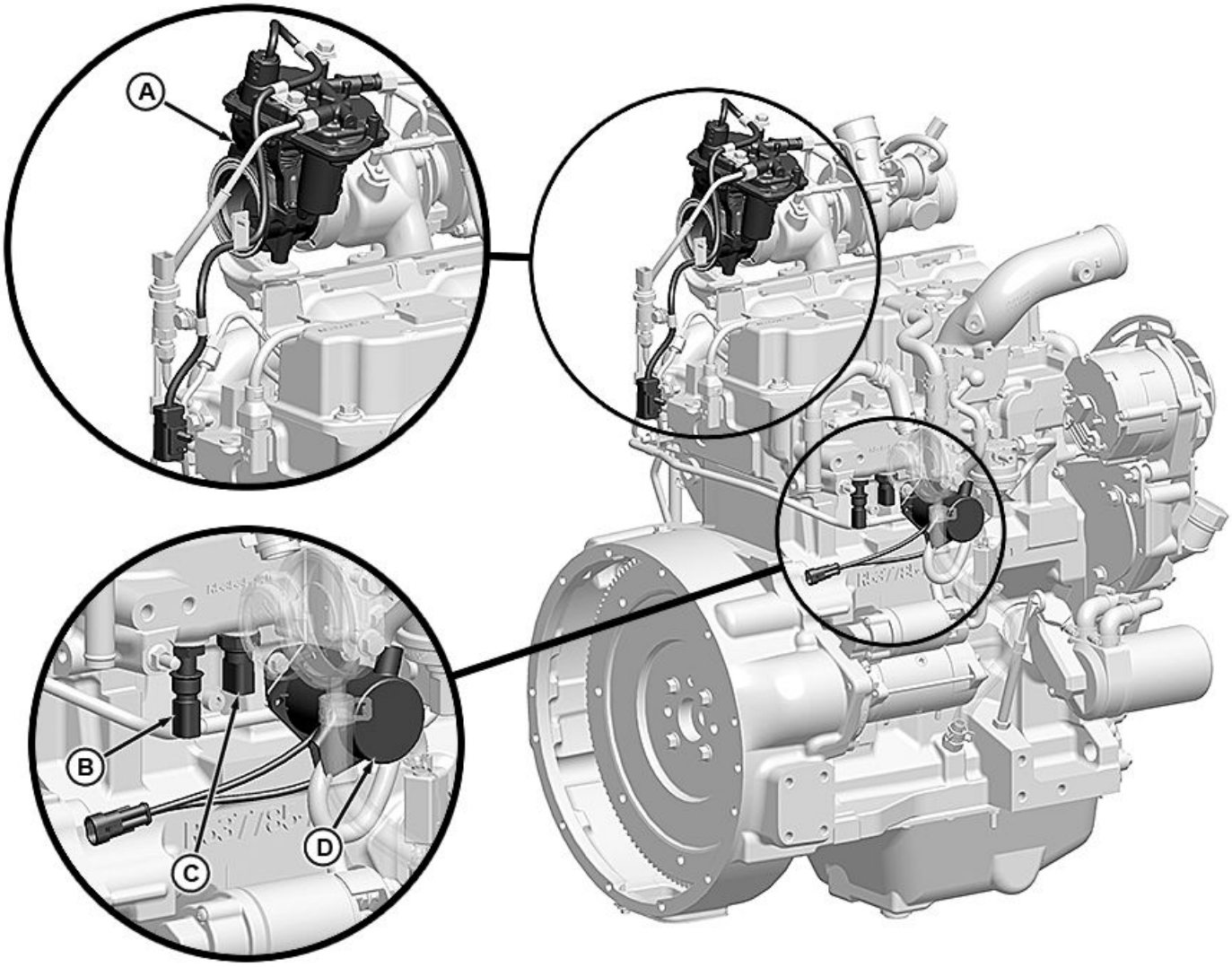
Engine Wiring Harness Layout

NOTE: Location of some sensors may change depending upon the application.



A—Exhaust Throttle Actuator
B—Manifold Air Temperature (MAT) Sensor
C—Manifold Air Pressure (MAP) Sensor
D—Cold Start Aid Relay

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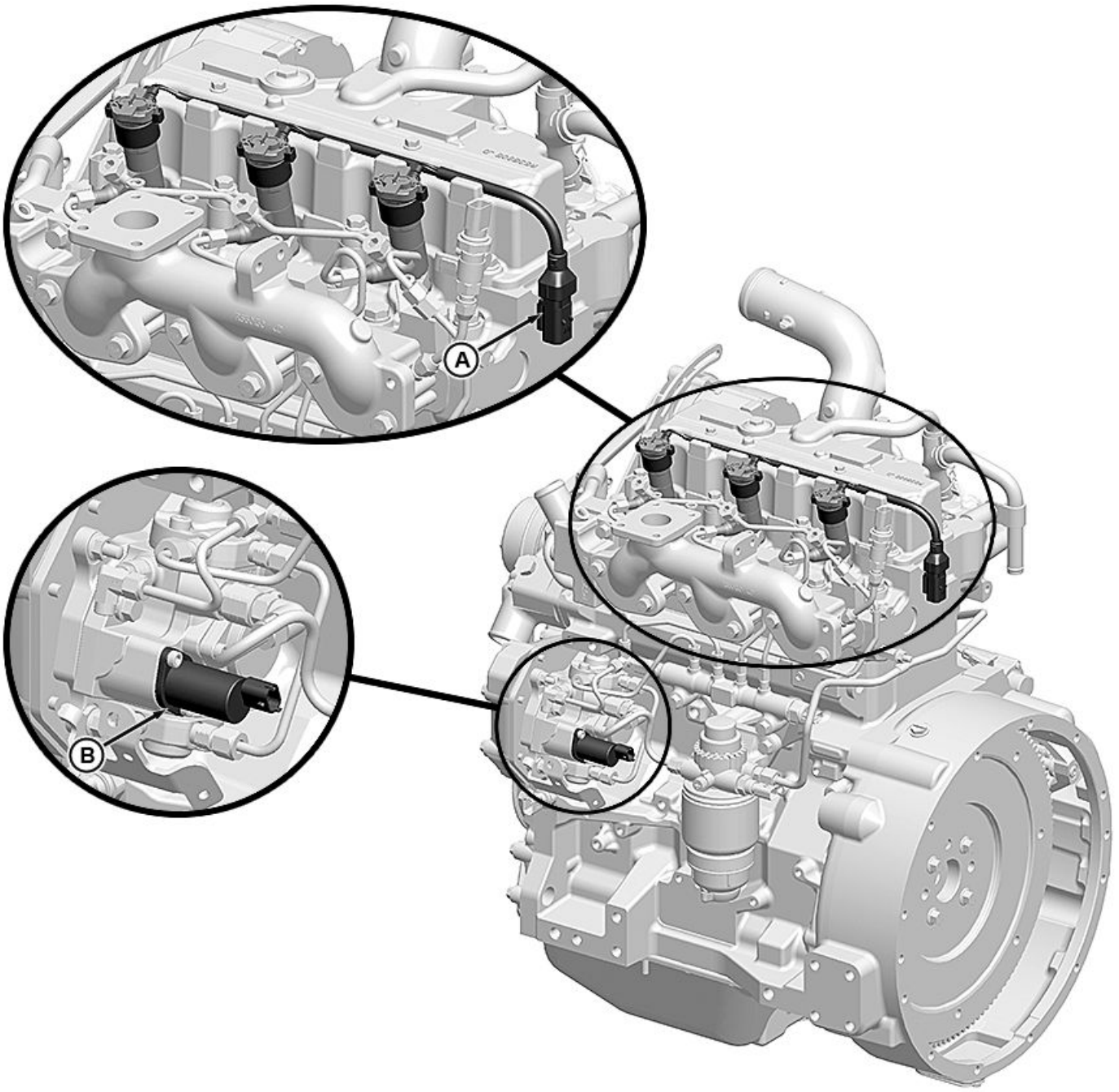

A—Fuel Injector Harness Connector

B—Suction Control Valve

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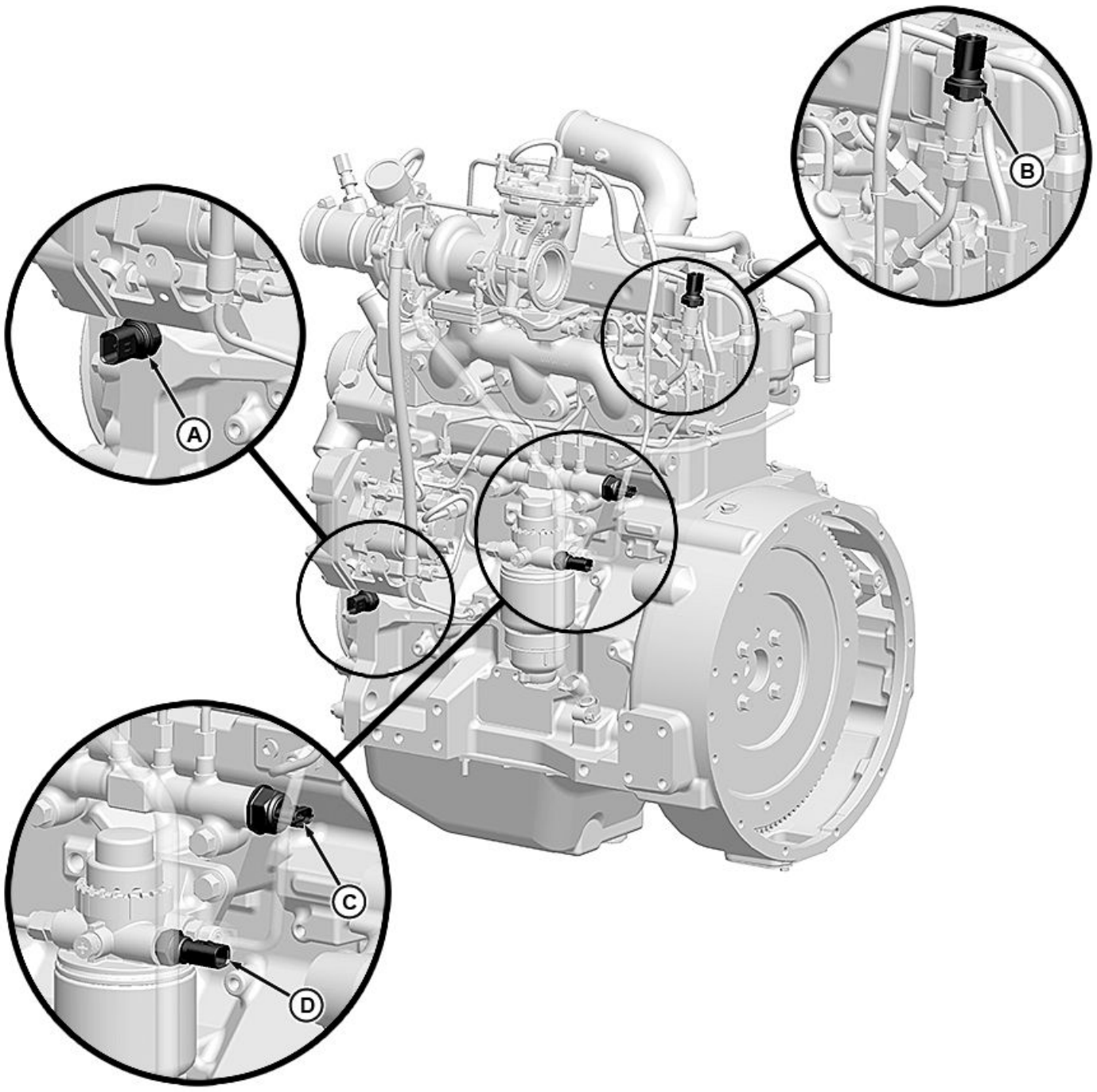

A—Engine Oil Pressure Sensor
B—Exhaust Manifold Pressure Sensor
C—Fuel Rail Pressure Sensor
D—Fuel Temperature Sensor

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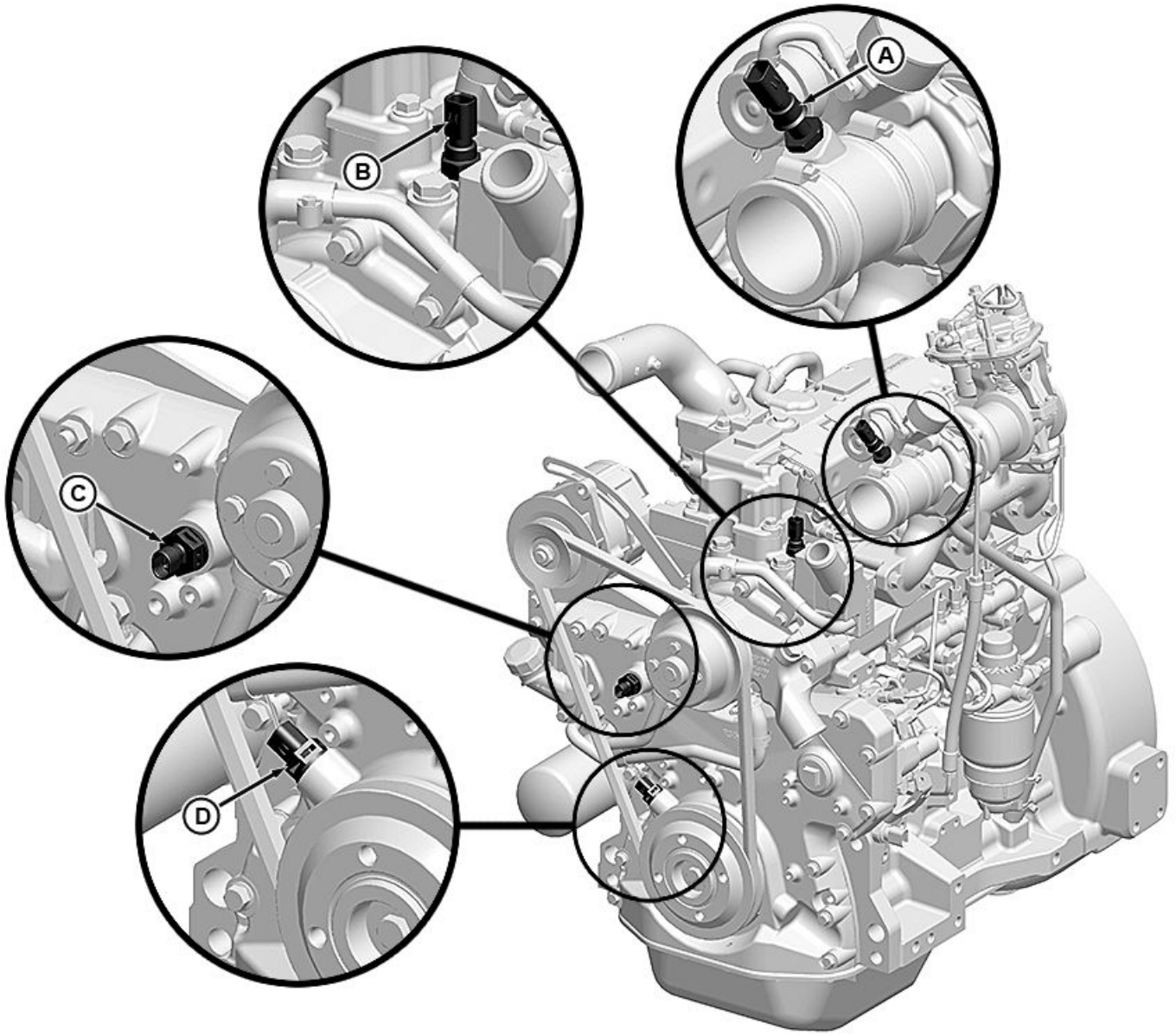

A—Intake Air Temperature Sensor

B—Engine Coolant Temperature Sensor

C—Camshaft Position Sensor

D—Crankshaft Position Sensor

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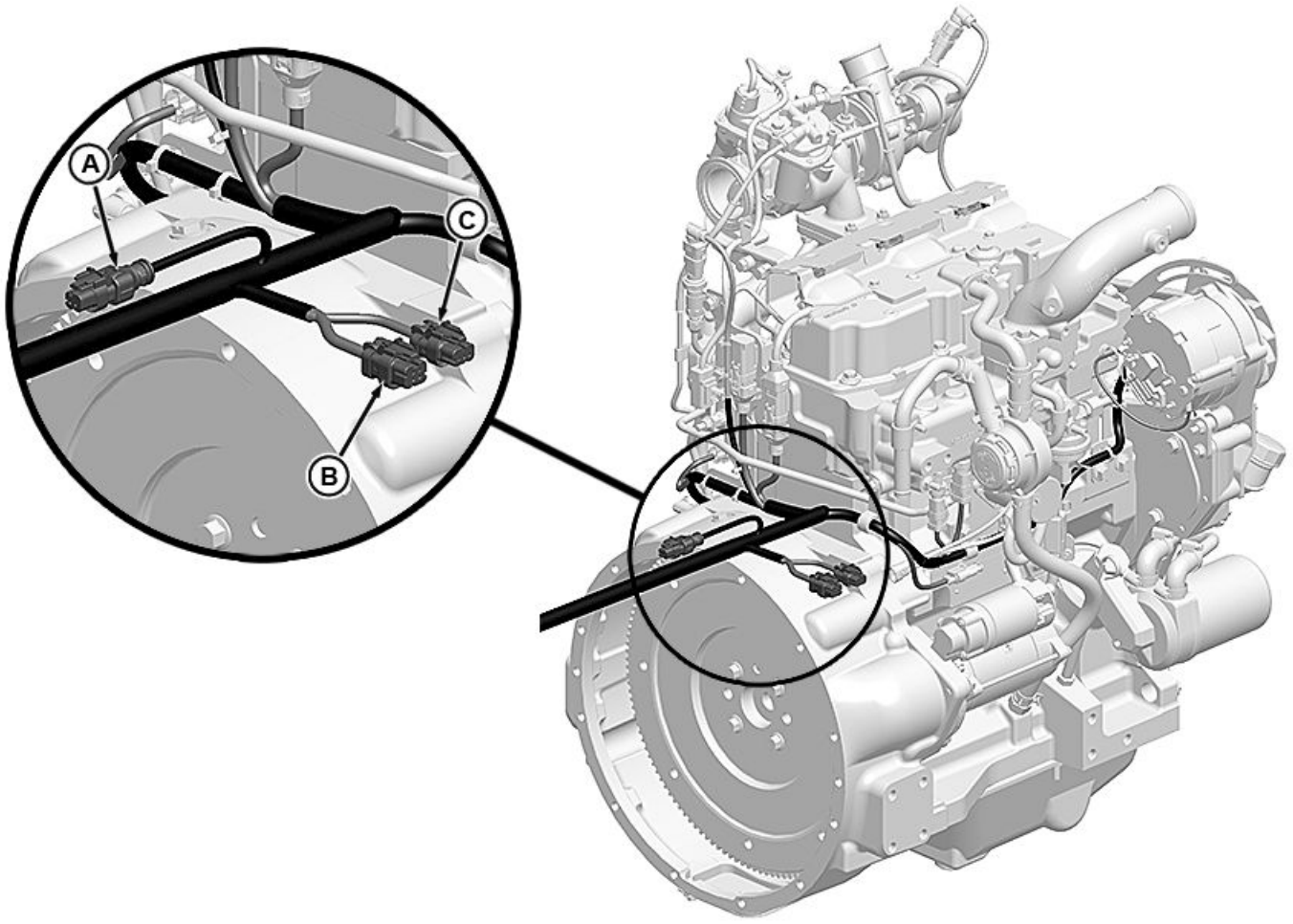

A—Air Filter Restriction Indicator Connector
B—Exhaust Filter Temperature Module Connector
C—DPF Differential Pressure Sensor Connector

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Precautions for Welding

Remove paint before welding or heating (see Safety Section in this manual for more information on paint removal and high-pressure lines).

CAUTION: Avoid potentially toxic fumes and dust. Hazardous fumes can be generated when paint is heated by welding, soldering, or using a torch. Do all work outside or in a well ventilated area. Dispose of paint and solvent properly. If you sand or grind paint, avoid breathing the dust by wearing an approved respirator. If you use solvent or paint stripper, remove with soap and water before welding. Remove solvent or paint stripper containers and other flammable material from area before welding. Allow fumes to disperse at least 15 minutes before welding or heating.

IMPORTANT: Welding on the engine is NOT ALLOWED. If welding must be performed on the machine, follow these precautions.

IMPORTANT: High currents or electrostatic discharge into electronic components from welding may cause permanent damage.

1. Remove paint from the area to be welded and ground cable clamp location.
2. Disconnect the negative (-) battery cable(s) or open battery (-) switch if equipped.

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3. Disconnect the positive (+) battery cable(s) or open battery (+) switch if equipped.
4. Clear or move any wiring harness sections away from the welding area.
5. Welding on engine components is not allowed.
6. Never connect the welder ground to any engine component or engine driven components that may be connected to the engine.
7. After welding, reverse steps 2—3.

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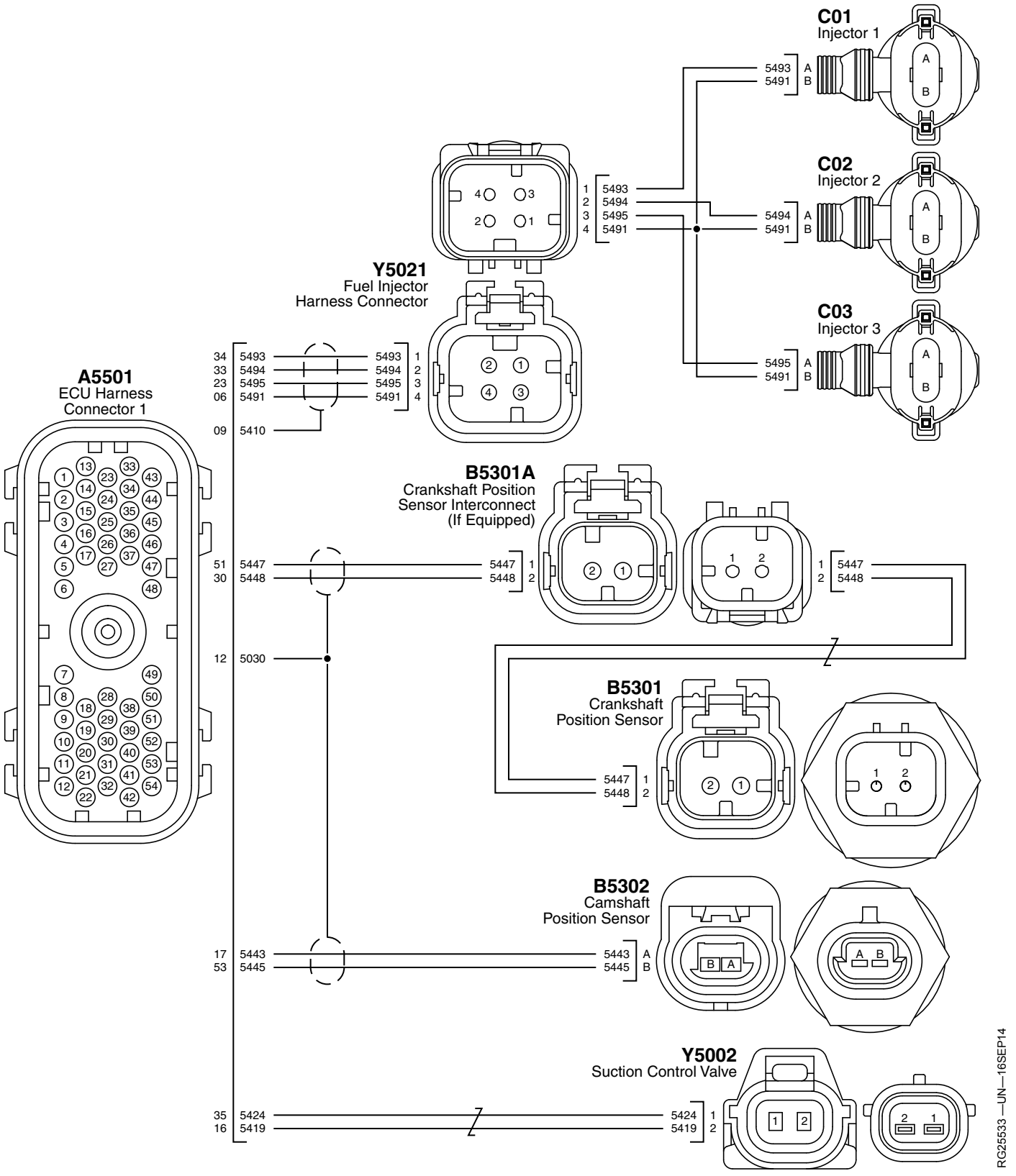
2.9 L Wiring Diagram 1



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A5501— ECU Connector 1
A5501-06— [5491 Brown] Injector #1, #2, and #3 Power
A5501-09— [5410 Black] Wiring Shield
A5501-12— [5030 Black] Wiring Shield
A5501-16— [5419 White] Suction Control Valve Drive Negative
A5501-17— [5443 Orange] Camshaft Position Sensor Return
A5501-23— [5495 Green] Injector #3 Pulse
A5501-30— [5448 Gray] Crankshaft Position Sensor Return
A5501-33— [5494 Yellow] Injector #2 Pulse
A5501-34— [5493 Orange] Injector #1 Pulse
A5501-35— [5424 Yellow] Suction Control Valve Drive Positive
A5501-51— [5447 Violet] Crankshaft Position Sensor Signal
A5501-53— [5445 Green] Camshaft Position Sensor Signal
B5301— Crankshaft Position Sensor
B5301A— Crankshaft Position Sensor Interconnect (If Equipped)
B5302— Camshaft Position Sensor
C01— Fuel Injector #1
C02— Fuel Injector #2
C03— Fuel Injector #3
Y5002— Suction Control Valve
Y5021— Fuel Injector Harness Connector

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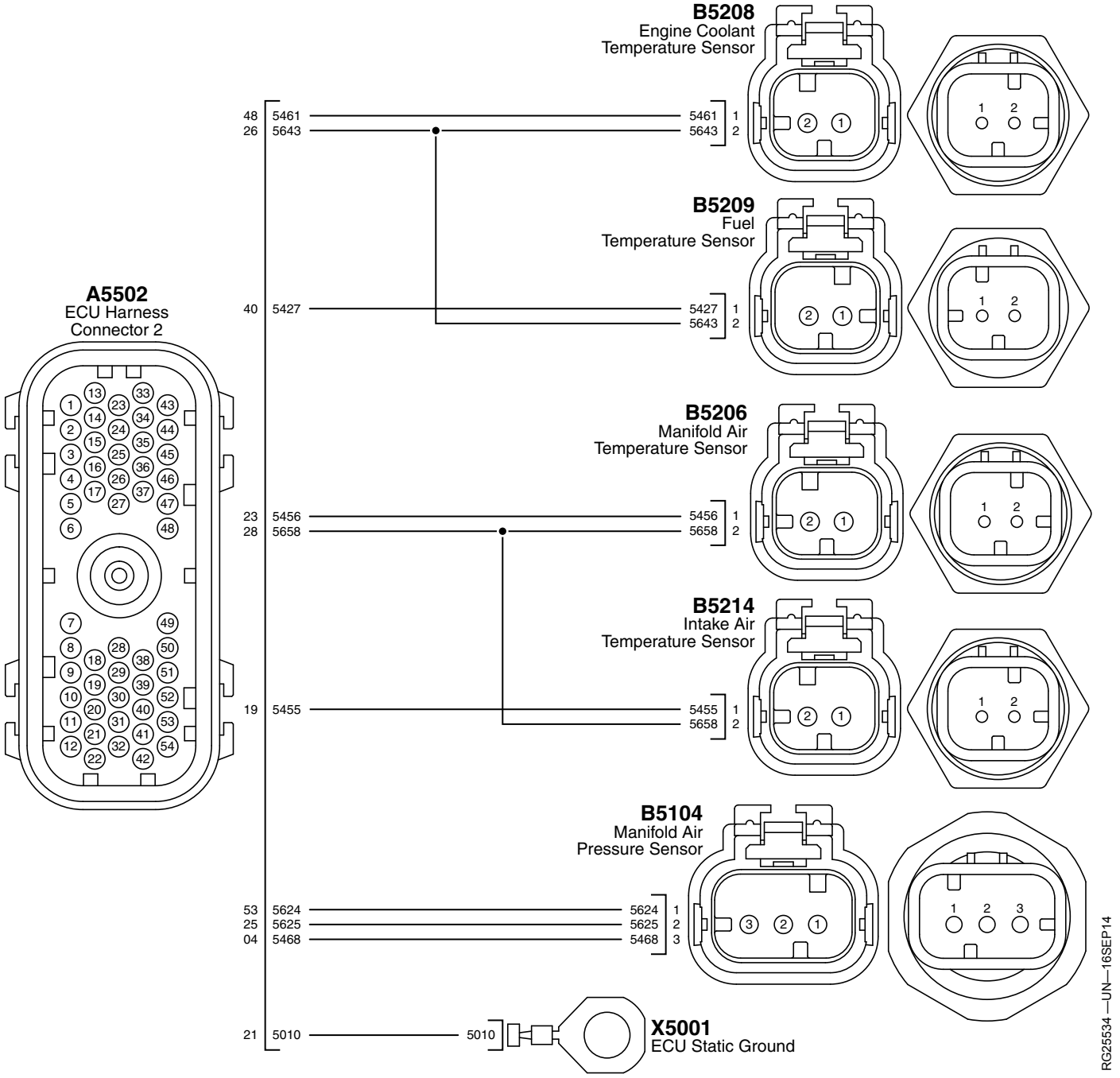
2.9 L Wiring Diagram 2



A5502— ECU Connector 2
A5502-04— [5468 Gray] Manifold Air Pressure Sensor Signal
A5502-19— [5455 Green] Intake Air Temperature Sensor Signal
A5502-21— [5010 Black] Single Point Ground
A5502-23— [5456 Blue] Manifold Air Temperature Sensor Signal
A5502-25— [5625 Green] 5 V Sensor Supply #7 Return
A5502-26— [5643 Orange] Sensor Return #1
A5502-28— [5658 Gray] Sensor Return #6
A5502-40— [5427 Violet] Fuel Temperature Sensor Signal
A5502-48— [5461 Brown] Engine Coolant Temperature Sensor Signal
A5502-53— [5624 Yellow] 5 V Sensor Supply #7 Positive
B5104— Manifold Air Pressure Sensor
B5206— Manifold Air Temperature Sensor
B5208— Engine Coolant Temperature Sensor
B5209— Fuel Temperature Sensor
B5214— Intake Air Temperature Sensor
X5001— ECU Static Ground

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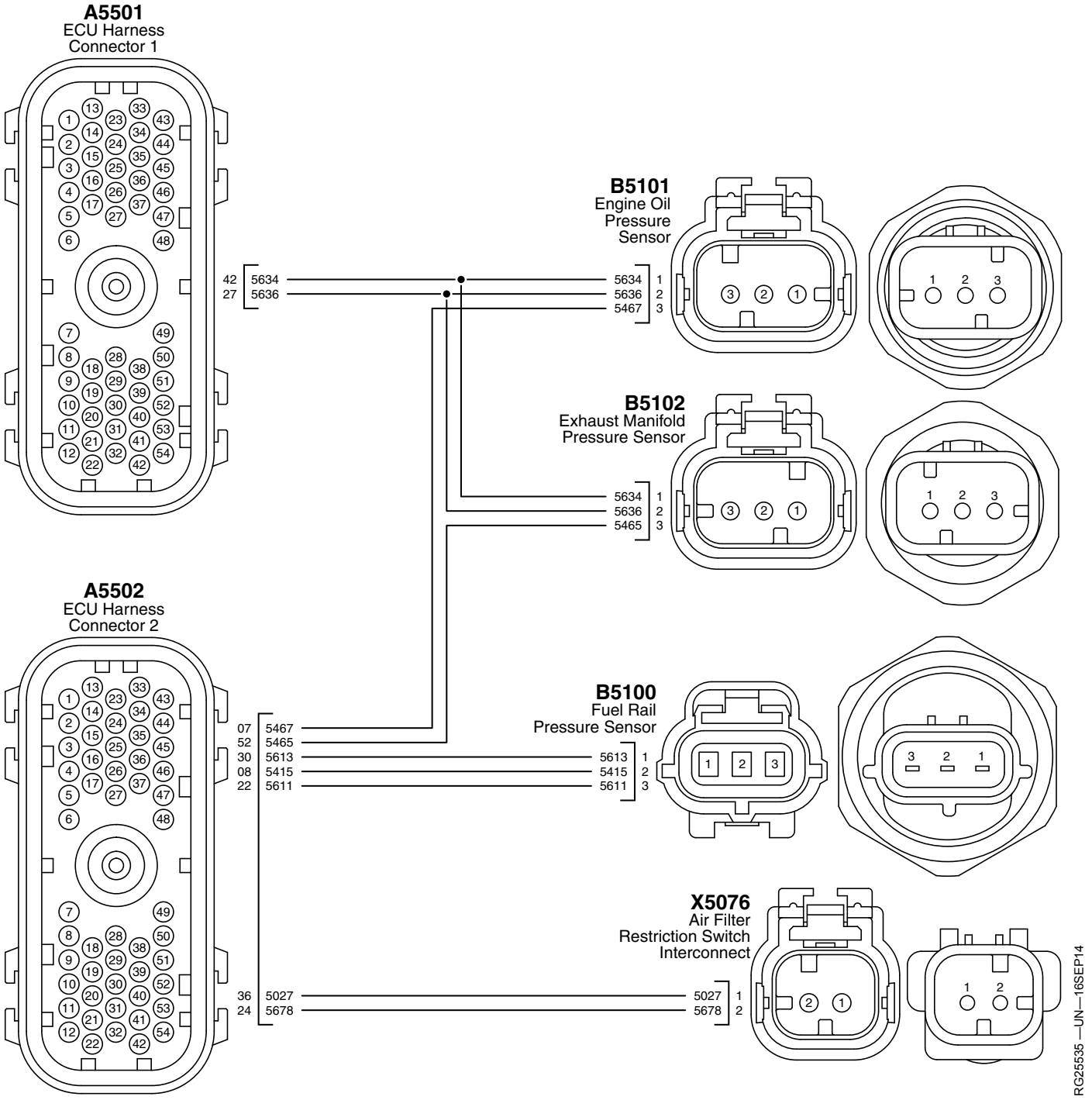
2.9 L Wiring Diagram 3



A5501— ECU Connector 1
A5501-27— [5636 Blue] 5 V Sensor Supply #8 Return
A5501-42— [5634 Yellow] 5 V Sensor Supply #8 Positive
A5502— ECU Connector 2
A5502-07— [5467 Violet] Engine Oil Pressure Sensor Signal
A5502-08— [5415 Green] Fuel Rail Pressure Sensor Signal
A5502-22— [5611 Brown] 5 V Sensor Supply #1 Positive
A5502-24— [5678 Gray] Sensor Return #8
A5502-30— [5613 Orange] 5 V Sensor Supply #1 Return
A5502-36— [5027 Violet] Air Filter Restriction Switch Signal
A5502-52— [5465 Green] Exhaust Manifold Pressure Sensor Signal
B5100— Fuel Rail Pressure Sensor
B5101— Engine Oil Pressure Sensor
B5102— Exhaust Manifold Pressure Sensor
X5076— Air Filter Restriction Switch Interconnect

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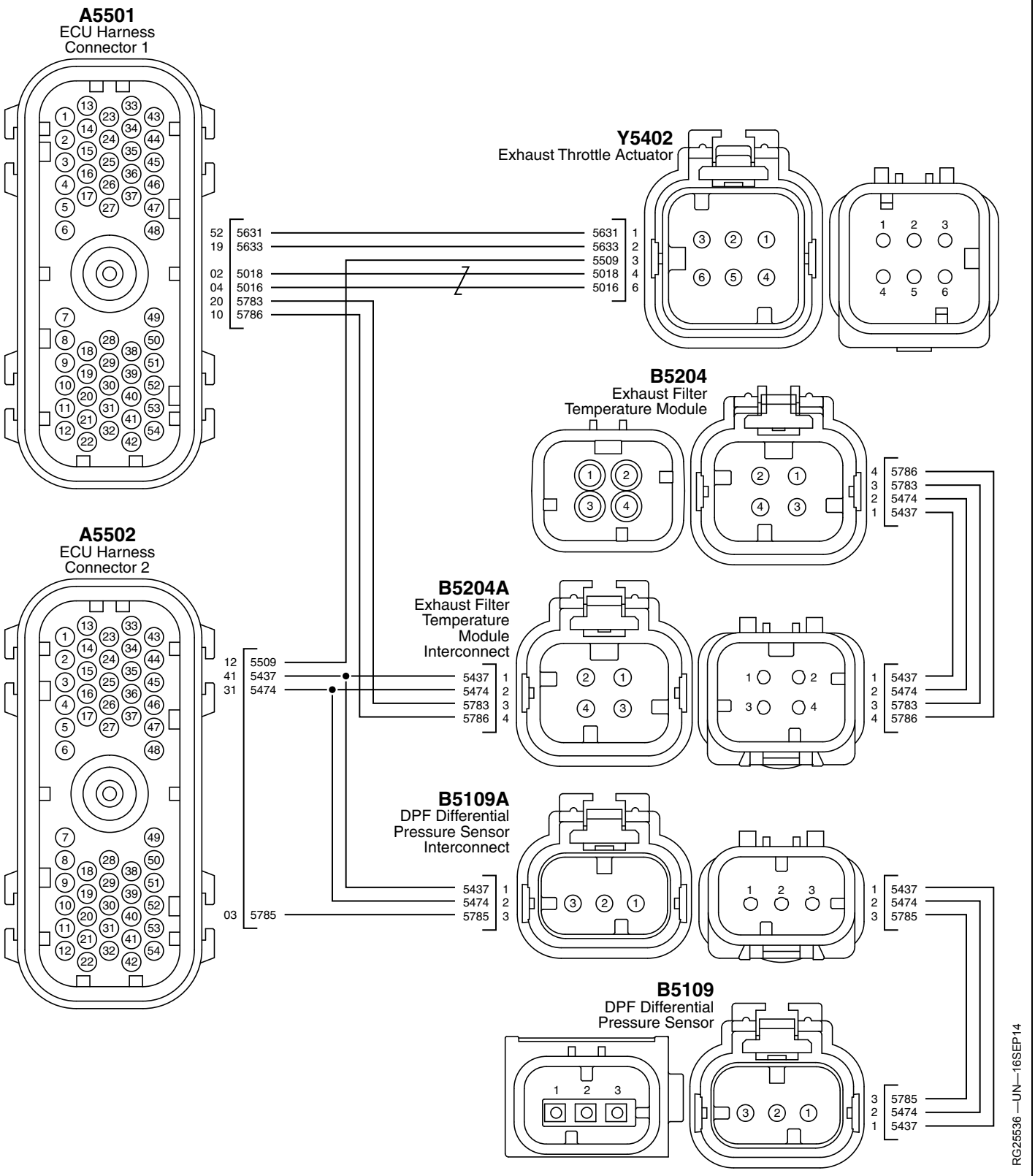
2.9 L Wiring Diagram 4



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A5501— ECU Connector 1
A5501-02— [5018 Gray] Exhaust Throttle Actuator Drive Negative
A5501-04— [5016 Blue] Exhaust Throttle Actuator Drive Positive
A5501-10— [5786 Blue] Exhaust Filter Temperature Module Signal
A5501-19— [5633 Orange] 5 V Sensor Supply #3 Return
A5501-20— [5783 Orange] 10 V Sensor Supply
A5501-52— [5631 Brown] 5 V Sensor Supply #3 Positive
A5502— ECU Connector 2
A5502-03— [5785 Green] DPF Differential Pressure Sensor Signal
A5502-12— [5509 White] Exhaust Throttle Actuator Position Signal
A5502-31— [5474 Yellow] 5 V Sensor Supply #6 Return
A5502-41— [5437 Violet] 5 V Sensor Supply #6 Positive
B5109— DPF Differential Pressure Sensor
B5109A— DPF Differential Pressure Sensor Interconnect
B5204— Exhaust Filter Temperature Module
B5204A— Exhaust Filter Temperature Module Interconnect
Y5402— Exhaust Throttle Actuator

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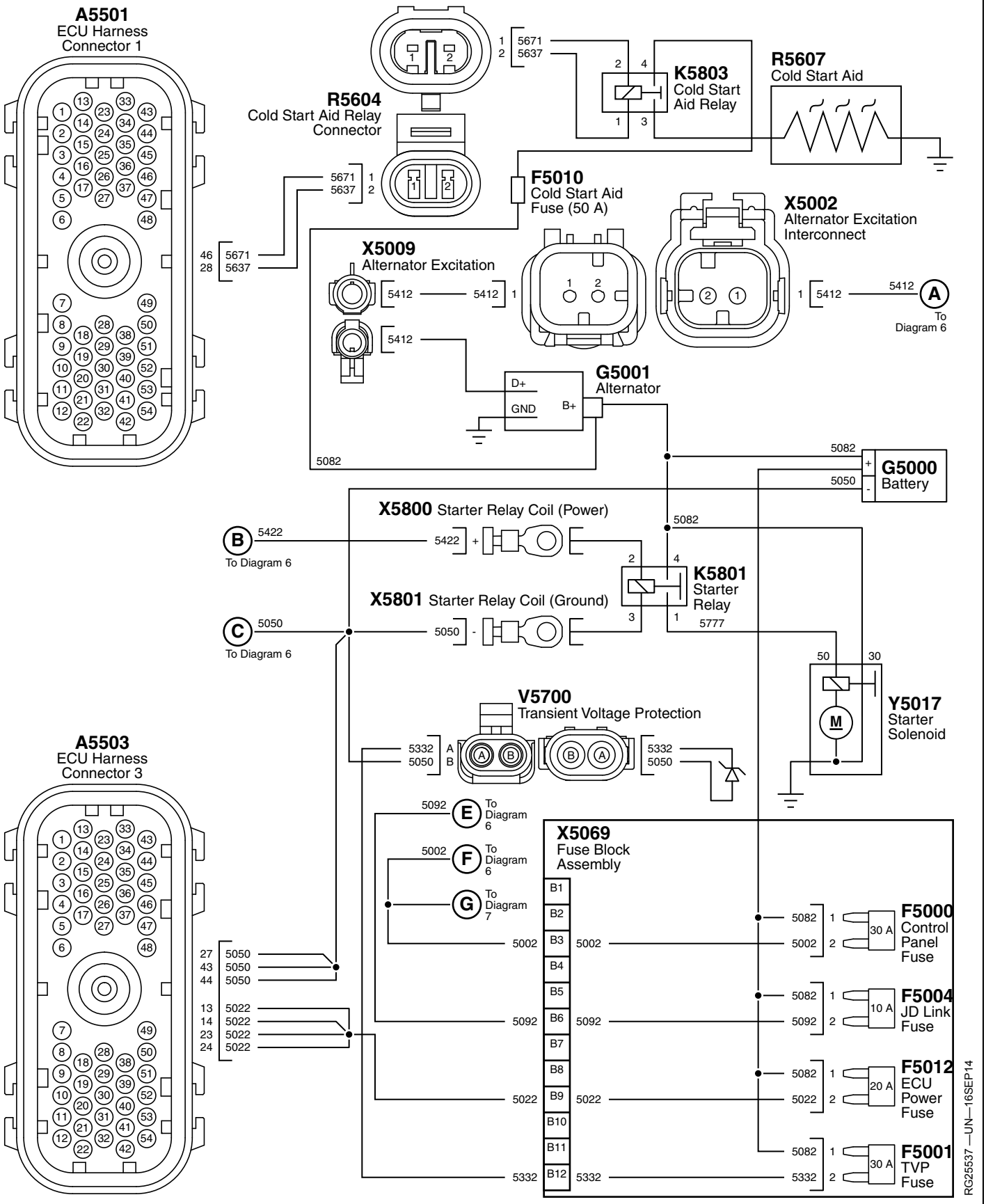
2.9 L Wiring Diagram 5



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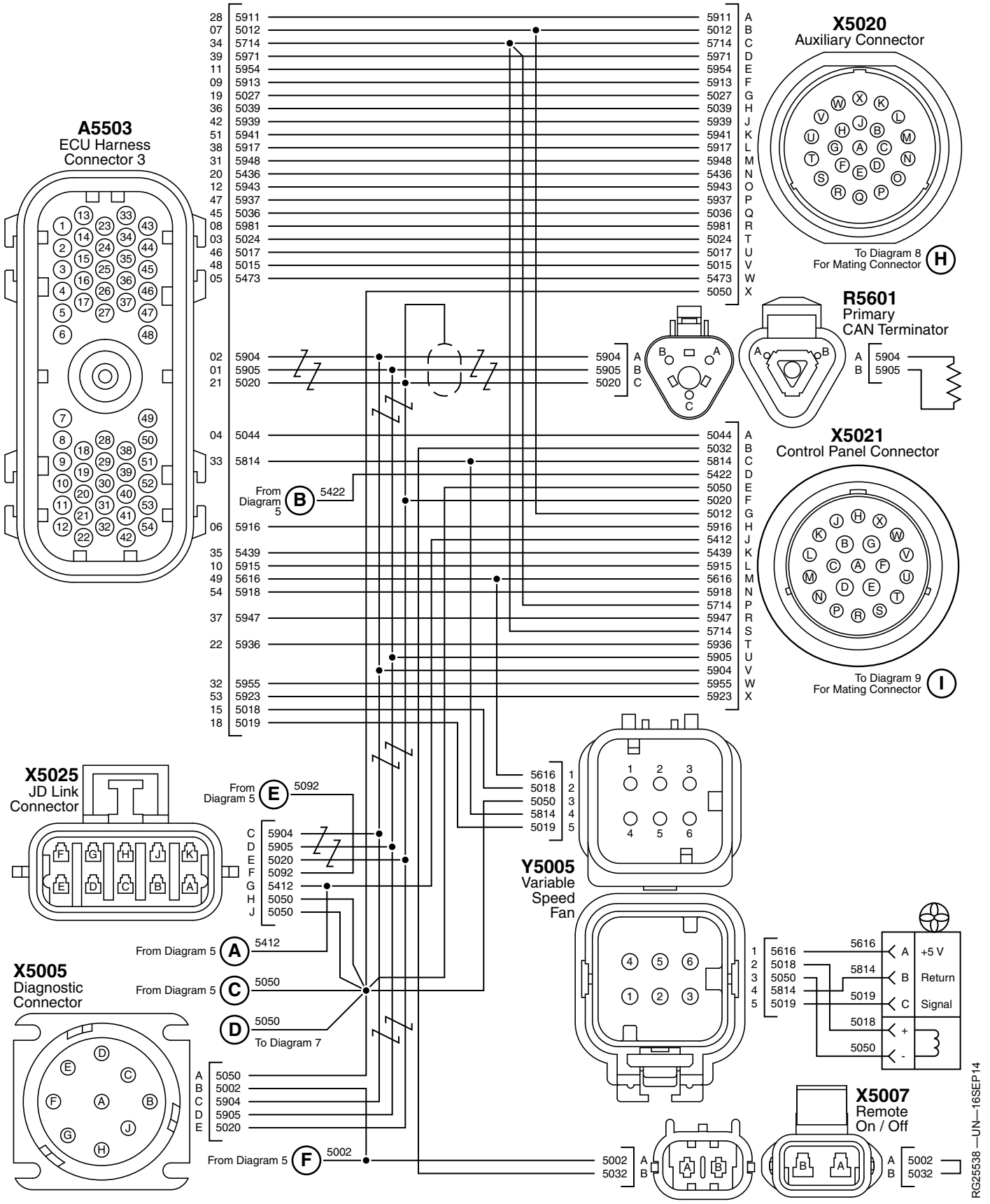
A— [5412 Red] Alternator Excitation To 2.9 L Wiring Diagram 6
A5501— ECU Connector 1
A5501-28— [5637 Violet] Sensor Return #4
A5501-46— [5671 Brown] Cold Start Aid Relay Drive Positive
A5503— ECU Connector 3
A5503-13— [5022 Red] ECU Power Positive
A5503-14— [5022 Red] ECU Power Positive
A5503-23— [5022 Red] ECU Power Positive
A5503-24— [5022 Red] ECU Power Positive
A5503-27— [5050 Black] Battery Negative
A5503-43— [5050 Black] Battery Negative
A5503-44— [5050 Black] Battery Negative
B— [5422 Red] Start To 2.9 L Wiring Diagram 6
C— [5050 Black] Battery Negative To 2.9 L Wiring Diagram 6
E— [5092 Red] JD Link Unswitched Power To 2.9 L Wiring Diagram 6
F— [5002 Red] Control Panel Unswitched Power To 2.9 L Wiring Diagram 6
F5000— Control Panel Fuse (30 Amp)
F5001— Transient Voltage Protection Fuse (30 Amp)
F5004— JD Link Fuse (10 Amp)
F5010— Cold Start Aid Fuse (50 Amp)
F5012— ECU Power Fuse (20 Amp)
G— [5002 Red] Control Panel Unswitched Power To 2.9 L Wiring Diagram 7
G5000— Battery
G5000-Positive— [5082 Red] Battery Power Positive
G5001— Alternator
K5801— Starter Relay
K5801-1— [5777 Violet] Starter Excitation
K5803— Cold Start Aid Relay
R5604— Cold Start Aid Relay Connector
R5607— Cold Start Aid
V5700— Transient Voltage Protection
X5002— Alternator Excitation Interconnect
X5009— Alternator Excitation
X5069— Fuse Block Assembly
X5069-B12— [5332 Red] Transient Voltage Protection
X5800— Starter Relay Coil (Power)
X5801— Starter Relay Coil (Ground)
Y5017— Starter Solenoid

ZE59858,0000065 -19-17SEP14-2/2

2.9 L Wiring Diagram 6



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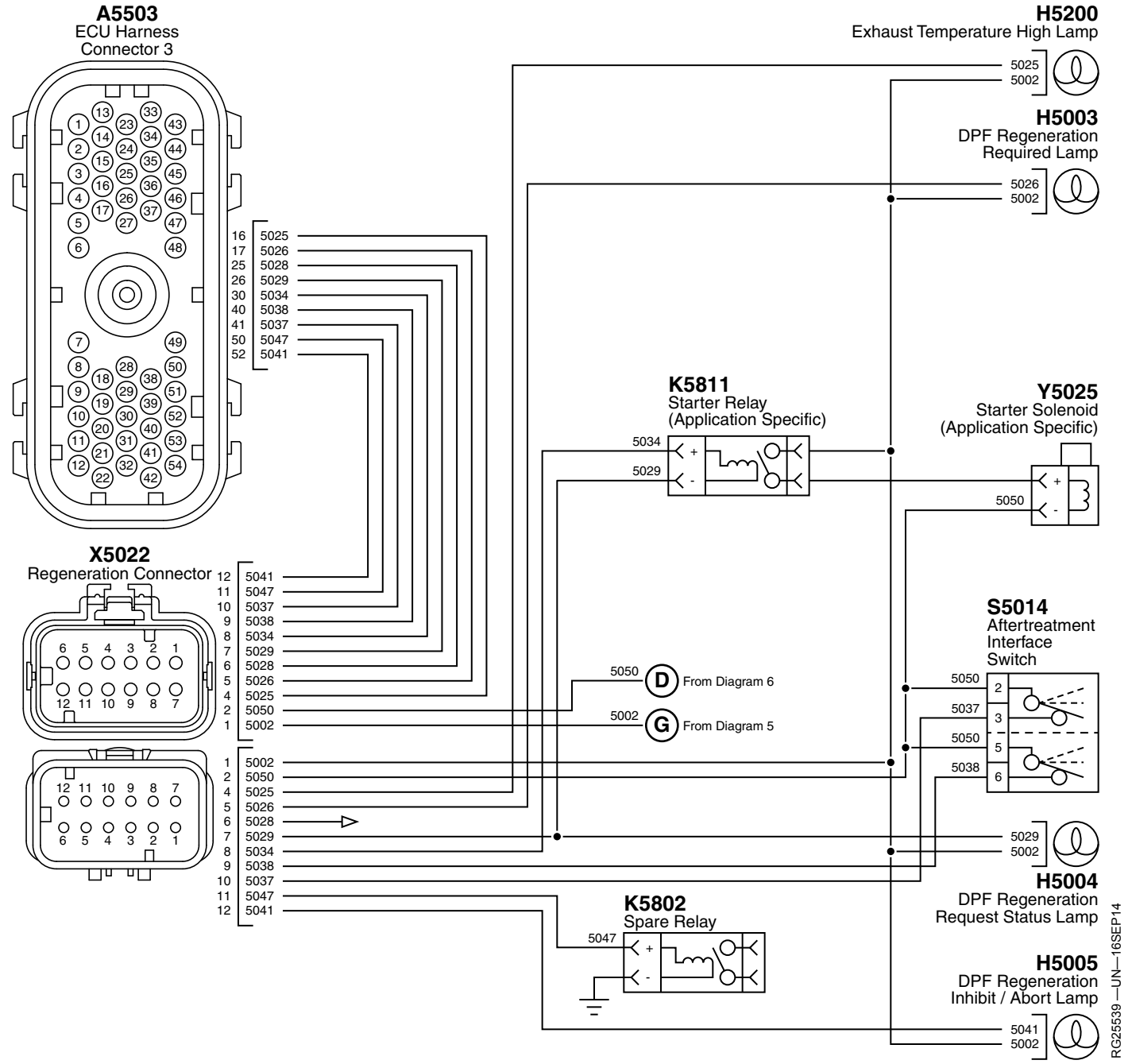
ZE59858,0000066 -19-17SEP14-1/2

A— [5412 Red] Alternator Excitation From 2.9 L Wiring Diagram 5
A5503— ECU Connector 3
A5503-01— [5905 Green] Primary CAN Low
A5503-02— [5904 Yellow] Primary CAN High
A5503-03— [5024 Yellow] Remote Throttle
A5503-04— [5044 Yellow] Wait To Start Lamp
A5503-05— [5473 Orange] Stop Engine Lamp
A5503-06— [5916 Blue] Warning Lamp
A5503-07— [5012 Red] Key Switch
A5503-08— [5981 Brown] PWM Throttle/Alternator Feedback
A5503-09— [5913 Orange] Secondary Throttle
A5503-10— [5915 Green] Primary Throttle
A5503-11— [5954 Yellow] Cruise On Switch
A5503-12— [5943 Orange] Cruise Brake Switch
A5503-15— [5018 Gray] Variable Speed Fan Clutch Control
A5503-18— [5019 White] Variable Speed Fan Signal
A5503-19— [5027 Violet] PTO Speed
A5503-20— [5436 Blue] Engine Coolant Level Switch
A5503-21— [5020 Black] Primary CAN Shield
A5503-22— [5936 Blue] Cruise Resume/Bump Down Switch
A5503-28— [5911 Brown] 5 V Sensor Supply #5 Positive
A5503-31— [5948 Gray] Cruise External Override
A5503-32— [5955 Green] Set Accelerator/Bump Up Switch
A5503-33— [5814 Yellow] 5 V Sensor Supply #4 Return
A5503-34— [5714 Yellow] 5 V Sensor Supply #5 Return
A5503-35— [5439 White] Tachometer
A5503-36— [5039 White] Vehicle Speed Signal
A5503-37— [5497 Violet] Multi-State Throttle
A5503-38— [5917 Violet] Cruise Remote Switch
A5503-39— [5971 Brown] Cruise Cancel/Resume Switch
A5503-42— [5939 White] External Derate Switch
A5503-45— [5036 Blue] Optional Sensor
A5503-46— [5017 Violet] AC High Pressure Switch
A5503-47— [5937 Violet] Isochronous Governor
A5503-48— [5015 Green] Spare Driver Positive
A5503-49— [5616 Blue] 5 V Sensor Supply #4 Positive
A5503-51— [5941 Brown] External Shutdown Switch
A5503-53— [5923 Orange] Bump Enable Switch
A5503-54— [5918 Gray] Shutdown Override Switch
B— [5422 Red] Start From 2.9 L Wiring Diagram 5
C— [5050 Black] Battery Negative From 2.9 L Wiring Diagram 5
D— [5050 Black] Battery Negative To 2.9 L Wiring Diagram 7
E— [5092 Red] JD Link Unswitched Power From 2.9 L Wiring Diagram 5
F— [5002 Red] Control Panel Unswitched Power From 2.9 L Wiring Diagram 5
H— To 2.9 L Wiring Diagram 8 For Mating Connector
I— To 2.9 L Wiring Diagram 9 For Mating Connector
R5601— Primary CAN Terminator
X5005— Diagnostic Connector
X5007— Remote On/Off
X5020— Auxiliary Connector
X5021— Control Panel Connector
X5021-B— [5032 Red] Fused Unswitched Power
X5025— JD Link Connector
Y5005— Variable Speed Fan

ZE59858,0000066 -19-17SEP14-2/2

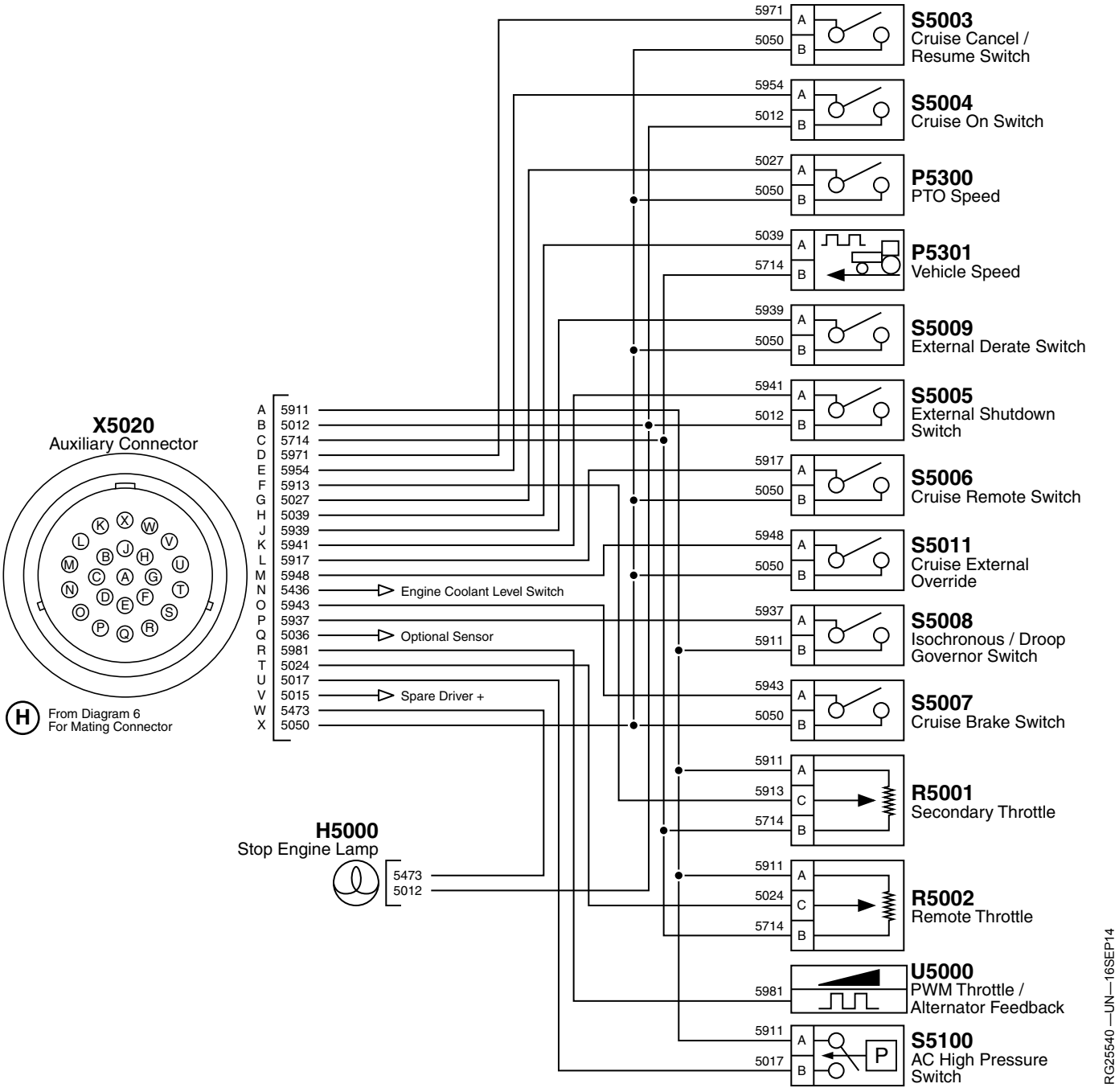
2.9 L Wiring Diagram 7



A5503— ECU Connector 3
A5503-16— [5025 Green] Exhaust Temperature High Lamp
A5503-17— [5026 Blue] DPF Regeneration Required Lamp
A5503-25— [5028 Gray] Spare Driver Positive
A5503-26— [5029 White] DPF Regeneration Status Lamp/Starter Relay Control Negative
A5503-30— [5034 Yellow] Starter Relay Control Positive
A5503-40— [5038 Gray] DPF Regeneration Request Switch
A5503-41— [5037 Violet] DPF Regeneration Inhibit/Abort Switch
A5503-50— [5047 Violet] Spare Driver Positive
A5503-52— [5041 Brown] DPF Regeneration Inhibit/Abort Lamp
D— [5050 Black] Battery Negative From 2.9 L Wiring Diagram 6
G— [5002 Red] Control Panel Unswitched Power From 2.9 L Wiring Diagram 5
H5003— DPF Regeneration Required Lamp
H5004— DPF Regeneration Request Status Lamp
H5005— DPF Regeneration Inhibit/Abort Lamp
H5200— Exhaust Temperature High Lamp
K5802— Spare Relay
K5811— Starter Relay (Application Specific)
S5014— Aftertreatment Interface Switch
X5022— Regeneration Connector
Y5025— Starter Solenoid (Application Specific)

ZE59858,0000067 -19-17SEP14-1/1

2.9 L Wiring Diagram 8



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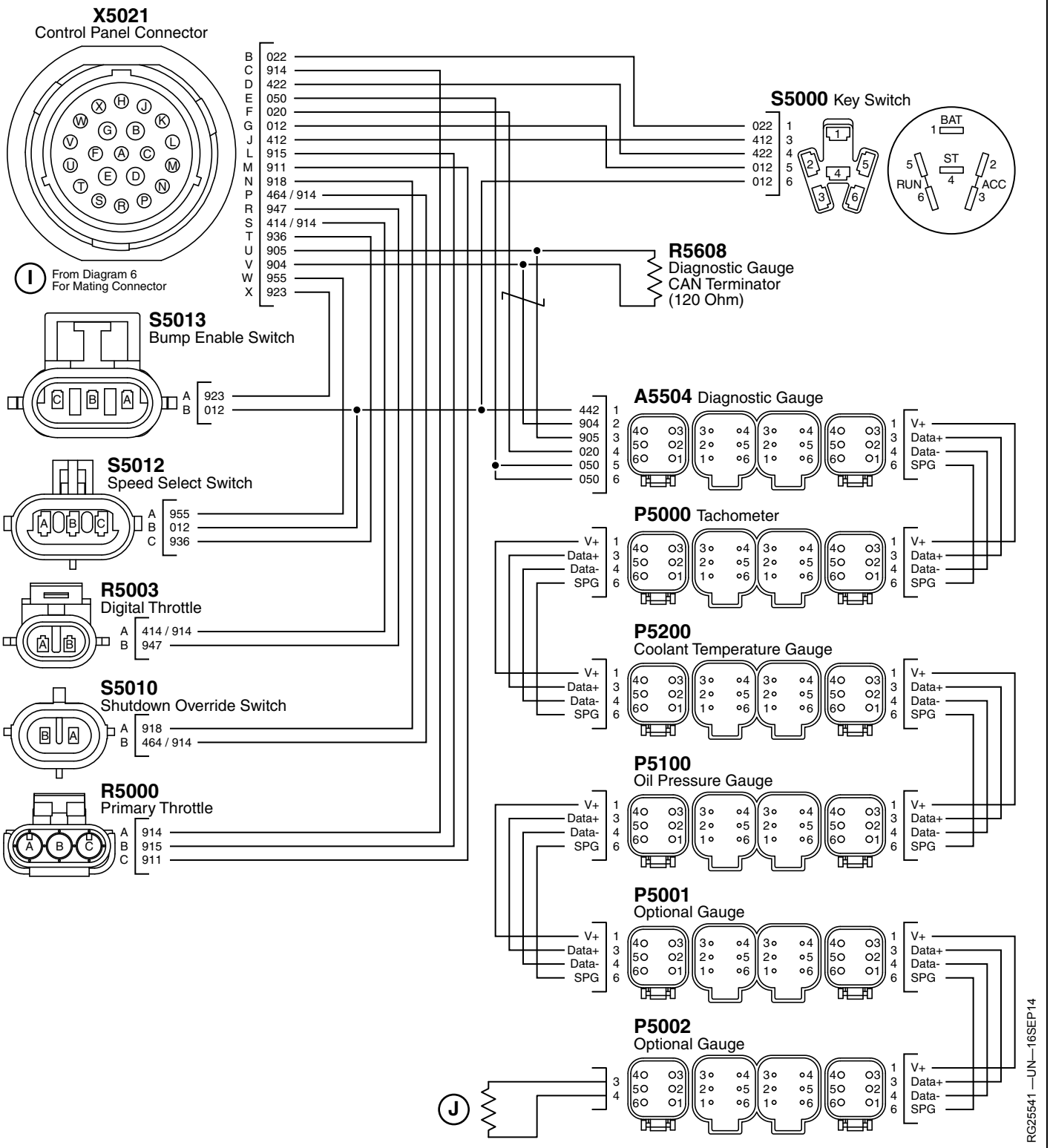
ZE59858,0000068 -19-17SEP14-1/2

H— From 2.9 L Wiring Diagram 6 For Mating Connector
H5000— Stop Engine Lamp
P5300— PTO Speed
P5301— Vehicle Speed
R5001— Secondary Throttle
R5002— Remote Throttle
S5011— Cruise External Override
S5003— Cruise Cancel/Resume Switch
S5004— Cruise On Switch
S5005— External Shutdown Switch
S5006— Cruise Remote Switch
S5007— Cruise Brake Switch
S5008— Isochronous/Droop Governor Switch
S5009— External Derate Switch
S5100— AC High Pressure Switch
U5000— PWM Throttle/Alternator Feedback
X5020— Auxiliary Connector
X5020-A— [5911 Brown] 5 V Sensor Supply #5 Positive
X5020-B— [5012 Red] Key Switch
X5020-C— [5714 Yellow] 5 V Sensor Supply #5 Return
X5020-D— [5971 Brown] Cruise Cancel/Resume Switch
X5020-E— [5954 Yellow] Cruise On Switch
X5020-F— [5913 Orange] Secondary Throttle
X5020-G— [5027 Violet] PTO Speed
X5020-H— [5039 White] Vehicle Speed Signal
X5020-J— [5939 White] External Derate Switch
X5020-K— [5941 Brown] External Shutdown Switch
X5020-L— [5917 Violet] Cruise Remote Switch
X5020-M— [5948 Gray] Cruise External Override
X5020-N— [5436 Blue] Engine Coolant Level Switch
X5020-O— [5943 Orange] Cruise Brake Switch
X5020-P— [5937 Violet] Isochronous Governor
X5020-Q— [5036 Blue] Optional Sensor
X5020-R— [5981 Brown] PWM Throttle/Alternator Feedback
X5020-T— [5024 Yellow] Remote Throttle
X5020-U— [5017 Violet] AC High Pressure Switch
X5020-V— [5015 Green] Spare Driver Positive
X5020-W— [5473 Orange] Stop Lamp
X5020-X— [5050 Black] Battery Negative

ZE59858,0000068 -19-17SEP14-2/2

2.9 L Wiring Diagram 9



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ZE59858,0000069 -19-17SEP14-1/2

A5504— Diagnostic Gauge
A5504-01— [Red] Voltage Positive
A5504-03— [White] Data Positive
A5504-04— [Orange] Data Negative
A5504-06— [Black] Single Point Ground
I— From 2.9 L Wiring Diagram 6 For Mating Connector
J— Resistor 120 Ohm
R5000— Primary Throttle
R5003— Digital Throttle
R5608— Diagnostic Gauge CAN Terminator (120 Ohm)
S5000— Key Switch
S5010— Shutdown Override Switch
S5012— Speed Select Switch
S5013— Bump Enable Switch
X5021— Control Panel Connector
X5021-B— [022 White] Fused Unswitched Power
X5021-C— [914 White] 5 V Sensor Supply #4 Return
X5021-D— [422 White] Start
X5021-E— [050 White] Battery Negative
X5021-F— [020 White] Primary CAN Shield
X5021-G— [012 White] Key Switch
X5021-J— [412 White] Alternator Excitation
X5021-L— [915 White] Primary Throttle
X5021-M— [911 White] 5 V Sensor Supply #4 Positive
X5021-N— [918 White] Shutdown Override Switch
X5021-P— [464/914 White] 5 V Sensor Supply #5 Return
X5021-R— [947 White] Multi-State Throttle
X5021-S— [414/914 White] 5 V Sensor Supply #5 Return
X5021-T— [936 White] Cruise Resume/Bump Down Switch
X5021-U— [905 White] Primary CAN Low
X5021-V— [904 White] Primary CAN High
X5021-W— [955 White] Set Accelerator/Bump Up Switch
X5021-X— [923 White] Bump Enable Switch

ZE59858,0000069 -19-17SEP14-2/2

Engine Storage Guidelines

IMPORTANT: Special considerations should be taken prior to storage when using BioDiesel. See BioDiesel Fuel in the Fuels, Lubricants, and Coolant Section.

1. John Deere engines can be stored outside for up to three months with no long-term preparation if covered by a waterproof covering. No outside storage is recommended without a waterproof covering.
2. John Deere engines can be stored in a standard overseas shipping container for up to three months with no long-term preparation.
3. John Deere engines can be stored inside for up to six months with no long-term preparation.
4. John Deere engines expected to be stored more than six months **must** have long-term storage preparation. See Preparing Engine for Long-Term Storage in the Storage Section.

RK80614,0000060 -19-04FEB15-1/1

Preparing Engine for Long-Term Storage

IMPORTANT: Any time the engine is not used for over six months, the following recommendations for storing it and removing it from storage helps to minimize corrosion and deterioration.

IMPORTANT: Long-term storage is not advised when using BioDiesel. For storage longer than one year, use straight hydrocarbon fuel.

If BioDiesel must be used it is recommended the blend not exceed B7 and a high-quality fuel stabilizer be used. Storage should not exceed one year.

For more information see BioDiesel Fuel in the Fuels, Lubricants, and Coolants Section.

NOTE: The following storage preparations are used for long-term engine storage up to one year. After that, the engine should be started, warmed up, and retreated for an extended storage period.

1. Change engine oil and replace filter. Used oil does not give adequate protection. Add 30 mL of rust preventive oil to the engine crankcase for every 1 L of engine oil, or 1 oz of rust preventative oil per 1 qt. of engine oil. This rust preventive oil should be an SAE 10 oil with 1%-4% morpholine or equivalent vapor corrosion inhibitor.
2. Replace air cleaner.
3. Draining and flushing of cooling system is not necessary if the engine is only stored for less than one year. However, for extended storage periods of a year or longer, it is recommended that the cooling system be drained, flushed, and refilled. Refill with appropriate coolant. See Diesel Engine Coolant (engine with wet sleeve cylinder liners) in the Fuels, Lubricants, and Coolants Section.
4. Prepare a solution of diesel fuel and rust preventive oil in a temporary container, add 78 mL of rust preventive oil per 1 L of diesel fuel, 10 oz. of rust preventive oil per 1 gal. of diesel fuel.
5. Remove existing lines and plugs as required. Run a temporary line from the temporary container to the engine fuel intake before the fuel filters, and another temporary line from the fuel return to the temporary container, so rust preventive oil solution is circulated through the injection system during cranking.

IMPORTANT: Do not operate starter more than 30 seconds at a time. Wait at least 2 minutes for starter to cool before trying again.

6. Crank the engine several revolutions with starter. Do not allow the engine to start. This allows rust preventive oil solution to circulate.

   See your authorized dealer for the proper procedure for your application.
7. Remove temporary lines installed in Step 5 above, and replace any lines or plugs previously removed.
8. Loosen (or remove) and store fan and alternator poly-vee belt.
9. Remove and clean batteries. Store them in a cool, dry place and keep them fully charged.
10. Disengage the clutch for any driveline.
11. Clean the exterior of the engine with salt-free water and touch up any scratched or chipped painted surfaces with a good quality paint.
12. Coat all exposed bare metal surfaces with grease or corrosion inhibitor if not feasible to paint.
13. Seal all openings on engine with plastic bags and tape.
14. Store the engine in a dry protected place. If engine must be stored outside, cover it with a waterproof canvas or other suitable protective material and use a strong waterproof tape.

ZE59858,00002D8 -19-04FEB15-1/1

Removing Engine from Long-Term Storage

NOTE: The following storage removal procedure is used for long-term engine storage up to one year. After that, the engine should be started, warmed up, and retreated for an extended storage period.

Refer to the appropriate section for detailed services listed below or have an authorized servicing dealer or engine distributor perform unfamiliar services.

1. Remove all protective coverings from engine. Unseal all openings in engine and remove covering from electrical systems.
2. Remove grease from all exposed metal surfaces.
3. Remove the batteries from storage. Install batteries (fully charged) and connect the terminals.
4. Install fan and alternator poly-vee belt, if removed.
5. Fill fuel tank.
6. Perform all appropriate prestarting checks. See Daily Prestarting Checks in the Lubrication & Maintenance — Daily Section for more information.

IMPORTANT: DO NOT operate starter more than 30 seconds at a time. Wait at least 2 minutes for starter to cool before trying again.

7. Crank engine for 20 seconds with starter. Do not allow the engine to start. Wait 2 minutes and crank engine an additional 20 seconds to assure bearing surfaces are adequately lubricated.

   See your authorized dealer for the proper procedure for your application.
8. Start engine and run at low idle and no load for 15 minutes.
9. Shut engine off. Change engine oil and replace filter.
10. Warm up engine and check all gauges before placing engine under load.
11. On the first day of operation after storage, check overall engine for leaks and check all gauges for correct operation.

NOTE: If using BioDiesel blends after long-term storage, frequency of fuel filter plugging can increase initially.

ZE59858,00002D9 -19-06DEC13-1/1

General OEM Engine Specifications

ITEM	UNIT OF MEASURE	3029HFC03 3029HFG03
General Data		
Number of Cylinders		3
Bore	mm (in.)	106.5 (4.2)
Stroke	mm (in.)	110 (4.3)
Displacement	L (cu in.)	2.9 (177)
Compression Ratio		16.9:1
Aspiration		Turbocharged
Engine Firing Order		1-2-3
Valves Per Cylinder		1 Intake 1 Exhaust
Valve Clearance (Cold)	mm (in.)	Intake — 0.35 (0.014) Exhaust — 0.45 (0.018)
Physical Dimensions		
Length	mm (in.)	715 (28.1)
Width	mm (in.)	596 (23.5)
Height	mm (in.)	956 (37.6)
Weight	kg (lb.)	400 (882)
Performance Data		
Power and Speed Ratings	See Engine Power And Speed Rating Specifications in the Specifications Section.	
Lubrication System		
Crankcase Oil Fill Capacity	See Engine Crankcase Oil Fill Quantities in the Specifications Section.	
Oil Pressure At Rated Speed	kPa (Bar) (psi)	357 (3.57) (52)
Oil Pressure At Low Idle (Minimum)	kPa (Bar) (psi)	254 (2.54) (37)
Cooling System		
Thermostat Start To Open Temperature	°C (°F)	83 (181)
Thermostat Fully Open Temperature	°C (°F)	95 (203)
Recommended Radiator Pressure Cap	kPa (Bar) (psi)	125 (1.25) (18)
Fuel System		
ECU Level		L23
Fuel Injection Type		HPCR
Primary Fuel Filter		5 micron
Electrical System		
Battery Capacities 12-Volt System	CCA	640
Battery Capacities 24-Volt System	CCA	570
Air System		
Maximum Air Intake Restriction	kPa (Bar) (psi)	3.0 (0.03) (0.44)
Maximum Exhaust Back Pressure	kPa (Bar) (psi)	7.5 (0.075) (1.09)

ZE59858,000006C -19-23SEP14-1/1

Engine Power Ratings And Fuel System Specifications

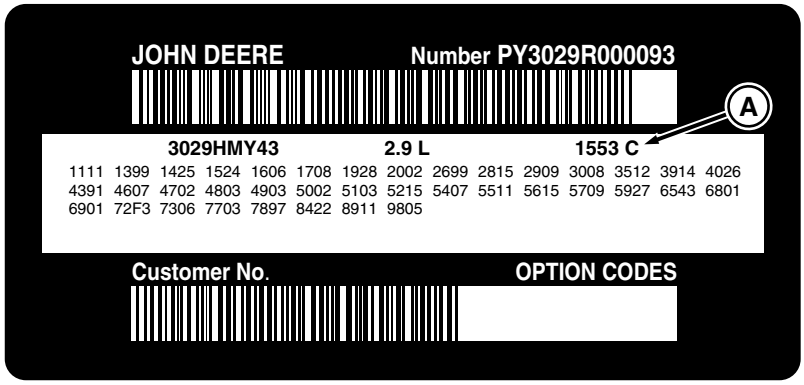
NOTE: Power ratings are for bare engines without drag effect of cooling fan or accessories like air compressors.

NOTE: Engine speeds listed are preset to factory specification. Slow idle speed may be reset depending upon specific vehicle application requirements. Refer to your machine operator's manual for engine speeds that are different from those preset at the factory.

Engine Model	Electronic Software Option Codes	System Voltage V	Power Rating @ Rated Speed kW (hp)	Rated Speed (rpm)
3029HFC03	7APG	12	36 (48)	2200
	7APE	12	36 (48)	2400
	7ANY	12	48 (64)	2200
	7ANW	12	48 (64)	2400
	7ANU	12	55 (74)	2200
	7ANS	12	55 (74)	2400
3029HFG03	7APN	12	36 (48); 36 (48)	1800; 1500
	7APL	12	48 (64); 48 (64)	1800; 1500
	7APJ	12	55 (74); 48 (64)	1800, 1500

ZE59858,000006D -19-10MAR15-1/1

Engine Crankcase Oil Fill Quantities



RG24034 —UN—06AUG13

A—Engine Base Code

To determine the option code for the oil fill quantity of your engine, refer to the engine option code label affixed to the rocker arm cover. The first two digits of the code (19) identify the oil pan option group. The last two digits of each code identify the specific oil pan on your engine.

The following table lists engine crankcase oil fill quantities:

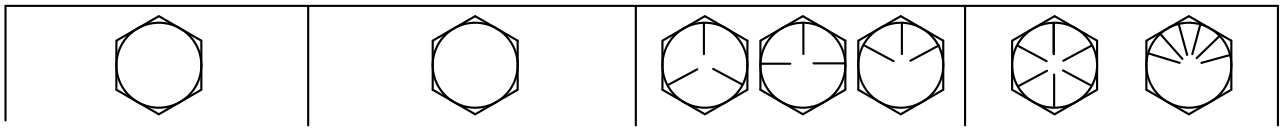
Oil Pan Option Code	Crankcase Oil Capacity
19GN	8.5 L (9.0 qt.)

NOTE: Crankcase oil capacity may vary slightly from amount shown. ALWAYS fill crankcase to within crosshatch on dipstick. DO NOT overfill.

ZE59858,000006E -19-28JUL14-1/1

Unified Inch Bolt and Screw Torque Values

TS1671 —UN—01MAY03



Bolt or Screw Size	SAE Grade 1				SAE Grade 2[a]				SAE Grade 5, 5.1 or 5.2				SAE Grade 8 or 8.2			
	Lubricated[b]		Dry[c]		Lubricated[b]		Dry[c]		Lubricated[b]		Dry[c]		Lubricated[b]		Dry[c]	
	N·m	lb.-in.	N·m	lb.-in.	N·m	lb.-in.	N·m	lb.-in.	N·m	lb.-in.	N·m	lb.-in.	N·m	lb.-in.	N·m	lb.-in.
1/4	3.7	33	4.7	42	6	53	7.5	66	9.5	84	12	106	13.5	120	17	150
													N·m	lb.-ft.	N·m	lb.-ft.
5/16	7.7	68	9.8	86	12	106	15.5	137	19.5	172	25	221	28	20.5	35	26
									N·m	lb.-ft.	N·m	lb.-ft.				
3/8	13.5	120	17.5	155	22	194	27	240	35	26	44	32.5	49	36	63	46
			N·m	lb.-ft.	N·m	lb.-ft.	N·m	lb.-ft.								
7/16	22	194	28	20.5	35	26	44	32.5	56	41	70	52	80	59	100	74
	N·m	lb.-ft.														
1/2	34	25	42	31	53	39	67	49	85	63	110	80	120	88	155	115
9/16	48	35.5	60	45	76	56	95	70	125	92	155	115	175	130	220	165
5/8	67	49	85	63	105	77	135	100	170	125	215	160	240	175	305	225
3/4	120	88	150	110	190	140	240	175	300	220	380	280	425	315	540	400
7/8	190	140	240	175	190	140	240	175	490	360	615	455	690	510	870	640
1	285	210	360	265	285	210	360	265	730	540	920	680	1030	760	1300	960
1-1/8	400	300	510	375	400	300	510	375	910	670	1150	850	1450	1075	1850	1350
1-1/4	570	420	725	535	570	420	725	535	1280	945	1630	1200	2050	1500	2600	1920
1-3/8	750	550	950	700	750	550	950	700	1700	1250	2140	1580	2700	2000	3400	2500
1-1/2	990	730	1250	930	990	730	1250	930	2250	1650	2850	2100	3600	2650	4550	3350

Torque values listed are for general use only, based on the strength of the bolt or screw. DO NOT use these values if a different torque value or tightening procedure is given for a specific application. For plastic insert or crimped steel type lock nuts, for stainless steel fasteners, or for nuts on U-bolts, see the tightening instructions for the specific application. Shear bolts are designed to fail under predetermined loads. Always replace shear bolts with identical grade.

Replace fasteners with the same or higher grade. If higher grade fasteners are used, tighten these to the strength of the original. Make sure fastener threads are clean and that you properly start thread engagement. When possible, lubricate plain or zinc plated fasteners other than lock nuts, wheel bolts or wheel nuts, unless different instructions are given for the specific application.

[a]Grade 2 applies for hex cap screws (not hex bolts) up to 6 in. (152 mm) long. Grade 1 applies for hex cap screws over 6 in. (152 mm) long, and for all other types of bolts and screws of any length.

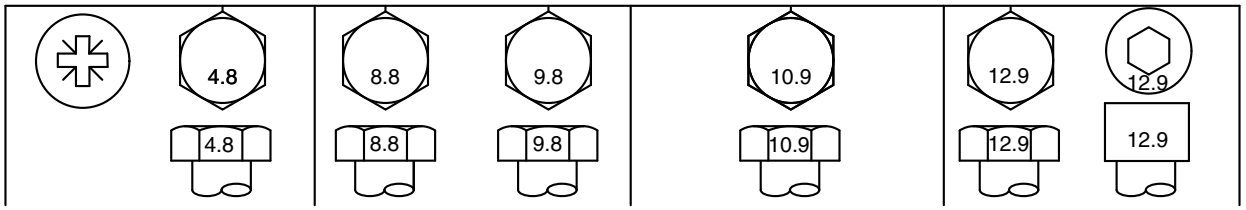
[b]"Lubricated" means coated with a lubricant such as engine oil, fasteners with phosphate and oil coatings, or 7/8 in. and larger fasteners with JDM F13C, F13F or F13J zinc flake coating.

[c]"Dry" means plain or zinc plated without any lubrication, or 1/4 to 3/4 in. fasteners with JDM F13B, F13E or F13H zinc flake coating.

DX,TORQ1 -19-12JAN11-1/1

Metric Bolt and Screw Torque Values

TS1670 —UN—01MAY03



Bolt or Screw Size	Class 4.8				Class 8.8 or 9.8				Class 10.9				Class 12.9			
	Lubricated[a]		Dry[b]		Lubricated[a]		Dry[b]		Lubricated[a]		Dry[b]		Lubricated[a]		Dry[b]	
	N·m	lb.-in.	N·m	lb.-in.	N·m	lb.-in.	N·m	lb.-in.	N·m	lb.-in.	N·m	lb.-in.	N·m	lb.-in.	N·m	lb.-in.
M6	4.7	42	6	53	8.9	79	11.3	100	13	115	16.5	146	15.5	137	19.5	172
									N·m	lb.-ft.	N·m	lb.-ft.	N·m	lb.-ft.	N·m	lb.-ft.
M8	11.5	102	14.5	128	22	194	27.5	243	32	23.5	40	29.5	37	27.5	47	35
			N·m	lb.-ft.	N·m	lb.-ft.	N·m	lb.-ft.								
M10	23	204	29	21	43	32	55	40	63	46	80	59	75	55	95	70
	N·m	lb.-ft.														
M12	40	29.5	50	37	75	55	95	70	110	80	140	105	130	95	165	120
M14	63	46	80	59	120	88	150	110	175	130	220	165	205	150	260	190
M16	100	74	125	92	190	140	240	175	275	200	350	255	320	235	400	300
M18	135	100	170	125	265	195	330	245	375	275	475	350	440	325	560	410
M20	190	140	245	180	375	275	475	350	530	390	675	500	625	460	790	580
M22	265	195	330	245	510	375	650	480	725	535	920	680	850	625	1080	800
M24	330	245	425	315	650	480	820	600	920	680	1150	850	1080	800	1350	1000
M27	490	360	625	460	950	700	1200	885	1350	1000	1700	1250	1580	1160	2000	1475
M30	660	490	850	625	1290	950	1630	1200	1850	1350	2300	1700	2140	1580	2700	2000
M33	900	665	1150	850	1750	1300	2200	1625	2500	1850	3150	2325	2900	2150	3700	2730
M36	1150	850	1450	1075	2250	1650	2850	2100	3200	2350	4050	3000	3750	2770	4750	3500

Torque values listed are for general use only, based on the strength of the bolt or screw. DO NOT use these values if a different torque value or tightening procedure is given for a specific application. For stainless steel fasteners or for nuts on U-bolts, see the tightening instructions for the specific application. Tighten plastic insert or crimped steel type lock nuts by turning the nut to the dry torque shown in the chart, unless different instructions are given for the specific application.

Shear bolts are designed to fail under predetermined loads. Always replace shear bolts with identical property class. Replace fasteners with the same or higher property class. If higher property class fasteners are used, tighten these to the strength of the original. Make sure fastener threads are clean and that you properly start thread engagement. When possible, lubricate plain or zinc plated fasteners other than lock nuts, wheel bolts or wheel nuts, unless different instructions are given for the specific application.

[a] *"Lubricated" means coated with a lubricant such as engine oil, fasteners with phosphate and oil coatings, or M20 and larger fasteners with JDM F13C, F13F or F13J zinc flake coating.*

[b] *"Dry" means plain or zinc plated without any lubrication, or M6 to M18 fasteners with JDM F13B, F13E or F13H zinc flake coating.*

DX,TORQ2 -19-12JAN11-1/1

Lubrication and Maintenance Records

Using Lubrication and Maintenance Records

Refer to specific Lubrication and Maintenance Section for detailed service procedures.

1. Keep a record of the number of hours you operate your engine by regular observation of hour meter.
2. Check your record regularly to learn when your engine needs service.
3. DO ALL the services within an interval section. Write the number of hours (from your service records) and the date in the spaces provided. For a complete listing of all items to be performed and the service intervals required, refer to the quick-reference chart near the front of the Lubrication and Maintenance Section.

IMPORTANT: The service recommendations covered in this manual are for the accessories that are provided by John Deere. Follow manufacturer's service recommendations for servicing engine driven equipment not supplied by Deere.

RG,RG34710,5620 -19-24AUG10-1/1

Daily (Prestarting) Service

- Check engine oil level.
- Check coolant level.
- Check fan, alternator, and drive belts.
- Check fuel filters/water bowls.
- Check air cleaner dust unloader valve and air filter restriction indicator, if equipped.
- Perform visual walkaround inspection.

ZE59858,00002CE -19-06DEC13-1/1

250 Hours or 12 Months Service

- Replace fuel filter elements.

Hours									
Date									
Hours									
Date									
Hours									
Date									
Hours									
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Hours									
Date									
Hours									
Date									

RK80614,0000536 -19-12DEC14-1/1

500 Hours or 12 Months Service

- Service fire extinguisher.
- Service battery.
- Change engine oil and filter.[1]
- Inspect coolant pump.
- Check open crankcase vent system.
- Check engine mounts.
- Check V-belt wear.
- Check Air Intake System.
- Check engine electrical ground connection.
- Check cooling system.
- Pressure test cooling system.
- Check engine speeds.

Hours									
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[1]Service intervals depend on sulfur content of the diesel fuel, oil pan capacity, and the oil and filter used. (See DIESEL ENGINE OIL AND FILTER SERVICE INTERVALS, in Fuels, Lubricants, and Coolant Section.)

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1200 Hours

- Check and Adjust Engine Valve Clearance.

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1500 Hours or 24 Months Service

- Changing Open Crankcase Ventilation (OCV) Filter.

Hours									
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6000 Hours or 72 Months Service

- Flush and refill cooling system.
- Test thermostats.

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Hours									
Date									
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Service As Required

- Drain water from fuel filter.
- Bleed fuel system.
- Add coolant.
- Pre-Start Cleaning Guide.
- Service/Replace air cleaner.
- Clean exhaust filter.
- Replace fan belt.
- Check fuses.
- Check electrical wiring and connections.
- Check air compressor (if equipped).

Hours									
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John Deere Warranty in OEM Applications

Overview

This section focuses on John Deere engines marketed in products manufactured by companies other than John Deere or its affiliates, and on John Deere repower engines in all applications. Herein appears the original warranty applicable to the engine as delivered to the retail purchaser on or after 1 May 2010. The following is information about the warranty and warranty service.

NOTE: "John Deere" means John Deere Power Systems with respect to users in the United States, John Deere Limited with respect to users in Canada, and Deere & Company or its subsidiary responsible for making John Deere equipment in other countries where the user is located.

Promptly register your engine online at https://www.johndeere.com/enginewarranty

or

Mail or FAX the registration form found in this manual to John Deere as indicated on the form.

When Warranty Service Is Needed

The nearest dealer stands ready with genuine parts and trained and equipped personnel should the need arise. If following the Operator's Manual delivered with the engine/machine are not adequate to correct an engine problem, contact the nearest John Deere service dealer for assistance. Authorized engine service dealers can be found at: https://www.johndeere.com/ (click on "Dealer Locator").

NOTE: When requesting warranty service, the purchaser must be prepared to provide proof that the engine is within the warranty period.

The following information is always required: Engine serial number, date of delivery, engine owner, name and location of dealer and specific person contacted, date of contact, nature of engine problem, and outcome of the service dealer contact.

Given that normally it is the dealer contacted who in the end will provide the service required, maintaining a purchaser-dealer relationship of mutual respect from the beginning is always helpful.

Privacy Notice

At John Deere your privacy is important to us. We collect, use, and disclose your personal information in accordance with the John Deere privacy statement. For instance, we collect, use, and disclose your personal information to provide you with the products and services that you request; to communicate with you as our customer (examples include warranty and product improvement programs) and to meet safety and legal requirements; and for marketing and promotional purposes. Sometimes, we may ask our John Deere affiliates, dealers, or business partners to do work for us which involves your information. For complete details on your privacy rights and to obtain a copy of the John Deere Privacy Statement, please visit our website at https://www.johndeere.com/.

Warranty Duration

Unless otherwise provided in writing by John Deere, John Deere makes the following warranty to the first retail purchaser and each subsequent purchaser (if purchase is made prior to the expiration of applicable warranty) of each John Deere new off-highway engine marketed as part of a product manufactured by a company other than John Deere or its affiliates and on each John Deere engine used in an off-highway repower application:

- 12 months, unlimited hours of use, or
- 24 months and before the accumulation of 2000 hours of use.

NOTE: In the absence of a functional hourmeter, hours of use will be determined on the basis of 12 hours of use per calendar day.

Warranty Coverage

This warranty applies to the engine and to integral components and accessories sold by John Deere, and delivered to the first retail purchaser on or after 1 May 2010.

All John Deere-warranted parts and components of John Deere engines which, as delivered to the purchaser, are defective in materials and/or workmanship will be repaired or replaced, as John Deere elects. Warrantable repairs will be made without charge for parts or engine repair labor, including reasonable labor costs to remove and reinstall non-engine parts or components of the equipment in which the engine is installed. If required, reasonable labor costs for engine removal and reinstallation will also be included. All coverage is based on the defect appearing within the warranty period as measured from the date of delivery to the first retail purchaser.

Obtaining Warranty Service

Warranty service must be requested of the nearest authorized John Deere engine service outlet before the expiration of the warranty. An *authorized* service outlet is a John Deere engine distributor, a John Deere engine service dealer, or a John Deere equipment dealer selling and servicing equipment with an engine of the type covered by this warranty. (See When Warranty Service is Needed above.)

Authorized service outlets will use only new or remanufactured parts or components furnished or approved by John Deere.

NOTE: Authorized engine service locations are listed on the Internet at https://www.johndeere.com/ (Click on "Dealer Locator".)

Continued on next page

At the time of requesting warranty service, the purchaser must be prepared to present evidence of the date of delivery of the engine.

John Deere reimburses authorized service outlets for limited travel expenses incurred in making warranty service repairs in non-John Deere applications when travel is actually performed. The limit, as of the date of publication of this booklet, is US$400.00 (US$500.00 if engine is marine) or equivalent. **If distances and travel times are greater than reimbursed by John Deere, the service outlet will charge the purchaser for the difference.**

Warranty Exclusions

John Deere's obligations will not apply to components and accessories which are not furnished or installed by John Deere, nor to failures caused by such items, except as required by law.

Purchaser's Responsibilities

The cost of normal maintenance and depreciation.

Periodic cleaning of the diesel particulate filter (DPF).

Consequences of negligence, misuse, or accident involving the product, or improper application, installation, or storage.

Consequences of service performed by someone other than an authorized John Deere engine service outlet.

Consequences of any product modification or alteration not approved by John Deere, including, but not limited to, tampering with engine fuel and air delivery systems.

Consequences of failure of non-product components.

Consequences of fuels, lubricants, or coolants that fail to meet the specifications and requirements listed in the Operator's Manual.

The effects of cooling system neglect as manifested in cylinder liner or cylinder block cavitation ("pitting, "erosion", "electrolysis").

Any premium for overtime labor requested by the purchaser.

Costs of transporting the product or the equipment in which it is installed to and from the location at which the warranty service is performed, if such costs are in excess of the travel reimbursement payable to the dealer had the warranty service been performed at the product's location.

Costs incurred in gaining access; for example, overcoming physical barriers such as walls, fences, floors, decks, or similar structures impeding access to the product, rental of cranes or similar, or construction of ramps or lifts or protective structures for product removal and reinstallation.

Incidental travel costs including meals, lodging, and similar, and any travel time or mileage costs in excess of the maximum allowance.

Service outlet costs incurred in solving or attempting to solve non-warrantable problems.

Services performed by a party other than an authorized John Deere service dealer.

Charges by dealers for initial start-up and inspection deemed unnecessary by John Deere when an Operator's Manual is supplied with the product are followed.

Costs related to interpretation or translation services.

No Representations or Implied Warranty

Where permitted by law, neither John Deere nor any company affiliated with it makes any guaranties, warranties, conditions, representations or promises, express or implied, oral or written, as to the nonoccurrence of any defect or the quality of performance of its engines other than those set forth in this booklet, and DOES NOT MAKE ANY IMPLIED WARRANTY OR CONDITIONS OF MERCHANTABILITY OR FITNESS otherwise provided for in the Uniform Commercial Code or required by any Sale of Goods Act or any other statute. This exclusion includes fundamental terms. In no event will a John Deere engine distributor or engine service dealer, John Deere equipment dealer, or John Deere or any company affiliated with John Deere be liable for incidental or consequential damages or injuries including, but not limited to, loss of profits, loss of crops, rental of substitute equipment or other commercial loss, damage to the equipment in which the engine is installed or for damage suffered by purchaser as a result of fundamental breaches of contract or breach of fundamental terms, unless such damages or injuries are caused by the gross negligence or intentional acts of the foregoing parties.

Remedy Limitation

The remedies set forth in this warranty are the purchaser's exclusive remedies in connection with the performance of, or any breach of guaranty, condition, or warranty in respect of new John Deere engines. In the event the above warranty fails to correct purchaser's performance problems caused by defects in workmanship and/or materials, purchaser's exclusive remedy shall be limited to payment by John Deere of actual damages in an amount not to exceed the cost of the engine.

No Seller's Warranty

No person or entity, other than John Deere, who sells the engine or product in which the engine has been installed makes any guaranty or warranty of its own on any engine warranted by John Deere unless it delivers to the purchaser a separate written guaranty certificate specifically guaranteeing the engine, in which case John Deere shall have no obligation to the purchaser. Neither original equipment manufacturers, engine or equipment distributors, engine or equipment dealers, nor any other person or entity, has any authority to make any representation or promise on behalf of John Deere or to modify the terms or limitations of this warranty in any way.

Continued on next page

Replacement Parts Warranty

John Deere and John Deere Reman parts and components (excluding replacement engines) installed during engine warranty service are warranted for the remaining warranty period of the engine or the applicable warranty term for the installed service part, whichever is greater. A new or remanufactured engine replacing a failed engine under warranty is warranted for 90 days or the remaining warranty period of the original engine, whichever is greater.

Warranty Transfer

The remainder of the original engine warranty and the emissions control-related warranty may be transferred to a subsequent owner of the engine. The Engine Warranty Transfer card should be used to report the transfer to John Deere. If a card is not available, contact your Dealer or simply send the following Information to JDPS Warranty Administration at Diesel-US@JohnDeere.com.

1. The complete 13-character engine serial number.
2. The name and mailing address of the original purchaser.
3. Delivery date to the original purchaser.
4. Hours at the time of transfer.
5. Date of transfer to the new owner.
6. Name and mailing address of the new owner.
7. How the engine/drivetrain being used, i.e., what equipment it powers, by manufacturer and model.
8. Equipment it powers, by manufacturer and model.

Purchased Extended Warranty

Extended warranty may be purchased on most engines in many areas of the world. John Deere engine distributors and equipment dealers, and dealers of manufacturers using John Deere engines in their products, have details. John Deere may also be contacted at U.S.A. fax number 1-319-292-5844, or in Europe fax number 33.2.38.84.62.66.

Emissions Warranties

Emissions warranties appear in the Operator's Manual furnished with the engine/machine. **(Warning: Statutes providing severe penalties for tampering with emissions controls may apply at the user's location.)** John Deere may also be contacted at U.S.A. fax number 1-319-292-5844; or in Europe fax number 33.2.38.84.62.66.

Local Warranty Requirements

Warranties required by local statutes will be furnished by the seller.

Option Codes (Engine Manufacturing Configuration)

When in need of engine replacement parts, your authorized John Deere service dealer will need to know the corresponding "Option Codes" for your engine. The option code label on the engine rocker arm cover may become damaged over time. By recording the four-digit codes when the engine is new, and storing this manual where it can be found when parts are needed, fast, accurate parts ordering and service will be assured. (See Engine Option Codes in the Record Keeping Section).

Should there be a question about an engine option code, note the engine serial number and call 1-800-JDENGINE from the U.S.A. or Canada, or fax U.S.A. number 1-319-292-5844; or E-mail at diesel-us@johndeere.com, Attention: Warranty Administration; or in Europe fax number 33.2.38.84.62.66, or E-mail at saranservice@johndeere.com.

Registering The Engine For Warranty

Completion and submission of the John Deere Engine Warranty Registration form (cut out sheet found in this manual) is very important. John Deere will not deny warranty service on an engine within its warranty period if the engine has not been registered. However, registering your engine will assure your servicing dealer that the engine is within the warranty period.

The easiest way to register your engine is via the Internet. Go to website https://www.johndeere.com/enginewarranty You can use the sheet in this manual to gather the information needed to register the warranty.

NOTE: Information provided on the form must be legible!

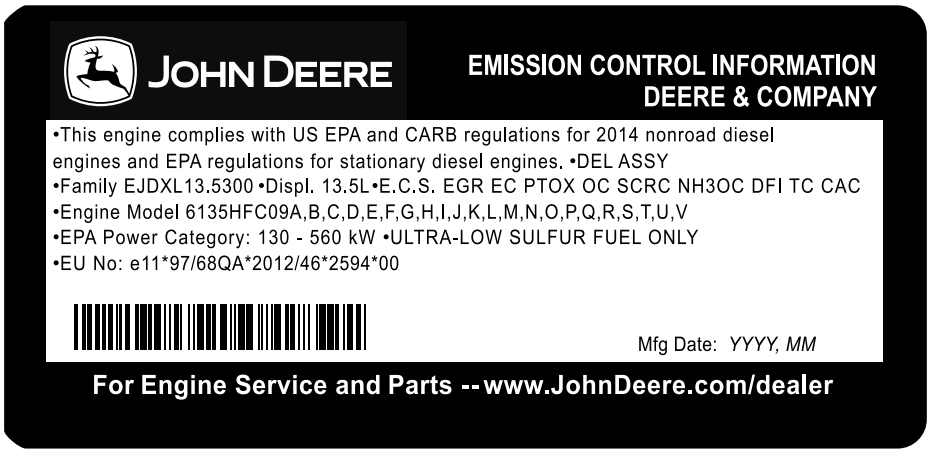
Typing is preferred, but legible handwritten reports are acceptable. "Block" numbers and Roman alphabet letters should be used. For example: 1,2,3,4 and A, B, C, D.

All requested information should be given. Much of it contributes to reports, including those required by governments.

The purchaser's telephone number or E-mail address allows John Deere to make contact should there be questions concerning the registration. The purchaser should sign and date the form.

JR74534,0000462 -19-22AUG14-3/3

Emissions Control System Certification Label



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Engine Emissions Label

CAUTION: Statutes providing severe penalties for tampering with emissions controls may apply to the user or dealer.

The emissions warranty applies to those engines marketed by John Deere that have been certified by the United States Environmental Protection Agency (EPA) and/or California Air Resources Board (CARB); and used in the United States and Canada in Non-road equipment. The presence of an emissions label like the one shown signifies that the engine has been certified with the EPA and/or CARB. The EPA and CARB warranties only apply to new engines having the certification label affixed to the engine and sold as stated above in the geographic areas. The presence of an EU number signifies that the engine has been certified with the European Union countries per Directive 97/68/EC. The EPA and/or CARB emissions warranties do not apply to the EU countries.

The emissions label has applicable US EPA and/or CARB regulatory year. The regulatory year determines which warranty statement is applicable to engine. See “EPA Non-road Emissions Control Warranty Statement—Compression Ignition” and “CARB Non-road Emissions Control Warranty Statement—Compression Ignition”. For additional regulatory year warranty statements, see www.JohnDeere.com or contact the nearest John Deere service dealer for assistance.

Emission Control System(s) Laws

The U.S. EPA and California ARB prohibit the removal or rendering inoperative of any device or element of design installed on or in engines/equipment in compliance with applicable emission regulations prior to or after the sale and delivery of the engines/equipment to the ultimate purchaser.

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EPA Non-road Emissions Control Warranty Statement—Compression Ignition

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JOHN DEERE

U.S. AND CANADA EMISSION CONTROL WARRANTY STATEMENT
YOUR WARRANTY RIGHTS AND OBLIGATIONS

To determine if the John Deere engine qualifies for the additional warranties set forth below, look for the "Emissions Control Information" label located on the engine. If the engine is operated in the United States or Canada and the Emissions Control information label states: "This engine complies with US EPA regulations for nonroad and stationary diesel engines", or "This engine conforms to US EPA nonroad compression-ignition regulations", refer to the "U.S. and Canada Emission Control Warranty Statement." If the engine is operated in California, and the label states: "This engine complies with US EPA and CARB regulations for nonroad diesel engines", or "This engine conforms to US EPA and California nonroad compression-ignition emission regulations", also refer to the "California Emission Control Warranty Statement."

Warranties stated on this certificate refer only to emissions-related parts and components of your engine. The complete engine warranty, less emissions-related parts and components, is provided separately. If you have any questions about your warranty rights and responsibilities, you should contact John Deere at 1-319-292-5400.

JOHN DEERE'S WARRANTY RESPONSIBILITY

John Deere warrants to the ultimate purchaser and each subsequent purchaser that this off-road diesel engine including all parts of its emission-control system was designed, built and equipped so as to conform at the time of the sale with Section 213 of the Clean Air Act and is free from defects in materials and workmanship which would cause the engine to fail to conform with applicable US EPA regulations for a period of five years from the date the engine is placed into service or 3,000 hours of operation, whichever first occurs.

Where a warrantable condition exists, John Deere will repair or replace, as it elects, any part or component with a defect in materials or workmanship that would increase the engine's emissions of any regulated pollutant within the stated warranty period at no cost to you, including expenses related to diagnosing and repairing or replacing emission-related parts. Warranty coverage is subject to the limitations and exclusions set forth herein. Emission- related components include engine parts developed to control emissions related to the following:

Air-Induction System
Fuel System
Ignition System
Exhaust Gas Recirculation Systems
Aftertreatment Devices
Crankcase Ventilation Valves
Sensors
Engine Electronic Control Units

EMISSION WARRANTY EXCLUSIONS

John Deere may deny warranty claims for malfunctions or failures caused by:

- Non-performance of maintenance requirements listed in the Operator's Manual
- The use of the engine/equipment in a manner for which it was not designed
- Abuse, neglect, improper maintenance or unapproved modifications or alterations
- Accidents for which it does not have responsibility or by acts of God

The off-road diesel engine is designed to operate on diesel fuel as specified in the Fuels, Lubricants and Coolants section in the Operators Manual. Use of any other fuel can harm the emissions control system of the engine/equipment and is not approved for use.

To the extent permitted by law John Deere is not liable for damage to other engine components caused by a failure of an emission-related part, unless otherwise covered by standard warranty.

THIS WARRANTY IS EXPRESSLY IN LIEU OF ANY OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. REMEDIES UNDER THIS WARRANTY ARE LIMITED TO THE PROVISIONS OF MATERIAL AND SERVICES AS SPECIFIED HEREIN. WHERE PERMITTED BY LAW, NEITHER JOHN DEERE NOR ANY AUTHORIZED JOHN DEERE ENGINE DISTRIBUTOR, DEALER, OR REPAIR FACILITY OR ANY COMPANY AFFILIATED WITH JOHN DEERE WILL BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES.

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JOHN DEERE

U.S. AND CANADA EMISSION CONTROL WARRANTY STATEMENT
YOUR WARRANTY RIGHTS AND OBLIGATIONS

To determine if the John Deere engine qualifies for the additional warranties set forth below, look for the "Emissions Control Information" label located on the engine. If the engine is operated in the United States or Canada and the Emissions Control information label states: "This engine complies with US EPA regulations for nonroad and stationary diesel engines", or "This engine conforms to US EPA nonroad compression-ignition regulations", refer to the "U.S. and Canada Emission Control Warranty Statement." If the engine is operated in California, and the label states: "This engine complies with US EPA and CARB regulations for nonroad diesel engines", or "This engine conforms to US EPA and California nonroad compression-ignition emission regulations", also refer to the "California Emission Control Warranty Statement."

Warranties stated on this certificate refer only to emissions-related parts and components of your engine. The complete engine warranty, less emissions-related parts and components, is provided separately. If you have any questions about your warranty rights and responsibilities, you should contact John Deere at 1-319-292-5400.

JOHN DEERE'S WARRANTY RESPONSIBILITY

John Deere warrants to the ultimate purchaser and each subsequent purchaser that this off-road diesel engine including all parts of its emission-control system was designed, built and equipped so as to conform at the time of the sale with Section 213 of the Clean Air Act and is free from defects in materials and workmanship which would cause the engine to fail to conform with applicable US EPA regulations for a period of five years from the date the engine is placed into service or 3,000 hours of operation, whichever first occurs.

Where a warrantable condition exists, John Deere will repair or replace, as it elects, any part or component with a defect in materials or workmanship that would increase the engine's emissions of any regulated pollutant within the stated warranty period at no cost to you, including expenses related to diagnosing and repairing or replacing emission-related parts. Warranty coverage is subject to the limitations and exclusions set forth herein. Emission- related components include engine parts developed to control emissions related to the following:

Air-Induction System
Fuel System
Ignition System
Exhaust Gas Recirculation Systems
Aftertreatment Devices
Crankcase Ventilation Valves
Sensors
Engine Electronic Control Units

EMISSION WARRANTY EXCLUSIONS

John Deere may deny warranty claims for malfunctions or failures caused by:

- Non-performance of maintenance requirements listed in the Operator's Manual
- The use of the engine/equipment in a manner for which it was not designed
- Abuse, neglect, improper maintenance or unapproved modifications or alterations
- Accidents for which it does not have responsibility or by acts of God

The off-road diesel engine is designed to operate on diesel fuel as specified in the Fuels, Lubricants and Coolants section in the Operators Manual. Use of any other fuel can harm the emissions control system of the engine/equipment and is not approved for use.

To the extent permitted by law John Deere is not liable for damage to other engine components caused by a failure of an emission-related part, unless otherwise covered by standard warranty.

THIS WARRANTY IS EXPRESSLY IN LIEU OF ANY OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. REMEDIES UNDER THIS WARRANTY ARE LIMITED TO THE PROVISIONS OF MATERIAL AND SERVICES AS SPECIFIED HEREIN. WHERE PERMITTED BY LAW, NEITHER JOHN DEERE NOR ANY AUTHORIZED JOHN DEERE ENGINE DISTRIBUTOR, DEALER, OR REPAIR FACILITY OR ANY COMPANY AFFILIATED WITH JOHN DEERE WILL BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES.

Emission_CI_EPA (18Dec09)

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DX,EMISSIONS,EPA -19-12DEC12-2/2

CARB Non-road Emissions Control Warranty Statement—Compression Ignition

Emissions Control Warranty Statement 2013 through 2015

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JOHN DEERE

CALIFORNIA EMISSIONS CONTROL WARRANTY STATEMENT
YOUR WARRANTY RIGHTS AND OBLIGATIONS

To determine if the John Deere engine qualifies for the additional warranties set forth below, look for the “Emission Control Information” label located on the engine. If the engine is operated in the United States or Canada and the engine label states: “This engine complies with US EPA regulations for nonroad and stationary diesel engines”, or “This engine complies with US EPA regulations for stationary emergency diesel engines”, refer to the “U.S. and Canada Emission Control Warranty Statement.” If the engine is operated in California, and the engine label states: “This engine complies with US EPA and CARB regulations for nonroad diesel engines” also refer to the “California Emissions Control Warranty Statement.”

Warranties stated on this certificate refer only to emissions-related parts and components of your engine. The complete engine warranty, less emission-related parts and components, is provided separately. If you have any questions about your warranty rights and responsibilities, you should contact John Deere at 1-319-292-5400.

CALIFORNIA EMISSIONS CONTROL WARRANTY STATEMENT:

The California Air Resources Board (CARB) is pleased to explain the emission-control system warranty on 2013 through 2015 off-road diesel engines. In California, new off-road engines must be designed, built and equipped to meet the State’s stringent anti-smog standards. John Deere must warrant the emission control system on your engine for the periods of time listed below provided there has been no abuse, neglect or improper maintenance of your engine.

Your emission control system may include parts such as the fuel injection system and the air induction system. Also included may be hoses, belts, connectors and other emission-related assemblies.

John Deere warrants to the ultimate purchaser and each subsequent purchaser that this off-road diesel engine was designed, built, and equipped so as to conform at the time of sale with all applicable regulations adopted by CARB and is free from defects in materials and workmanship which would cause the failure of a warranted part to be identical in all material respects to the part as described in John Deere's application for certification for a period of five years from the date the engine is delivered to an ultimate purchaser or 3,000 hours of operation, whichever occurs first for all engines rated at 19 kW and greater. In the absence of a device to measure hours of use, the engine shall be warranted for a period of five years.

EMISSIONS WARRANTY EXCLUSIONS:

John Deere may deny warranty claims for failures caused by the use of an add-on or modified part which has not been exempted by the CARB. A modified part is an aftermarket part intended to replace an original emission-related part which is not functionally identical in all respects and which in any way affects emissions. An add-on part is any aftermarket part which is not a modified part or a replacement part.

In no event will John Deere, any authorized engine distributor, dealer, or repair facility, or any company affiliated with John Deere be liable for incidental or consequential damage.

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JOHN DEERE'S WARRANTY RESPONSIBILITY:

Where a warrantable condition exists, John Deere will repair or replace, as it elects, your off-road diesel engine at no cost to you, including diagnosis, parts or labor. Warranty coverage is subject to the limitations and exclusions set forth herein. The off-road diesel engine is warranted for a period of five years from the date the engine is delivered to an ultimate purchaser or 3,000 hours of operation, whichever occurs first. The following are emissions-related parts:

Air Induction System

- Intake manifold
- Turbocharger
- Charge air cooler

Fuel Metering system

- Fuel injection system

Exhaust Gas Recirculation

- EGR valve

Catalyst or Thermal Reactor Systems

- Catalytic converter
- Exhaust manifold

Emission control labels

Particulate Controls

- Any device used to capture particulate emissions
- Any device used in the regeneration of the capturing system
- Enclosures and manifolding
- Smoke Puff Limiters

Positive Crankcase Ventilation (PCV) System

- PCV valve
- Oil filler cap

Advanced Oxides of Nitrogen (NOx) Controls

- NOx absorbers and catalysts

SCR systems and urea containers/dispensing systems

Miscellaneous Items used in Above Systems

- Electronic control units, sensors, actuators, wiring harnesses, hoses, connectors, clamps, fittings, gasket, mounting hardware

Any warranted emissions-related part scheduled for replacement as required maintenance is warranted by John Deere for the period of time prior to the first scheduled replacement point for the part. Any warranted emissions-related part not scheduled for replacement as required maintenance or scheduled only for regular inspection is warranted by John Deere for the stated warranty period.

OWNER'S WARRANTY RESPONSIBILITIES:

As the off-road diesel engine owner you are responsible for the performance of the required maintenance listed in your Operator's Manual. John Deere recommends that the owner retain all receipts covering maintenance on the off-road diesel engine, but John Deere cannot deny warranty solely for the lack of receipts or for the owner's failure to ensure the performance of all scheduled maintenance. However, as the off-road diesel engine owner, you should be aware that John Deere may deny you warranty coverage if your off-road diesel engine or a part has failed due to abuse, neglect, improper maintenance or unapproved modifications.

The off-road diesel engine is designed to operate on diesel fuel as specified in the Fuels, Lubricants and Coolants section in the Operators Manual. Use of any other fuel may result in the engine no longer operating in compliance with applicable emissions requirements.

The owner is responsible for initiating the warranty process, and should present the machine to the nearest authorized John Deere dealer as soon as a problem is suspected. The warranty repairs should be completed by the authorized John Deere dealer as quickly as possible.

Emissions regulations require the customer to bring the unit to an authorized servicing dealer when warranty service is required. As a result, John Deere is NOT liable for travel or mileage on emissions warranty service calls.

Emission_CI_CARB (19Sep12)

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DX,EMISSIONS,CARB -19-01AUG14-2/8

Emissions Control Warranty Statement 2013 through 2015

DXLOGOV1 —UN—28APR09

JOHN DEERE

CALIFORNIA EMISSIONS CONTROL WARRANTY STATEMENT
YOUR WARRANTY RIGHTS AND OBLIGATIONS

To determine if the John Deere engine qualifies for the additional warranties set forth below, look for the “Emission Control Information” label located on the engine. If the engine is operated in the United States or Canada and the engine label states: “This engine complies with US EPA regulations for nonroad and stationary diesel engines”, or “This engine complies with US EPA regulations for stationary emergency diesel engines”, refer to the “U.S. and Canada Emission Control Warranty Statement.” If the engine is operated in California, and the engine label states: “This engine complies with US EPA and CARB regulations for nonroad diesel engines” also refer to the “California Emissions Control Warranty Statement.”

Warranties stated on this certificate refer only to emissions-related parts and components of your engine. The complete engine warranty, less emission-related parts and components, is provided separately. If you have any questions about your warranty rights and responsibilities, you should contact John Deere at 1-319-292-5400.

CALIFORNIA EMISSIONS CONTROL WARRANTY STATEMENT:

The California Air Resources Board (CARB) is pleased to explain the emission-control system warranty on 2013 through 2015 off-road diesel engines. In California, new off-road engines must be designed, built and equipped to meet the State’s stringent anti-smog standards. John Deere must warrant the emission control system on your engine for the periods of time listed below provided there has been no abuse, neglect or improper maintenance of your engine.

Your emission control system may include parts such as the fuel injection system and the air induction system. Also included may be hoses, belts, connectors and other emission-related assemblies.

John Deere warrants to the ultimate purchaser and each subsequent purchaser that this off-road diesel engine was designed, built, and equipped so as to conform at the time of sale with all applicable regulations adopted by CARB and is free from defects in materials and workmanship which would cause the failure of a warranted part to be identical in all material respects to the part as described in John Deere's application for certification for a period of five years from the date the engine is delivered to an ultimate purchaser or 3,000 hours of operation, whichever occurs first for all engines rated at 19 kW and greater. In the absence of a device to measure hours of use, the engine shall be warranted for a period of five years.

EMISSIONS WARRANTY EXCLUSIONS:

John Deere may deny warranty claims for failures caused by the use of an add-on or modified part which has not been exempted by the CARB. A modified part is an aftermarket part intended to replace an original emission-related part which is not functionally identical in all respects and which in any way affects emissions. An add-on part is any aftermarket part which is not a modified part or a replacement part.

In no event will John Deere, any authorized engine distributor, dealer, or repair facility, or any company affiliated with John Deere be liable for incidental or consequential damage.

RG25841 —UN—19MAY14

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DX,EMISSIONS,CARB -19-01AUG14-3/8

JOHN DEERE'S WARRANTY RESPONSIBILITY:

Where a warrantable condition exists, John Deere will repair or replace, as it elects, your off-road diesel engine at no cost to you, including diagnosis, parts or labor. Warranty coverage is subject to the limitations and exclusions set forth herein. The off-road diesel engine is warranted for a period of five years from the date the engine is delivered to an ultimate purchaser or 3,000 hours of operation, whichever occurs first. The following are emissions-related parts:

Air Induction System

- Intake manifold
- Turbocharger
- Charge air cooler

Fuel Metering system

- Fuel injection system

Exhaust Gas Recirculation

- EGR valve

Catalyst or Thermal Reactor Systems

- Catalytic converter
- Exhaust manifold

Emission control labels

Particulate Controls

- Any device used to capture particulate emissions
- Any device used in the regeneration of the capturing system
- Enclosures and manifolding
- Smoke Puff Limiters

Positive Crankcase Ventilation (PCV) System

- PCV valve
- Oil filler cap

Advanced Oxides of Nitrogen (NOx) Controls

- NOx absorbers and catalysts

SCR systems and urea containers/dispensing systems

Miscellaneous Items used in Above Systems

- Electronic control units, sensors, actuators, wiring harnesses, hoses, connectors, clamps, fittings, gasket, mounting hardware

Any warranted emissions-related part scheduled for replacement as required maintenance is warranted by John Deere for the period of time prior to the first scheduled replacement point for the part. Any warranted emissions-related part not scheduled for replacement as required maintenance or scheduled only for regular inspection is warranted by John Deere for the stated warranty period.

OWNER'S WARRANTY RESPONSIBILITIES:

As the off-road diesel engine owner you are responsible for the performance of the required maintenance listed in your Operator's Manual. John Deere recommends that the owner retain all receipts covering maintenance on the off-road diesel engine, but John Deere cannot deny warranty solely for the lack of receipts or for the owner's failure to ensure the performance of all scheduled maintenance. However, as the off-road diesel engine owner, you should be aware that John Deere may deny you warranty coverage if your off-road diesel engine or a part has failed due to abuse, neglect, improper maintenance or unapproved modifications.

The off-road diesel engine is designed to operate on diesel fuel as specified in the Fuels, Lubricants and Coolants section in the Operators Manual. Use of any other fuel may result in the engine no longer operating in compliance with applicable emissions requirements.

The owner is responsible for initiating the warranty process, and should present the machine to the nearest authorized John Deere dealer as soon as a problem is suspected. The warranty repairs should be completed by the authorized John Deere dealer as quickly as possible.

Emissions regulations require the customer to bring the unit to an authorized servicing dealer when warranty service is required. As a result, John Deere is NOT liable for travel or mileage on emissions warranty service calls.

Emission_CI_CARB (19Sep12)

TS1723 —UN—15JUL13

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DX,EMISSIONS,CARB -19-01AUG14-4/8

Emissions Control Warranty Statement 2016 through 2018

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JOHN DEERE

CALIFORNIA EMISSIONS CONTROL WARRANTY STATEMENT
YOUR WARRANTY RIGHTS AND OBLIGATIONS

To determine if the John Deere engine qualifies for the additional warranties set forth below, look for the “Emission Control Information” label located on the engine. If the engine is operated in the United States or Canada and the engine label states: “This engine complies with US EPA regulations for nonroad and stationary diesel engines”, or “This engine complies with US EPA regulations for stationary emergency diesel engines”, refer to the “U.S. and Canada Emission Control Warranty Statement.” If the engine is operated in California, and the engine label states: “This engine complies with US EPA and CARB regulations for nonroad diesel engines” also refer to the “California Emissions Control Warranty Statement.”

Warranties stated on this certificate refer only to emissions-related parts and components of your engine. The complete engine warranty, less emission-related parts and components, is provided separately. If you have any questions about your warranty rights and responsibilities, you should contact John Deere at 1-319-292-5400.

CALIFORNIA EMISSIONS CONTROL WARRANTY STATEMENT:

The California Air Resources Board (CARB) is pleased to explain the emission-control system warranty on 2016 through 2018 off-road diesel engines. In California, new off-road engines must be designed, built and equipped to meet the State’s stringent anti-smog standards. John Deere must warrant the emission control system on your engine for the periods of time listed below provided there has been no abuse, neglect or improper maintenance of your engine.

Your emission control system may include parts such as the fuel injection system and the air induction system. Also included may be hoses, belts, connectors and other emission-related assemblies.

John Deere warrants to the ultimate purchaser and each subsequent purchaser that this off-road diesel engine was designed, built, and equipped so as to conform at the time of sale with all applicable regulations adopted by CARB and is free from defects in materials and workmanship which would cause the failure of a warranted part to be identical in all material respects to the part as described in John Deere's application for certification for a period of five years from the date the engine is delivered to an ultimate purchaser or 3,000 hours of operation, whichever occurs first for all engines rated at 19 kW and greater. In the absence of a device to measure hours of use, the engine shall be warranted for a period of five years.

EMISSIONS WARRANTY EXCLUSIONS:

John Deere may deny warranty claims for failures caused by the use of an add-on or modified part which has not been exempted by the CARB. A modified part is an aftermarket part intended to replace an original emission-related part which is not functionally identical in all respects and which in any way affects emissions. An add-on part is any aftermarket part which is not a modified part or a replacement part.

In no event will John Deere, any authorized engine distributor, dealer, or repair facility, or any company affiliated with John Deere be liable for incidental or consequential damage.

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DX,EMISSIONS,CARB -19-01AUG14-5/8

JOHN DEERE'S WARRANTY RESPONSIBILITY:

Where a warrantable condition exists, John Deere will repair or replace, as it elects, your off-road diesel engine at no cost to you, including diagnosis, parts or labor. Warranty coverage is subject to the limitations and exclusions set forth herein. The off-road diesel engine is warranted for a period of five years from the date the engine is delivered to an ultimate purchaser or 3,000 hours of operation, whichever occurs first. The following are emissions-related parts:

Air Induction System

- Intake manifold
- Turbocharger
- Charge air cooler

Fuel Metering system

- Fuel injection system

Exhaust Gas Recirculation

- EGR valve

Catalyst or Thermal Reactor Systems

- Catalytic converter
- Exhaust manifold

Emission control labels

Particulate Controls

- Any device used to capture particulate emissions
- Any device used in the regeneration of the capturing system
- Enclosures and manifolding
- Smoke Puff Limiters

Positive Crankcase Ventilation (PCV) System

- PCV valve
- Oil filler cap

Advanced Oxides of Nitrogen (NOx) Controls

- NOx absorbers and catalysts

SCR systems and urea containers/dispensing systems

Miscellaneous Items used in Above Systems

- Electronic control units, sensors, actuators, wiring harnesses, hoses, connectors, clamps, fittings, gasket, mounting hardware

Any warranted emissions-related part scheduled for replacement as required maintenance is warranted by John Deere for the period of time prior to the first scheduled replacement point for the part. Any warranted emissions-related part not scheduled for replacement as required maintenance or scheduled only for regular inspection is warranted by John Deere for the stated warranty period.

OWNER'S WARRANTY RESPONSIBILITIES:

As the off-road diesel engine owner you are responsible for the performance of the required maintenance listed in your Operator's Manual. John Deere recommends that the owner retain all receipts covering maintenance on the off-road diesel engine, but John Deere cannot deny warranty solely for the lack of receipts or for the owner's failure to ensure the performance of all scheduled maintenance. However, as the off-road diesel engine owner, you should be aware that John Deere may deny you warranty coverage if your off-road diesel engine or a part has failed due to abuse, neglect, improper maintenance or unapproved modifications.

The off-road diesel engine is designed to operate on diesel fuel as specified in the Fuels, Lubricants and Coolants section in the Operators Manual. Use of any other fuel may result in the engine no longer operating in compliance with applicable emissions requirements.

The owner is responsible for initiating the warranty process, and should present the machine to the nearest authorized John Deere dealer as soon as a problem is suspected. The warranty repairs should be completed by the authorized John Deere dealer as quickly as possible.

Emissions regulations require the customer to bring the unit to an authorized servicing dealer when warranty service is required. As a result, John Deere is NOT liable for travel or mileage on emissions warranty service calls.

Emission_CI_CARB (13Jun14)

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Emissions Control Warranty Statement 2016 through 2018

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JOHN DEERE

CALIFORNIA EMISSIONS CONTROL WARRANTY STATEMENT
YOUR WARRANTY RIGHTS AND OBLIGATIONS

To determine if the John Deere engine qualifies for the additional warranties set forth below, look for the “Emission Control Information” label located on the engine. If the engine is operated in the United States or Canada and the engine label states: “This engine complies with US EPA regulations for nonroad and stationary diesel engines”, or “This engine complies with US EPA regulations for stationary emergency diesel engines”, refer to the “U.S. and Canada Emission Control Warranty Statement.” If the engine is operated in California, and the engine label states: “This engine complies with US EPA and CARB regulations for nonroad diesel engines” also refer to the “California Emissions Control Warranty Statement.”

Warranties stated on this certificate refer only to emissions-related parts and components of your engine. The complete engine warranty, less emission-related parts and components, is provided separately. If you have any questions about your warranty rights and responsibilities, you should contact John Deere at 1-319-292-5400.

CALIFORNIA EMISSIONS CONTROL WARRANTY STATEMENT:

The California Air Resources Board (CARB) is pleased to explain the emission-control system warranty on 2016 through 2018 off-road diesel engines. In California, new off-road engines must be designed, built and equipped to meet the State’s stringent anti-smog standards. John Deere must warrant the emission control system on your engine for the periods of time listed below provided there has been no abuse, neglect or improper maintenance of your engine.

Your emission control system may include parts such as the fuel injection system and the air induction system. Also included may be hoses, belts, connectors and other emission-related assemblies.

John Deere warrants to the ultimate purchaser and each subsequent purchaser that this off-road diesel engine was designed, built, and equipped so as to conform at the time of sale with all applicable regulations adopted by CARB and is free from defects in materials and workmanship which would cause the failure of a warranted part to be identical in all material respects to the part as described in John Deere's application for certification for a period of five years from the date the engine is delivered to an ultimate purchaser or 3,000 hours of operation, whichever occurs first for all engines rated at 19 kW and greater. In the absence of a device to measure hours of use, the engine shall be warranted for a period of five years.

EMISSIONS WARRANTY EXCLUSIONS:

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In no event will John Deere, any authorized engine distributor, dealer, or repair facility, or any company affiliated with John Deere be liable for incidental or consequential damage.

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DX,EMISSIONS,CARB -19-01AUG14-7/8

JOHN DEERE'S WARRANTY RESPONSIBILITY:

Where a warrantable condition exists, John Deere will repair or replace, as it elects, your off-road diesel engine at no cost to you, including diagnosis, parts or labor. Warranty coverage is subject to the limitations and exclusions set forth herein. The off-road diesel engine is warranted for a period of five years from the date the engine is delivered to an ultimate purchaser or 3,000 hours of operation, whichever occurs first. The following are emissions-related parts:

Air Induction System

- Intake manifold
- Turbocharger
- Charge air cooler

Fuel Metering system

- Fuel injection system

Exhaust Gas Recirculation

- EGR valve

Catalyst or Thermal Reactor Systems

- Catalytic converter
- Exhaust manifold

Emission control labels

Particulate Controls

- Any device used to capture particulate emissions
- Any device used in the regeneration of the capturing system
- Enclosures and manifolding
- Smoke Puff Limiters

Positive Crankcase Ventilation (PCV) System

- PCV valve
- Oil filler cap

Advanced Oxides of Nitrogen (NOx) Controls

- NOx absorbers and catalysts

SCR systems and urea containers/dispensing systems

Miscellaneous Items used in Above Systems

- Electronic control units, sensors, actuators, wiring harnesses, hoses, connectors, clamps, fittings, gasket, mounting hardware

Any warranted emissions-related part scheduled for replacement as required maintenance is warranted by John Deere for the period of time prior to the first scheduled replacement point for the part. Any warranted emissions-related part not scheduled for replacement as required maintenance or scheduled only for regular inspection is warranted by John Deere for the stated warranty period.

OWNER'S WARRANTY RESPONSIBILITIES:

As the off-road diesel engine owner you are responsible for the performance of the required maintenance listed in your Operator's Manual. John Deere recommends that the owner retain all receipts covering maintenance on the off-road diesel engine, but John Deere cannot deny warranty solely for the lack of receipts or for the owner's failure to ensure the performance of all scheduled maintenance. However, as the off-road diesel engine owner, you should be aware that John Deere may deny you warranty coverage if your off-road diesel engine or a part has failed due to abuse, neglect, improper maintenance or unapproved modifications.

The off-road diesel engine is designed to operate on diesel fuel as specified in the Fuels, Lubricants and Coolants section in the Operators Manual. Use of any other fuel may result in the engine no longer operating in compliance with applicable emissions requirements.

The owner is responsible for initiating the warranty process, and should present the machine to the nearest authorized John Deere dealer as soon as a problem is suspected. The warranty repairs should be completed by the authorized John Deere dealer as quickly as possible.

Emissions regulations require the customer to bring the unit to an authorized servicing dealer when warranty service is required. As a result, John Deere is NOT liable for travel or mileage on emissions warranty service calls.

Emission_CI_CARB (13Jun14)

RG26036 —UN—24JUN14

DX,EMISSIONS,CARB -19-01AUG14-8/8

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T

U

V

W

Engine Registration

OEM Engine and Drivetrain Warranty Registration

Why registering your OEM engine or drivetrain product is a really smart idea:[1]

Get faster service. Registering your engine or drivetrain product gives us the information we need to meet your service needs promptly and completely.

Protect your investment. You'll be kept up-to-date on engine or drivetrain product updates.

Extend your warranty. You'll be given the option to extend your coverage before your standard warranty term expires.

Stay informed. Be the first to know about new products and money-saving offers from John Deere.

NOTE: A mail-in registration form is located at the back of this manual.

You're Covered

When you buy a John Deere engine or drivetrain product you aren't just buying pistons and crankshafts and gear drives. You're buying the ability to get work done. Without downtime, without worries, and without hassles. And you're buying the assurance that if you do need help, a strong support network will be there — ready to step in.

Confidence. That's what John Deere engines, John Deere drivetrains, and John Deere Warranties are all about.

Long durations. Warranties designed to give you confidence in your engine or drivetrain product.

Worldwide support. Get service when and where you need it. John Deere has 4,000+ service locations worldwide.

Genuine John Deere parts and service. Authorized service outlets will use only new or remanufactured parts or components furnished by John Deere.

Warranty Duration

[1]*Register your OEM engine or drivetrain product online and select an authorized John Deere service location. If available in your region, you'll receive information regarding new products and current money-saving offers from John Deere. Limit one money-saving offer per engine warranty registration. Not transferable. Not valid with any other offer. Offer ends 90 days from the date of issue. Some restrictions apply. See your John Deere service location for complete details.*

RG24614 —UN—21OCT13

Scan this code to register your OEM engine online now and learn of current money-saving offers available to you.[1] You can also visit us directly at JohnDeere.com/warranty.

Equipment operators can't afford downtime or unexpected repairs. That's why we offer a 2-year/2,000-hour warranty, with unlimited hours in the first year, on our OEM industrial and marine engines. This warranty takes effect the date that the engine is delivered to the first retail purchaser. In addition, extended warranties are available under certain conditions. John Deere offers a variety of purchased warranties to extend the warranty period for your engine. You'll be given the option to extend your coverage before your standard warranty term expires. Be sure to register your engine or drivetrain product and take full advantage of the John Deere service and support network.

Obtaining Warranty Service

Warranty service must be requested through an authorized John Deere service outlet before the expiration of the warranty. Evidence of the engine's or drivetrain product's delivery date to the first retail purchaser must be presented when requesting warranty service. Authorized service outlets include:

- John Deere distributor
- John Deere OEM service dealer
- John Deere equipment dealer
- John Deere marine dealer

Worldwide Support Network

Visit JohnDeere.com/dealer to find the authorized engine or drivetrain service location nearest you. For complete warranty details visit JohnDeere.com/warrantystatements to view, download, or print the warranty statement for your engine or drivetrain product.

ZE59858,000025E -19-02DEC13-1/1

Mail-In Registration

OEM Engine and Drivetrain Warranty Registration

Register your OEM engine or drivetrain product online at JohnDeere.com/warranty or fax this from to John Deere at 319-292-5844.

PURCHASER INFORMATION*: Type or print in BLOCK letters

Company Name: _____

First Name: _____

Last Name: _____

Email: _____

Telephone: _____

Country: _____

Street Address: _____

City / State / Prov: _____

Zip / Postal Code: _____

PURCHASER TYPE:

- □ Commercial
- □ Federal Government
- □ State / Province
- □ County
- □ City / Town / Village
- □ Armed Forces
- □ National Account
- □ Residential
- □ Farm
- □ Very Large Fleet (>74)
- □ Large Fleet (25-74)
- □ Medium Fleet (10-24)
- □ Small Fleet (<10)

EQUIPMENT TYPE:

- □ Agriculture
- □ Earth Moving
- □ Forestry
- □ Generator Set (Industrial / Marine)
- □ Industrial Moveable
- □ Marine Propulsion
- □ Material Handling
- □ Municipal / Utility Commercial
- □ On-Highway
- □ Road and Miscellaneous Construction
- □ Rail Maintenance
- □ Other

Purchase's Signature: _____

PRODUCT AND EQUIPMENT INFORMATION

Product Serial Number: _____

Date Delivered: _____

Amount of Use: (Hours / Miles) _____

New or Used: _____

* Use of Information: All personal information obtained with this registration is subject to the John Deere privacy policy. It will be used for the purpose of offer fulfillment and may be used to provide you with additional information about John Deere products and services. For complete details on your privacy rights and to obtain a copy of the John Deere Privacy Statement, visit www.JohnDeere.com/privacy.

Cut out to mail in registration card

BL90236,0000028 -19-19NOV13-1/1

Mail-In Registration

MAILING INFORMATION
(Return Address)

_____
_____
_____
_____

John Deere Power Systems
P.O. Box 5100
Waterloo, IA 50704-5100
USA

BL90236,0000029 -19-19NOV13-1/1

CONTENTS

SAUER SUNDSTRAND

Series 90

Axial Piston

Pumps and Motors

Service Manual

1. Introduction

1.1 Use of This Manual

This manual includes information for the normal operation, maintenance, and servicing of the Series 90 family of hydrostatic pumps and motors. The manual includes the description of the units and their individual components, troubleshooting information, adjustment instructions, and minor repair procedures. Unit warranty obligations should not be affected if maintenance, adjustment, and minor repairs are performed according to the procedures described in this manual.

Many service and adjustment activities can be performed without removing the unit from the vehicle or machine. However, adequate access to the unit must be available, and the unit must be thoroughly cleaned before beginning maintenance, adjustment, or repair activities. Since dirt and contamination are the greatest enemies of any type of hydraulic equipment, cleanliness requirements must be strictly adhered to. This is especially important when changing the system filter and during adjustment and repair activities.

A worldwide network of Sauer-Sundstrand Authorized Service Centers is available should repairs be needed. Contact any Sauer-Sundstrand Authorized Service Center for details. A list of all Service Centers can be found in bulletin BLN-2-40527, or in brochure SAW (Ident. No. 698266).

1.2 Safety Precautions

Observe the following safety precautions when using and servicing hydrostatic products.

Loss of Hydrostatic Braking Ability

WARNING
When Series 90 units are used in vehicular hydrostatic drive systems, the loss of hydrostatic drive line power in any mode of operation (e.g. acceleration, deceleration or "neutral" mode) may cause a loss of hydrostatic braking capacity. A braking system which is independent of the hydrostatic transmission must, therefore, be provided which is adequate to stop and hold the system should the condition develop.

Disable Work Function

WARNING
Certain service procedures may require the vehicle/machine to be disabled (wheels raised off the ground, work function disconnected, etc.) while performing them in order to prevent injury to the technician and bystanders.

Fluid Under High Pressure

WARNING
Use caution when dealing with hydraulic fluid under pressure. Escaping hydraulic fluid under pressure can have sufficient force to penetrate your skin causing serious injury. This fluid may also be hot enough to burn. Serious infection or reactions can develop if proper medical treatment is not administered immediately.

Flammable Cleaning Solvents

WARNING
Some cleaning solvents are flammable. To avoid possible fire, do not use cleaning solvents in an area where a source of ignition may be present.

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2. Functional Description

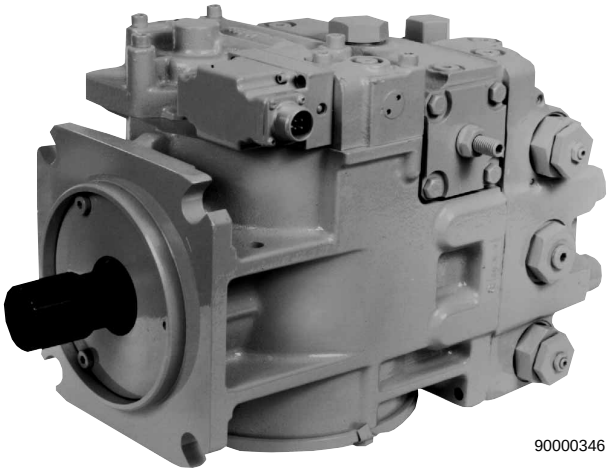
This section describes the operation of pumps, motors, and their various serviceable features. It is a useful reference for readers unfamiliar with the functioning of a specific system.

2.1 General Description and Cross Sectional Views

2.1.1 Variable Displacement Pumps

The Variable Displacement Pump (PV) is designed to convert an input torque into hydraulic power. The input shaft turns the pump cylinder which contains a ring of pistons. The pistons run against a tilted plate, called the swashplate. This causes the pistons to compress the hydraulic fluid which imparts the input energy into the hydraulic fluid. The high pressure fluid is then ported out to provide power to a remote function.

The swashplate angle can be varied by the control piston. Altering the swashplate angle varies the displacement of fluid in a given revolution of the input shaft. A larger angle causes greater displacement which yields greater output torque for a given input. A smaller angle reduces the displacement per revolution and yields greater speed for a given input.



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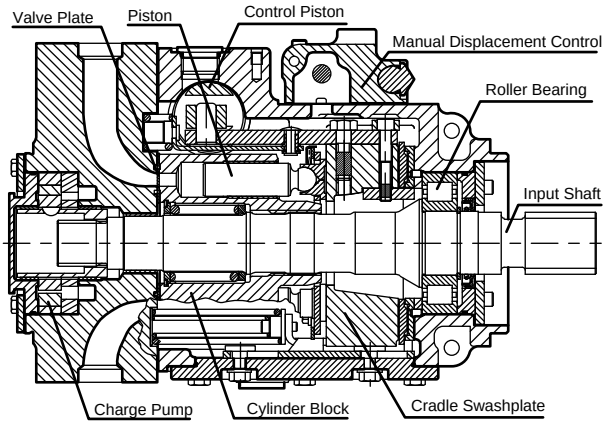
Series 90 Variable Displacement Pump (PV)



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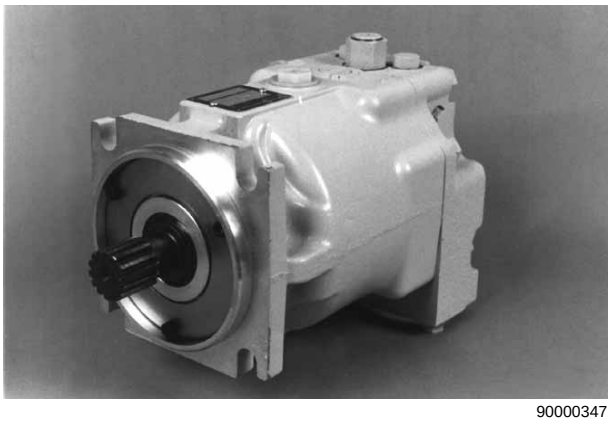
Series 90 PV Cross Section

2.1.2 Fixed Displacement Motor

The Fixed Displacement Motor (MF) is designed to convert an input of hydraulic power into an output torque. It operates in the reverse manner of the pump. The high pressure hydraulic fluid enters through the input port. The fluid pressure builds behind the pistons causing them to move down the swashplate (the path of least resistance). As the piston returns up the swashplate again, the fluid is allowed to exit through the exit port. The spinning pistons are housed in a cylinder which is connected to the output shaft. The output torque can be applied to a mechanical function.



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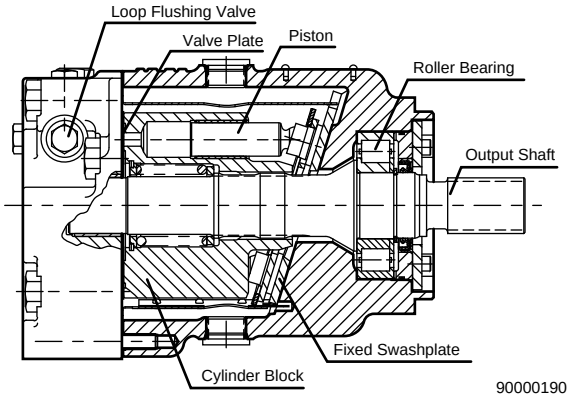
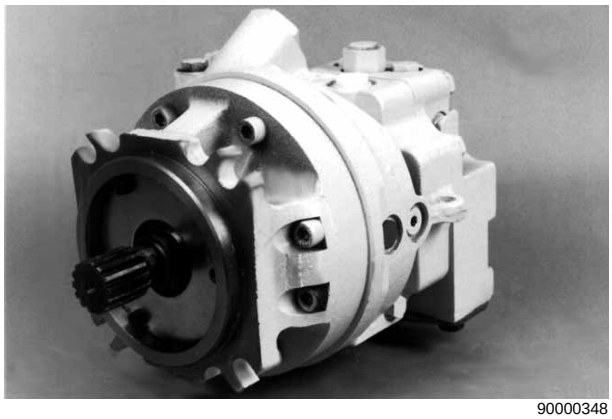
Series 90 Fixed Displacement Motor (MF)



Series 90 MF Cross Section

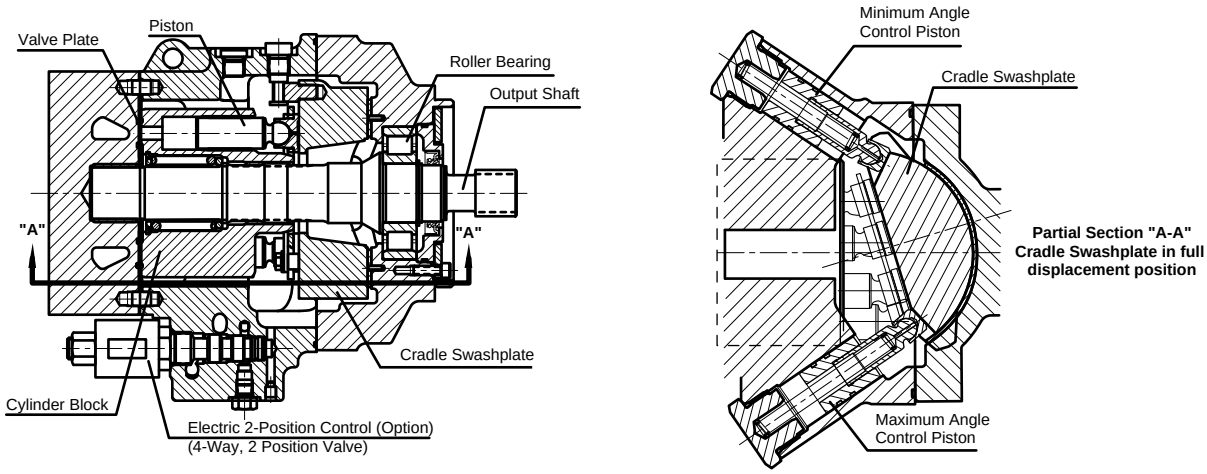
In the Fixed Displacement Motor the "swashplate" is fixed, so any variation in motor speed and torque must be made by the input mechanism, i.e. the pump.



Series 90 Variable Displacement Motor (MV)

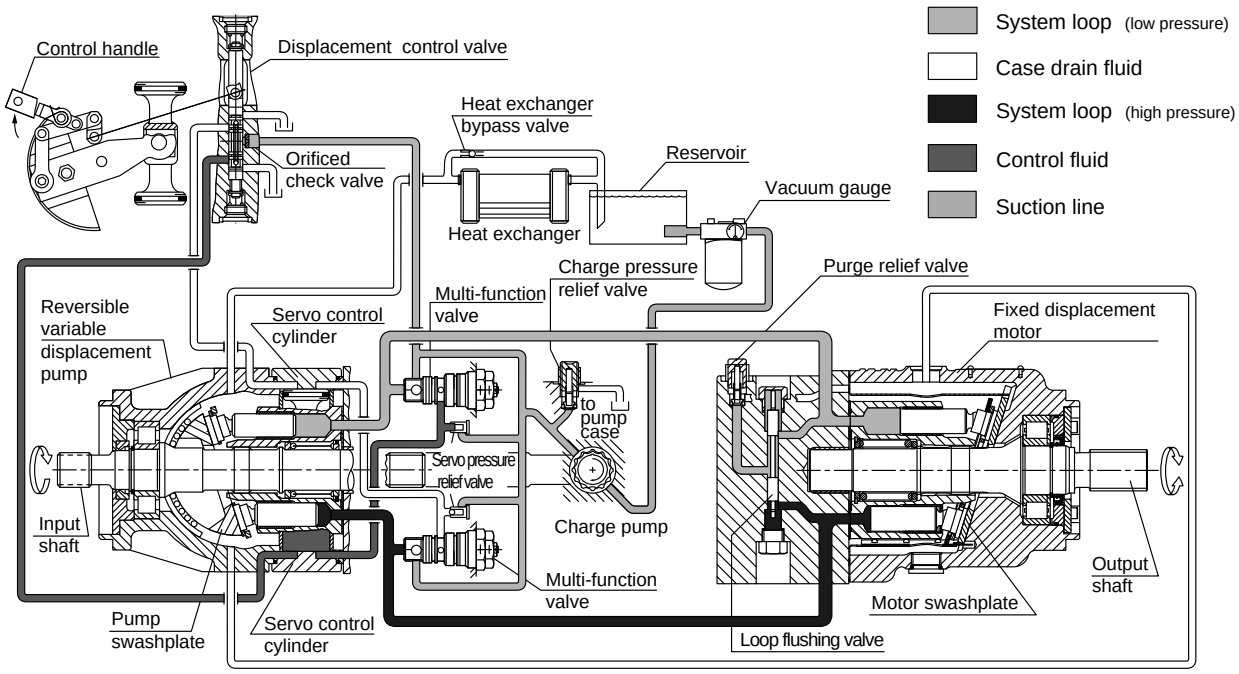
2.1.3 Variable Displacement Motor

The Variable Displacement Motor (MV) operates in the same manner as the fixed motor. However, its swashplate is not fixed; it can be switched between minimum and maximum angle to amplify torque or speed like the Variable Displacement Pump.



Series 90 MV Cross Section

2.2 The System Circuit



90000800

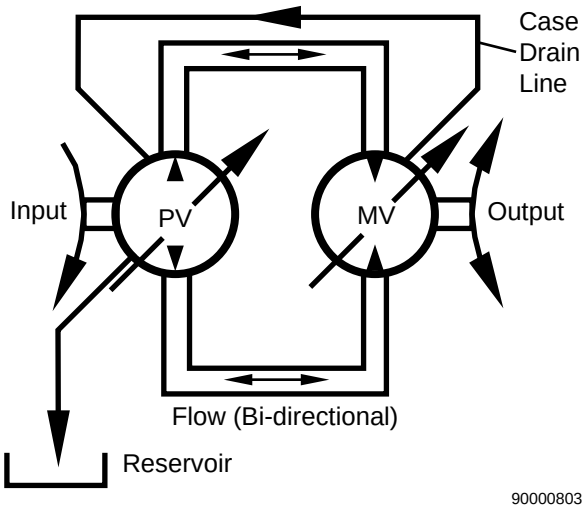
Circuit Diagram for Series 90 PV and Series 90 MF

The Basic Closed Circuit

The main ports of the pump are connected by hydraulic lines to the main ports of the motor. Fluid flows, in either direction, from the pump to the motor then back to the pump in this closed circuit. Either of the hydraulic lines can be under high pressure. The position of the pump swashplate determines which line is high pressure as well as the direction of fluid flow.

Case Drain and Heat Exchanger

The pump and motor require case drain lines to remove hot fluid from the system. The motor should be drained from its topmost drain port to ensure the case remains full of fluid. The motor case drain can then be connected to the lower drain port on the pump housing and out the top most port. A heat exchanger, with a bypass valve, is required to cool the case drain fluid before it returns to the reservoir.



90000803

Basic Closed Circuit

2.3 Common Features of Pumps and Motors

2.3.1 End Caps and Shafts

Series 90 pumps and motors can be supplied with a variety of end caps and shafts to allow for almost any configuration. For pumps, end caps are available with system ports on either side ("side ports") or both ports on one side ("twin ports"). Motors have end caps with ports on the face of the end cap ("axial ports") or both ports on one side ("twin ports"). See the Series 90 Technical Information manuals (BLN-10029 and BLN-10030) or the Series 90 Price Book (BLN-2-40588) for information on available options. **Removing the end cap will void the warranty on a Series 90 pump or motor.**

2.3.2 Speed Sensors

An optional speed sensor can be installed on Series 90 pumps and motors to provide unit speed information. The sensor reads a magnetic ring wrapped about the unit's cylinder. See Sec. 4 to locate the speed sensor port. See Sec. 8.4 and 9.6 to adjust and install the sensor.

90000810

Speed Sensor

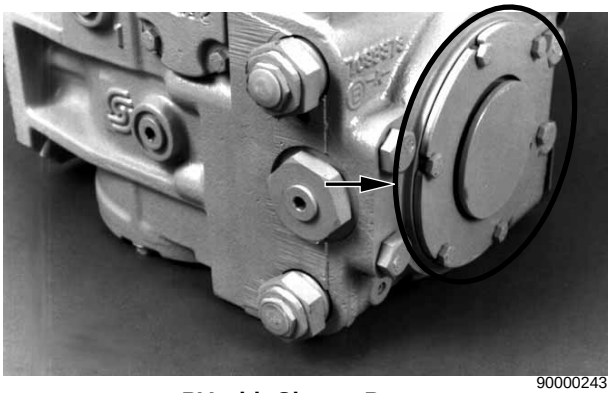
2.4 Pump Features

2.4.1 Charge Pump

The charge pump is necessary to supply cool fluid to the system, to maintain positive pressure in the main system loop, to provide pressure to operate the control system, and to make up for internal leakage. Charge pressure must be at its specified pressure under all conditions of driving and braking to prevent damage to the transmission.

The charge pump is a fixed-displacement, gerotor type pump installed in the variable displacement pump and driven off the main pump shaft. Charge pressure is limited by a relief valve (Sec. 2.4.2).

The standard charge pump will be satisfactory for most applications. However, if the charge pump sizes available for the given main pump size are not adequate, a gear pump may be mounted to the auxiliary mounting pad (Sec. 2.4.8) and supply the required additional charge flow. For repairs to the charge pump see Sec. 9.2.4.



90000243

PV with Charge Pump

90000349

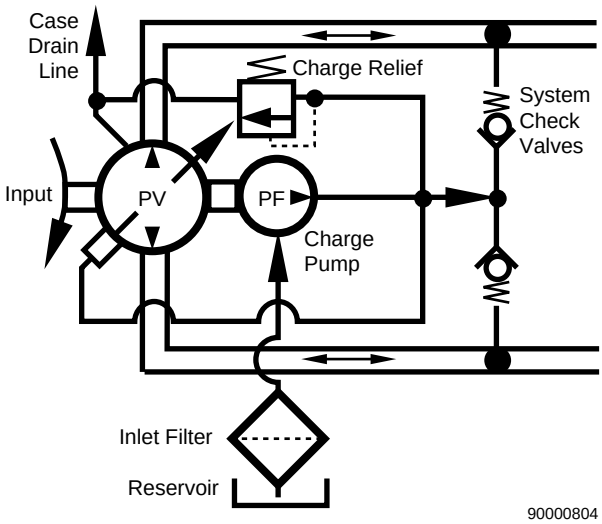
Charge Pump Components

2.4.2 Charge Relief Valve

The charge relief valve on the pump serves to maintain charge pressure at a designated level. A direct-acting poppet valve relieves charge pressure whenever it surpasses a certain level. This level is nominally set referencing case pressure at 1775 rpm. This nominal setting assumes the pump is in neutral (zero flow); in forward or reverse charge pressure will be lower. The charge relief valve setting is specified on the model code of the pump (Sec. 8.1.1). For repairs to the pump charge relief valve see Sec. 9.2.3.

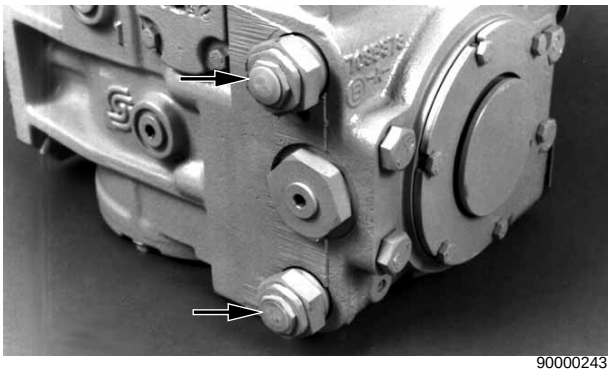
2.4.3 System Check Valves

The system check valves allow pressurized flow from the charge pump to enter the low pressure side of the loop whenever system pressure dips below a certain level. This is needed as the pump will generally lose system pressure due to leakage and other factors. Since the pump can operate in either direction, two system check valves are used to direct the charge supply into the low pressure lines. The system check valves are poppet valves located in the multi-function valve assembly (next section).



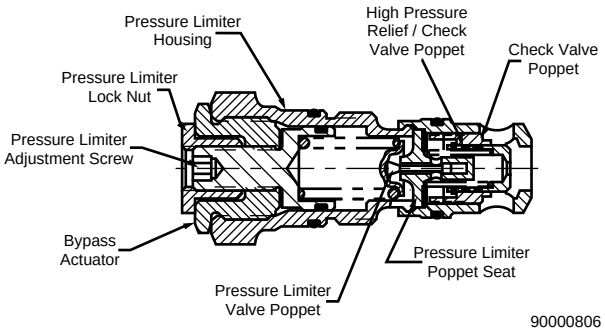
90000804

Pump Charge System



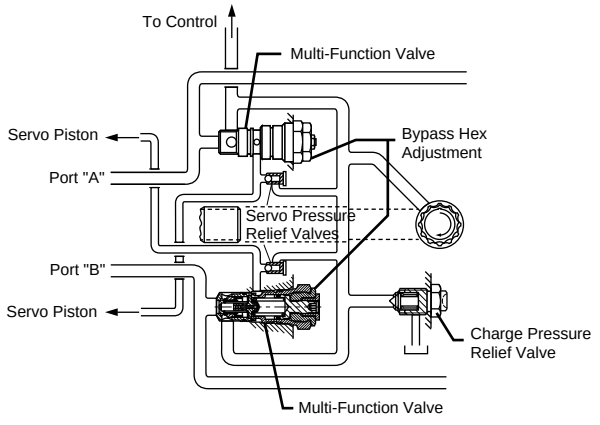
90000243

PV showing location of Multi-Function Valves



90000806

Cross Section of Multi-Function Valve



90000801

Circuit Diagram Showing Pressure Control Mechanisms

2.4.4 Multi-Function Valves

All Series 90 pumps include two multi-function valves. The multi-function valve incorporates the system check valve, the pressure limiter valve, the high pressure relief valve, and the bypass valve in a replaceable cartridge. These functions are described separately. There are two multi-function valve cartridges in each Series 90 pump to handle functions in either direction. See Secs. 8.1.2 and 9.2.1 for adjustments and repairs.

NOTE: Some multi-function valves do not include a pressure limiter valve.

2.4.5 Pressure Limiter and High Pressure Relief Valves

Series 90 pumps are designed with a sequenced pressure limiting system and high pressure relief valves. When the preset pressure is reached, the pressure limiter system acts to rapidly destroke the pump so as to limit the system pressure. For unusually rapid load application, the high pressure relief valve acts to immediately limit system pressure by cross-porting system flow to the low pressure side of the loop. The pressure limiter valve acts as the pilot for the high pressure relief valve spool. The high pressure relief valve is sequenced to operate at approximately 35 bar (500 psi) above the level that initiates the pressure limiter valve.

Both the pressure limiter sensing valves and relief valves are built into the multi-function valves (see above).

NOTE: For some applications, such as dual path vehicles, the pressure limiter function may be defeated so that only the high pressure relief valve function remains.

2.4.6 Bypass Valves

The bypass valves ("tow") can be operated when it is desired to move the vehicle or mechanical function when the pump is not running. The valve is opened by manually resetting the valve position (Sec. 8.1.3).

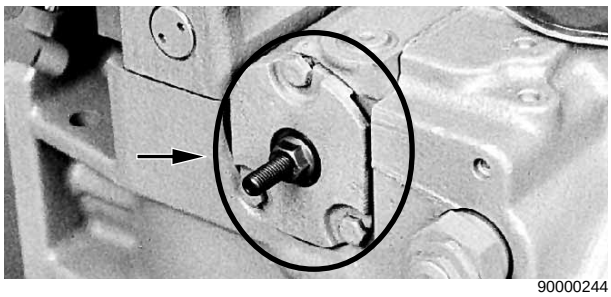
The bypass valves are built into the multi-function valves (see above).

2.4.7 Displacement Limiters

Series 90 pumps sizes 042 - 250 are designed for optional mechanical displacement (stroke) limiters. The maximum displacement of the pump can be limited in either direction.

The setting can be set as low as 0° in either direction.

For instructions on adjustment see Sec. 8.1.5.

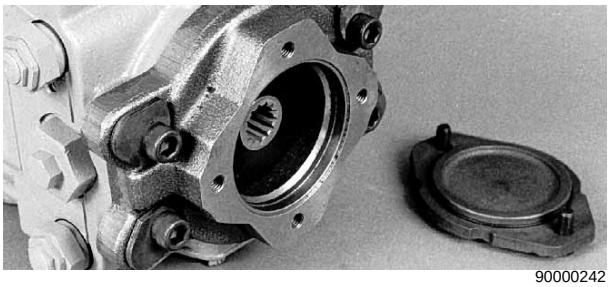


90000244

PV with Displacement Limiters

2.4.8 Auxiliary Mounting Pads

Auxiliary mounting pads are available on all Series 90 pumps. SAE A through E and H mounts are available (availability varies by pump size). This pad is used for mounting auxiliary hydraulic pumps and for mounting additional Series 90 pumps to make tandem pumps. The pads allow for full through-torque capability.



90000242

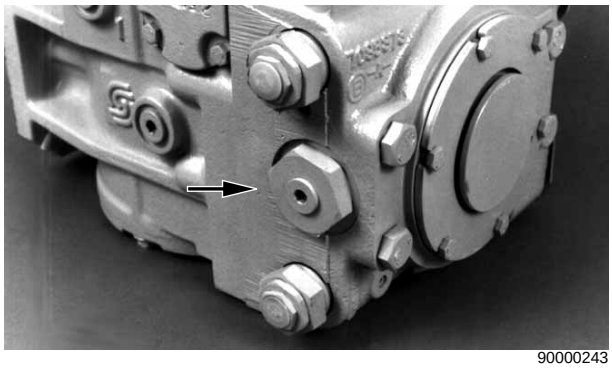
PV with Auxiliary Mounting Pad

2.4.9 Filtration Options

All Series 90 pumps are available with provisions for either suction or charge pressure filtration (integral or remote mounted) to filter the fluid entering the charge circuit. (See Sec. 6 for more information.)

Suction Filtration

The suction filter is placed in the circuit between the reservoir and the inlet to the charge pump. When suction filtration is used, a reducer fitting is placed in the charge pressure gauge port (M3). Filtration devices of this type are provided by the user.



90000243

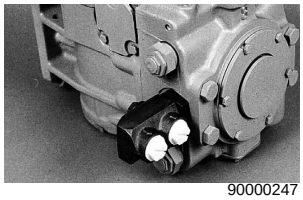
PV with Suction Filtration
(No filtration device attached)

Charge Pressure Filtration

The pressure filter may be integrally mounted directly on the pump or a filter may be remotely mounted for ease of servicing.

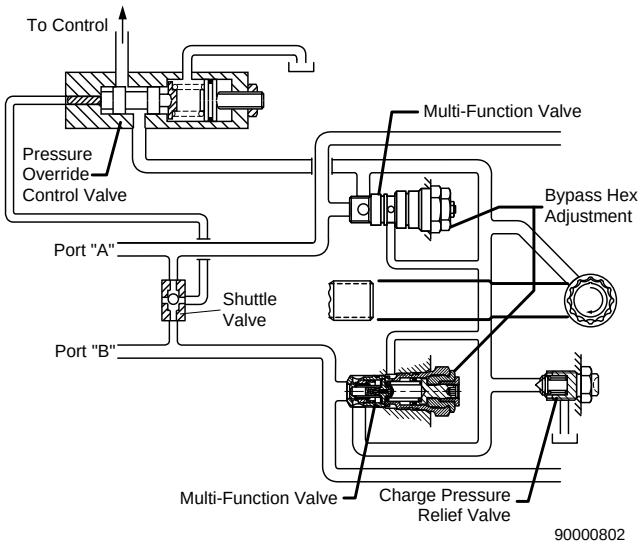
A 200 mesh screen, located in the reservoir or the charge inlet line, is recommended when using this filtration option. A non-bypass filter is preferred on all types of filtration.

90000246



90000247

PV with Integral Charge Pressure Filtration (left)
PV with Remote Charge Pressure Filtration (right, filter attached remotely)



Pressure Override - 180 Frame Size Only

2.4.10 Pressure Override (POR) - 180 Frame Size Only

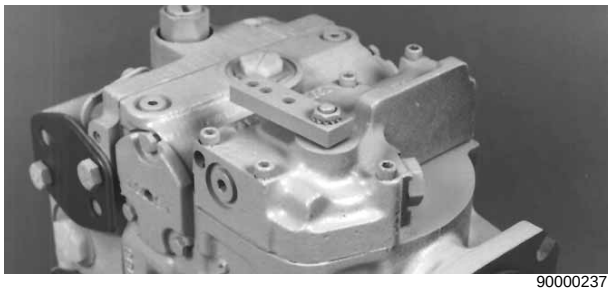
The pressure override valve (POR) modulates the control pressure to the displacement control to maintain a pump displacement which will produce a system pressure level less than or equal to the POR setting. For unusually rapid load application, the high pressure relief valve function of the multifunction valves is available to also limit the pressure level.

The pressure override consists of a three-way normally open valve which operates in series with the pump displacement control. Control supply pressure is normally ported through the pressure override valve to the displacement control valve for controlling the pump's displacement. If the system demands a pressure above the override setting, the POR valve will override the control by reducing the control pressure supplied to the displacement control. As the control pressure reduces, the internal forces tending to rotate the swashplate overcome the force of the servo pistons and allow the pump's displacement to decrease.

2.5 Pump Control Options

2.5.1 Manual Displacement Control (MDC)

The manual displacement control converts a mechanical input signal to a hydraulic signal using a spring-centered four-way servo valve. This valve ports hydraulic pressure to either side of a dual-acting servo piston. The servo piston rotates the cradle swashplate through an angular rotation of ±17°, thus varying the pump's displacement from full displacement in one direction to full displacement in the opposite direction. The MDC is designed so the angular position of the pump swashplate is proportional to the rotation of the control input shaft. For adjustments see 8.2.1; for repairs see 9.3.2, 9.3.8.

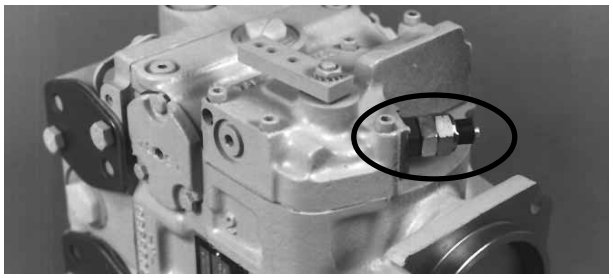


90000237

PV with Manual Displacement Control

Non-Linear MDC

The non-linear manual displacement control (photo in Sec. 8.2.2) operates in the same manner as the regular MDC except that it is designed so the change in the angular position of the pump swashplate *progressively* increases as the control input shaft is rotated toward its maximum displacement position. For adjustments see Sec. 8.2.2; for repairs see 9.3.2.



90000239

PV with Manual Displacement Control and Neutral Start Switch

Solenoid Override Valve

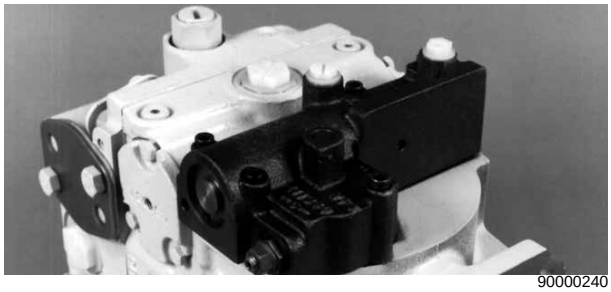
A solenoid override valve option (not shown here) is available for MDC. This safety feature will return the swashplate to zero displacement position when activated. The valve may be set in either a normally open or normally closed mode. For repairs see 9.3.3, 9.3.4.

Neutral Start Switch (NSS)

The neutral start switch is an optional feature available with MDC. When connected properly with the vehicle's electrical system, the neutral start switch ensures that the prime mover can be started only when the control is in a neutral position. For adjustments see Sec. 8.2.3.

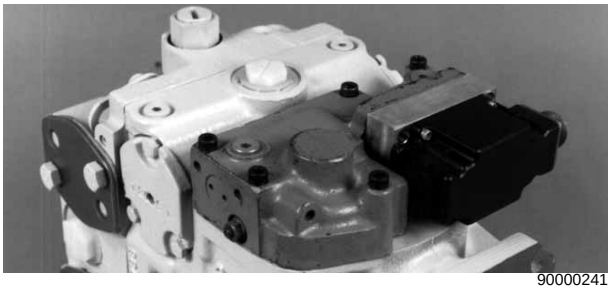
2.5.2 Hydraulic Displacement Control (HDC)

The hydraulic displacement control uses a hydraulic input signal to operate a spring-centered four-way servo valve. This valve ports hydraulic pressure to either side of a dual-acting servo piston. The servo piston rotates the cradle swashplate through an angular rotation of ±17°, thus varying the pump's displacement from full displacement in one direction to full displacement in the opposite direction. The HDC is designed so the angular position of the pump swashplate is proportional to input pressure. For adjustments see 8.2.4; for repairs see 9.3.5, 9.3.8.



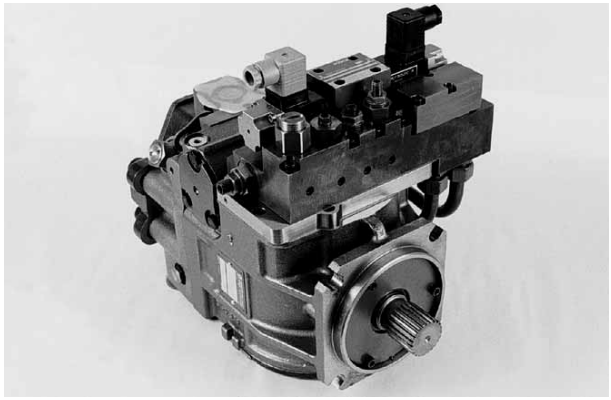
90000240

PV with Hydraulic Displacement Control



90000241

PV with Electric Displacement Control

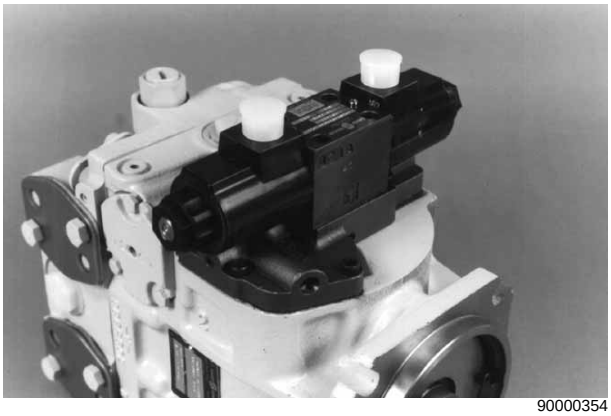


90000353

PV with Automotive Control (AC)

F000645

PV with Automotive Control Type II (AC II)



90000354

PV with 3-Position (FNR) Electric Control

2.5.3 Electric Displacement Control (EDC)

The electric displacement control is similar to the hydraulic displacement control with the input signal pressure controlled by a pressure control pilot (PCP) valve. The PCP valve converts a DC electrical input signal to a hydraulic signal which operates a spring-centered four-way servo valve. This valve ports hydraulic pressure to either side of a dual-acting servo piston. The servo piston rotates the cradle swashplate through an angular rotation of ±17°, thus varying the pump's displacement from full displacement in one direction to full displacement in the opposite direction. The control is designed so the angular position of the swashplate is proportional to the EDC input. For neutral adjustment see Sec. 8.2.4; for repairs see Sec. 9.3.5, 9.3.6, and 9.3.8.

2.5.4 Automotive Control (AC and AC II)

Automotive Control (AC) allows a vehicle to be driven in a manner similar to an automobile with an automatic transmission.

The AC control includes a three-position electric control to provide direction control.

The AC II control can be combined with a manual, hydraulic, or electric displacement control to provide both direction control and control over maximum vehicle speed. It may also be combined with a 3-position electric control to provide direction control.

2.5.5 3-Position (FNR) Electric Control

This control utilizes a 12 or 24 VDC electrically operated spool valve to port pressure to either side of the pump displacement control piston. Energizing one of the solenoids will cause the pump to go to its maximum displacement in the corresponding direction.

All functions of the three-position (FNR) electric control are preset at the factory. For repairs, see Sec. 9.3.7.

2.6 Motor Features

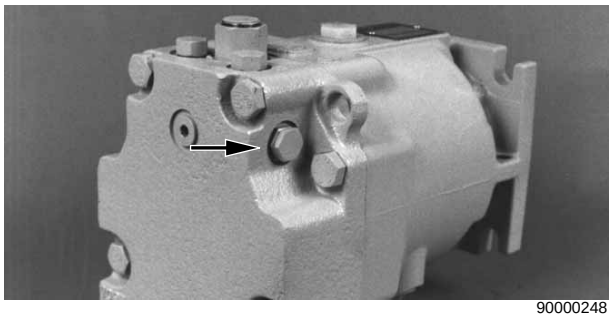
2.6.1 Motor Loop Flushing Valve and Charge Relief Valve

All Series 90 motors are designed to accommodate a loop flushing valve. The loop flushing valve is used in installations which require additional fluid to be removed from the main hydraulic circuit because of transmission cooling requirements, or unusual circuits requiring additional loop flushing to remove excessive contamination in the high pressure circuit.

A shuttle valve and charge relief valve are installed in the motor end cap to provide the loop flushing function. The shuttle valve provides a circuit between the low pressure side of the closed loop and the charge relief valve in the motor end cap.

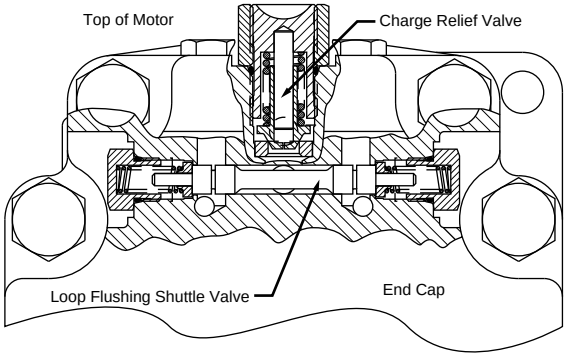
The motor charge relief valve regulates the charge pressure level only when there is a pressure differential in the main loop. The shuttle valve is spring centered to the closed position so that no high pressure fluid is lost from the circuit when reversing pressures.

For charge relief valve adjustment see Sec. 8.3.1, for repairs see Sec. 9.4.1.



90000248

MF showing location of Loop Flushing Valve



90000238

Motor Charge Relief Valve and Loop Flushing Shuttle Valve

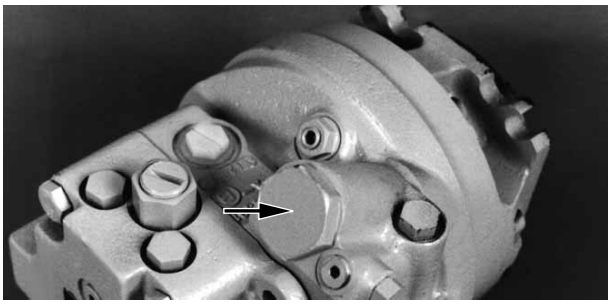
2.6.2 Variable Motor Displacement Limiters

All Series 90 variable motors include mechanical displacement (stroke) limiters. Both the maximum and minimum displacement of the motor can be limited.

The range of the settings is as follows:

	055 MV Frame	075 MV Frame
Minimum Displacement	19 - 40 cm^3 1.2 - 2.4 in^3	26 - 54 cm^3 1.6 - 3.3 in^3
Maximum Displacement	65 - 100%	65 - 100%

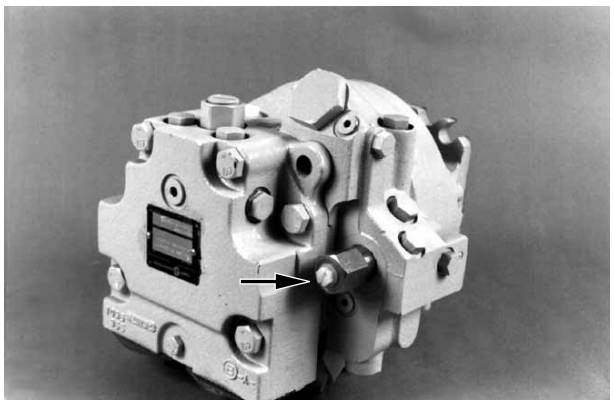
For adjustments see Sec. 8.3.2.



90000352

MV Maximum Displacement Limiter (Minimum Displacement Limiters on Opposite Side)

2.7 Variable Motor Controls



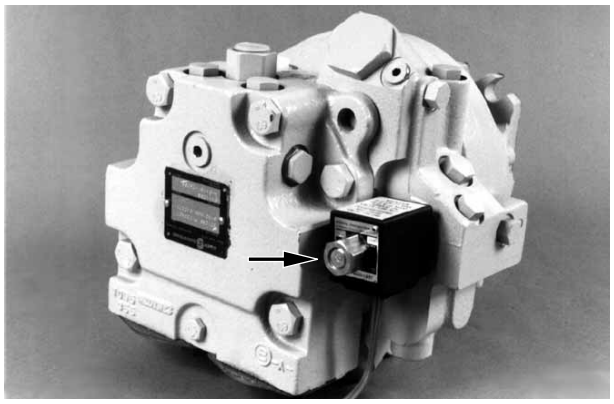
90000350

MV with Hydraulic 2-Position Control

2.7.1 Hydraulic 2-Position Control

This control utilizes a hydraulically operated three-way hydraulic valve to port system pressure to either of the motor displacement control pistons. The motor is normally held at its maximum displacement. Supplying pilot hydraulic pressure to the valve will cause the motor to go to its minimum displacement.

All functions of the hydraulic two-position control are preset at the factory. For repairs see Sec. 9.5.2 and 9.5.4.



90000351

MV with Electric 2-Position Control

2.7.2 Electric 2-Position Control

This control utilizes an electric solenoid operated three-way hydraulic valve to port system pressure to either of the motor displacement control pistons. The motor is normally held at its maximum displacement. Energizing the solenoid will cause the motor to go to its minimum displacement.

All functions of the electric two-position control are preset at the factory. For repairs see Sec. 9.5.1 and 9.5.4.

3. Technical Specifications

3.1 General Specifications

Design

Variable Pumps and Motors: Axial piston pump of variable displacement, cradle swashplate design.

Fixed Motors: Axial piston motor with fixed displacement, fixed swashplate design.

Type of Mounting (per SAE J744)

SAE flange, Size "B" mounting pad, 2 bolts
SAE flange, Size "C" mounting pad, 4 bolts
Cartridge flange, 2 bolts (for motor only)

Port Connections (See Sec. 4.2 for exact specs.)

Main pressure ports: SAE flange, Code 62
Remaining ports: SAE straight thread O-ring boss

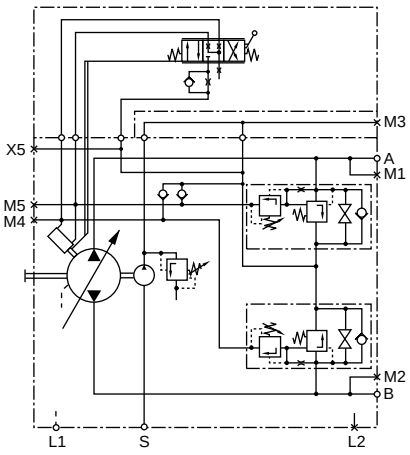
Direction of Rotation

Clockwise or counterclockwise (motors are bidirectional)

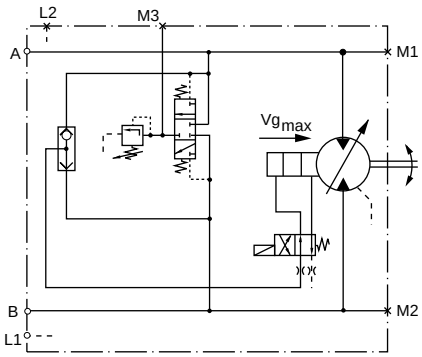
Installation Position

Installation position is discretionary. The housing must always be filled with hydraulic fluid, so note position of drain ports.

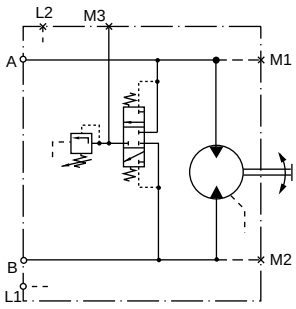
3.2 Circuit Diagrams



PV with charge pump and manual displacement control



MV with electrohydraulic two-position control



MF

90000811
90000812
90000813

3.3 Hydraulic Parameters

System Pressure Range

Maximum Pressure	480 bar	[6960 psi]
Rated Pressure	420 bar	[6000 psi]

Charge Pump Inlet Vacuum (on pumps only)

Maximum Vacuum, Continuous	0.7 bar abs	[10 in Hg]
Maximum Vacuum, Cold Start	0.2 bar abs	[25 in Hg]

Case Pressure

Maximum, Continuous	3 bar	[44 psi]
Maximum, Intermittent or Cold Start	5 bar	[73 psi]

Hydraulic Fluid

Refer to SAS publication BLN 9887 or Publication SDF (Id. No. 697581). Also refer to publication ATI-E 9101 for information relating to biodegradable fluids

Temperature Range[1]

Minimum, Intermittent or Cold Start	-40°C	[-40°F]
Maximum, Continuous	104°C	[220°F]
Maximum, Intermittent	115°C	[240°F]

Fluid Viscosity Limits

Minimum, Intermittent	5 mm^2/s	[42 SUS]
Minimum, Continuous	6.4 mm^2/s	[47 SUS]
Minimum, Optimum	13 mm^2/s	[70 SUS]
Maximum, Continuous	110 mm^2/s	[510 SUS]
Maximum, Intermittent or Cold Start	1600 mm^2/s	[7400 SUS]

Filtration

Required cleanliness level: ISO 4406 Class 18/13 or better. Refer to SAS publications BLN 9887 or Publication SDF (Id. No. 697581) and ATI-E 9201.

1. At hottest point in system, normally the case drain port. Temperature and viscosity limits must be met simultaneously.

3.4 Technical Data

Table 1 - Variable Displacement Pumps

	Dimension	030 PV	042 PV	055 PV	075 PV	100 PV	130 PV	180 PV	250 PV
Displacement (maximum)	cm^3 in^3	30.0 1.83	42.0 2.56	55.0 3.35	75.0 4.57	100.0 6.10	130.0 7.93	180.0 10.98	250.0 15.25
Minimum speed	min^{-1} (rpm)	500	500	500	500	500	500	500	500
Rated speed*	min^{-1} (rpm)	4200	4200	3900	3600	3300	3100	2600	2300
Maximum speed*	min^{-1} (rpm)	4600	4600	4250	3950	3650	3400	2850	2500
Max. attainable speed* at max. disp.	min^{-1} (rpm)	5000	5000	4700	4300	4000	3700	3150	2750
Theoretical torque at max. disp.	Nm / bar lbf•in/1000 psi	0.48 290	0.67 380	0.88 530	1.19 730	1.59 970	2.07 1260	2.87 1750	3.97 2433
Weight (Base Unit)	kg lb	28 62	34 75	40 88	49 108	68 150	88 195	136 300	154 340

Table 2 - Fixed and Variable Displacement Motors

		Dimension	030 MF	042 MF	055 MF	075 MF	100 MF	130 MF	055 MV	075 MV
Displacement (maximum)		cm^3 in^3	30.0 1.83	42.0 2.56	55.0 3.35	75.0 4.57	100.0 6.10	130.0 7.93	55.0 3.35	75.0 4.57
Displacement (minimum)		cm^3 in^3	—	—	—	—	—	—	19.0 1.16	26.0 1.59
Rated speed*	at max. disp.	min^{-1} (rpm)	4200	4200	3900	3600	3300	3100	3900	3600
	at min. disp.	min^{-1} (rpm)	—	—	—	—	—	—	4600	4250
Maximum speed*	at max. disp.	min^{-1} (rpm)	4600	4600	4250	3950	3650	3400	4250	3950
	at min. disp.	min^{-1} (rpm)	—	—	—	—	—	—	5100	4700
Max. attainable speed* at max. disp.		min^{-1} (rpm)	5000	5000	4700	4300	4000	3700	4700	4300
Theoretical torque at max. disp.		Nm / bar lbf•in/1000 psi	0.48 290	0.67 380	0.88 530	1.19 730	1.59 970	2.07 1260	0.88 530	1.19 730
Maximum flow at max. disp.		l / min gal / min	138 36.5	193 51	234 62	296 78	365 96	442 117	234 62	296 78
Max. corner power		kW hp	111 149	155 208	187 251	237 318	292 392	354 475	224 300	282 378
Weight (SAE Flange)		kg lb	11 24	15 34	20 45	26 57	34 74	45 99	39 86	44 98
Weight (Cartridge Motor)		kg lb	—	17 37	26 57	33 72	—	—	40 88	46 101

* = Refer to Series 90 Technical Information manual for definitions

4. Pressure Measurement

4.1 Required Tools

The service procedures described in this manual for Series 90 pumps and motors can be performed using common mechanic's tools. Special tools, if required are shown.

Pressure gauges should be calibrated frequently to ensure accuracy. Snubbers are recommended to protect pressure gauges.

4.2 Port Locations and Pressure Gauge Installation

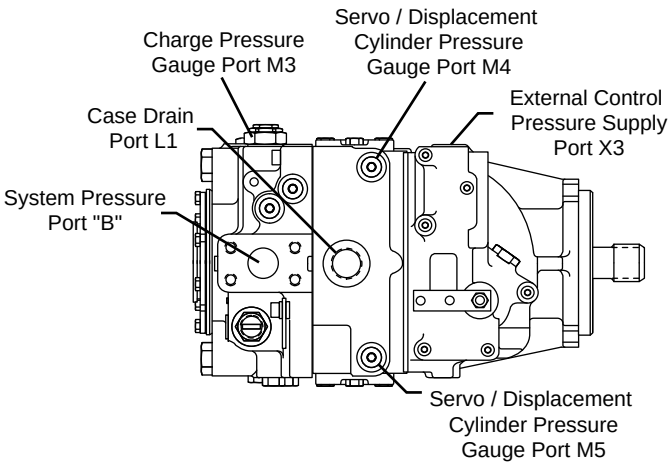
The following sections list the ports for each type of hydraulic unit. The recommended pressure gauge and fitting are also specified.

Outline drawings showing port locations follow the tables.

4.2.1 Variable Pump

Port	Function	Recommended Gauge Size and Fitting
M1	System Pressure Port "A"	1000 bar or 10 000 psi Gauge 9/16—18 O-Ring Fitting
M2	System Pressure Port "B"	1000 bar or 10 000 psi Gauge 9/16—18 O-Ring Fitting
M3 (M6)	Charge Pressure	50 bar or 1000 psi Gauge 9/16—18 O-Ring Fitting
M4 M5	Servo Pressure	50 bar or 500 psi Gauge 9/16—18 O-Ring Fitting

Port	Function	Recommended Gauge Size and Fitting	
L1 L2	Case Pressure	10 bar or 100 psi Gauge	
		SAE O-Ring Fitting:	
		030, 042	7/8—14
		055, 075, 100	1-1/16—12
		130	1-5/16—12
		180, 250	1-5/8—12
X1 X2	HDC / EDC Pressure	50 bar or 1000 psi Gauge 7/16 — 20 O-Ring Fitting or 9/16 — 18 O-Ring Fitting	
X3	Ext. Control Pressure	50 bar or 1000 psi Gauge 9/16 — 18 O-Ring Fitting	
S	Charge Pump Inlet	Vacuum Gauge, Tee into Inlet Line	
		SAE O-Ring Fitting:	
		030, 042	1-1/16 — 12
		055, 075	1-5/16 — 12
		100, 130, 180	1-5/8 — 12
		250	1-1/2 SAE Split Flange



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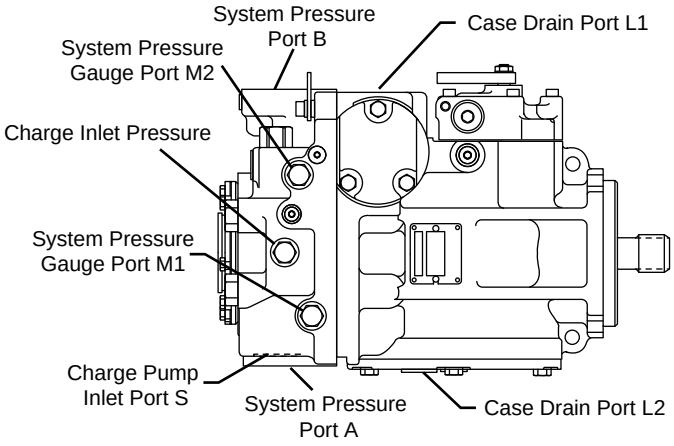
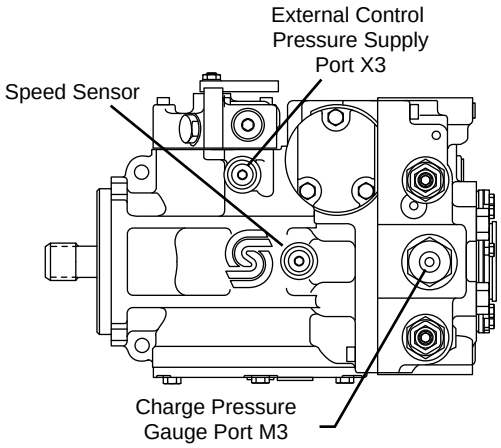
Top View



Left Side View



Right Side View

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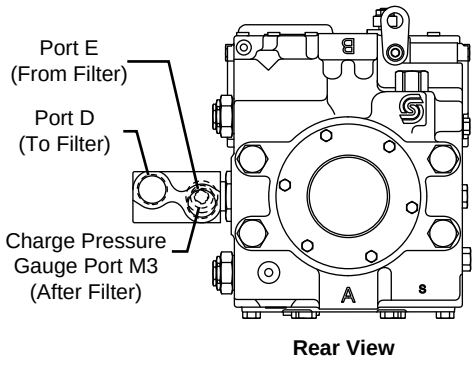
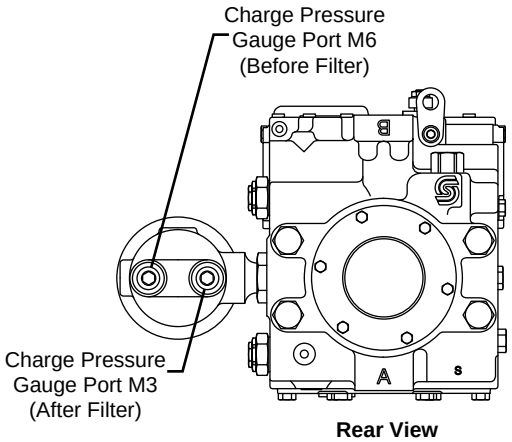
PV with Side Port End Cap and Manual Displacement Control



Rear View

PV with Side Port End Cap and Remote Pressure Filtration



Rear View

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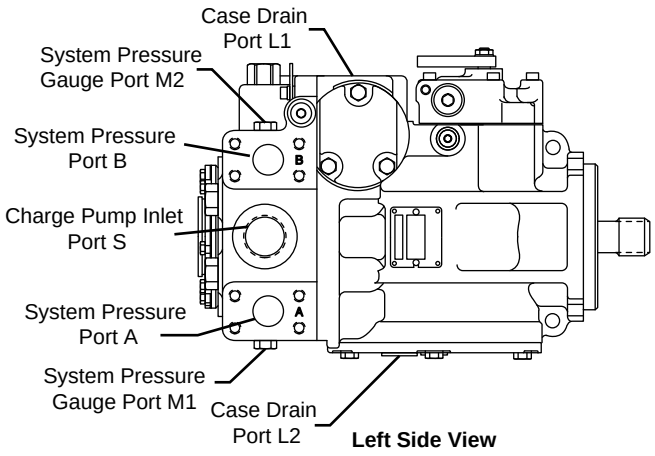
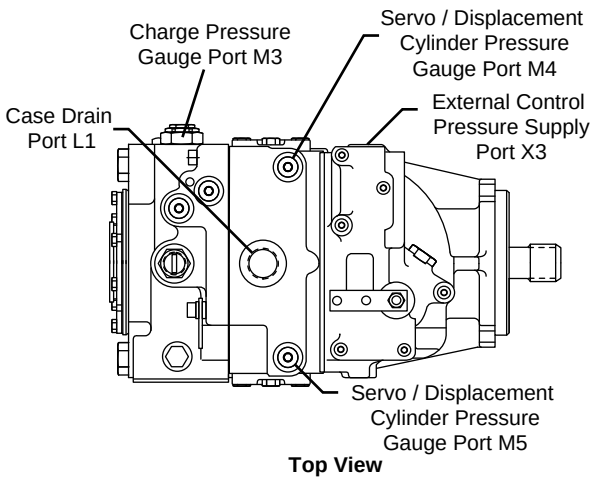
PV with Side Port End Cap and Integral Pressure Filtration



Left Side View



Top View

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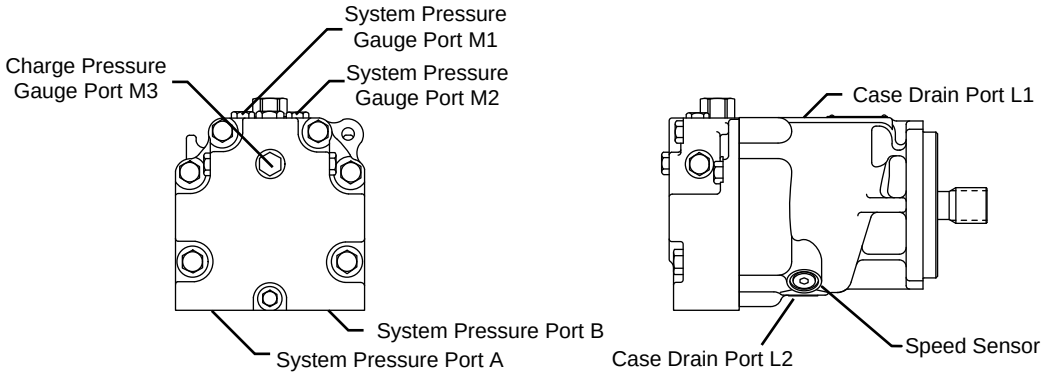
PV with Twin Port End Cap and Manual Displacement Control

4.2.2 Fixed Motor

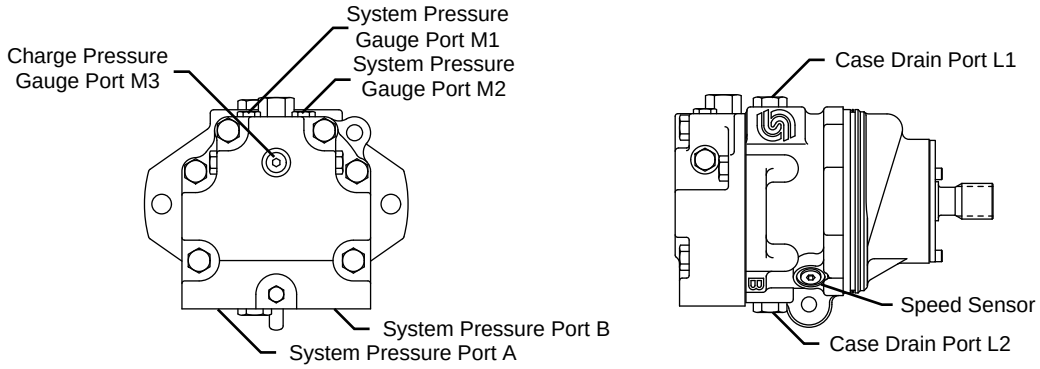
Port	Function	Recommended Gauge Size and Fitting
M1	System Pressure Port "A"	1000 bar or 10 000 psi Gauge 9/16—18 O-Ring Fitting
M2	System Pressure Port "B"	1000 bar or 10 000 psi Gauge 9/16—18 O-Ring Fitting
M3	Charge Pressure Port M3	50 bar or 1000 psi Gauge 9/16—18 O-Ring Fitting

Port	Function	Recommended Gauge Size and Fitting	
L1 L2	Case Pressure	10 bar or 100 psi Gauge	
		SAE O-Ring Fitting:	
		030, 042, 055	7/8—14
		075, 100, 130	1-1/16—12



Rear View **Left Side View**

MF with SAE Flange



Rear View **Left Side View**

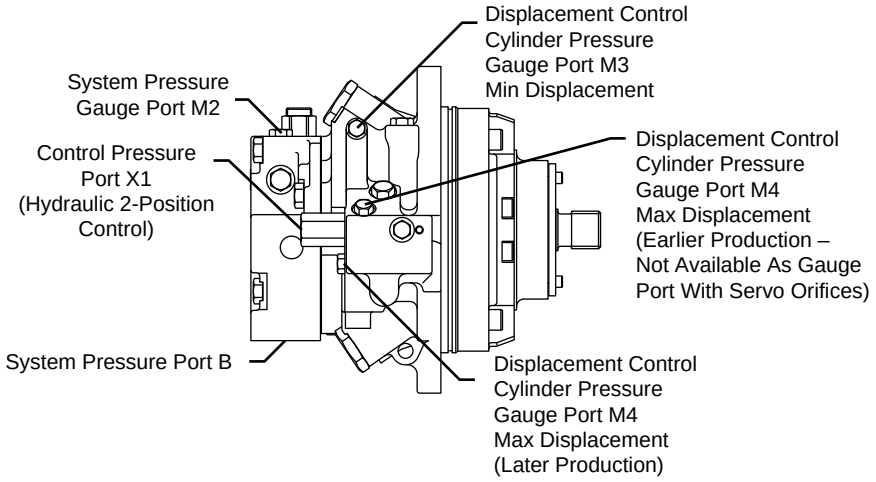
90000821

MF with Cartridge Flange

4.2.3 Variable Motor

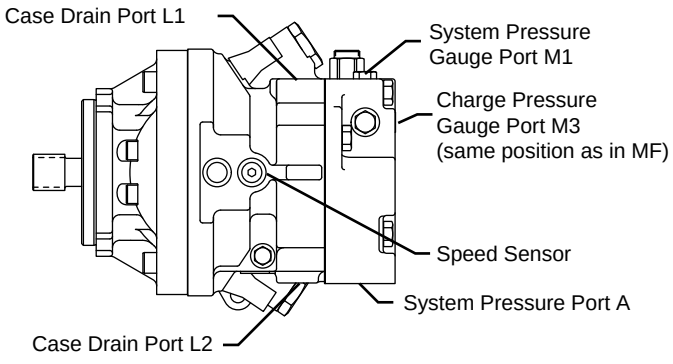
Port	Function	Recommended Gauge Size and Fitting
M1	System Pressure Port "A"	1000 bar or 10 000 psi Gauge 9/16—18 O-Ring Fitting
M2	System Pressure Port "B"	1000 bar or 10 000 psi Gauge 9/16—18 O-Ring Fitting
M3	Charge Pressure	50 bar or 1000 psi Gauge 9/16—18 O-Ring Fitting

Port	Function	Recommended Gauge Size and Fitting
M3	Disp. Cylinder Pressure Min Disp.	1000 bar or 10 000 psi Gauge 7/16—20 O-Ring Fitting
M4	Disp. Cylinder Pressure Max Disp.	1000 bar or 10 000 psi Gauge 7/16—20 O-Ring Fitting
L1 L2	Case Pressure	10 bar or 100 psi Gauge 1-1/16—12 O-Ring Fitting



Left Side View

MV with Cartridge Flange and Hydraulic 2-Position Control (SAE Flange Version Similar)



Right Side View

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MV with SAE Flange (Cartridge Flange Version Similar)

5. Initial Start-Up Procedure

The following start-up procedure should always be followed when starting-up a new Series 90 installation or when restarting an installation in which either the pump or motor had been removed.

WARNING
The following procedure may require the vehicle/machine to be disabled (wheels raised off the ground, work function disconnected, etc.) while performing the procedure in order to prevent injury to the technician and bystanders. Take necessary safety precautions before moving the vehicle/machine.

Prior to installing the pump and/or motor, inspect the units for damage incurred during shipping and handling. Make certain all system components (reservoir, hoses, valves, fittings, heat exchanger, etc.) are clean prior to filling with fluid.

Fill the reservoir with recommended hydraulic fluid. This fluid should be passed through a 10 micron (nominal, no bypass) filter prior to entering the reservoir. The use of contaminated fluid will cause damage to the components, which may result in unexpected vehicle/machine movement. See the publications BLN-9887 and SDF 697581 for further related information.

The inlet line leading from the reservoir to the pump must be filled prior to start-up. Check inlet line for properly tightened fittings and make sure it is free of restrictions and air leaks.

Be certain to fill the pump and/or motor housing with clean hydraulic fluid prior to start up. Fill the housing by pouring filtered oil into the upper case drain port.

Install a 50 bar (or 1000 psi) pressure gauge in the charge pressure gauge port (see Sec. 4.2 for location) to monitor the charge pressure during start-up.

It is recommended that the external control input signal (linkage for MDC, hydraulic lines for HDC, or electrical connections for EDC) be disconnected at the pump control until after initial start-up. This will ensure that the pump remains in its neutral position.

WARNING
Do not start prime mover unless pump is in neutral position (0° swashplate angle). Take precautions to prevent machine movement in case pump is actuated during initial start up.

“Jog” or slowly rotate prime mover until charge pressure starts to rise. Start the prime mover and run at the lowest possible RPM until charge pressure has been established. Excess air may be bled from the high pressure lines through the high pressure system gauge port.

Once charge pressure has been established, increase speed to normal operating RPM. Charge pressure should be as indicated in the pump model code (see Sec. 8.1.1). If charge pressure is inadequate, shut down and determine cause for improper pressure. Refer to Troubleshooting Sec. 7.

WARNING
Inadequate charge pressure will affect the operator’s ability to control the machine.

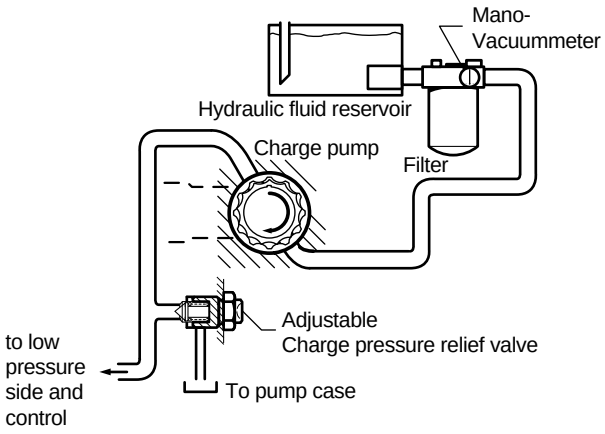
Shut down the prime mover and connect the external control input signal. Also reconnect the machine function if disconnected earlier. Start the prime mover, checking to be certain the pump remains in neutral. With the prime mover at normal operating speed, slowly check for forward and reverse machine operation.

Charge pressure may slightly decrease during forward or reverse operation. Continue to cycle slowly between forward and reverse for at least five minutes.

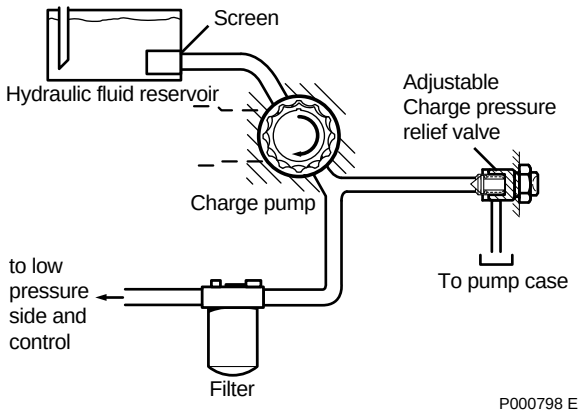
Shut down prime mover, remove gauges, and plug ports. Check reservoir level and add filtered fluid if needed.

The transmission is now ready for operation.

6. Fluid and Filter Maintenance



Suction Filtration Schematic



Charge Pressure Filtration Schematic (Partial Flow)

To ensure optimum service life of Series 90 products, regular maintenance of the fluid and filter must be performed. Contaminated fluid is the main cause of unit failure. Care should be taken to maintain fluid cleanliness while performing any service procedure.

Check the reservoir daily for proper fluid level, the presence of water (noted by a cloudy to milky appearance, or free water in bottom of reservoir), and rancid fluid odor (indicating excessive heat). If either of these conditions occur, change the fluid and filter immediately.

It is recommended that the fluid and filter be changed per the vehicle/machine manufacturer's recommendations or at the following intervals:

System with a sealed-type reservoir	2000 hours
System with a breathing-type reservoir	500 hours

It may be necessary to change the fluid more frequently than the above intervals if the fluid becomes contaminated with foreign matter (dirt, water, grease, etc.) or if the fluid has been subjected to temperature levels greater than the recommended maximum. Never reuse fluid.

The filter should be changed whenever the fluid is changed or whenever the filter indicator shows that it is necessary to change the filter.

Filters can be in either pressure filtration or suction filtration configurations. For suction filtration, filters should have a Beta-ratio of β_{10}>2. For charge pressure filtration, filters should have a Beta-ratio of β_{10}>10. See Sauer-Sundstrand publication BLN-9887 or 697581 and ATI-E 9201 for more information on filtration.

7. Troubleshooting

This section provides general steps to follow if certain undesirable system conditions are observed. Follow the steps in a section until the problem is solved. Some of the items will be system specific. For areas covered in this manual, a section is referenced. **Always observe the safety precautions listed in Sec. 1.2 and related to your specific equipment.**

7.1 "Neutral" Difficult or Impossible to Find

Item	Description	Action
1. Check input to pump control.	Input to control module is operating improperly.	Check control input and repair or replace as necessary.
2. Check pump displacement control.	Control linkages are not secure, control orifices are blocked, etc.	Adjust, repair, or replace control module as necessary (8.2 and 9.3).
3. Repair or replace pump.		Consult a Sauer-Sundstrand Authorized Service Center.

7.2 System Operating Hot

Item	Description	Action
1. Check oil level in reservoir.	Insufficient hydraulic fluid will not meet cooling demands of system.	Fill reservoir to proper level.
2. Inspect heat exchanger.	Heat exchanger not sufficiently cooling the system.	Check air flow and input air temperature for heat exchanger. Clean, repair or replace heat exchanger.
3. Check charge pressure.	Low charge pressure will overwork system.	Measure charge pressure (4.2). Inspect and adjust or replace charge relief valve (8.1.1 and 9.2.3). Or repair leaky charge pump (9.2.4).
4. Check charge pump inlet vacuum.	High inlet vacuum will overwork system. A dirty filter will increase the inlet vacuum. Inadequate line size will restrict flow.	Check charge inlet vacuum (4.2). If high, inspect inlet filter and replace as necessary. Check for adequate line size, length or other restrictions.
5. Check system relief pressure settings.	If the system relief settings are too low, the relief valves will be overworked.	Verify settings of pressure limiters and high pressure relief valves and adjust or replace multi-function valves as necessary (8.1.2, 9.2.1)
6. Check for internal leakage in motor.	Leakage will reduce low side system pressure and overwork the system.	Monitor motor case flow without loop flushing in the circuit (use defeat spool 9.4.1.3). If flow is excessive, replace motor.
7. Check system pressure.	High system pressure will overheat system.	Measure system pressure (4.2). If pressure is high reduce loads.
8. Replace transmission.		Replace pump and motor.

7.3 Transmission Operates Normally in One Direction Only

Item	Description	Action
1. Check input to pump control.	Input to control module is operating improperly.	Check control input and repair or replace as necessary.
2. Check pump displacement control.	Control linkages are not secure, control orifices are blocked, etc.	Repair or replace control module as necessary (8.2 and 9.3).
3. Interchange system pressure limiters, high pressure relief valves, and system check valves.	Interchanging the multi-function valves will show if the problem is related to the valve functions contained in the multi-function valves.	Interchange multi-function valves. If the problem changes direction, repair or replace the valve on the side that does not operate (8.1.2 and 9.2.1).
4. Check charge pressure.	If charge pressure decays in one direction the loop flushing valve may be “sticking” in one direction.	Measure charge pressure in forward and reverse (4.2). If pressure decays in one direction, inspect and repair the motor loop flushing valve (9.4.1.1).

7.4 System Will Not Operate in Either Direction

Item	Description	Action
1. Check oil level in reservoir.	Insufficient hydraulic fluid to supply system loop.	Fill reservoir to proper level.
2. Check input to pump control.	Input to control module is operating improperly.	Check control input and repair or replace as necessary.
3. Check pump displacement control.	Control linkages are not secure, control orifices are blocked, etc.	Repair or replace control module as necessary (8.2 and 9.3).
4. Ensure bypass valve(s) are closed.	If bypass valve(s) is open, the system loop will be depressurized.	Close bypass valves (8.1.3). Replace multi-function valve if defective (9.2.1).
5. Check charge pressure with pump in neutral.	Low charge pressure insufficient to recharge system loop.	Measure charge pressure with the pump in neutral (4.2). If pressure is low, go to step 6; otherwise continue with step 5.
6. Check charge pressure with pump in stroke.	Low charge pressure with the pump in stroke indicates a motor charge relief valve or system pressure relief valve may be improperly set.	Measure charge pressure with pump in stroke (4.2). If pressure is low, adjust or replace motor charge relief valve (8.3.1 and 9.4.1.2), otherwise go to step 9.
7. Inspect pump charge relief valve.	A pump charge relief valve that is leaky or set too low will depressurize the system.	Adjust or replace pump charge relief valve as necessary (8.1.1, 9.2.3)
8. Check charge pump inlet filter.	A clogged filter will undersupply system loop.	Inspect filter and replace if necessary.

(continued)

9. Check charge pump.	A malfunctioning charge pump will provide insufficient charge flow.	Repair or replace the charge pump (9.2.4). If OK go to last step.
10. Check pump displacement control.	Control linkages are not secure, control orifices are blocked, etc.	Repair or replace control module as necessary (8.2 and 9.3).
11. Check system pressure.	Low system pressure will not provide power necessary to move load.	Measure system pressure (4.2). Continue with next step.
12. Check system multi-function valves.	Defective multi-function valves will cause system pressure to be low.	Repair or replace multi-function valve(s) (9.2.1).
13. Replace transmission.		Replace pump and motor.

7.5 Low Motor Output Torque

Item	Description	Action
1. Check system pressure at motor.	Low system pressure at the motor will reduce torque.	Measure system pressure at motor (4.2). If pressure limiter setting is low, increase setting.
2. Variable motor stuck at minimum displacement.	Minimum motor displacement yields low output torque.	Check control supply pressure (4.2.3) or repair displacement control (9.5). Check motor control orifices (9.5.4).
3. Check for internal leakage.	Internal leakage will reduce system pressure.	Check for leakage in O-rings, gaskets, and other fittings (9.1.1 and others). Repair unit as required, or replace leaky unit.
4. Replace transmission.		Replace pump and motor.

7.6 Improper Motor Output Speed

Item	Description	Action
1. Check oil level in reservoir.	Insufficient hydraulic fluid will reduce motor speed.	Fill oil to proper level.
2. Check charge pressure.	Incorrect charge pressure can result in a low speed motor.	Measure charge pressure (8.1.1), adjust charge system as necessary (9.2.3 and 9.2.4).
3. Check pump output flow.	Incorrect outflow will affect output speed. Incorrect output flow indicates the swashplate is out of position.	Measure pump output flow by teeing into outflow hose. Check for proper pump speed and see that the pump is in full stroke.
4. Check variable motor displacement control.	If variable motor displacement control is not functioning correctly, variable motor swashplate may be in wrong position.	See if variable motor displacement control is responding. If not, repair or replace control (9.5).

7.7 Excessive Noise and/or Vibration

Item	Description	Action
1. Check oil in reservoir.	Insufficient hydraulic fluid will lead to cavitation.	Fill reservoir to proper level.
2. Air in system.	Air bubbles will lead to cavitation.	Look for foam in reservoir. Check for leaks on inlet side of system loop. Afterwards, let reservoir settle until bubbles are gone. Run system at low speed to move system fluid to reservoir. Repeat.
3. Check pump inlet vacuum.	High inlet vacuum will create noise. A dirty filter will increase the inlet vacuum.	Inspect and replace filter as necessary. Check for proper suction line size.
4. Inspect shaft couplings.	A loose shaft coupling will cause excessive noise.	Replace loose shaft coupling in charge pump (Sec. 9.2.4) or replace pump or motor.
5. Inspect shaft alignment.	Unaligned shafts will create excessive frictional noise.	Align shafts.

7.8 System Response is Sluggish

Item	Description	Action
1. Check oil level in reservoir.	Insufficient hydraulic fluid will reduce output pressure.	Fill reservoir to proper level.
2. Check multi-function valves' pressure settings.	Incorrect pressure settings will affect system reaction time.	Adjust or replace multi-function valves (8.1.2 and 9.2.1).
3. Check pump inlet vacuum.	High pump inlet vacuum will reduce system pressure.	Measure charge inlet vacuum (4.2). If high replace inlet filter.
4. Check prime mover speed.	Low engine speed will reduce system performance.	Adjust engine speed.
5. Check charge and control pressures.	Incorrect charge or control pressures will affect system performance.	Measure charge and control pressures and correct if necessary (4.2 and others).
6. Check system internal leakage.	Internal leakage will reduce system pressure.	Check for leakage in O-rings, gaskets, and other fittings (9.1.1 and others).
7. Replace transmission.		Replace pump and motor.

8. Inspections and Adjustments

This section offers instruction on how to perform inspections and adjustments on pump and motor components. Read through the entire related section before beginning a service activity. Refer to Sec. 4 for location of gauge ports and suggested gauge size.

8.1 Pump Adjustments

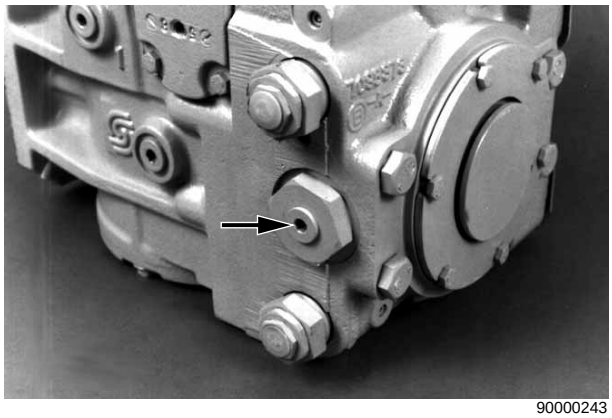
8.1.1 Charge Relief Valve Adjustment

The following procedure explains how to check and adjust the charge relief valve. (For description see Sec. 2.4.2.)

WARNING
The following procedure may require the vehicle/machine to be disabled (wheels raised off the ground, work function disconnected, etc.) in order to prevent injury to the technician and bystanders.

1. To measure pump charge pressure, install a pressure gauge in the pump charge pressure gauge port (M3). Also install a gauge to measure case pressure (tee into L1 or L2 or use servo gauge port). Operate the system with the pump in "neutral" (zero displacement) when measuring pump charge pressure.
2. The table on the following page shows the acceptable pump charge pressure range for some nominal charge relief valve settings (see sample model code at right). These pressures assume 1775 pump rpm and a reservoir temperature of 49°C (120°F), and are referenced to case pressure (see footnote on next page). Smaller displacement charge pumps will produce charge pressure readings in the lower portion of the range, while larger displacement charge pumps will produce readings in the higher portion of the range.

(continued)



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Charge Pressure Gauge Port (Reducer fitting shown - if filtration device attached, see Sec. 4.2.1 for alternate location of this port)

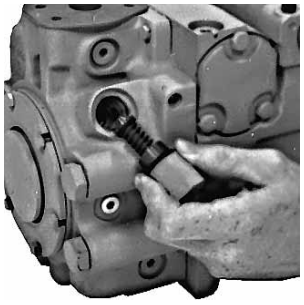
90L055 EA 1 N
6 S 3 C6 C 03
HNN 35 35 **24**

Nominal Charge Pressure Setting

Model Code on Unit Name Plate ("24 bar")

Model Code Setting	Measured Charge Pressure* (stated range ±1.7 bar [±25 psi])
20 bar	20.1 to 21.2 bar [291 to 308 psi]
24 bar	24.0 to 25.2 bar [348 to 365 psi]
28 bar	27.8 to 29.0 bar [403 to 420 psi]

NOTE: These pressures assume a pump speed of 1775 rpm. At higher pump input speeds (with higher charge flows) the charge pressure will rise over the rated setting.



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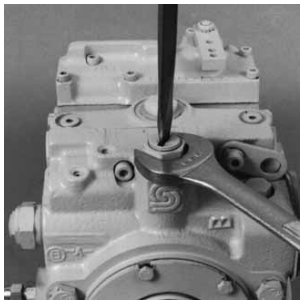
Shim Adjustable Charge Pressure Relief Valve (Pump)



90000264

Screw Adjustable Charge Pressure Relief Valve (Pump)

3. Earlier production Series 90 pumps are equipped with a shim adjustable charge relief valve. Shim kits are available from Sauer-Sundstrand. Adjustment of charge pressure is accomplished by removing the plug [1 inch Hex] and changing the shim thickness behind the spring. The plug for this type of charge relief valve should be torqued to 68 Nm (50 lbf•ft).

   Later production Series 90 pumps are equipped with an external screw adjustable charge relief valve. Adjustment of the charge pressure is accomplished by loosening the lock nut (with a 1-1/16 inch hex wrench for 030 through 100 units, or a 1-5/8 inch hex wrench for 130 through 250 units), and turning the adjustment plug with a large screwdriver or a 1/2 inch hex wrench. Clockwise rotation of the plug increases the setting, and counterclockwise rotation decreases the setting (at a rate of approximately 3.4 bar (50 psi) per turn). The lock nut for this type of charge relief valve should be torqued to 52 Nm (38 lbf•ft).

4. Once the desired charge pressure setting is achieved, remove the gauges.

* This is the actual charge pressure port gauge reading minus the case pressure port gauge reading.

8.1.2 Multi-Function Valve Pressure Adjustment

Adjustment of the pressure limiter setting and the high pressure relief valve setting is accomplished simultaneously. The latter is automatically set approximately 35 bar (500 psi) above the former. For description of multi-function valve see Sec. 2.4.4.

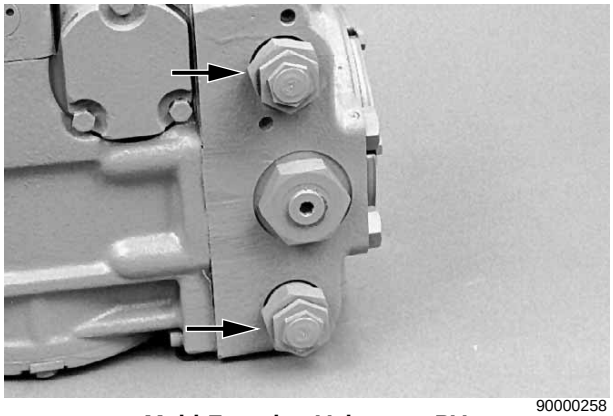
In order to adjust the pressure limiter setting, the motor output shaft must be locked so it does not rotate. This may be accomplished by locking the vehicle's brakes or rigidly fixing the work function so it cannot rotate.

WARNING
Take necessary precautions that the motor shaft remains stationary during the adjustment procedure.

1. Install two 1000 bar (or 10,000 psi) pressure gauges in the high pressure gauge ports (M1 and M2). Install a 50 bar (or 1000 psi) pressure gauge in the pump charge pressure gauge port (M3).
2. Start the prime mover and operate at normal speed.
3. Loosen locking nut (smallest hex on multi-function valve) with a 10 mm wrench for earlier 042 through 100 frame size units, a 19 mm wrench for 030 and later 042 through 100 frame size units, or a 13 mm wrench for earlier 130 frame size units.
4. Insert a 3 mm (early 042 through 100 units), 5 mm 030 and (late 042 through 100 units), or 4 mm (earlier 130 units) internal hex wrench into the pressure adjusting screw.

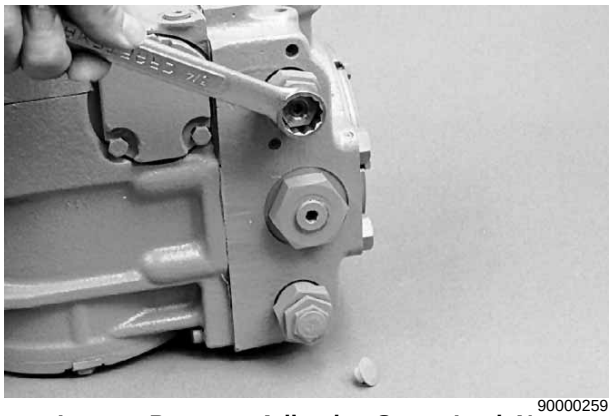
   NOTE: A plastic dust plug is installed in the adjusting screw on 030 and late 042 through 250 units.
5. The factory preset pressure limiter setting is shown on the model code as at right. It is referenced to charge pressure, so the pressure limiter setting is the difference between the high and low pressure sides of the system loop. Activate or move the control input so that pressure increases in the high pressure side of the closed circuit to the pressure limiter pressure setting. The pressure limiter setting is reached when the pressure stops increasing and remains steady at a given pressure level (as shown on the gauges).

(continued)



90000258

Multi-Function Valves on PV

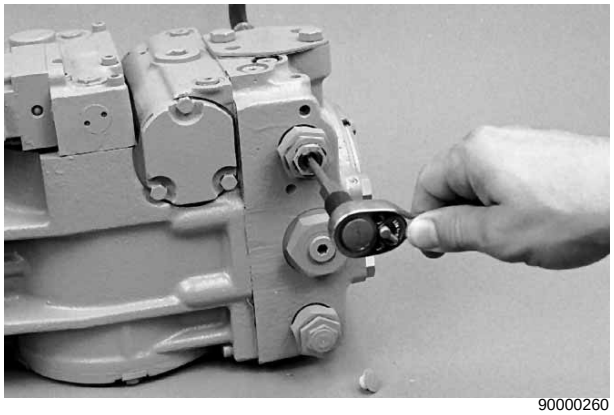


90000259

Loosen Pressure Adjusting Screw Lock Nut

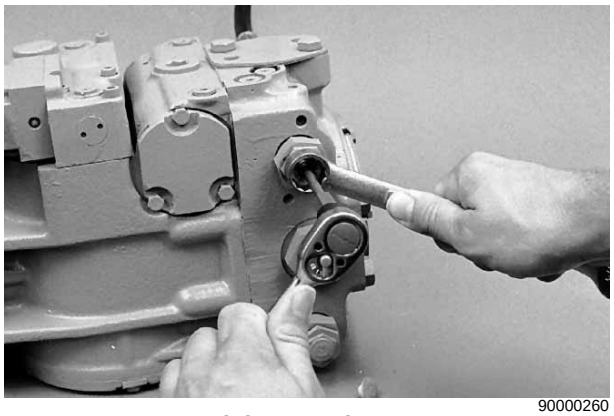
90L055 EA 1 N
6 S 3 C6 C 03
HNN **35** **35** 24

Pressure Limiter Setting
Ports A and B (differential
pressure in 10s of bars,
e.g. "35" = 350 bar)



90000260

Rotate Pressure Adjusting Screw



90000260

Tighten Lock Nut

6. Return the pump to its “neutral” (zero flow) position and adjust the pressure limiter setting by rotating the pressure adjusting screw with the internal hex wrench.

   Clockwise rotation of the pressure adjustment screw will increase the pressure setting, and counterclockwise rotation will decrease the pressure setting. Each complete rotation of the pressure adjusting screw changes the pressure setting by approximately 83 bar (1200 psi) on earlier 042 through 100 units, or by approximately 93 bar (1350 psi) on 030 and later 042 through 100 units.

7. To verify the actual pressure setting, actuate or move the control input so that the pump again develops pressure in the high pressure circuit to the newly adjusted pressure limiter pressure setting, and read the high pressure gauge. Then allow the pump to return to its “neutral” position. The pressure in the high pressure circuit should return to the charge pressure setting.

8. While holding the pressure adjusting screw stationary, tighten the pressure adjusting screw lock nut to 3 Nm (26 in•lbf) on early production units, or 16 Nm (12 ft•lbf) on late production units. **Do not over-torque.**

9. Shut down the prime mover, remove the gauges and install the gauge port plugs. Replace the plastic dust plugs (if used).

The same procedure is used for setting the pressure limit of the other multi-function valve, but the control input signal must be activated or moved in the opposite direction so that high pressure develops in the opposite side of the closed circuit.

8.1.3 Engaging the Bypass Function

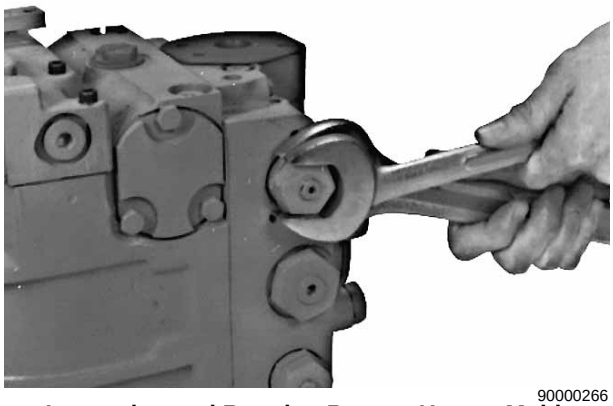
The bypass function (see Sec. 2.4.6 for description) is performed by the multi-function valve cartridges. The prime mover should be shut down when opening or closing the bypass valves.

The bypass valves on both of the multi-function valves must be opened to engaged the bypass function.

1. Using a 1-1/16 inch (030 through 100) or 1-3/8 inch (130 through 250) wrench on the middle sized hex of the multi-function valve cartridge, and a 1-1/4 inch (030 through 100) or 1-5/8 inch (130 through 250) wrench on the large hex to prevent rotation of the cartridge assembly, rotate the middle hex three revolutions counterclockwise to open the bypass valve. Do not rotate more than 3-1/2 revolutions, as additional rotation will permit external leakage.
2. For units with an MDC-type control, prior to moving the vehicle or otherwise causing the motor shaft to turn, move the control handle of the manual displacement control on the pump to the maximum full forward position. Hold the handle in this position during bypass valve operation.

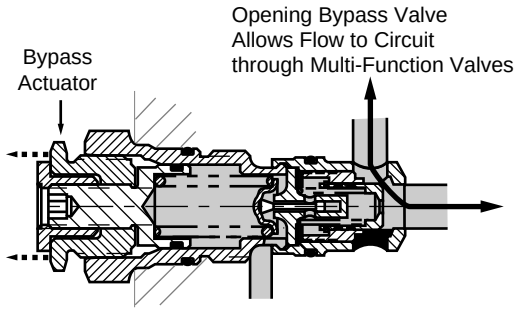
WARNING
"Tow" at extremely low speeds and for short distances only.

3. To close the bypass valve, rotate the middle hex clockwise until it is seated. Then torque the middle hex to 41 Nm (30 lbf•ft).



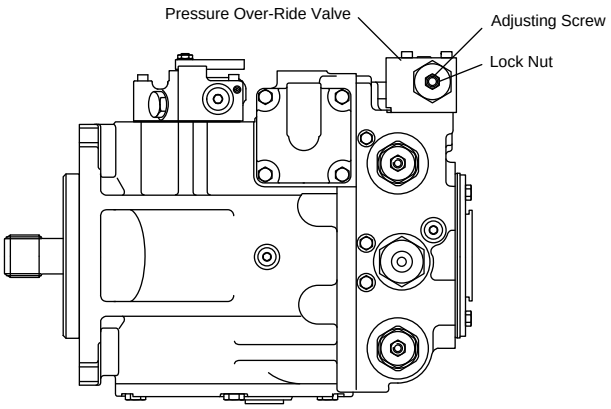
90000266

Loosening and Rotating Bypass Hex on Multi-Function Valve



90000827

Multi-Function Valve with Bypass Function Engaged



Pressure Over-Ride Valve for 180 Frame Size

8.1.4 Pressure Override (POR) Valve Pressure Adjustment (Option for 180 Frame Size)

The Pressure Override Valve is explained in Sec. 2.4.10.

1. Install two 1000 bar (or 10,000 psi) pressure gauges in the high pressure gauge ports (M1 and M2). Install a 50 bar (or 1000 psi) pressure gauge in the pump charge pressure gauge port (M3).
2. Start the prime mover and operate at normal speed.
3. With the pump operating at approximately 20% displacement, load the work function and note the pressure as the POR valve operates (pump displacement reduces to “zero”).
4. Adjustment of the pressure override setting is made by loosening the lock nut with a 9/16 inch hex wrench and turning the adjustment screw with a 3/16 inch internal hex wrench. The POR setting should be at least 50 bar (750 psi) below the high pressure relief valve setting of the multi-function valves for proper operation.
5. Following the adjustment, torque the lock nut to 43 Nm (32 lbf•ft).
6. Shut down the prime mover and remove the gauges and install the gauge port plugs.

8.1.5 Displacement Limiter Adjustment

The maximum displacement can be limited in either direction (see Sec. 2.4.7).

1. Loosen the seal lock nut retaining the displacement limiter adjusting screw.

Frame Size	Wrench Size
042 - 100	13 mm
130	17 mm
180 - 250	19 mm

2. Rotate the adjusting screw.

Frame Size	Internal Hex Wrench Size
042 - 100	4 mm
130	5 mm
180 - 250	6 mm

Rotating the adjusting screw clockwise will decrease the maximum displacement of the pump while rotating the adjusting screw counterclockwise will increase the maximum displacement.

WARNINGS
Care should be taken in adjusting displacement limiters to avoid undesirable flow or speed conditions. See Sec. 3 for speed and pressure limits.

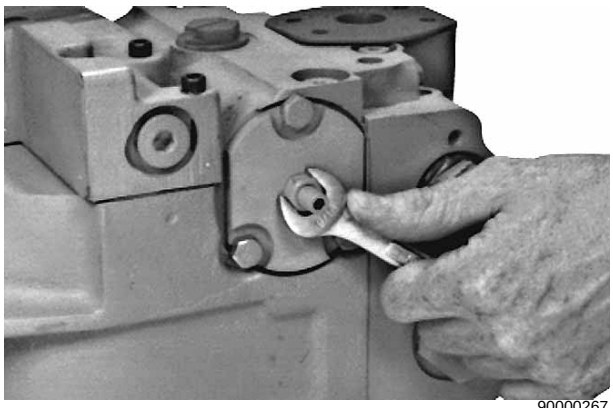
The seal lock nut must be retorqued after every adjustment to prevent an unexpected change in operating conditions and to prevent external leakage during unit operation.

3. After establishing the desired maximum displacement setting, tighten the lock nut on the adjusting screw as follows.

Frame Size	Torque
042 - 100	24 Nm [18 lbf•ft]
130	48 Nm [35 lbf•ft]
180 - 250	125 Nm [92 lbf•ft]

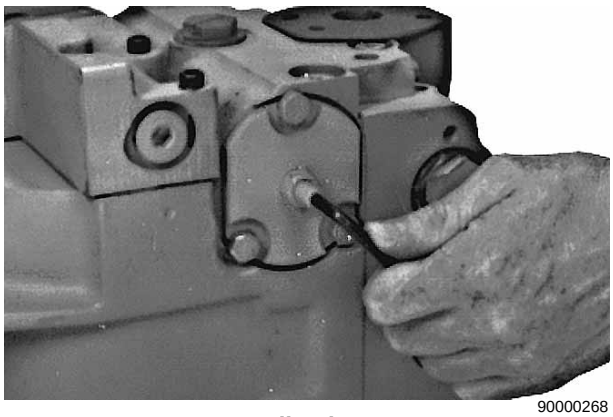
4. One turn of the adjusting screw will change the maximum displacement approximately as follows.

Frame Size	Approx Change in Disp per Rev of Adjusting Screw
030	2.8 cm^3/rev (0.17 in^3/rev)
042	3.4 cm^3/rev (0.21 in^3/rev)
055	4.0 cm^3/rev (0.25 in^3/rev)
075	5.0 cm^3/rev (0.31 in^3/rev)
100	6.0 cm^3/rev (0.37 in^3/rev)
130	9.0 cm^3/rev (0.55 in^3/rev)
180	12.5 cm^3/rev (0.76 in^3/rev)
250	17.3 cm^3/rev (1.06 in^3/rev)



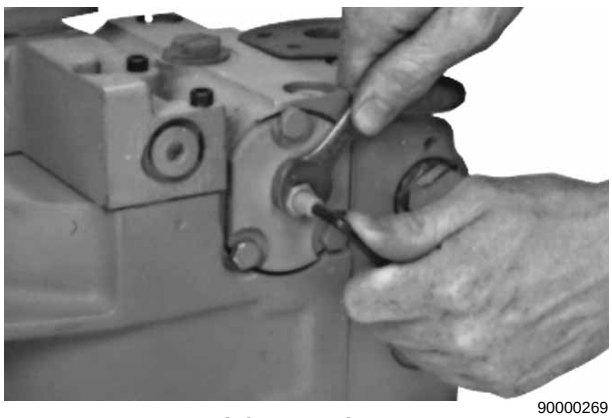
90000267

Loosen Displacement Limiter Lock Nut



90000268

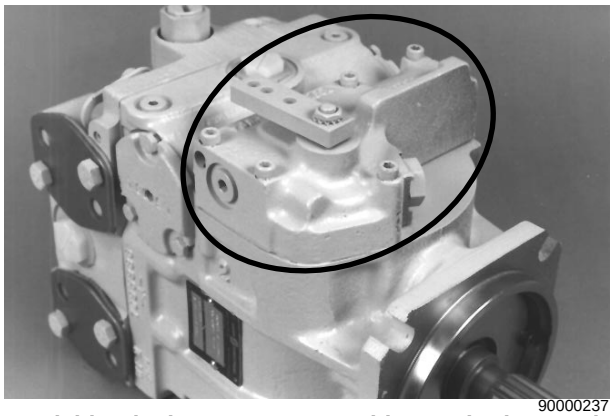
Rotate Adjusting Screw



90000269

Tighten Lock Nut

8.2 Pump Control Adjustments



90000237

Variable Displacement Pump with Standard Manual Displacement Control

8.2.1 Standard Manual Displacement Control (MDC) Adjustment

There are no adjustable elements in the manual displacement control. The control spool is held in its “neutral” position by centering springs and washers on each end of the spool. Since there is no centering spring on the control input shaft, the shaft will automatically assume the appropriate position when the control is installed on the pump.

For a functional description see Sec. 2.5.1.

8.2.2 Non-Linear Manual Displacement Control (MDC)

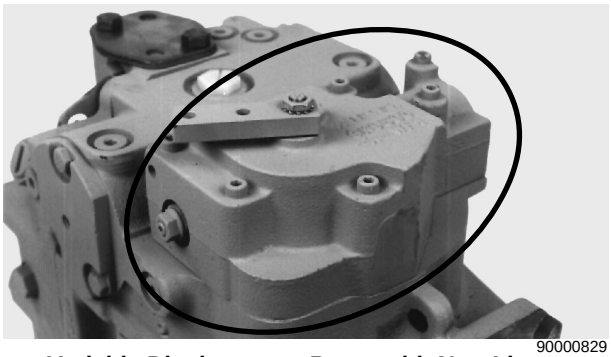
A centering spring, located on the control input shaft, locates the control shaft in its “neutral” position. A bias spring on the control spool maintains a force on the spool and the control linkage to eliminate looseness (“free-play”) in the linkage.

The “neutral” adjustment is the only adjustment that can be made on the nonlinear manual displacement control. All other functions are preset at the factory.

This adjustment must be made on a test stand or on the vehicle/machine with the prime mover operating.

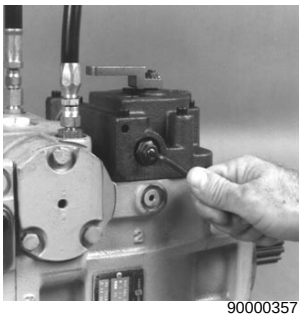
WARNING
The following procedure requires the vehicle/machine to be disabled (wheels raised off the ground, work function disconnected, etc.) in order to prevent injury to the technician and bystanders.

1. Install two 50 bar (or 1000 psi) gauges in each of the displacement control cylinder gauge ports (M4 and M5). Disconnect the external control linkage from the control handle and make certain the control shaft is in its “neutral” position. Start the prime mover and operate at normal speed.
2. Loosen the lock nut on the neutral adjusting screw with a 13 mm hex wrench.
3. Using a 4 mm internal hex wrench, rotate the neutral adjusting screw clockwise until the pressure increases on one of the pressure gauges. Note the angular position of the wrench.
4. Rotate the adjusting screw counterclockwise until the pressure increases by an equal amount on the other gauge. Note the angular position of the wrench.
5. Rotate the adjusting screw clockwise half the distance between the locations noted above. The gauges should read the same pressure (case pressure), indicating that the control is in its “neutral” position.
6. Hold the adjusting screw stationary and tighten the lock nut to 13.6 Nm (10 in•lbf). **Do not overtorque the nut.**
7. Once the neutral position is set, stop the prime mover, remove the gauges, and install the gauge port plugs. Reconnect the external control linkage.



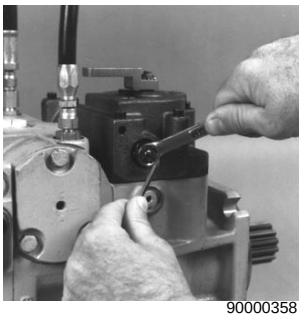
90000829

Variable Displacement Pump with Non-Linear Manual Displacement Control



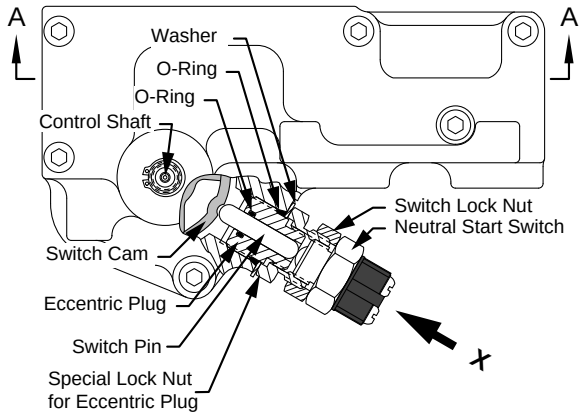
90000357

Rotate Neutral Adjusting Screw

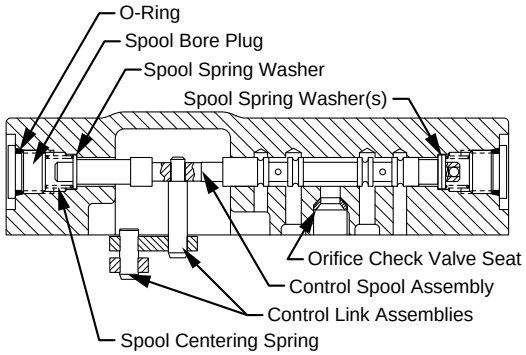


90000358

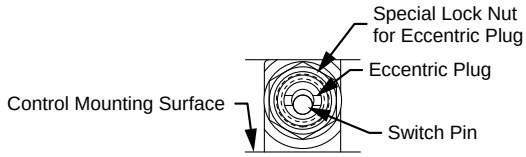
Tighten Neutral Adjusting Screw Lock Nut



MDC With Neutral Start Switch
Top View



View At Section A-A



View In Direction X
With Switch And Lock Nut Removed

90000830

Components of Standard Manual Displacement Control with Neutral Start Switch

8.2.3 MDC Neutral Start Switch (NSS) Adjustments

The neutral start switch (NSS) provides a means to prevent the system prime mover from starting while the pump control handle and control input shaft are in a position which would command the pump to go “in-stroke” in either the “forward” or “reverse” direction.

When the control input shaft is in its “neutral” position, the inner end of the switch pin moves into a slot on the eccentric cam attached to the control shaft. This allows the spring loaded NSS to close, completing the electrical starting circuit for the prime mover.

When the control input shaft is NOT in its “neutral” position, the eccentric cam moves the switch pin out of the slot. This forces the NSS to open, breaking the electrical starting circuit for the prime mover.

(continued)

The NSS must be adjusted to meet the following three requirements:

i. The distance the control handle can be turned without opening the NSS is called the “NSS deadband.” The distance the control handle can be moved without moving the control spool enough to port hydraulic fluid to the pump displacement control cylinders is called the “control deadband.” These deadbands **must** be centered in relation to each other.

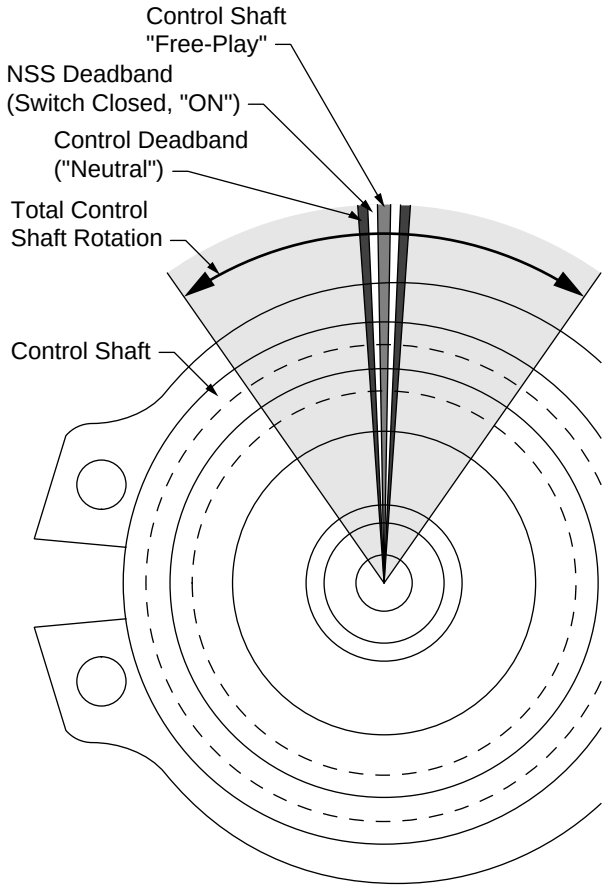
   Since the position of the control deadband cannot be adjusted, the position of the NSS deadband must be adjusted to match it. The switch pin is located in an eccentric plug which is turned to move the center of the NSS deadband.

ii. The NSS deadband must be wide enough so the NSS **will not** open within the loose area of control handle movement caused by normal operating clearances in the control linkage (control shaft “free-play”). By setting the NSS to open outside this area, the control spool springs or control shaft centering spring can always act to return the handle to “neutral” and re-close the NSS.

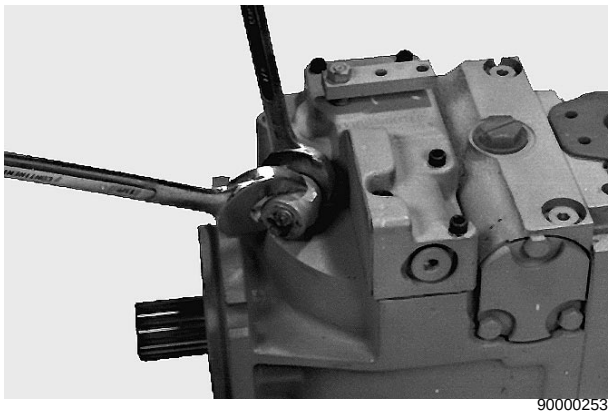
iii. The NSS deadband must be narrow enough so the NSS **will** open before the unit builds 7 bar (100 psi) differential system pressure in either direction.

   The neutral start switch is threaded into the special lock nut for the eccentric plug. Turning the NSS clockwise (CW) into the special nut will move the NSS closer to the switch cam on the control shaft, and will narrow the NSS deadband. Turning the NSS counterclockwise (CCW) out of the special nut will move the NSS farther from the switch cam on the control shaft, and will widen the NSS deadband.

(continued)

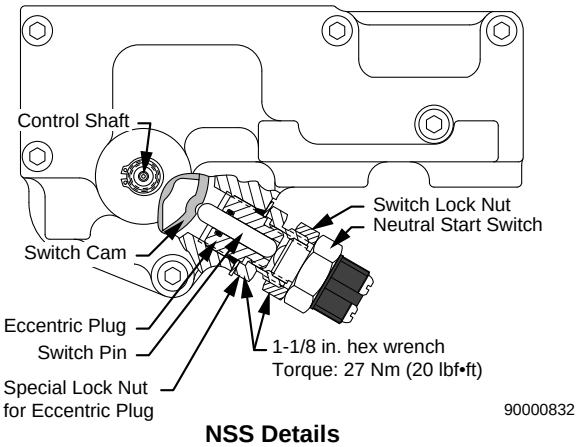


Neutral Start Switch Adjustment Requirements



90000253

Loosening the NSS Lock Nut



90000832

NSS Details

90000255

Checking Continuity of NSS

NSS Deadband Adjustment (Conditions ii & iii)

The NSS deadband must be wide enough so the NSS **will not** open within the control shaft "free-play" area, and it must be narrow enough so the NSS **will** open before the unit builds 7 bar (100 psi) differential system pressure in either direction.

1. Using two 1-1/8 inch wrenches, hold the neutral start switch from turning and loosen the locknut.
2. Disconnect the external control linkage and make certain the control shaft is in its "neutral" position.
3. Attach a continuity checker to the terminals of the switch. With the control shaft in its "neutral" position, turn the switch clockwise (CW) until electrical continuity is broken, then turn the switch counterclockwise (CCW) until electrical continuity is obtained. Turn the switch counterclockwise (CCW) an additional 1/4 turn (90°) after continuity has been obtained.
4. Hold the switch in place and tighten the locknut to 27 Nm (20 ft•lbf) torque.
5. With the continuity checker attached to the switch, rotate the control handle (or the control shaft) in each direction to assure continuity is broken when the control is not in the "neutral" position.
6. If continuity is obtained in "neutral" and satisfactorily interrupted in each direction, proceed to check the switch with the prime mover running. The switch must open **before** the unit builds 7 bar (100 psi) differential system pressure in either direction.

   If the switch opens **after** the unit builds system pressure in either direction, loosen the switch lock nut and turn the switch clockwise (CW) 1⁄12 turn (30°). Tighten the switch lock nut and recheck the switch operation. Repeat this procedure if necessary.
7. If neutral start switch operation is satisfactory, reconnect the external control linkage.
8. If continuity is not interrupted with an **equal** movement of the control handle in each direction, continue with the next section.

Neutral Start Switch Eccentric Plug Adjustment (Condition i)

The NSS deadband and the control deadband **must** be centered in relation to each other.

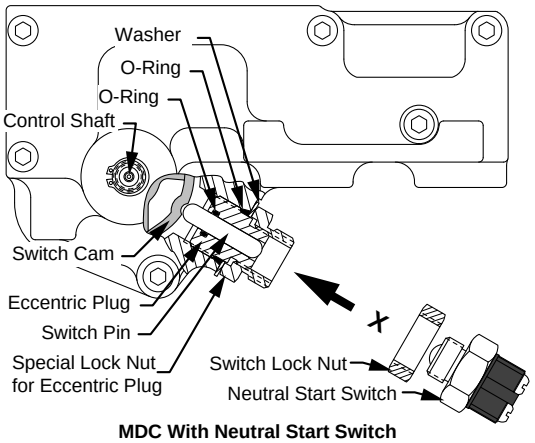
Since the position of the control deadband cannot be adjusted, the position of the NSS deadband must be adjusted to match it. The switch pin is located in an eccentric plug which is turned to move the center of the NSS deadband.

The MDC should be installed on the pump and be in its “neutral” position when adjusting the neutral start switch eccentric plug.

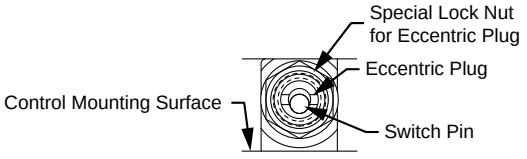
The accompanying drawing provides dimensions for an Eccentric Plug Adjustment Tool.

1. Hold the switch and eccentric plug from turning and use two 1-1⁄8 inch wrenches to loosen the locknut. Remove the neutral start switch.

CAUTION
Do not start the prime mover while the neutral start switch is removed from the control. Case pressure will force the pin out of the eccentric plug, causing oil loss.



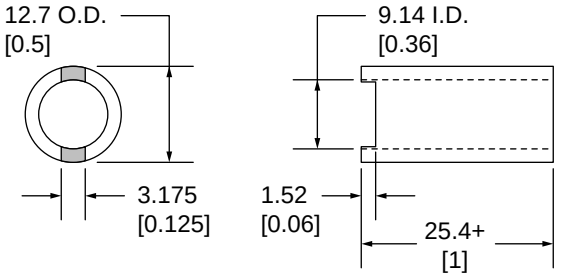
MDC With Neutral Start Switch Top View



View In Direction X With Switch And Lock Nut Removed

90000833

NSS Showing Eccentric Plug

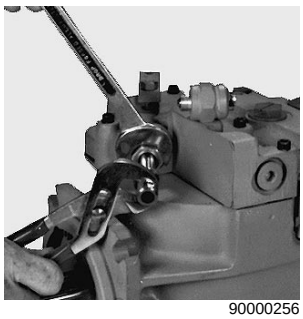


90000834

Eccentric Plug Adjustment Tool

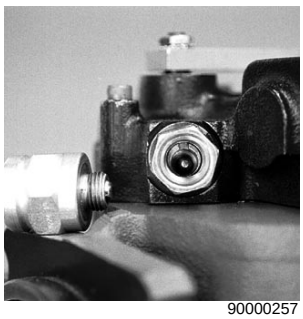
2. Note the slots on the eccentric plug for the adjustment tool. Hold the eccentric plug in place with the adjustment tool, and loosen the lock nut with a 1-1/8 inch wrench.

(continued)



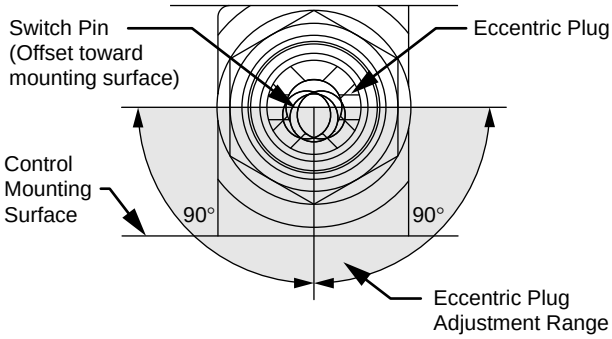
90000256

Loosen Eccentric Lock Nut

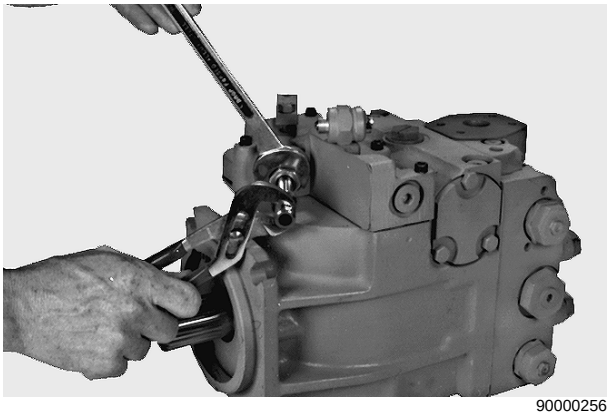


90000257

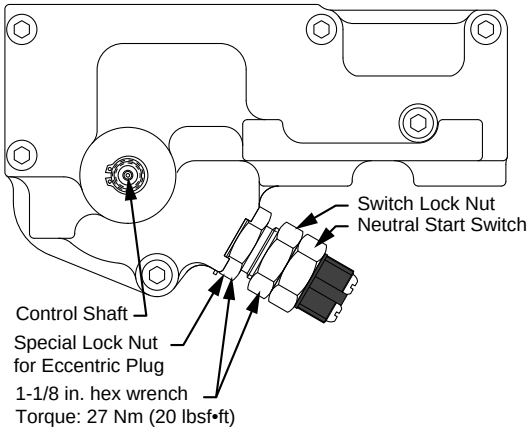
NSS Removed



Eccentric Plug Adjustment



Adjust Eccentric Plug



MDC With Neutral Start Switch
Top View

Neutral Start Switch Installed

3. Position the eccentric plug so the switch pin is offset toward the control mounting surface. This will provide the best contact between the pin and the cam on the control shaft.
4. Hold the control shaft in its “neutral” position (in the center of the control shaft “free-play” area). Locate the switch pin in the slot of the switch cam by turning the eccentric plug while checking the pin position (depth) in the plug. When the pin engages the cam slot, the pin will be at its maximum depth in the plug. Hand tighten the plug lock nut to hold the eccentric plug in position.
5. Turn the control shaft an equal amount in either direction from “neutral.” The switch pin should move out of the eccentric plug an equal distance when the control shaft is turned. Turn the eccentric plug to center the switch pin with the cam slot. Only a small amount of adjustment in either direction should be needed to center the pin.
6. While holding the eccentric plug in place, tighten the eccentric plug lock nut to 27 Nm (20 ft•lbf). Reinstall and adjust the switch as outlined in the previous section.

   NOTE: The eccentric plug normally requires between 5-1/2 and 6-1/2 turns to install into the control housing .

CAUTION
Do not turn the eccentric plug into or out of the housing beyond specifications.

7. Once the switch is correctly adjusted, hold the switch in place and tighten the locknut to 27 Nm (20 ft•lbf) torque.

(continued)

Checking Switch Continuity

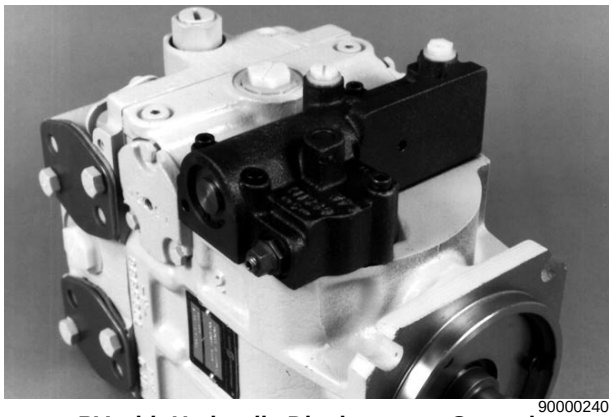
Recheck switch continuity to determine whether additional adjustment of the eccentric plug is necessary.

WARNING
The following procedure requires the vehicle/machine to be disabled (wheels raised off the ground, work function disconnected, etc.) in the event the pump should go into stroke during this adjustment.

1. Install two 50 bar (or 1000 psi) gauges in each of the displacement control cylinder gauge ports (M4 and M5). Attach a continuity checker to the terminals of the neutral start switch.
2. Energize the starter circuit, and start the prime mover.
3. While operating at normal speed and with the pump in its “neutral” (zero flow) position, note the pressure reading on the gauges. This reading should be noted as the base pressure.
4. Slowly move the control handle in one direction while observing the pressure gauges and the continuity checker. Continuity **must** be broken before the pressure on either gauge increases more than 0.9 bar (12 psi) from the base pressure obtained at “neutral.”
5. Slowly move the control handle in the opposite direction. Again, continuity must be broken before the gauge pressure increases more than 0.9 bar (12 psi) from base pressure.
6. Continuity must again be verified when the control is returned to neutral.
7. If continuity is not broken at base pressure plus 0 to 0.9 bar (0 to 12 psi) in either direction, stop the prime mover and readjust the eccentric plug as described in the previous section. If the pressure difference is equal in each direction but greater than 0.9 bar (12 psi), loosen the switch locknut and turn the switch clockwise 1/12 turn (30°) to increase the sensitivity. Retighten the locknut and recheck pressure differences and continuity.
8. After verifying proper control and switch operation, stop the prime mover. Remove the continuity checker and pressure gauges. Reinstall the servo pressure port plugs and reconnect the electrical leads from the machine starter circuit to the neutral start switch. Install and adjust, if necessary, the external control linkage.

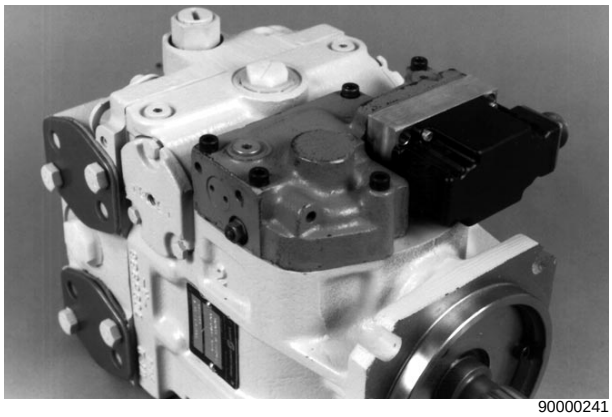
90000255

Checking Continuity of NSS (Gauges Installed in Servo Gauge Ports)



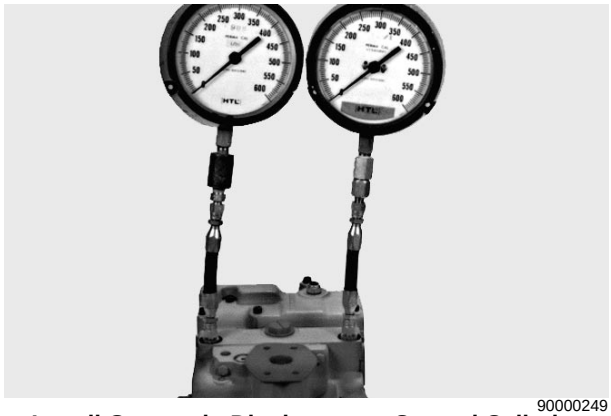
90000240

PV with Hydraulic Displacement Control



90000241

PV with Electric Displacement Control



90000249

Install Gauges in Displacement Control Cylinder Gauge Ports

8.2.4 Hydraulic Displacement Control (HDC) and Electric Displacement Control (EDC) Adjustment

The “neutral” adjustment is the only adjustment that can be made on hydraulic and electric displacement controls. All other functions are preset at the factory. For functional descriptions see Sec. 2.5.2 and 2.5.3.

This adjustment must be made on a test stand or on the vehicle/machine with the prime mover operating.

The neutral adjustment is performed by adjusting a neutral adjusting shaft (earlier production EDCs) or a neutral adjusting screw (HDCs and current production EDCs).

WARNING
The following procedure requires the vehicle/machine to be disabled (wheels raised off the ground, work function disconnected, etc.) in order to prevent injury to the technician and bystanders.

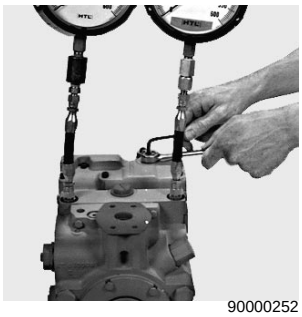
1. Install two 50 bar (or 1000 psi) gauges in each of the two displacement control cylinder gauge ports (M4 and M5). Disconnect the external control input (hydraulic or electronic) from the control. Start the prime mover and operate at normal speed.
2. Loosen the lock nut with a 17 mm hex wrench for the neutral adjusting shaft or with a 10 mm or 13 mm hex wrench for the neutral adjusting screw.

(continued)

3. Using a 5 mm internal hex wrench for the neutral adjusting shaft or a 3 mm or 4 mm internal hex wrench for the neutral adjusting screw, rotate clockwise until the pressure increases in one of the pressure gauges. Note the angular position of the wrench. Then rotate the neutral adjusting shaft or screw counterclockwise until the pressure increases by an equal amount on the other gauge. Again note the angular position of the wrench.
4. Rotate the neutral shaft or adjusting screw clockwise half the distance between the locations noted above. The gauges should read the same pressure (case pressure), indicating that the control is in its "neutral" position.
5. Hold the neutral adjusting shaft or screw stationary. Tighten the neutral shaft lock nut (early production controls) to 22 Nm (195 in•lbf). Tighten the neutral adjusting screw lock nut (later production controls) to 7 Nm (62 in•lbf) for the 6 mm screw or 13.6 Nm (120 in•lbf) for the 8 mm screw. Do not overtorque the nut.
6. Once the neutral position is set, stop the prime mover, remove the gauges, and install the gauge port plugs. Reconnect the external control input.

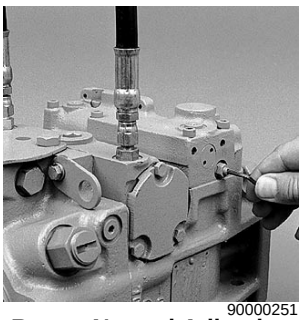
90000250

Rotate Neutral Adjusting Shaft (Early Production)



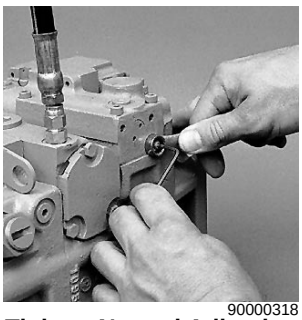
90000252

Tighten Neutral Adjusting Shaft Lock Nut (Early Production)



90000251

Rotate Neutral Adjusting Screw (Later Production)



90000318

Tighten Neutral Adjusting Screw Lock Nut (Later Production)

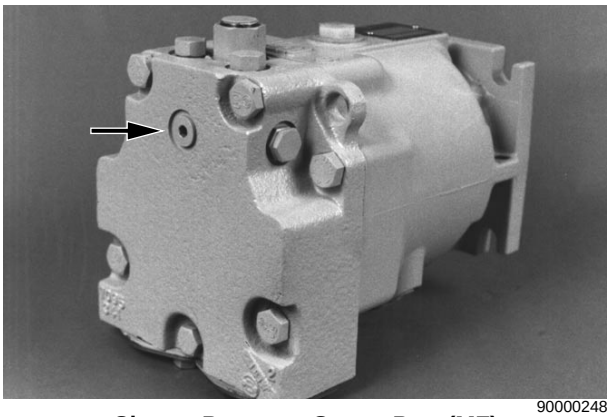
90000355

Rotate Neutral Adjusting Screw (Current Production HDC)

90000356

Tighten Neutral Adjusting Screw Lock Nut (Current Production HDC)

8.3 Motor Adjustments



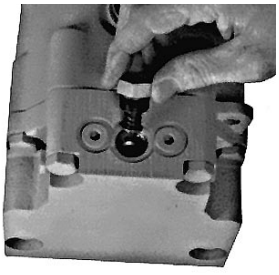
90000248

Charge Pressure Gauge Port (MF)

90M055 NC 0 N
8 N 0 C6 W 00
NNN 00 00 **24**

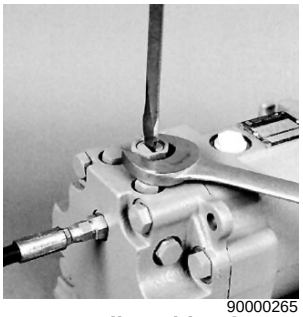
Nominal Charge Pressure Setting

e.g. “24” = 24 bar



90000263

Shim Adjustable Charge Pressure Relief Valve (Motor)



90000265

Screw Adjustable Charge Pressure Relief Valve (Motor)

8.3.1 Charge Relief Valve Adjustment

Motor charge relief is explained in Sec. 2.6.1.

1. To measure motor charge pressure, install a 50 bar (or 1000 psi) pressure gauge in the motor charge pressure gauge port (M3). Also install a gauge to measure case pressure. Operate the system with the pump in stroke (forward or reverse) when measuring motor charge pressure.
2. The following table shows acceptable motor charge pressures for some nominal charge relief valve settings (see model code at right). These pressures assume a reservoir temperature of 49°C (120°F). They are referenced to case pressure and assume a one pump/one motor system.

Model Code Setting	Motor Charge Pressure (Acceptable Range) (±1.4 bar [±20 psi])
10 bar	8.1 bar (117 psi)
18 bar	16.1 bar (233 psi)
20 bar	18.1 bar (262 psi)
24 bar	22.1 bar (320 psi)
28 bar	26.1 bar (378 psi)
30 bar	30.0 bar (435 psi)

3. Earlier production Series 90 motors are equipped with a shim adjustable charge relief valve. Shim kits are available as service items. Adjustment of the charge pressure is accomplished by removing the plug (7/8 inch hex) and changing the shim thickness behind the spring. The plug for this type charge relief port should be torqued to 68 Nm (50 ft•lbf).

   Later production Series 90 motors are equipped with an external screw adjustable charge relief valve. Adjustment of charge pressure is accomplished by loosening the lock nut (with a 1-1/16 inch hex wrench for 030 through 100 units, or a 1-5/8 inch hex wrench for 130 through 250 units), and turning the adjustment plug with a large screwdriver or a 1/2 inch hex wrench. Clockwise rotation of the plug increases the setting, and counterclockwise rotation decreases the setting (at a rate of approximately 3.4 bar [50 psi] per turn). The lock nut for this type charge relief valve should be torqued to 52 Nm (38 ft•lbf).
4. Once the desired charge pressure setting is achieved, remove the gauges.

8.3.2 Displacement Limiter Adjustment (MV)

Both the maximum and minimum displacement may be limited. For description see Sec. 2.6.2.

1. Remove the tamper resistant cap from the displacement limiter screw. Loosen the seal lock nut retaining the displacement limiter adjusting screw with a 19 mm wrench.
2. Rotate the adjusting screw with a 6 mm internal hex wrench. Rotating the maximum displacement adjusting screw clockwise will decrease the maximum displacement of the motor. Rotating the minimum displacement adjusting screw clockwise will increase the minimum displacement of the motor.

WARNINGS
Care should be taken in adjusting displacement limiters to avoid undesirable flow or speed conditions. See Sec. 3 for speed and pressure limits.

The seal lock nut must be retorqued after every adjustment to prevent an unexpected change in operating conditions and to prevent external leakage during unit operation.

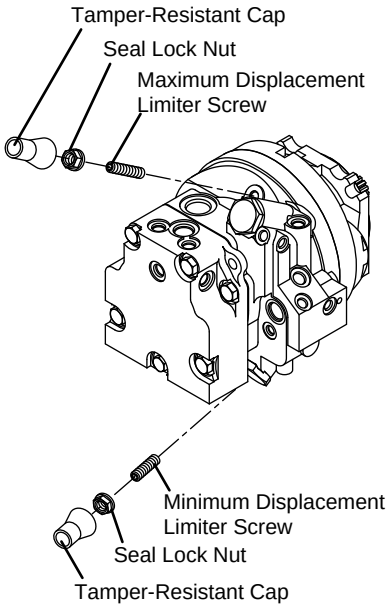
3. After establishing the desired displacement setting, tighten the lock nut on the adjusting screw to 54 Nm (40 ft•lbf). Install a new tamper resistant cap.
4. One turn of the adjusting screw will change the maximum or minimum displacement according to the following chart.

Frame Size	Approx Change in Disp per Rev of Adjusting Screw
055	5.6 cm^3 / Rev (0.34 in^3 / Rev)
075	7.1 cm^3 / Rev (0.43 in^3 / Rev)

CAUTION
The displacement limiters act as travel stops for the swashplate. Do not turn the limiter screws counterclockwise beyond the point of contact with the swashplate for either the maximum or minimum displacement position.

8.3.3 Displacement Control Adjustments

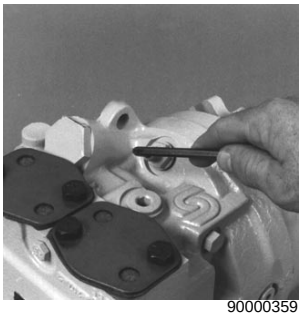
All variable motor displacement control settings do not require adjusting.



SAE Flange Version shown
(Cartridge Version similar)

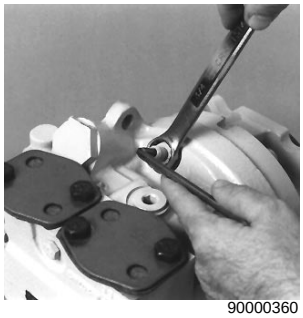
90000837

MV Displacement Limiters



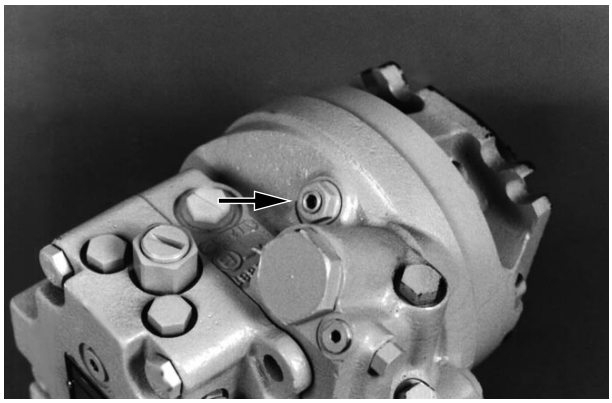
90000359

Rotate Adjusting Screw for Minimum Displacement Limiter



90000360

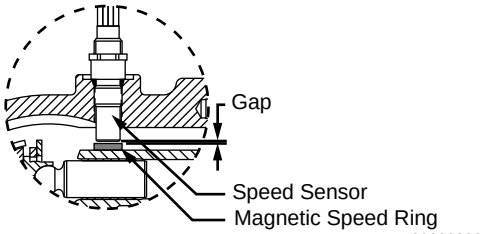
Tighten Lock Nut for Minimum Displacement Limiter



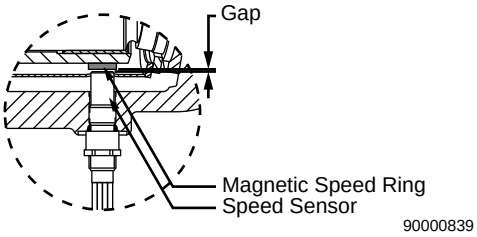
90000352

Maximum Displacement Limiter

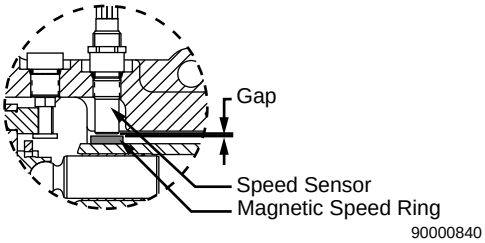
8.4 Speed Sensor Adjustment



Cross Section View of Speed Sensor in Variable Pump



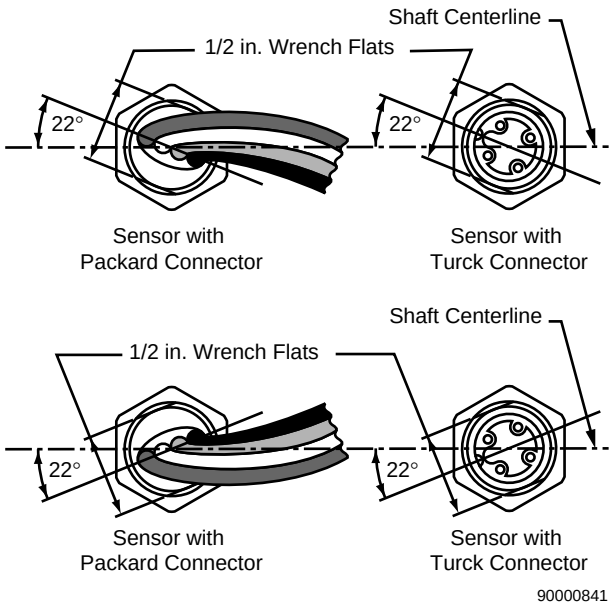
Cross Section View of Speed Sensor in Fixed Motor



Cross Section View of Speed Sensor in Variable Motor

When installing or adjusting the speed sensor on a pump or motor, it must be set at a specific distance from the speed ring on the unit's cylinder. To locate the position of the speed sensor on the unit, see Sec. 4. For a description see Sec. 2.3.2.

1. Loosen the sensor lock nut with an 11/16 inch hex wrench.
2. Turn the sensor clockwise (CW) by hand until it contacts the speed ring.



Positioning Speed Sensor Relative to Pump or Motor Shaft

3. Turn the sensor counterclockwise (CCW) 1/2 turn (180°) to establish the nominal gap of 0.71 mm (0.028 in).
4. Then turn the sensor clockwise (CW) until the wrench flats on sensor body are positioned at a 22° angle to the pump shaft center line.

   NOTE: Many adjustable wrenches have a 22° handle offset.
5. The final sensor position should be between 1/2 (180°) and 1/4 turn (90°) counterclockwise (CCW) from the point where the sensor contacts the speed ring.
6. Hold sensor in position with a 1/2 inch hex wrench while tightening the lock nut to 13 Nm (10 ft•lbf).

9. Minor Repair Instructions

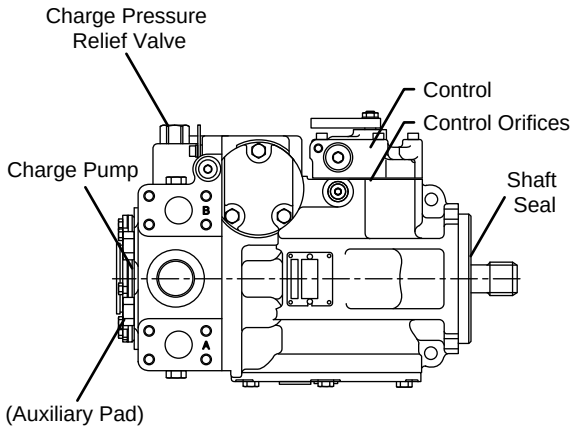
Minor repairs may be performed, following the procedures in this section, without voiding the unit warranty. Although specific models are shown, these procedures apply to all series and types of units in the Series 90 Family.

Cleanliness is a primary means of ensuring satisfactory transmission life, on either new or repaired units. Cleaning parts by using a solvent wash and air drying is adequate, providing clean solvent is used. As with any precision equipment, the internal mechanism and related items must be kept free of foreign materials and chemicals.

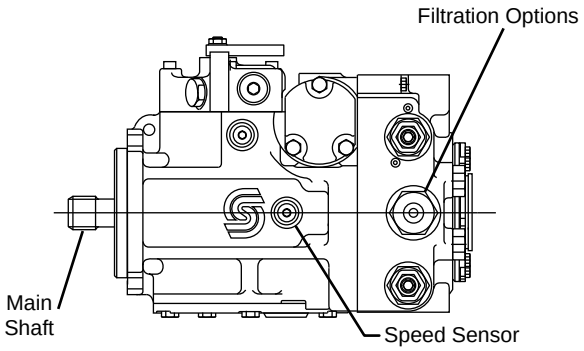
Protect all exposed sealing surfaces and open cavities from damage and foreign material.

It is recommended that all gaskets and O-rings be replaced when servicing. All gasket sealing surfaces must be cleaned prior to installing new gaskets. Lightly lubricate all O-rings with clean petroleum jelly prior to assembly.

Hydrostatic Unit Outlines for Minor Repair Reference



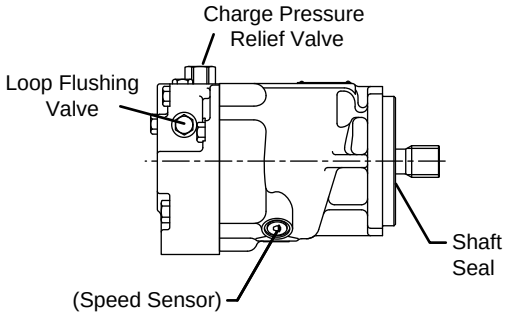
Left Side View



Right Side View

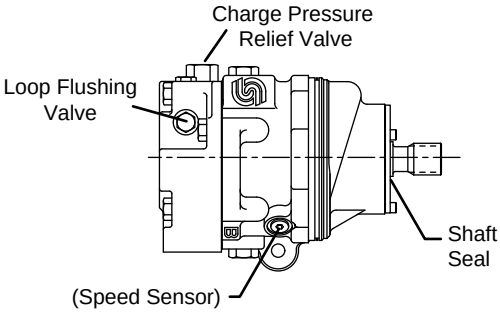
90000843

SAE Flange PV



Left Side View

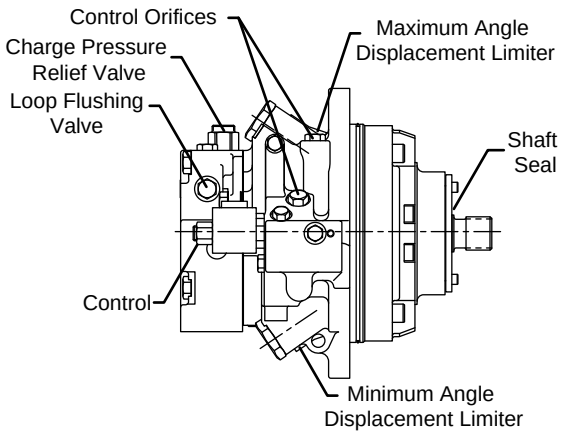
SAE Flange MF



Left Side View

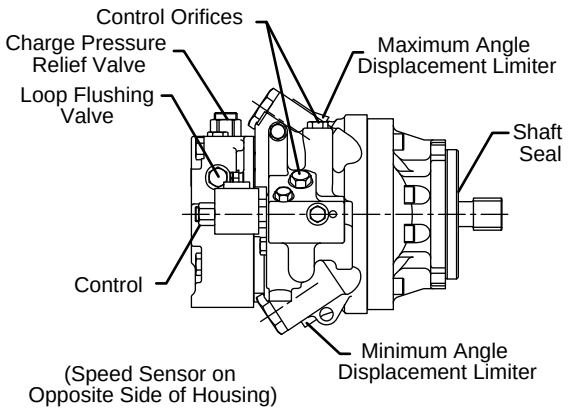
90000844

Cartridge Flange MF



Left Side View

Cartridge Flange MV



Left Side View

90000845

SAE Flange MV

9.1 Pump and Motor Minor Repair

9.1.1 Plug / Fitting Torques

If any plugs or fittings are removed from the pump or motor during servicing, they should be torqued as indicated in the accompanying table.

Always install new O-rings before reinstalling the plugs or fittings.

CAUTION
Plugs or fittings installed into aluminum housings should always be torqued to the lower values specified for internal hex plugs of the same size.

Description	Torque
7/16 — 20 O-Ring 9/16 inch Hex Wrench	20 Nm (15 lbf•ft)
7/16 — 20 O-Ring 3/16 inch Internal Hex Wrench	12 Nm (9 lbf•ft)
9/16 — 18 O-Ring 11/16 inch Hex Wrench	37 Nm (27 lbf•ft)
9/16 — 18 O-Ring 1/4 inch Internal Hex Wrench	23 Nm (17 lbf•ft)
3/4 — 16 O-Ring 7/8 inch Hex Wrench	68 Nm (50 lbf•ft)
3/4 — 16 O-Ring 5/16 inch Internal Hex Wrench	68 Nm (50 lbf•ft)
7/8 — 14 O-Ring 1 inch Hex Wrench	95 Nm (70 lbf•ft)
7/8 — 14 O-Ring 3/8 inch Internal Hex Wrench	68 Nm (50 lbf•ft)
1-1/16 — 12 O-Ring 1-1/4 inch Hex Wrench	163 Nm (120 lbf•ft)
1-1/16 — 12 O-Ring 9/16 inch Internal Hex Wrench	115 Nm (85 lbf•ft)
1-5/16 — 12 O-Ring 1-1/2 inch Hex Wrench	190 Nm (140 lbf•ft)
1-5/16 — 12 O-Ring 5/8 inch Internal Hex Wrench	129 Nm (95 lbf•ft)
1-5/8 — 12 O-Ring 1-7/8 inch Hex Wrench	224 Nm (165 lbf•ft)

9.1.2 Shaft Seal and Shaft Replacement

Lip type shaft seals are used on Series 90 pumps and motors. These seals and/or the shafts can be replaced without major disassembly of the unit. However, replacement usually requires removal of the pump or motor from the machine.

1. Position the pump with the shaft facing up.

   NOTE: If the unit is positioned horizontally when the shaft is removed, the cylinder block could move out of place, making shaft installation difficult.

2. Remove the three or four screws holding the retainer plate and seal carrier to the housing, using a 10 mm hex wrench (030 and 042 units), a 5 mm internal hex wrench (055 through 100 units), or a 6 mm internal hex wrench (130 through 250 units). Remove the retainer plate.

   NOTE: Certain earlier production units use a one piece retainer plate and seal carrier.

3. After removing the screws, the spring force on the shaft may move the seal carrier out of its bore by approximately 5 mm (1/4 inch). If the seal carrier does not move from its bore after removing the screws, pry it from its bore as shown and/or lightly tap the end of the shaft with a soft mallet.

4. Remove the O-ring from the seal carrier.

5. Place seal carrier and seal in an arbor press and press out old seal.

6. Inspect the seal carrier, the new seal and the O-ring for any damage or nicks.

7. Using the arbor press, press the new seal into seal carrier. Be careful not to damage the seal.

   The outside diameter of the seal may be lightly coated with a sealant (such as Loctite High Performance Sealant #59231) prior to installation. This aids in preventing leaks caused by damage to the seal bore in the seal carrier.

90000270

Remove Screws Holding Retainer Plate and Seal Carrier

90000271

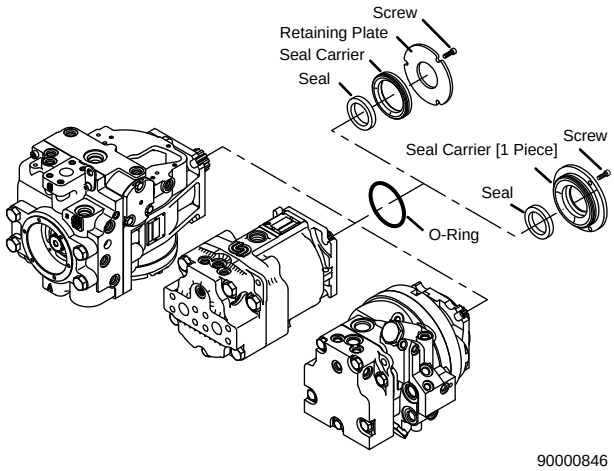
Remove Seal Carrier

90000272

Press Out Old Seal

90000273

New Seal Installed in Carrier

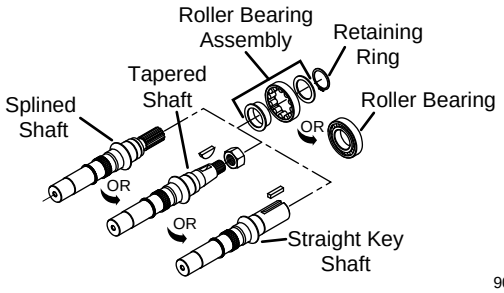


90000846

Series 90 Shaft Seal Components

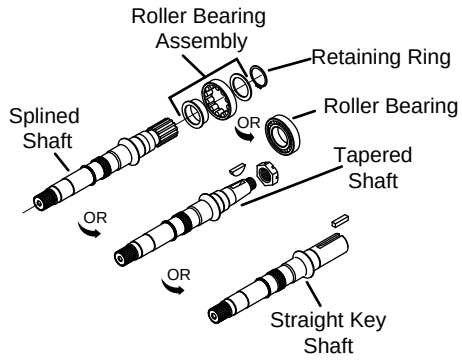
8. Inspect the sealing area on the shaft for rust, wear, or contamination. If the shaft is not being replaced proceed to step 12.
9. Remove shaft and roller bearing assembly from pump or motor. The bearing assembly can be transferred to the new shaft.
10. Remove the retaining ring that secures roller bearing assembly with a snap ring pliers. Remove the roller bearing assembly.
11. Place roller bearing assembly on new shaft and secure with the retaining ring.
12. Wrap spline or key end of shaft with plastic film to prevent damage to the sealing lip on the seal during installation.
13. Prior to assembly, lubricate the O-ring on the O.D. of the seal carrier and the I.D. of the seal with clean petroleum jelly.
14. Assemble the seal carrier and seal over the shaft and into the housing bore. Install the retainer plate (if used).
15. Install the screws and torque to 16 Nm (12 ft•lbf) for 030 through 100 pumps, 32 Nm (24 ft•lbf) for 130 through 250 pumps, 9.5 Nm (7 ft•lbf) for 055 through 100 motors, and 22.5 Nm (16.6 ft•lbf) for 130 motors.

NOTE: Torque the screws in a sequenced pattern then recheck.



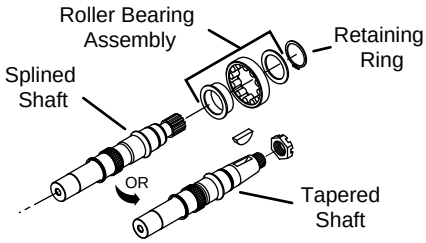
90000866

Fixed Motor Shaft Configuration



90000867

Variable Pump Shaft Configuration



90000868

Variable Motor Shaft Configuration

90000274

Install Seal Carrier

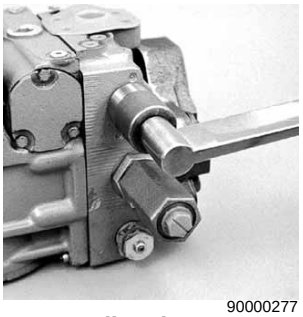
90000275

Torque Retainer Screws

9.2 Pump Minor Repairs

90000276

Remove Multi-Function Valve Cartridge



90000277

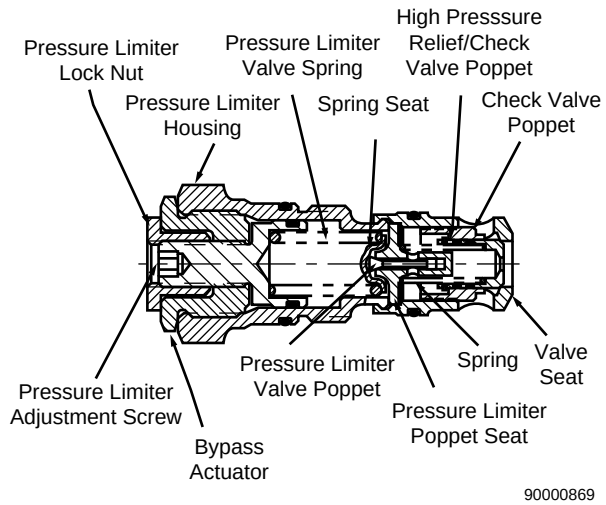
Install and Torque Cartridge

90000278

Multi-Function Valve Cartridge Components (Earlier Production)

90000279

Multi-Function Valve Cartridge Components (Later Production)



90000869

Multi-Function Valve Cartridge Sectional View

9.2.1 Multi-Function Valve Cartridges

1. The multi-function valve cartridge is removed with a 1-1/4 inch (030 through 100 pumps) or a 1-5/8 inch (130 through 250 pumps) hex wrench on the largest hex on the cartridge.
2. Inspect cartridge for damage to parts and O-rings.

   The multi-function valve cartridge may be disassembled for cleaning. However, if the pressure limiter housing assembly is disassembled, the pressure settings must be readjusted. Usually, if there is contamination problem, it will be in the valve seat assembly. If it is not necessary to clean the interior of the cartridge, proceed to step 7.

   NOTE: Multi-function valve components are not sold separately as service parts (except O-rings).
3. On early versions of the multi-function valves, the valve seat assembly is held by a retaining ring. Remove retaining ring with a snap ring pliers.

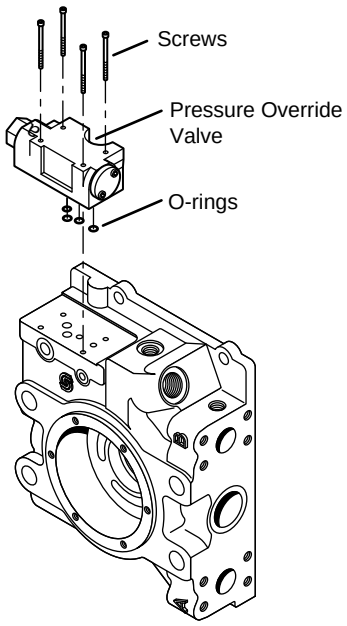
   On late versions, the valve seat section is pressed over a lip. Place the cartridge in a vise and pry the lower section off with an appropriate tool. Maintain sufficient control to prevent the contents from flying loose.
4. Remove pressure limiter lock nut and bypass actuator.
5. Unscrew the pressure limiter adjustment screw from the bypass actuator.
6. Clean and inspect all disassembled parts.
7. Reassemble with new, lightly lubricated O-rings by reversing the above procedure. For early versions assemble with the retaining ring. For late versions, place the cartridge in a vise and press on lower assembly.

CAUTION
The pressure settings must be readjusted after disassembling the pressure limiter housing of the multi-function valve cartridge (see Sec. 8.2.1)

8. Install cartridge in multi-function valve cavity and torque to 89 Nm (66 ft•lbf) for 030 through 100 pumps and 279 Nm (206 ft•lbf) for 130 through 250 pumps. **Do not overtorque the multi-function valve cartridge.**

9.2.2 Pressure Override Valve (Option for 180 Frame Size)

1. Remove the four screws attaching the pressure override valve to the pump end cap with a 5 mm internal hex wrench. Remove the O-rings.
2. Inspect valve for damage to parts.
3. Install new O-rings. Install the valve onto the pump end cap and torque the screws to 16 Nm (12 ft•lbf).



90000870

Pressure Override Valve Components

9.2.3 Charge Relief Valve

The pump charge relief valve may be shim adjustable (early models) or screw adjustable (late models).

1. Remove the shim adjustable charge relief valve plug with a 1 inch hex wrench.

   Before removing the screw adjustable relief valve plug, mark the plug, lock nut, and housing so as to approximately maintain the original adjustment when assembling. Remove the screw adjustable charge relief valve plug by loosening the lock nut with a 1–1/16 inch wrench for 030 through 100 units or a 1-5/8 inch for 130 through 250 units. Unscrew the plug with a large screwdriver or 1/2 inch hex wrench.
2. Remove the spring and relief valve poppet.
3. Inspect the poppet and mating seat in the end cap for damage or foreign material.

   When inspecting shim adjustable valves, do not alter the shims or interchange parts with another valve.
4. Install the poppet and spring. For shim adjustable valves, install the plug and torque to 68 Nm (50 ft•lbf). For screw adjustable valves, install the plug with its lock nut, aligning the marks made at disassembly, and torque the lock nut to 52 Nm (38 ft•lbf).

Check the charge pressure and adjust, if necessary (8.1.1).

90000280

Remove Charge Relief Valve (Shim Adjustable)

90000262

Shim Adjustable Charge Relief Valve

90000264

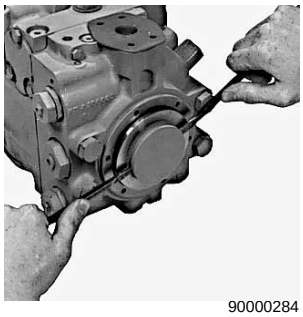
Remove Charge Relief Valve (Screw Adjustable)

90000265

Screw Adjustable Charge Relief Valve

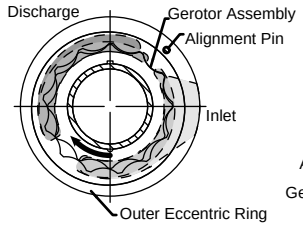
90000282

Remove Retainer Screws

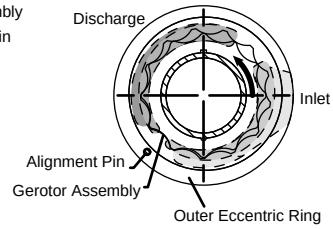


90000284

Remove Charge Pump Cover



Left Hand Rotation (Outside Looking Into Pump)



Right Hand Rotation (Outside Looking Into Pump)

90000871

Orienting Gerotor Outer Ring and Alignment Pin (CCW Rotation)

Orienting Gerotor Outer Ring and Alignment Pin (CW Rotation)

9.2.4 Charge Pump

The following procedure shows how to remove and install a charge pump.

1. For pumps with an auxiliary mounting pad, remove the four screws holding the pad to the end cap and remove the pad. Refer to the Auxiliary Mounting Pad Installation instructions (next section) for details.

   NOTE: Late production pumps may not have the smaller screws installed to secure the end cap to the pump housing when the large screws are removed. On these pumps, secure the end cap to the pump housing with a clamp to avoid gasket damage.

CAUTION
Do not allow the force of the cylinder block spring and swashplate leveler springs to separate the end cap from the pump housing. Gasket damage and external leakage may result.

2. Using a 10 mm (030 through 100 pumps) or a 13 mm (130 through 250 pumps) hex wrench, remove the six screws holding the charge pump cover retainer.
3. Remove the retainer and the charge pump cover. For pumps with an auxiliary mounting pad, remove the auxiliary drive coupling. Note the orientation of the gerotor.

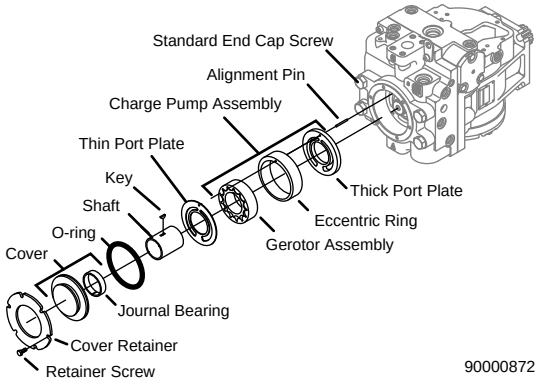
(continued)

4. Remove the charge pump shaft and charge pump drive key.
5. Remove the spacer plate(s), if present (intermediate production pumps only).

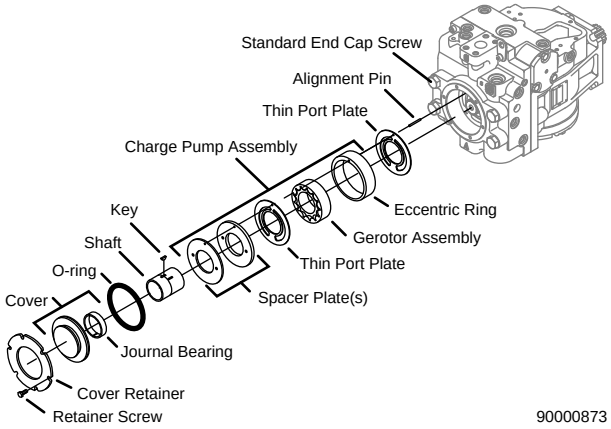
   Remove the charge pump outer port plate, if present (early and intermediate production pumps).

   Remove the charge pump gerotor assembly.
6. Remove the outer eccentric ring and alignment pin.
7. Remove the inner port plate.
8. Inspect all parts for abnormal wear or damage.

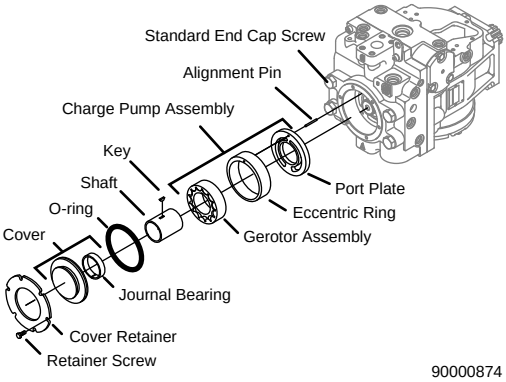
   NOTE: If a different displacement charge pump is being installed, the gerotor assembly, gerotor outer eccentric ring, and inner port plate (early and late production pumps) or outer spacer plate(s) (intermediate production pumps) must be replaced together. If different thickness port plates are used in an early production charge pump assembly, the thicker plate is the inner port plate (installed next to the pump end cap).



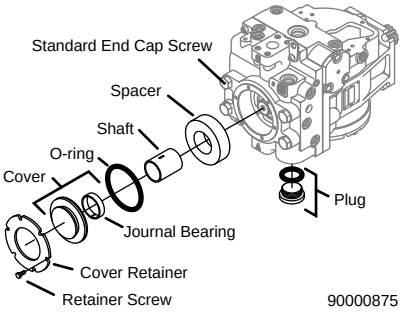
Charge Pump Components (Early Production)



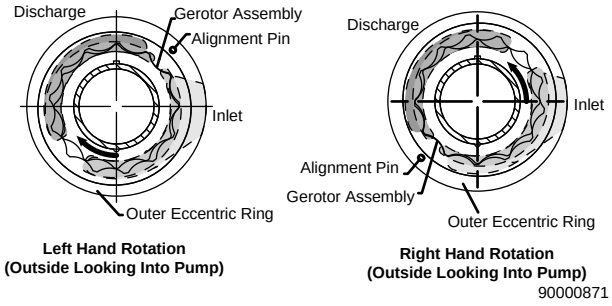
Charge Pump Components (Intermediate Production)



Charge Pump Components (Late Production)



"No Charge Pump" Components



Orienting Gerotor Outer Ring and Alignment Pin (CCW Rotation)

Orienting Gerotor Outer Ring and Alignment Pin (CW Rotation)

90000285

Install Inner Port Plate

90000286

Install Gerotor Assembly Outer Ring

90000287

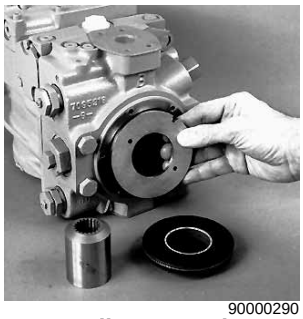
Install Alignment Pin

90000288

Install Gerotor Assembly

90000289

Install Outer Port Plate (Early and Intermediate Production Only)



90000290

Install Spacer Plate (Intermediate Production Only)

Installing the Charge Pump

Be sure to install the charge pump in the proper orientation. If unsure of charge pump rotation, refer to the model code.

*NOTE: The charge pump **rotation** is determined by the orientation of the gerotor assembly outer eccentric ring and the location of the alignment pin in the end cap.*

NOTE: Do not mix charge pump piece parts from different production periods. Always install as a complete assembly.

1. Install the inner port plate and the gerotor assembly outer ring.
2. Install the alignment pin to properly orient the port plates and outer eccentric ring for corresponding pump rotation.
3. Prior to installation, apply a small quantity of petroleum jelly to the I.D., O.D., and side faces of the gerotor assembly to provide initial lubrication.
4. Install the gerotor assembly.
5. Install the outer port plate (early production and intermediate production pumps only).
6. Install the spacer plate, if present (intermediate production pumps).

(continued)

7. Install the charge pump drive key into the charge pump shaft and retain with petroleum jelly.

   NOTE: Intermediate production 75 cc and 100 cc pumps use the same charge pump drive shaft. Two keyways are provided in the drive shaft for the charge pumps used in these units. The rear keyway (with identifier groove) is used in 75 cc pumps. The front keyway (closest to the internally splined end of the shaft) is used in 100 cc pumps.

8. Install the charge pump shaft. The internally splined end of the shaft must engage the main pump shaft.

   NOTE: The outside diameter of the internally splined end of some early production charge pump shafts was chamfered. Early production end caps may not be machined to accept a non-chamfered shaft. Always use a chamfered charge pump shaft in pumps with the early end cap.

9. For pumps with an auxiliary mounting pad, install the auxiliary drive coupling.

10. Install a new O-ring onto the non-auxiliary pad charge pump cover. (If an auxiliary pad is installed, an O-ring is not used on the cover.)

11. Carefully remove the alignment pin from the charge pump parts. Install the pin in its hole in the charge pump cover (see previous page for correct orientation) and retain with petroleum jelly. Install the cover (with alignment pin) into the end cap and aligned charge pump parts. (Take care not to damage the cover O-ring, if used.)

CAUTION
In order to avoid loss of charge pressure in pumps with an auxiliary mounting pad, always install the charge pump cover with the pad drain hole located on the same side of the end cap as the charge inlet port. Refer to Sec. 9.2.5 Auxiliary Pad Installation for details.

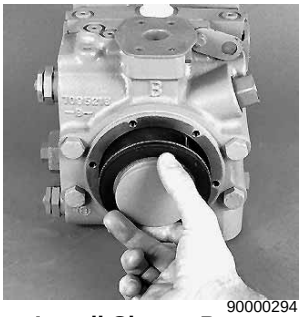
12. Install the charge pump cover retainer and the six hex screws and torque the screws to 13.5 Nm (10 ft•lbf) for 030 through 100 pumps, and 32 Nm (24 ft•lbf) for 130 through 250 pumps.

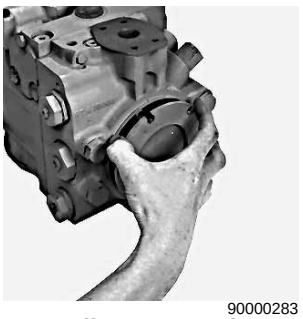
13. For pumps with auxiliary mounting pads, install the O-ring and auxiliary mounting pad adaptor onto the end cap. Refer to Sec. 9.2.5 for instructions on auxiliary pad installation.

90000291
Keyways in Charge Pump Shaft (Intermediate Production 075 and 100)


90000292
Install Charge Pump Shaft


90000293
Aligning Pin Installed in Cover

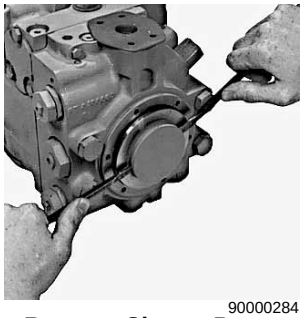

90000294
Install Charge Pump Cover


90000283
Install Cover Retainer


90000295
Torque Retainer Screws

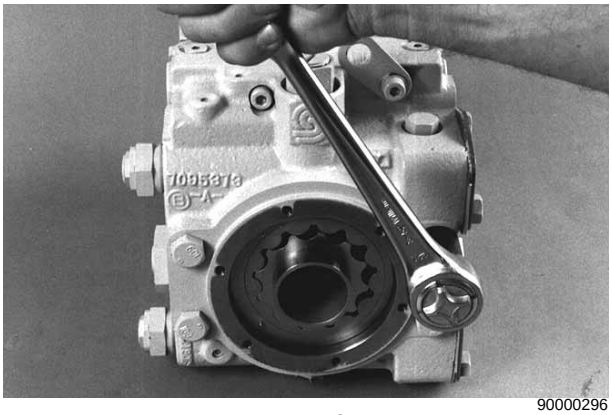
90000282

Remove Screws and Retainer



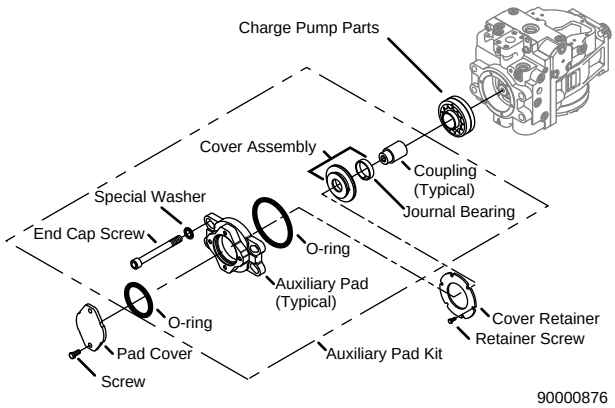
90000284

Remove Charge Pump Cover



90000296

Remove Large End Cap Screws



90000876

Auxiliary Pad Components (Typical)

9.2.5 Auxiliary Pad Installation

1. Using a 10 mm (030 through 100 pumps) or a 13 mm (130 through 250 pumps) hex wrench, remove the six screws holding the charge pump cover retainer. Remove the retainer.
2. Remove the charge pump cover and its O-ring.

   NOTE: The original charge pump cover will not be used when installing the auxiliary pad.
3. Remove the four large screws which fasten the end cap to the pump housing.

Frame Size	Hex Wrench Size	
	Internal Hex	External Hex
030 & 042 (early)	8 mm	
042 (late)	10 mm	
055		19 mm
075 & 100		24 mm
100 & 130	14 mm	
180 & 250	17 mm	

NOTE: Late production pumps may not have the smaller screws installed to secure the end cap to the pump housing when the large screws are removed. On these pumps, secure the end cap to the pump housing with a clamp to avoid gasket damage.

CAUTION
Do not allow the force of the cylinder block spring and swashplate leveler springs to separate the end cap from the pump housing. Gasket damage and external leakage may result.

4. Take care to assure the surfaces are clean and free of any foreign material or paint prior to installing the auxiliary pad.

(continued)

5. Install the auxiliary drive coupling onto the pump drive shaft spline (auxiliary drive spline must be toward the rear of the pump).
6. Carefully remove the alignment pin from the charge pump parts. Install the pin in its hole in the new charge pump cover (with hole for the auxiliary coupling) and retain with petroleum jelly. Install the new charge pump cover with alignment pin into the end cap and the aligned charge pump parts.

CAUTION
In order to avoid loss of charge pressure, always install the charge pump cover with the pad drain hole located on the same side of the end cap as the charge inlet port.

7. Install the charge pump cover retainer and the six hex screws and torque the screws to 13.5 Nm (10 ft•lbf) for 030 through 100 pumps, and 32 Nm (24 ft•lbf) for 130 through 250 pumps.
8. Install O-ring on end cap pilot.
9. Install the auxiliary mounting pad adapter on external pilot on rear of end cap.
10. Install four new large screws and washers through the mounting pad and end cap into the housing. Torque per the accompanying table.

Frame Size	Wrench Size (Internal Hex)	Torque	
		Nm	lbf•ft
030 & 042 (early)	8 mm	75	55
042 (late) & 055	10 mm	122	90
075	14 mm	256	189
100 & 130	14 mm	298	220
180 & 250	17 mm	580	429

11. Install the O-ring and flange cover or auxiliary pump.

Auxiliary Pad Conversion

To convert an auxiliary mounting pad to a different size mounting pad, use the above procedure with the following additions:

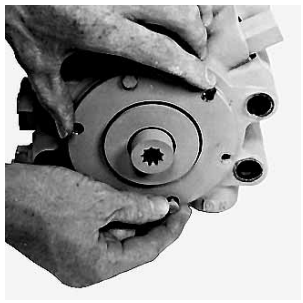
After removing the charge pump cover (step 2), remove the old auxiliary drive coupling.

After removing the four end cap retaining screws (step 3), remove the old auxiliary mounting pad adapter.


90000297
Install Drive Coupling

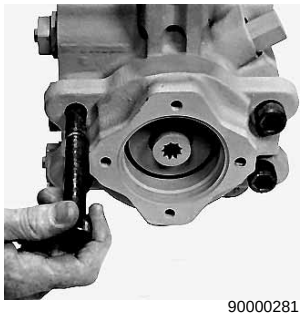

90000298-
Install Alignment Pin in Cover (CCW Rotation shown)

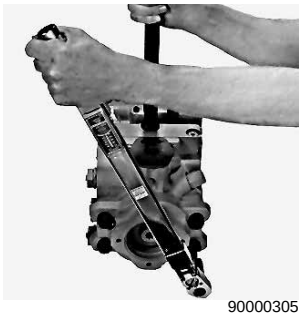

90000299
Install New Charge Pump Cover


90000300
Install Screws and Cover Retainer

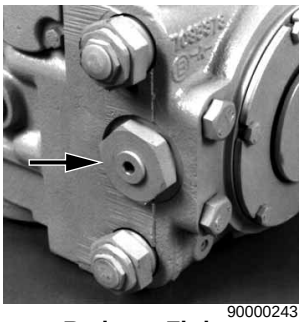

90000302
Install O-Ring on End Cap Pilot


90000303
Install Auxiliary Pad Adapter


90000281
Install Auxiliary Pad Adapter Screws


90000305
Torque Pad Adapter Screws

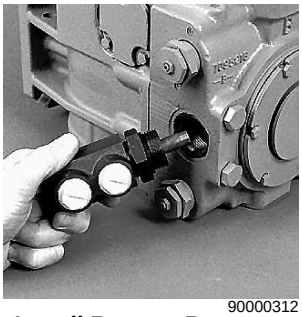
90000310
Charge Pump Inlet



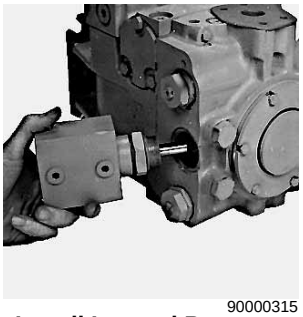
90000243
Reducer Fitting

90000311
Remote Pressure Filter Manifold

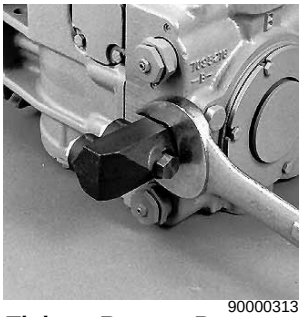
90000314
Integral Pressure Filter Head



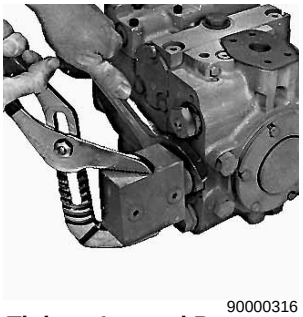
90000312
Install Remote Pressure Filter Manifold



90000315
Install Integral Pressure Filter Head



90000313
Tighten Remote Pressure Filter Manifold Lock Nut



90000316
Tighten Integral Pressure Filter Head Lock Nut

9.2.6 Filtration Options

9.2.6.1 Suction Filtration Installation

1. Install the hydraulic fitting to connect the external suction filter to the charge pump inlet port.
2. The reducer fitting (placed on the charge pressure gauge port) is installed as follows.

Frame Size	Wrench Size	Torque	
042	1–1/4"	70 Nm	[52 lbf•ft]
055 - 130	1–1/2"	122 Nm	[90 lbf•ft]
180 & 250	1–1/2"	156 Nm	[115 lbf•ft]

The gauge port plug is torqued to 27 Nm (20 ft•lbf).

9.2.6.2 Remote Charge Pressure Filtration or Integral Charge Pressure Filtration

Install either of these two filtration devices as follows.

1. Remove the reducer fitting, located at charge pressure gauge port, from pump end cap (this part will not be used).
2. Install the filter manifold or filter head into the port. The hydraulic tube should enter its mating bore in the pump end cap with a low force.
3. After rotating the filter manifold or filter head clockwise so that the threads engage with the threads in the end cap, continue to rotate it clockwise between 6 and 7 revolutions. Face manifold or head to the desired position.

CAUTION
Failure to install the filter manifold or filter head to a sufficient depth in the end cap will result in insufficient engagement of the tube in the end cap bore. This may allow unfiltered oil to bypass the filter and enter the charge system.

4. While holding the filter manifold or filter head in the desired position, tighten the swivel lock nut.

Frame Size	Wrench Size	Torque	
042	1–3/8"	70 Nm	52 lbf•ft
055 - 130	1–5/8"	122 Nm	90 lbf•ft
180 & 250	1–5/8"	156 Nm	115 lbf•ft

5. After installing the integral pressure filter head assembly, install the filter canister per the instructions on the filter canister.

9.3 Pump Controls

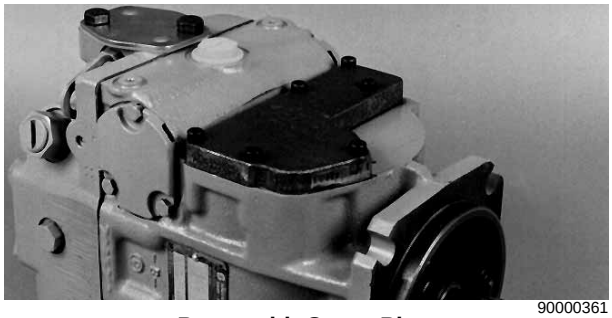
9.3.1 Cover Plate

1. Thoroughly clean external surfaces prior to removal of cover plate.
2. Using a 5 mm internal hex wrench, remove the eight cover plate mounting screws. Remove the cover plate and gasket from housing.

CAUTION
Protect exposed surfaces and cavities from damage and foreign material.

3. In preparation for installing the cover plate, place a new gasket on the housing. Place the cover plate into position and install the screws. Torque the screws to 16 Nm (12 ft•lbf).

   NOTE: A sealing washer must be installed under the head of any mounting screws that are installed into "thru" holes in the housing.



90000361

Pump with Cover Plate

90000319

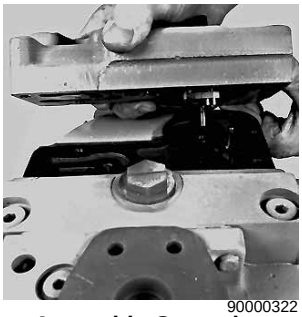
Remove Mounting Screws

90000320

Remove Control

90000321

Inner Face of Control



90000322

Assemble Control to Linkage

90000323

Assemble Control to Pump

90000324

Torque Mounting Screws

9.3.2 Manual Displacement Control (MDC)

1. Thoroughly clean external surfaces prior to removal of control.
2. Using a 5 mm internal hex wrench, remove the eight control mounting screws. Remove the control (with orifice check valve and spring) and control gasket from housing.

CAUTION
Protect exposed surfaces and cavities from damage and foreign material.

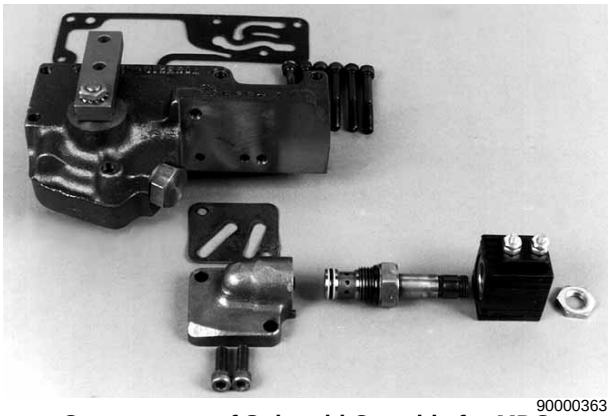
3. In preparation for installing the control, place a new gasket on the housing. Inspect to assure that the control orifice check valve and spring are in their proper position in the control.
4. While setting the control into position, engage the pin on the control linkage into the mating hole in the link attached to the swashplate.
5. With the control in position, move control lever both directions to check proper engagement of control linkage pin. Proper engagement will be indicated by centering torque as the lever is moved from center. Non-engagement of control linkage pin is indicated by lack of centering torque as the lever is moved. In case of non-engagement remove the control and repeat the above procedure.
6. Align the control gasket and install the screws. Torque the screws to 16 Nm (12 ft•lbf).

   NOTE: A sealing washer must be installed under the head of any mounting screws that are installed into "thru" holes in the housing.
7. If the control is equipped with a neutral start switch, refer to the "MDC Neutral Start Switch Adjustment" instructions in Sec. 8.2.3.

WARNING
The neutral start switch "neutral" must be readjusted after reassembling the MDC module.

9.3.3 Solenoid Override Valve for MDC

1. Thoroughly clean external surfaces prior to removal of valve.
2. Using a 5 mm internal hex wrench, remove the two screws and remove solenoid manifold from housing. Remove the old gasket.
3. The solenoid may be removed from the valve by removing the nut with a 3/4 inch hex wrench. The solenoid valve may be removed from the manifold with a 7/8 inch hex wrench.
4. When installing the solenoid valve into the manifold, the valve should be torqued to 18.6 Nm (13.8 ft•lbf). When installing the solenoid onto the valve, torque the nut to 2.8 Nm (25 in•lbf).
5. In preparation for installing the solenoid manifold, place a new gasket on the control housing. Install the manifold onto the control housing, align the gasket, and install the screws. Torque screws to 13.5 Nm (10 ft•lbf).

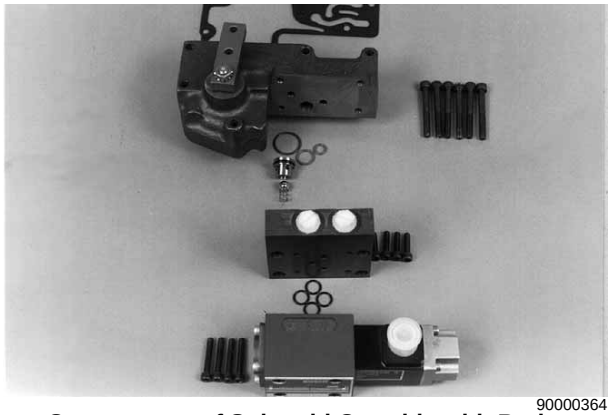


90000363

Components of Solenoid Override for MDC

9.3.4 Solenoid Override Valve for MDC with Pressure Released Brake

1. Thoroughly clean external surfaces prior to removal of valve.
2. Using a 4 mm internal hex wrench, remove the four solenoid valve mounting screws. Remove the solenoid valve (with O-rings) from the adapter plate.
3. Using a 4 mm internal hex wrench, remove the four adapter plate mounting screws. Remove the adapter plate and O-rings from the control housing.
4. Remove the check valve seat and O-ring from the control side of the adapter plate. Remove the check ball and spring.
5. Install a new O-ring on the check valve seat and reassemble the check valve spring, ball, and seat into the adapter plate.
6. Install new O-rings on the adapter plate. Place the adapter plate into position and install the screws. Torque the screws to 5.4 Nm (48 in•lbf).
7. Install new O-rings onto the solenoid valve assembly and install the solenoid valve onto the adapter plate. Install the screws and torque to 5.4 Nm (48 in•lbf).



90000364

Components of Solenoid Override with Brake Pressure Defeat for MDC

90000325

Remove Mounting Screws

90000326

Remove Control

90000327

Inner Face of Control

90000328

Assemble Control to Linkage

90000329

Install Mounting Screws

90000330

Torque Mounting Screws

90000332

PCP Components

90000334

Torque PCP Valve Screws

9.3.5 Hydraulic and Electric Displacement Controls

1. Thoroughly clean external surfaces prior to removal of control.
2. Using a 5 mm internal hex wrench, remove the eight control mounting screws. Remove the control (with orifice check valve and spring) and control gasket from housing.

CAUTION
Protect exposed surfaces and cavities from damage and foreign material.

3. In preparation for installing the control, place a new gasket on the housing. Inspect to ensure that the control orifice check valve and spring are in their proper position in the control.
4. While setting the control into position, engage the pin on the control linkage into the mating hole in the link attached to the swashplate.
5. With the control in position, move control assembly left and right to check engagement of pin in the link. Proper engagement will be indicated by an increasing resistance as the control is moved away from center position. Non-engagement of pin will be indicated by lack of spring force. In case of non-engagement, remove control and repeat the above procedure.
6. Align the control gasket and install the screws. Torque the screws to 16 Nm (12 ft•lbf).

   NOTE: A sealing washer must be installed under the head of any mounting screws that are installed into "through" holes in the housing.

9.3.6 Pressure Control Pilot (PCP) for Electric Displacement Control

1. Thoroughly clean external surfaces of control.
2. Using a 4 mm internal hex wrench, remove the four screws and remove the PCP.
3. Check surfaces for nicks or damage. Clean internal screens.
4. Install new O-rings in PCP Housing. Place PCP against EDC housing and install the screws. Torque to 5.4 Nm (48 in•lbf).

   NOTE: Do not remove black plastic cover from the aluminum plate. This is not a serviceable item and will void the product warranty.

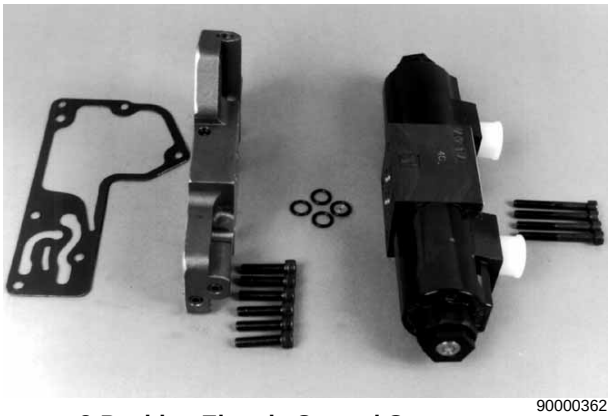
9.3.7 3-Position (FNR) Electric Control

1. Thoroughly clean external surfaces prior to removal of control.
2. Using a 4 mm internal hex wrench, remove the four solenoid valve mounting screws. Remove the solenoid valve (with O-rings and orifice) from the adapter plate.
3. Using a 5 mm internal hex wrench, remove the eight adapter plate mounting screws. Remove the adapter plate and gasket from housing.

CAUTION
Protect exposed surfaces and cavities from damage and foreign material.

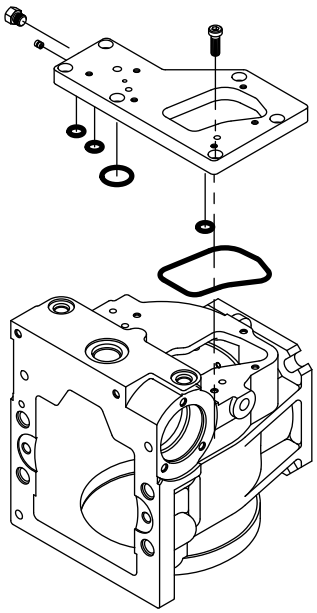
4. Inspect the orifice installed between the valve and adapter plate. This orifice MUST be installed in the case drain passage for proper pressure limiter operation.
5. In preparation for installing the adapter plate, place a new gasket on the housing. Place the adapter plate into position and install the screws. Torque the screws to 16 Nm (12 ft•lbf).

   NOTE: A sealing washer must be installed under the head of any mounting screws that are installed into "thru" holes in the housing.
6. Install new O-rings and the orifice onto the solenoid valve assembly and install the solenoid valve onto the adapter plate. Install the screws and torque to 5.4 Nm (48 in•lbf).



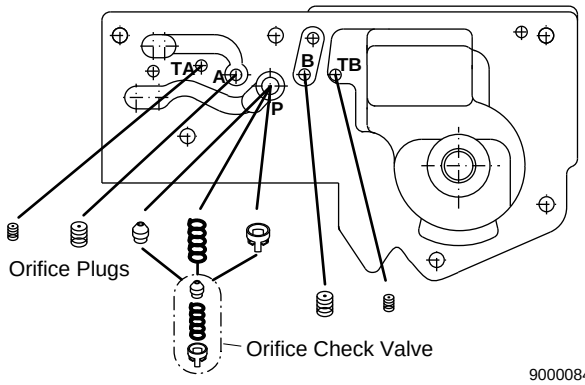
90000362

3-Position Electric Control Components



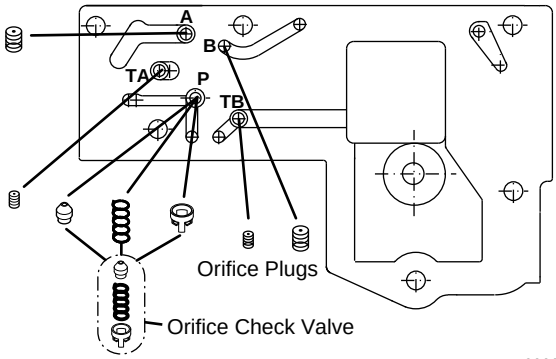
90000847

Displacement Control Adapter Plate (Early Production 130cc Pumps Only)



90000848

The Underside of an MDC Module Showing Orifice Locations



90000849

The Underside of an HDC/EDC Module Showing Orifice Locations

9.3.8 Displacement Control Components

9.3.8.1 Displacement Control Adapter Plate (Early Production 130 Pumps Only)

The screws fastening the control adapter plate to the housing have retaining compound on the threads. They are removed with a 6 mm internal hex wrench.

When installing the adapter plate, ensure the O-rings are in the proper position and torque the screws to 32 Nm (24 ft•lbf).

9.3.8.2 Displacement Control Filter Screens

If the pump is equipped with control filter screens in the pump housing (late production), they should be pressed into position (with the rounded edge of the filter screens facing the control) until they are flush to 2.0 mm (0.08 inch) below the surface of the housing.

9.3.8.3 Displacement Control Orifice Check Valve

1. Remove the control assembly as described in the instructions for the specific displacement control (9.3.2, 9.3.6, or 9.3.7).
2. The orifice check valve is located in the control assembly, at the surface of the pump housing face. Remove the spring retainer and spring from the orifice check valve cavity and then remove the orifice check valve.
3. Install the desired orifice check valve in the cavity and then install the spring and spring retainer to hold the orifice check valve in position.
4. Assemble the control onto the pump. Refer to the instructions for the specific control (9.3.2, 9.3.6, or 9.3.7).

9.3.8.4 Displacement Control Orifices

1. Remove the control assembly as described in the instructions for the specific displacement control (9.3.2, 9.3.6, or 9.3.7).
2. Orifice plugs may be located in the control assembly, at the pump housing face surface. Remove the orifice plugs with a 4 mm internal hex wrench. Note the location of each plug, do not interchange plugs. Torque the orifice plugs to 3 Nm (32 in•lbf).
3. Assemble the control onto the pump. Refer to the instructions for the specific control.

9.4 Minor Repairs - Motor

9.4.1 Loop Flushing and Charge Relief Valves

9.4.1.1 Loop Flushing Valve

1. Using an 11/16 inch wrench, remove the hex plugs and O-rings from both sides of the valve. Remove the springs, shoulder washers, and flushing valve shuttle spool. Note orientation of the washers. Remove the flushing valve spool.
2. Inspect parts for damage or foreign material.

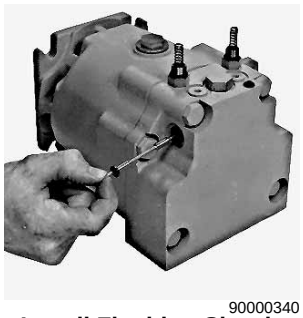
   NOTE: Early production motors used a small diameter shuttle valve spool. Late production motors use a larger diameter spool.
3. Install flushing valve spool in end cap, then install the shoulder washers (with shoulders facing "out") and springs on each end of the spool. Install the hex plugs with O-rings, and torque to 41 Nm (30 ft•lbf) on 030 through 100 motors or 68 Nm (50 ft•lbf) on 130 motors.

9.4.1.2 Motor Charge Relief Valve

1. Remove the shim adjustable charge relief valve plug with a 7/8 inch hex wrench. Before removing the screw adjustable relief valve plug, mark the plug, lock nut, and housing so as to be able to maintain the original adjustment when assembling. Remove the screw adjustable charge relief valve plug by loosening the lock nut with a 1-1/16 inch hex wrench for 030 through 100 units, or a 1-5/8 inch hex wrench for 130 units, and unscrewing the plug with a large screwdriver or 1/2 inch hex wrench.
2. Remove the spring and valve poppet.
3. Inspect the poppet and mating seat in the end cap for damage or foreign material. When inspecting shim adjustable valves, do not alter the shims or interchange parts with another valve.
4. Install the poppet and spring. For shim adjustable valves, install the plug and torque to 68 Nm (50 ft•lbf). For screw adjustable valves, install the plug with its lock nut, aligning the marks made at disassembly, and torque the lock nut to 52 Nm (38 ft•lbf).
5. Check and adjust the charge pressure.

90000338
Remove Plugs and Springs

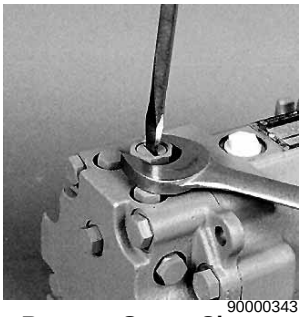
90000339
Remove Flushing Shuttle Spool



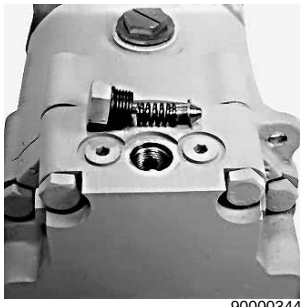
90000340
Install Flushing Shuttle Spool

90000341
Torque Plugs

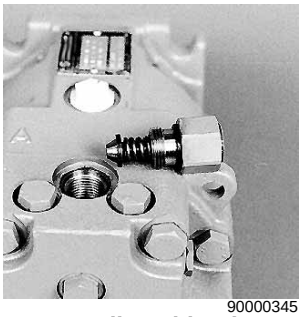
90000342
Remove Shim Charge Relief



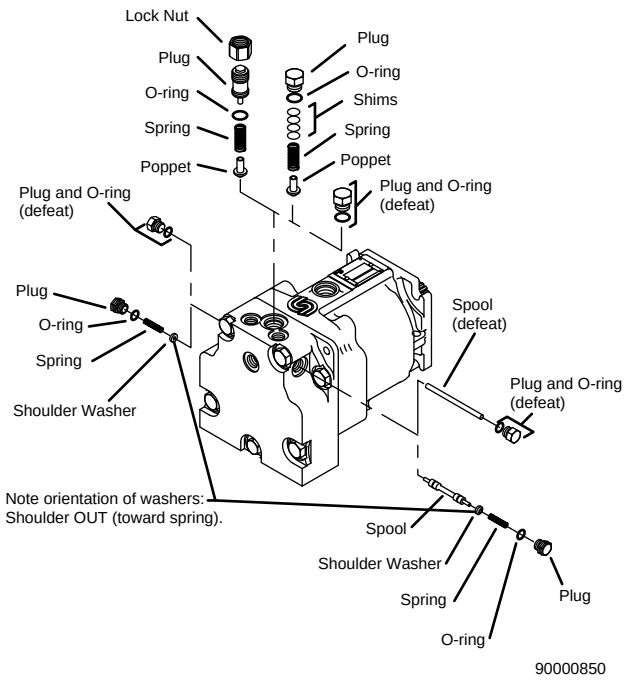
90000343
Remove Screw Charge Relief



90000344
Shim Adjustable Charge Relief Valve



90000345
Screw Adjustable Charge Relief Valve



Motor Charge Relief Valve and Loop Flushing Valve Parts

9.4.1.3 Defeating the Loop Flushing Valve

1. Remove loop flushing valve components (these parts will not be used).
2. Install defeating spool into spool bore in end cap.
3. Install hex plugs provided and torque to 41 Nm (30 ft•lbf) on 030 through 100 motors, or 68 Nm (50 ft•lbf) on 130 motors.
4. Remove charge relief valve components (these parts are not necessary).
5. Replace with the hex plug provided and torque to 41 Nm (30 ft•lbf) on 030 through 100 motors, or 68 Nm (50 ft•lbf) on 130 motors.

9.4.2 Variable Motor Displacement Limiters

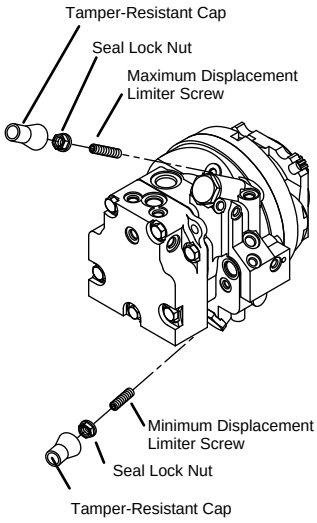
1. Remove the tamper-resistant cap from the displacement limiter. Using a 19 mm hex wrench, loosen the seal lock nut and remove the nut. Remove the limiter screw from the motor housing with a 6 mm internal hex wrench.
2. Install the limiter screw and seal lock nut. Do not install a new tamper-resistant cap until the limiter has been adjusted.
3. The displacement limiter should be initially adjusted so the motor swashplate contacts the limiter screws BEFORE it contacts the internal stops. Hold the swashplate in its maximum or minimum angle position and turn the appropriate limiter screw clockwise until it contacts the swashplate. Then turn the screw an additional 1/4 turn clockwise and torque the seal lock nut to 54 Nm (40 ft•lbf).
4. Final adjustment of the displacement limiters should be performed on a test stand. **Do not turn the limiter screws counterclockwise beyond their initial adjustment positions.**

WARNING
Care should be taken in adjusting displacement limiters to avoid undesirable speed conditions. The seal lock nut must be retorqued after every adjustment to prevent an unexpected change in operating conditions and to prevent external leakage during unit operation.

One full turn of the displacement limiter adjustment screw will change the displacement as follows:

Frame Size	Approx Change in Disp per Rev of Adjusting Screw
055	5.6 cm^3 / Rev (0.34 in^3 / Rev)
075	7.1 cm^3 / Rev (0.43 in^3 / Rev)

5. Following the final adjustment, install new tamper resistant caps.

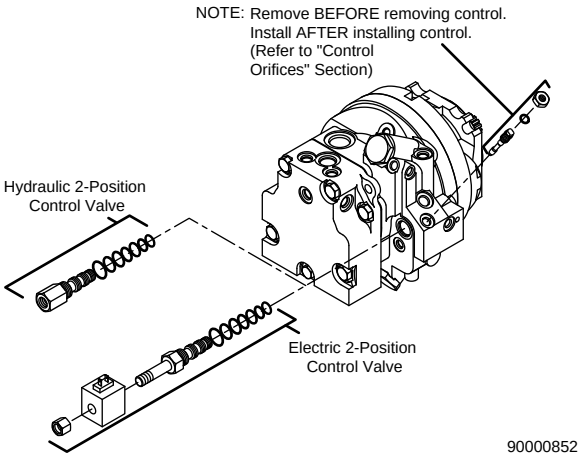


SAE Flange Version shown
(Cartridge Version similar)

90000851

MV Displacement Limiters

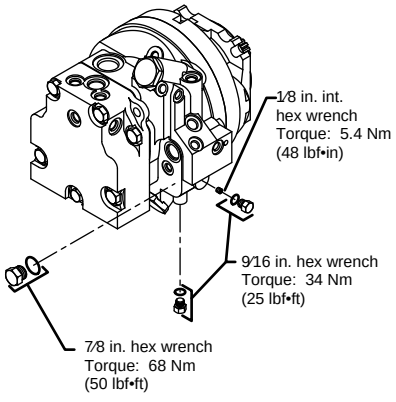
9.5 Variable Motor Controls



MV Control Components

9.5.1 Electrohydraulic 2-Position Control (Types NA, NB, NC, and ND)

1. Thoroughly clean external surfaces prior to removal of the control.
2. Disconnect the external electrical signal connection.
3. Remove the hex nut and solenoid from the control valve.
4. Remove the orifice check valve for the maximum angle control cylinder, if equipped.
5. Remove the control valve from the motor housing.
6. Remove O-rings from the valve.
7. Install new O-rings on the control valve.
8. Install the valve into the motor housing and torque to 47 Nm (35 ft•lbf). **Do not overtorque the control valve.** Over-torquing may result in the valve spool sticking.
9. Install the solenoid onto the valve and torque the hex nut to 5 Nm (44 in•lbf). **Do not overtorque the nut.**
10. If previously removed, reinstall the orifice check valve. Reconnect the external electrical signal connection.



MV Control Plugs

9.5.2 Hydraulic 2-Position Control (Type PT)

Follow the steps above, except that in step 2 a *hydraulic* signal line will be disconnected, and step 3 is not applicable.

9.5.3 Control Plugs

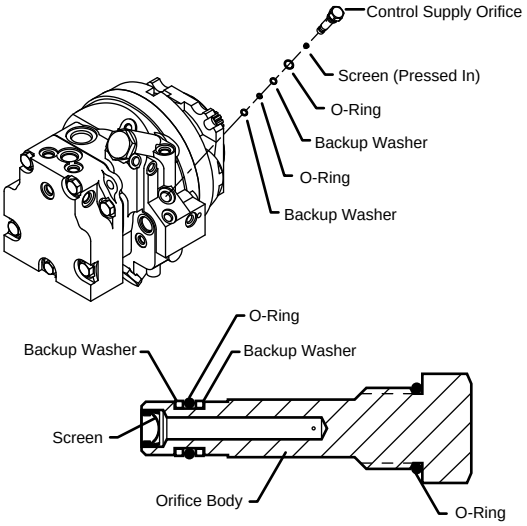
Remove the control plugs from the housings of earlier production motors, if necessary. Install new O-rings, reinstall, and torque.

9.5.4 Variable Motor Control Orifices

9.5.4.1 Control Supply Orifice

1. Remove the control supply orifice from the motor housing with an 11/16 inch hex wrench.
2. Remove the O-rings and the backup washers. Check that the filter screen is secure in the orifice body and that the screen and the orifice are not plugged.
3. Install new backup washers and O-rings onto the orifice body. Install the orifice into the motor housing and torque to 37 Nm (27 ft•lbf).

CAUTION
Do not interchange the control supply orifice with the minimum displacement orifice (next section).



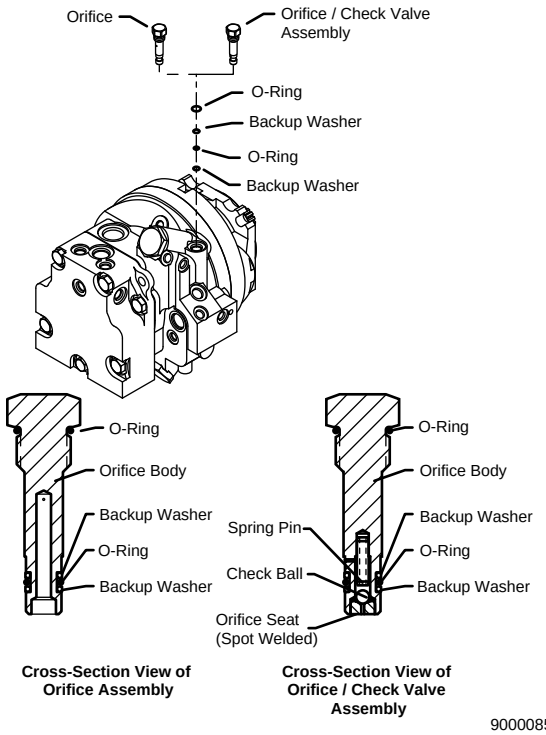
90000854

MV Control Supply Orifice

9.5.4.2 Minimum Displacement Cylinder Orifice or Orifice Check Valve

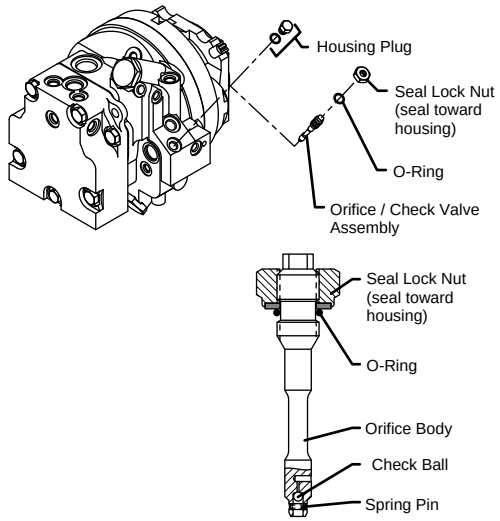
1. Remove the minimum displacement cylinder drain orifice or the orifice check valve from the motor housing with an 11/16 inch hex wrench.
2. Remove the O-rings and the backup washers. Check that the orifice is not plugged. Check that the check valve seat is secure in the body and that the check ball is free.
3. Install new backup washers and O-rings onto the orifice body. Install the orifice into the motor housing and torque to 37 Nm (27 ft•lbf).

CAUTION
Do not interchange the control supply orifice (previous section) with the minimum displacement orifice.



90000855

MV Minimum Displacement Orifice



Cross-Section View of Orifice / Check Valve Assembly

90000856

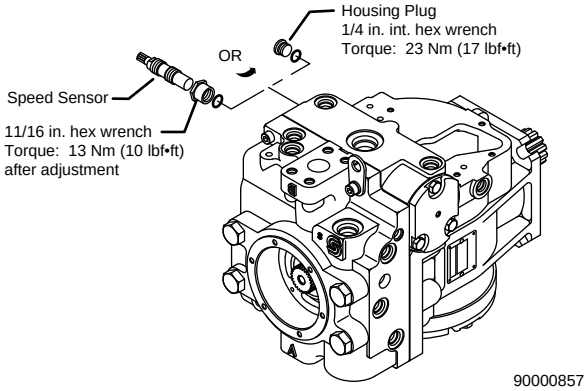
MV Maximum Displacement Orifice

9.5.4.3 Maximum Displacement Cylinder Orifice Check Valve

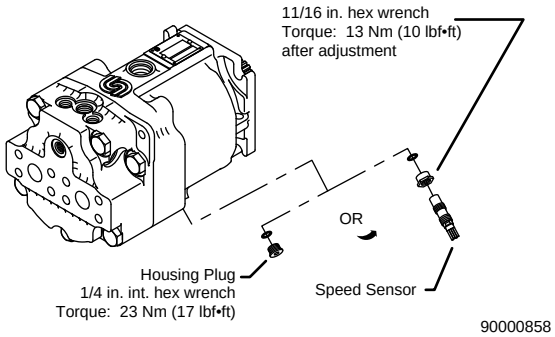
1. Remove the seal lock nut with a 3/4 inch hex wrench. Remove the maximum displacement cylinder orifice check valve from the motor housing with a 1/4 inch end wrench. Remove the O-ring. The check ball in the valve must be free.
2. Reinstall the check valve and torque to 15 Nm (11 ft•lbf). Install a new O-ring. Install the seal lock nut with the seal toward the motor housing. **Hold the check valve from turning while torquing the seal lock nut to 34 Nm (25 ft•lbf).**
3. If no orifice check valve is installed, the housing plug may be removed with a 9/16 inch hex wrench. Always install a new O-ring. Reinstall the plug and torque to 20 Nm (15 ft•lbf).

9.6 Speed Sensor

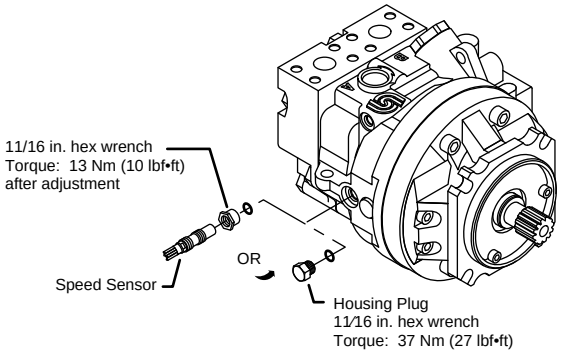
1. Remove the speed sensor by disconnecting the electrical connector, loosening the lock nut, and unscrewing the speed sensor from the pump or motor housing.
2. Always install a new O-ring before installing the sensor.
3. Reinstall the speed sensor (with lock nut and O-ring) into the housing. Adjust the gap between the sensor and the magnetic speed ring as instructed in Sec. 8.4 and torque the sensor lock nut.
4. If a speed sensor is not installed, the housing plug should be torqued as indicated in the accompanying figure.



Typical Location of Speed Sensor - PV



Typical Location of Speed Sensor - MF

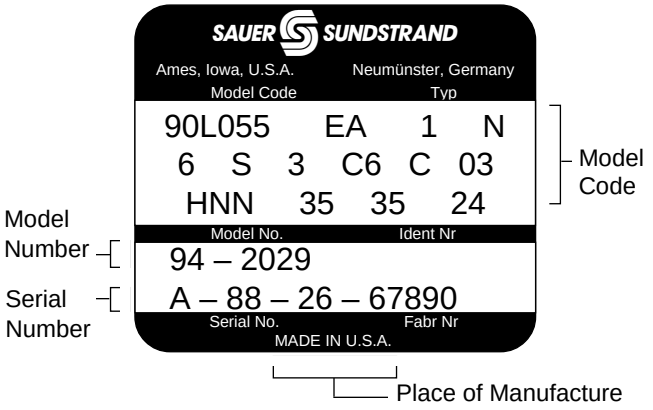


Typical Location of Speed Sensor - MV

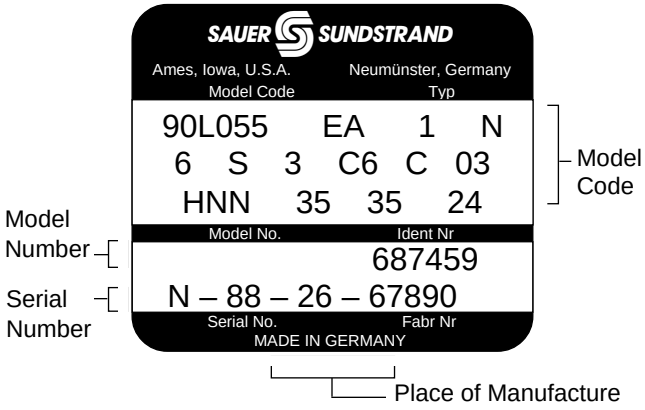
10. Exploded View Parts Drawings

10.1 Variable Pumps

10.1.1 Name Plates

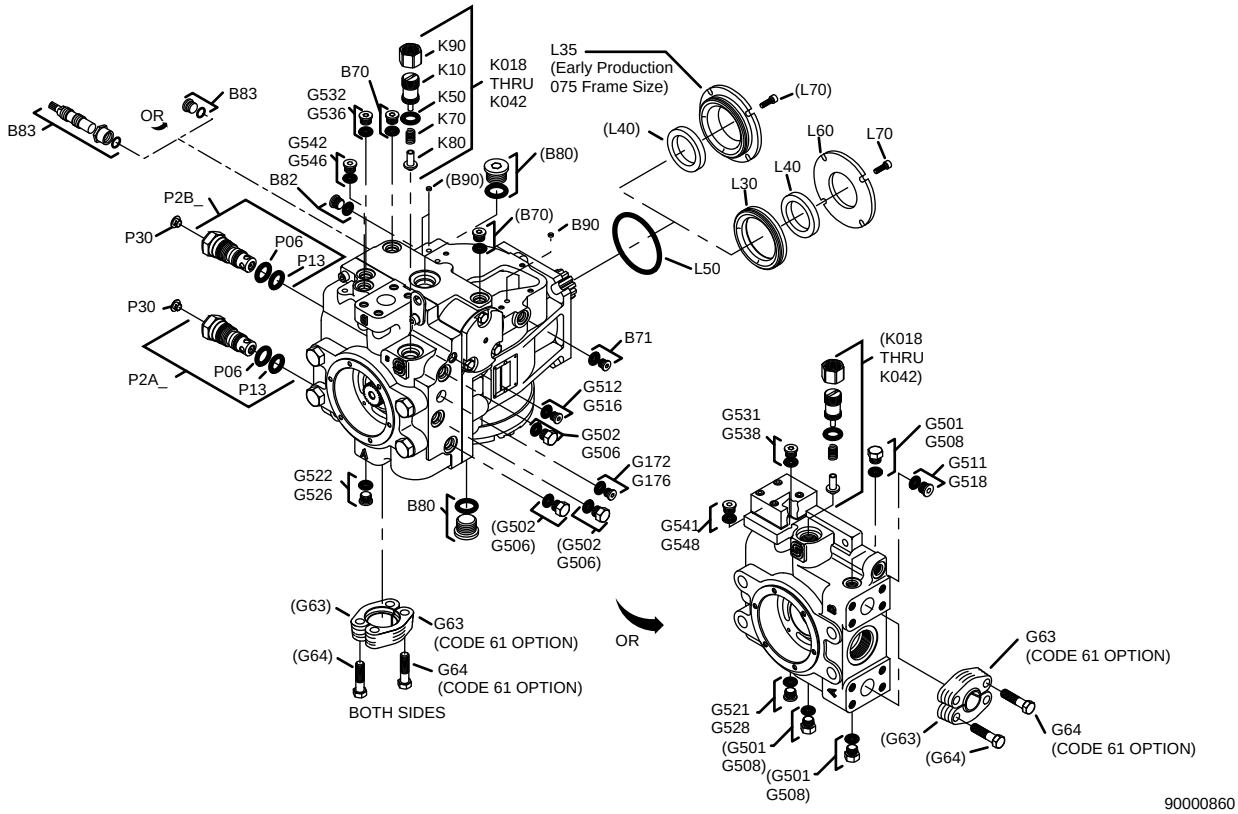


Name Plate (U.S.A. Production)

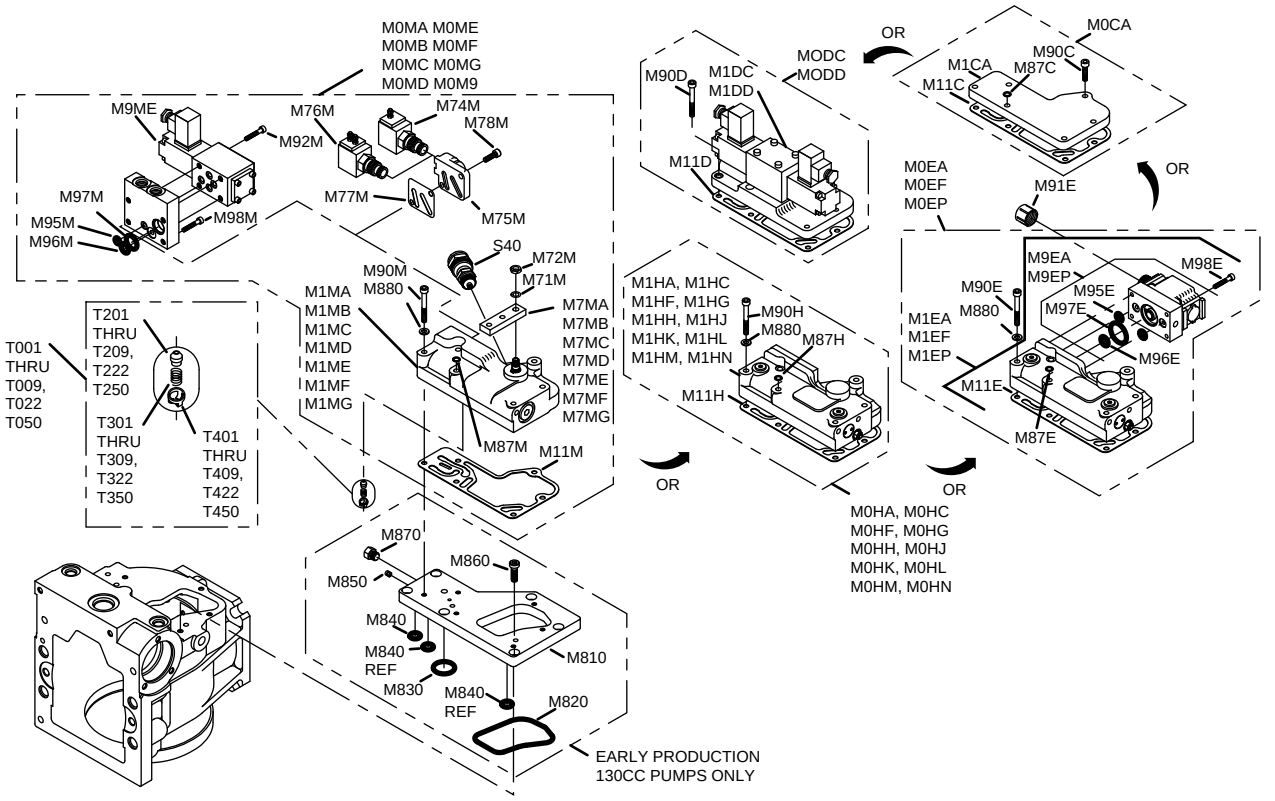


Name Plate (German Production)

10.1.2 Minor Repair Parts

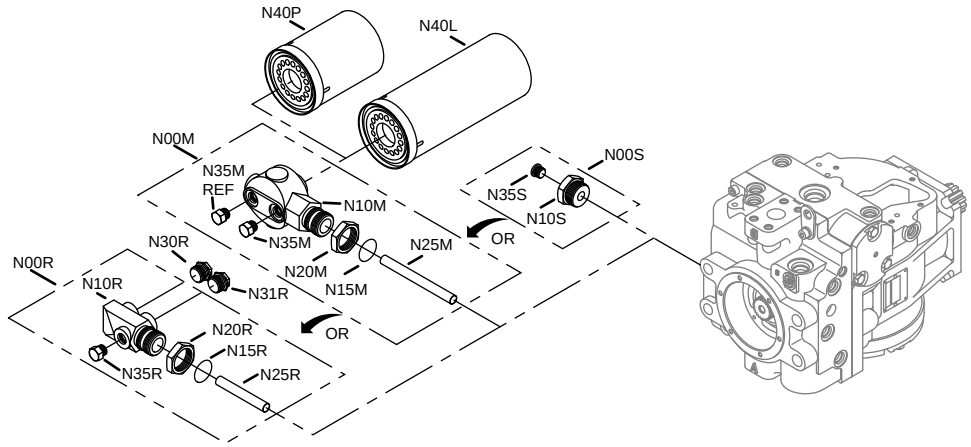


10.1.3 Controls

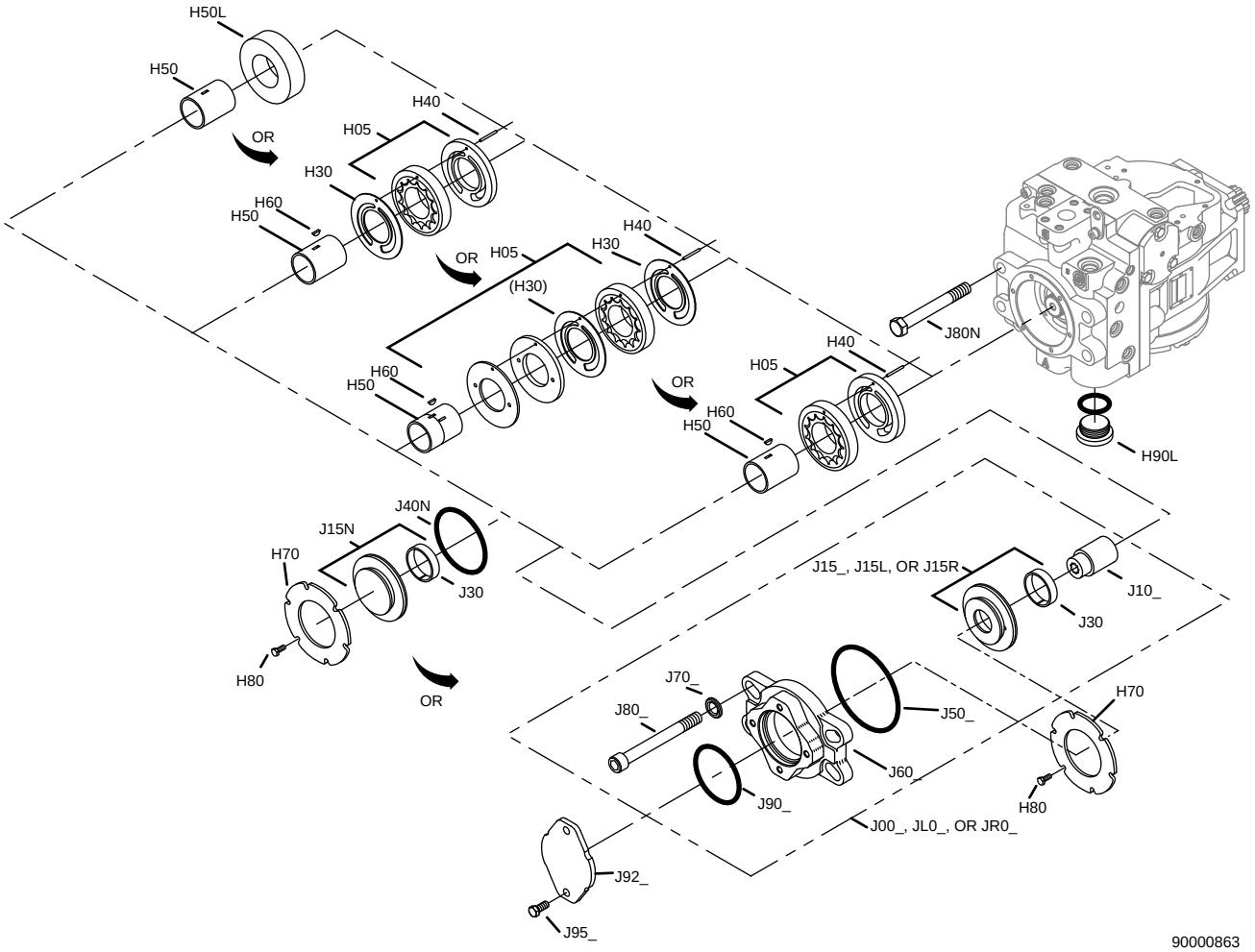


90000861

10.1.4 Filtration Options, Charge Pump Options, Auxiliary Pad Options



90000862



90000863

10.1.5 Pump Parts List

Item	Description	Qty
B70	Plug	2
B71	Plug	1
B80	Plug	1
B82	Plug	1
B90	Control Filter Screen	3
G63	Split Clamp	4
G64	Screw - Shipping Cover	4
G172	Plug	1
G176	Plug	1
G501	Plug	3
G502	Plug	3
G506	Plug	3
G508	Plug	3
G511	Plug	1
G512	Plug	1
G516	Plug	1
G518	Plug	1
G521	Plug	1
G522	Plug	1
G526	Plug	1
G528	Plug	1
G531	Plug	1
G532	Plug	1
G536	Plug	1
G538	Plug	1
G541	Plug	1
G542	Plug	1
G546	Plug	1
G548	Plug	1
H05B-H	Kit - Charge pump	1
H05L	Spacer (No Charge pump)	1
H30	Port plate	2
H40	Pin	1
H50	Charge pump shaft	1
H60	Key	1
H70	Retaining plate	1
H80	Screw	6
H90L	Plug	1
J00A	Aux. mtg. ‘A’ flange	1
J00B	Aux. mtg. ‘B’ flange	1
J00C	Aux. mtg. ‘C’ flange	1
J00D	Aux. mtg. ‘D’ flange	1
J00T	Aux. mtg. ‘A’ flange (11T)	1
J00V	Aux. mtg. ‘B-B flange	1
J00N	Aux. mtg. flange - none	1
J10A-V	Coupling	1
J15	Charge pump cover assembly	1
J15N	Charge pump cover assembly	1
J30	Bushing	1

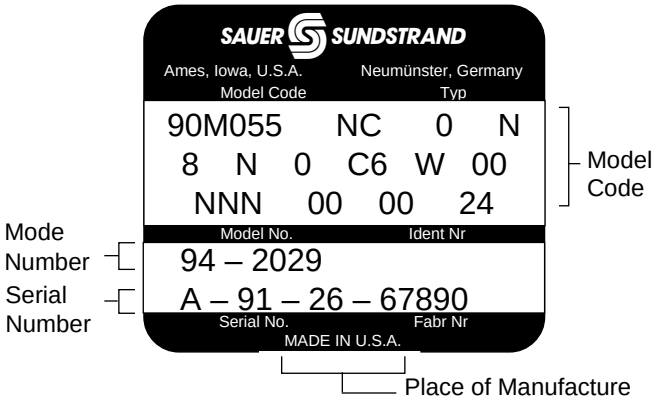
Item	Description	Qty
J50A-V	O ring	1
J60A/T	Flange adaptor	1
J60B/V	Flange adaptor	1
J60C	Flange adaptor	1
J60D	Flange adaptor	1
J70A-V	Washer	4
J80A-V	Screw	4
J80N	Screw	4
J90A-V	O ring	1
J92A-V	Cover plate	1
J95A-V	Screw	2/4
K10	Plug Assembly	1
K50	O ring	1
K70	Spring	1
K80	Poppet	1
K90	Nut	1
L30	Seal carrier	1
L35	Seal carrier	1
L40	Lip seal	1
L50	O ring	1
L60	Retainer	1
L70	Screw	3
L8	Key	1
L9	Slotted nut	1
M0CA	Control - Cover Plate Kit	1
M1CA	Cover plate	1
M11C	Control gasket	1
M87C	Washer, seal (042)	1
M90C	Screw	6
M0DC	Control kit 3 position FNR 12v	1
M0DD	Control kit 3 position FNR 24v	1
M1DC	Control 3 position FNR 12v	1
M1DD	Control 3 position FNR 24v	1
M80	Control gasket	1
M87D	Washer, seal (042)	1
M90D	Screw	6
M0EA	EDC kit w/MS connector	1
M0EP	EDC kit w/Packard connector	1
M1EA	EDC w/MS connector	1
M1EP	EDC w/Packard connector	1
M9EA	PCP type 3 oil filled (MS)	1
M9EA	PCP type 3 oil filled (Packard)	1
M80	Control gasket	1
M87E	Washer, seal (042)	1
M90E	Screw	6
M91E	Plastic cap (MS)	1
M95E	O ring	2

Item	Description	Qty
M96E	O ring	1
M97E	O ring	1
M98E	Screw	4
M0HA	HDC kit	1
M0HC	HDC kit	1
M1HA	HDC	1
M1HC	HDC	1
M80	Control gasket	1
M87H	Washer, seal (042)	1
M90H	Screw	6
M0MA	MDC w/o neutral start switch	1
M7M	Control handle	1
M71M	Washer	1
M72M	Nut	1
M80	Control gasket	1
M87M	Washer, seal (042)	1
M90M	Screw	6
M0MB	MDC w/neutral start switch	1
M7M	Control handle	1
M71M	Washer	1
M72M	Nut	1
M80	Control gasket	1
M87M	Washer, seal (042)	1
M90M	Screw	6
S40	Neutral start switch kit	1
M0MC	MDC w/sol. valve	1
M7M	Control handle	1
M71M	Washer	1
M72M	Nut	1
M74M	Solenoid valve	1
M75M	Control manifold	1
M77M	Manifold gasket	1
M78M	Screw	2
M80	Control gasket	1
M87M	Washer, seal (042)	1
M90M	Screw	6
M0MD	MDC w/sol. valve, nss	1
M7M	Control handle	1
M71M	Washer	1
M72M	Nut	1
M75M	Control manifold	1
M76M	Solenoid valve	1
M77M	Manifold gasket	1
M78M	Screw	2
M80	Control gasket	1
M87M	Washer, seal (042)	1
M90M	Screw	6
S40	Neutral start switch kit	1

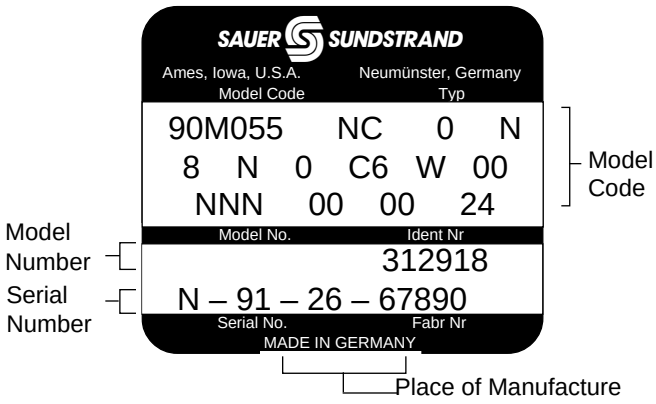
Item	Description	Qty
M810	Adapter Plate - Control (130 cc)	1
M820	O-ring (130 cc)	1
M830	O-ring (130 cc)	1
M840	O-ring (130 cc)	2
M850	Plug (130 cc)	1
M860	Screw (130 cc)	6
M870	Plug (130 cc)	1
N00M	Filtration manifold kit (Int)	1
N10M	Manifold	1
N15M	O ring	2
N20M	Nut	1
N25M	Tube	1
N30M	Plug	2
N40L	Filter	1
N40P	Filter	1
N00R	Filtration manifold kit (Rmt)	1
N10R	Manifold	1
N15R	O ring	1
N20R	Nut	1
N25R	Tube	1
N30R	Plastic plug	2
N00R	Plug	1
N00S	Filtration kit (Suction Flt)	1
N10S	Reducer fitting (Suction Flt)	1
N30S	Plug	1
P2A	Multi-function valve assembly	1
P2B	Multi-function valve assembly	1
P6	O ring	2
P13	O ring	2
P30	Plastic plug	2
T001-9	Control orifice kit	1
T201-9	Orificed check valve	1
T301-9	Spring	1
T401-9	Spring retainer	1

10.2 Fixed Motor

10.2.1 Name Plates

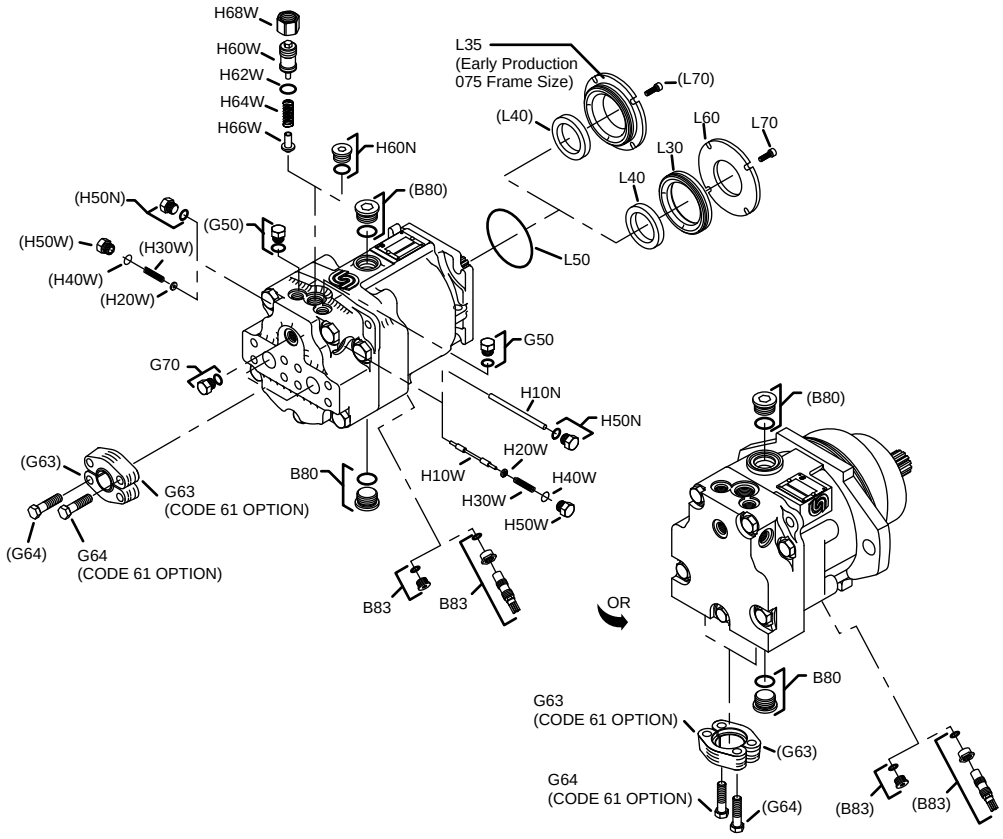


Name Plate (U.S.A. Production)



Name Plate (German Production)

10.2.2 Minor Repair Parts



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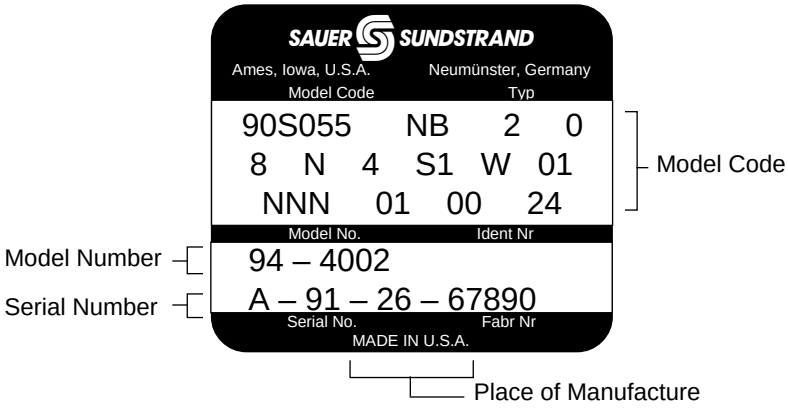
10.2.3 Fixed Motor Parts List

Item	Description	Qty	Item	Description	Qty
B80	Plug	2	L30	Seal carrier	1
B83	Plug	1	L35	Seal carrier	1
B83	Speed sensor	1	L40	Lip seal	1
			L50	O ring	1
G50	Plug	2	L60	Retainer	1
G70	Plug	1	L70	Metric screw	3
G63	Split Clamp	4			
G64	Screw - Shipping Cover	4	L8	Key	1
			L9	Slotted nut	1
H10N	Loop flushing spool - defeat	1			
H50N	Plug	2			
H10W	Shuttle valve spool	1			
H20W	Spring guide	2			
H30W	Spring	2			
H40W	O-ring	2			
H50W	Special plug	2			
H60W	Charge relief valve plug	1			
H62W	O-ring	1			
H64W	Spring	1			
H66W	Charge relief poppet	1			
H68W	Lock nut	1			

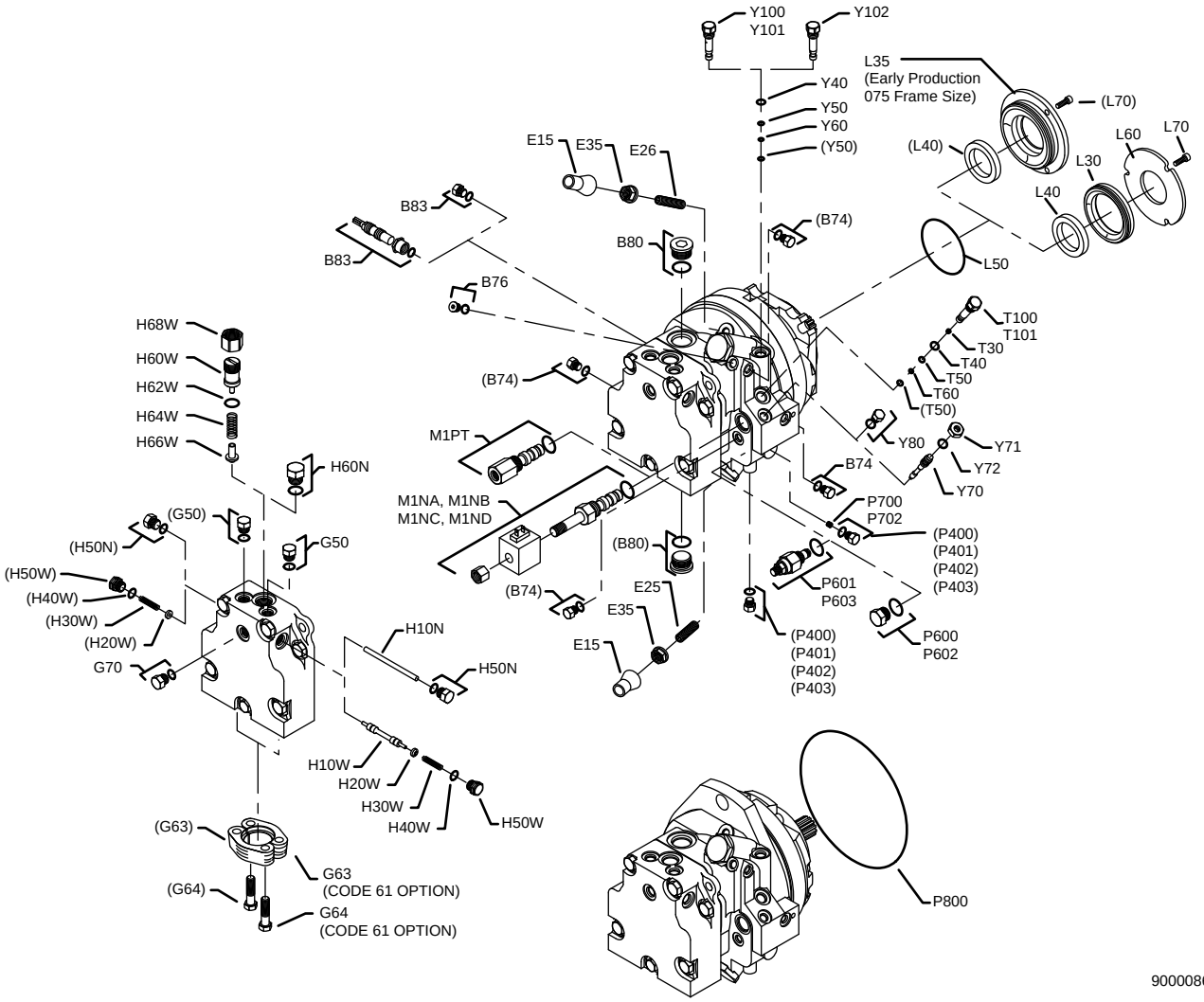
10.3 Variable Motor

10.3.1 Name Plate



Name Plate (U.S.A. Production)

10.3.2 Minor Repair Parts



10.3.3 Variable Motor Parts List

Item	Description	Qty
B74	Plug	4
B76	Plug	1
B80	Plug	2
B83	Plug	1
B83	Speed sensor	1
E15	Cap	1
E25	Set screw	1
E35	Nut - Seal Lock	1
G50	Plug	2
G63	Split flange clamp	4
G64	Shipping cover screw	4
G70	Plug	1
H10N	Loop flushing spool - defeat	1
H50N	Plug	2
H60N	Plug	1
H10W	Shuttle valve spool	1
H20W	Spring guide	2
H30W	Spring	2
H40W	O-ring	2
H50W	Special plug	2
H60W	Charge relief valve plug	1
H62W	O-ring	1
H64W	Spring	1
H66W	Charge relief poppet	1
H68W	Lock nut	1
L8	Key	1
L9	Slotted nut	1
L30	Seal carrier	1
L35	Seal carrier	1
L40	Lip seal	1
L50	O-ring	1
L60	Retainer	1
L70	Screw	3
M1N	Control valve - electric	1
M1P	Control valve - hydraulic	1
P400	Plug	2
P600	Plug	1
P601	Press compensator valve	1
P700	Special plug	1
P800	O-ring	1
T30	Filter screen	1
T40	O-ring	1
T50	Back up ring	2
T60	O-ring	1
T100	Orifice plug	1
Y40	O-ring	1
Y50	Back up ring	2
Y60	O-ring	1
Y70	Orifice check valve	1
Y71	Nut - Seal lock	1
Y72	O-ring	
Y80	Plug	1
Y100	Orifice plug	1
Y102	Orifice check valve	1

Notes

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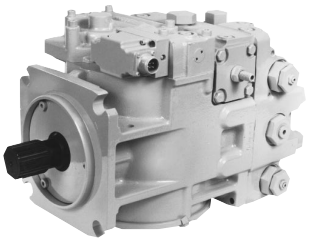
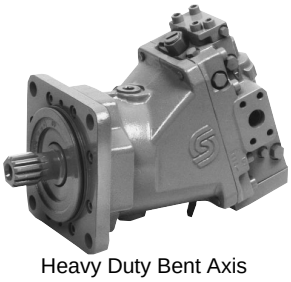
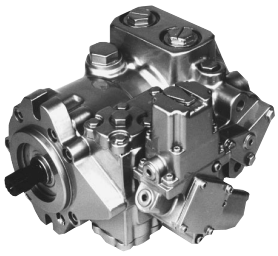


Heavy Duty Axial Piston Pumps and Motors

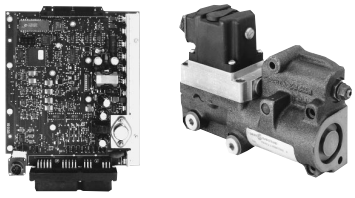


Heavy Duty Bent Axis Variable Motors

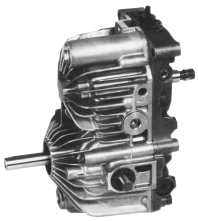
Cartridge Motors/ Compact Wheel Drives



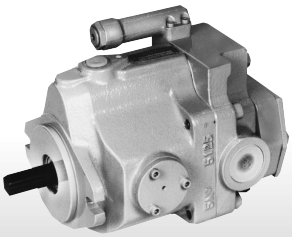
Medium Duty Axial Piston Pumps and Motors



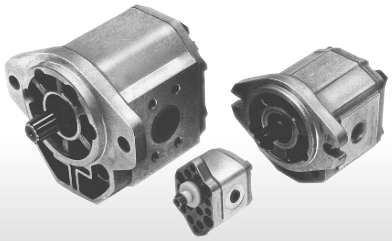
Microcontrollers and Electrohydraulic Controls



Hydrostatic Transmission Packages



Open Circuit Axial Piston Pumps



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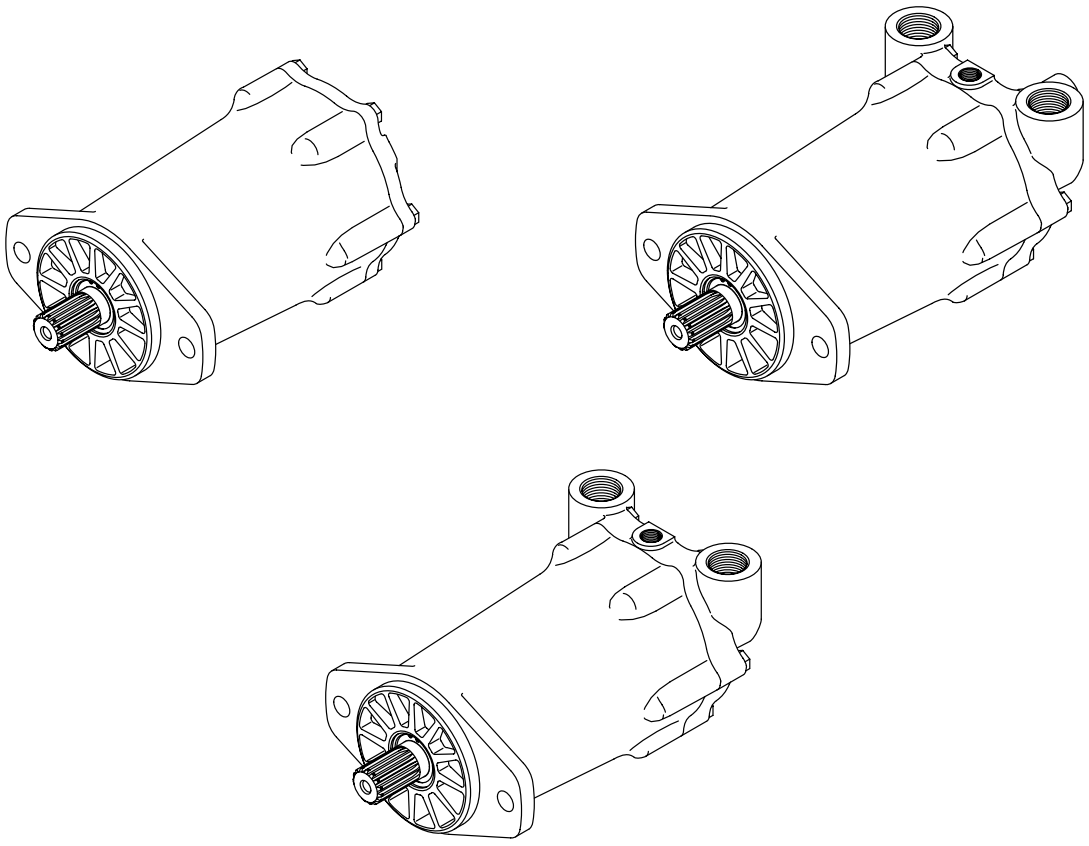
SM-S90 • 06/96 • 300947F
BLN-09947 • Rev. F • June 1996

Eaton®

Medium Duty Piston Motors

No. 06-161
May 1999

Parts Information



Model 74624 and 74644,

82,6 cm^3/r [5.04 in^3/r] Displacement

design code **B**

Identification and Tools Required

Identification Numbers

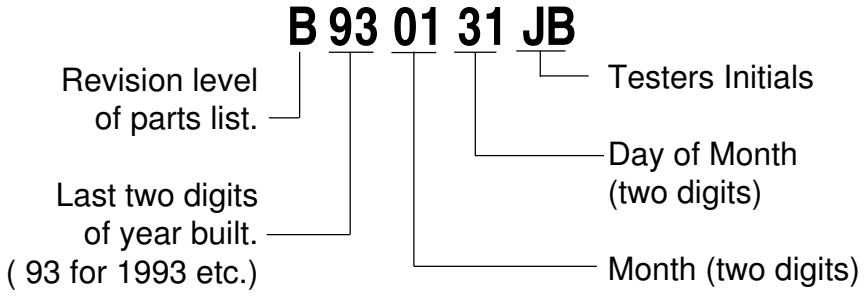
Stamped on each unit.

A - Product Number Descriptions
74624 = Fixed Motor 82,6 cm³/r [5.04 in³/r]
74644 = Fixed Motor thru Shaft for Brake Mount 82,6 cm³/r [5.04 in³/r]
B - Rotation,
D = Dual
C - Sequential Letters
D - Design Code Number

Single Motor - Product Number

7 4 6 2 4 - D A H - 0 1
A B C D

Serial Number Code:



Required Tools

- 1/2 in. Socket, w/ Ratchet Wrench
- External Retaining Ring Pliers (straight .090 tip)
- Internal Retaining Ring Pliers (straight .090 tip)
- O-ring Pick
- Torque Wrench (54 N·m [40 lbf·ft] capacity)
- Hammer (soft face)
- Light Petroleum Jelly
- Seal Driver

Parts List

	Item	Part No.	Qty.	Description
	1	Refer to List	1	Drive Shaft
	2	Refer to List	1	Backplate Assembly
	3	Refer to List	1	Housing Assembly
	4	74614-50	1	Rotating Kit Assembly - Refer to specific parts list
	4a	74614-52	1	Rotating Kit Assembly - Heat Treated - Refer to specific parts list
+~	5	16009-118	1	Retaining Ring
+~	6	160015-57	1	O-ring, 2,37 mm Dia. x 114,3 mm ID. [.0937 in. Dia. x 4.5 in. ID.]
	7	74600-102	1	Thrust Bearing
	8	74600-600	2	Pivot
	9	74600-601	1	Spider
	10	74600-603	1	Key
	11	74604-5	9	Piston
	12	74604-10	9	Piston Assembly
	13	74604-59	1	Connector Plate
	14	74600-605	1	Spacer
+~	15	16232-16	1	Shaft Seal
	16	74600-100	1	Bearing Race
	17	74600-110	1	Piston Race S/A
	18	17140-1	1	Spring - Refer to specific parts list
	18a	17141-10	1	Spring - Refer to specific parts list
	18b	17142-1	1	Spring - Refer to specific parts list
	19	74600-614	1	Pilot - Refer to specific parts list
	19a	74600-620	1	Pilot - Refer to specific parts list
	20	74600-104	1	Thrust Bearing
	21	16241-D916	1	Bearing Race
	22	16032-510	6	Cap Screws, 5/16-18, 25,4 mm [1 in.] Long - Refer to specific parts list
	22a	16032-514	4	Cap Screws, 5/16-18, 38,1 mm [1.5 in.] Long - Refer to specific parts list
+~	23	16077-26	1	Retaining Ring
	24	74600-103	A/R	Trust Race
	25	24500-628	1	Key - 74624-204, 74644-210 & 74644-215
~	26	16078-16	2	Retaining Ring
	27	16241-1625	1	Thrust Bearing
	28	16241-C1625	2	Bearing Race
~	29	16232-16	1	Shaft Seal
~	30	16048-336	1	Washer
~	31	16077-26	1	Retaining Ring
	32	16032-520	2	Cap Screws, 5/16-18, 50,8 mm [2 in.] Long
+~	33	16078-16	1	Retaining Ring
	34	24500-619	1	Key - Used with Shaft 74644-214 - Refer to specific parts list
	34a	16246-430	1	Key - Used with Shaft 74644-209 & 74644-210 - Refer to specific parts list
	35	16103-106	1	Plug S/A
	35-1	16133-6	1	O-ring, 1,98 mm Dia. x 11,89 mm ID. [.078 in. Dia. x .468 in. ID.]
	36	16048-616	A/R	Washer
	37	74600-115	A/R	Washer
	38	74640-600	1	Spring Collar

Seal Repair Kit

+	74640-904	Seal Repair Kit for 74624 rear or same side ported motor.
~	74640-910	Seal Repair Kit for 74644 Through shaft motor.

Drive Shaft S/A - Item #1

Item #	Part Number	Description
1a	74624-200	15 Tooth 16/32 Spline with Snap Ring Groove with Snap Ring, .375-16 UNC-2B Thread, 18.3 [.72] Min Full Thread, Shaft Ext 39.6 [1.56]
1b	74624-201	15 Tooth 16/32 Spline with Snap Ring Groove, Shaft Ext 46 [1.81]
1c	74624-202	Taper 1:8, Dia 25.4 [1.00], Woodruff Keyway Dia 25.4 [1.00] X 6.35 [.250], .625-18 UNC-2A Thread, Shaft Ext 69 [2.72]
1d	74624-203	13 Tooth 16/32 Spline, Shaft Ext 41.1[1.62]
1e	74624-204	Straight Shaft , Dia. 25,4 [1.00], Keyway 6,35 x 38,1 [.250 x 1.50], Shaft Ext. 63,5 [2.50]
1f	74624-206	15 Tooth 16/32 Spline Tapered 1:8 with .375-16 UNC-2B Thread, 18.3 [.72] Min Full Thread, Shaft Ext 46 [1.81]

Through Shaft (74644)

Item #	Part Number	Description
1g	74644-206	**Front** - 15 Tooth 16/32 Spline with Snap Ring Groove with Snap Ring, .375-16 UNC-2B Thread, 18.3 [.72] Min Full Thread, Shaft Ext 39.6 [1.56] **Rear** - 15 Tooth 16/32 Spline, Shaft Length From Mounting Flange 258.6 [10.18]
1h	74644-209	**Front** - 15 Tooth 16/32 Spline Tapered 1:8 with .375-16 UNC-2B Thread, 18.3 [.72] Min Full Thread, Shaft Ext 46 [1.81] **Rear** - Straight Shaft Dia 25.4 [1.00], Keyway 6.3 X 25.4 [.250 X 1.00], Shaft Length from Mounting Flange 274.3 [10.80]
1i	74644-210	**Front** - Straight Shaft , Dia. 25,4 [1.00], Keyway 6,35 x 38,1 [.250 x 1.50], Shaft Ext. 63,5 [2.50] (Key Included) **Rear** - Straight Shaft Dia 25.4 [1.00], Keyway 6.3 X 25.4 [.250 X 1.00], Shaft Length from Mounting Flange 274.3 [10.80]
1j	74644-212	**Front** - 15 Tooth 16/32 Spline Tapered 1:8 with .375-16 UNC-2B Thread, 18.3 [.72] Min Full Thread, Shaft Ext 46 [1.81] **Rear** - 15 Tooth 16/32 Spline, with .375-16 UNC-2B Thread, 18.3 [.72] Min Full Thread, Shaft Length from Mounting Flange 274.3 [10.80]
1k	74644-214	**Front** - 15 Tooth 16/32 Spline, Shaft Ext 46 [1.81] **Rear** - Straight Shaft Dia 22.22 [.875], Keyway 6.35 X 26.9 [.250 X 1.06], Shaft Length from Mounting Flange 271.5 [10.69] (Short Key Included)
1l	74644-215	**Front** - Taper .125:1 Dia 22.22 [.875], Woodruff Keyway Dia 15.75 [.620] X 3.96 [.156], .500-20 UNF-2A Thread, Shaft Ext 57.9 [2.28] **Rear** - Straight Shaft Dia 25.4 [1.00], Keyway 6.35 X 38.4 [.250 X 1.51], Shaft Length from Mounting Flange 292.1 [11.50]
1m	74644-216	**Front** - Taper .125:1 Dia 22.22 [.875], Woodruff Keyway Dia 15.75 [.620] X 3.96 [.156], .500-20 UNF-2A Thread, Shaft Ext 57.9 [2.28] **Rear** - Straight Shaft Dia 25.4 [1.00], Shaft Length from Mounting Flange 254 [10.00], Shaft End Hole Internal 6.40 [.252] X 14 [.55] Deep

Backplate S/A - Item #2

Item #	Part Number	Description
2a	74624-301	Rear porting, through drain into mounting flange
2b	74624-305	Rear porting, drain port Horizontal top rear of unit
2c	74624-315	Same side porting, drain port vertical top rear of unit, two mounting holes bottom rear
2d	74624-317	Same side porting, drain port vertical top rear of unit

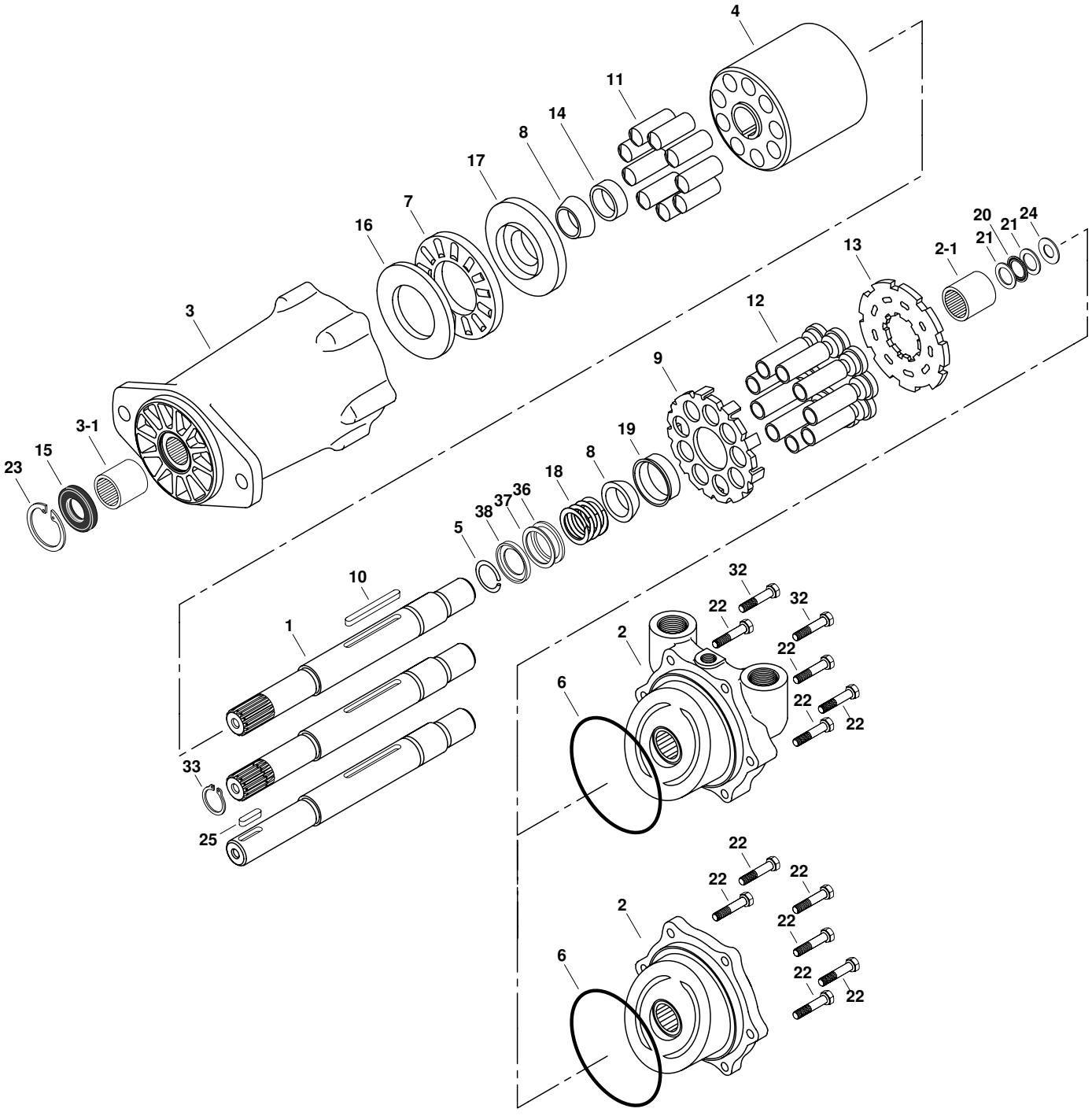
Housing for Through Shaft (74644)

Item #	Part Number	Description
2e	74644-308	Same side porting, drain port vertical top rear of unit

Housing S/A - Item #3

Item #	Part Number	Description
3a	74624-303	Through drain into mounting flange
3b	74624-307	No drain in housing
3c	74624-309	Special housing used with item 18 #17141-10 and item 19 #74600-620. Also has slotted 2 bolt B flange.

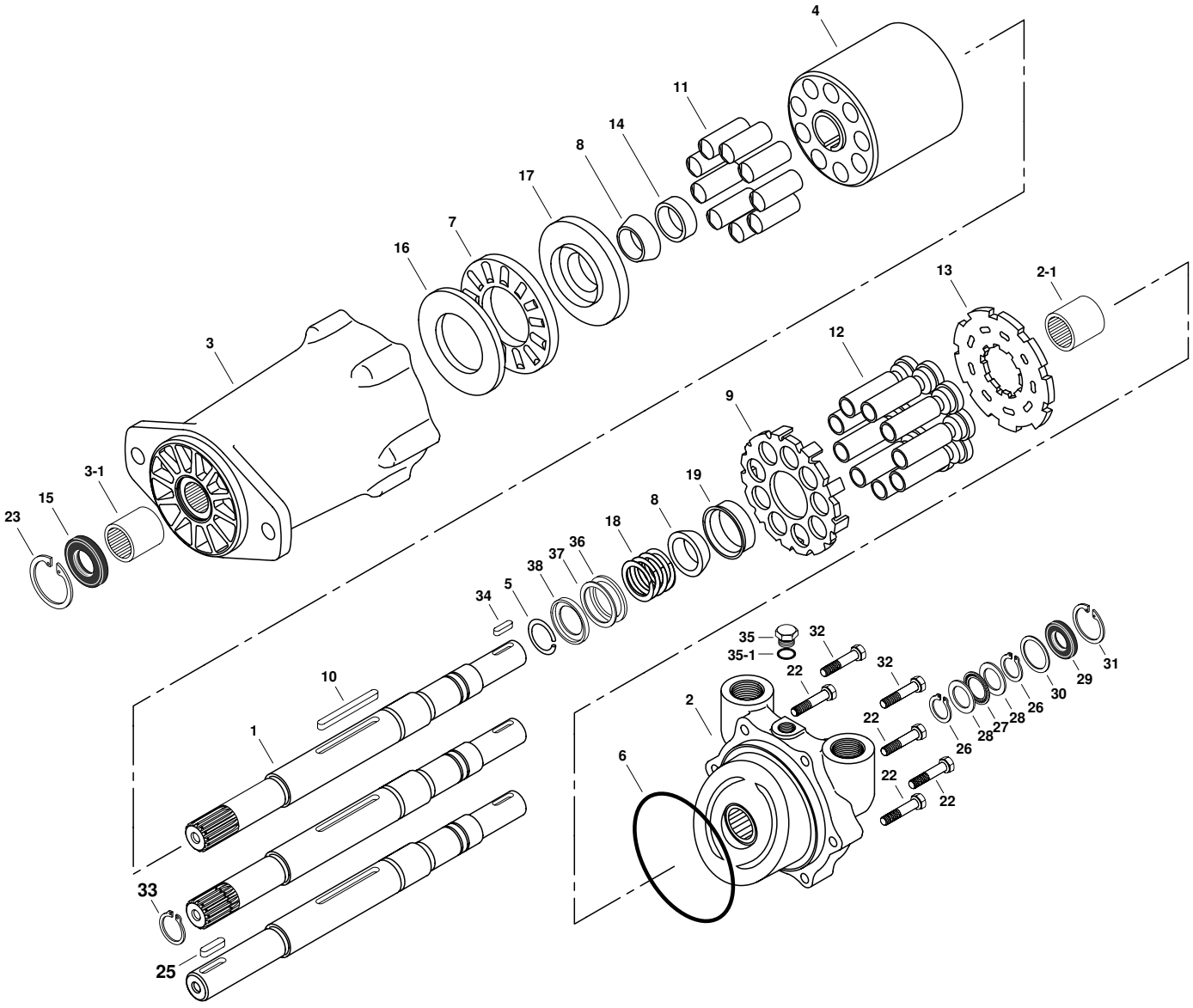
Parts Drawing



Specific Parts List

		Product Numbers 74624												
		- DAA	- DAB	- DAD	- DAE	- DAG	- DAH	- DAJ	- DAL	- DAM	- DAN	- DAP	- DAR	- DAS
Item #'s	1	1a	1b	1c	1d	1d	1e	1a	1e	1f	1f	1b	1b	1f
	2	2a	2b	2b	2b	2b	2b	2b	2c	2c	2d	2b	2b	2d
	3	3a	3b	3b	3c	3b	3b	3b	3b	3b	3b	3b	3b	3b
	4	4	4	4	4	4	4	4	4	4	4	4	4a	4
	5	X	X	X	X	X	X	X	X	X	X	X	X	X
	6	X	X	X	X	X	X	X	X	X	X	X	X	X
	7	X	X	X	X	X	X	X	X	X	X	X	X	X
	8	X	X	X	X	X	X	X	X	X	X	X	X	X
	9	X	X	X	X	X	X	X	X	X	X	X	X	X
	10	X	X	X	X	X	X	X	X	X	X	X	X	X
	11	X	X	X	X	X	X	X	X	X	X	X	X	X
	12	X	X	X	X	X	X	X	X	X	X	X	X	X
	13	X	X	X	X	X	X	X	X	X	X	X	X	X
	14	X	X	X	X	X	X	X	X	X	X	X	X	X
	15		X	X	X	X	X	X	X	X	X	X	X	X
	16	X	X	X	X	X	X	X	X	X	X	X	X	X
	17	X	X	X	X	X	X	X	X	X	X	X	X	X
	18	18	18b	18b	18a	18b	18b	18b	18b	18	18	18b	18b	
	19	19	19	19	19a	19	19	19	19	19a	19a	19	19	
	20	X	X	X	X	X	X	X	X	X	X	X	X	X
	21	X	X	X	X	X	X	X	X	X	X	X	X	X
	22	22	22	22	22	22	22	22	22a	22a	22a	22	22	22a
	23		X	X	X	X	X	X	X	X	X	X	X	X
	24	X	X	X		X	X	X	X	X	X	X	X	X
	25						X		X					
	32								X	X	X			X
	33	X						X						
	36									X	X			
	37									X	X			
	38				X					X	X			
Seal Repair Kit 72640		-904	-904	-904	-904	-904	-904	-904	-904	-904	-904	-904	-904	-904

Parts Drawing - Through Shaft



Specific Parts List

		Product Numbers 74644								
		- DAE	- DAG	- DAJ	- DAK	- DAM	- DAN	- DAP	- DAR	- DAS
Item #'s	1	1g	1h	1i	1j	1k	1l	1m	1j	1j
	2	2e	2e	2e	2e	2e	2e	2e	2e	2e
	3	3b	3a	3b	3a	3b	3b	3b	3a	3b
	4	4	4	4	4	4	4	4	4	4
	5	X	X	X	X	X	X	X	X	X
	6	X	X	X	X	X	X	X	X	X
	7	X	X	X	X	X	X	X	X	X
	8	X	X	X	X	X	X	X	X	X
	9	X	X	X	X	X	X	X	X	X
	10	X	X	X	X	X	X	X	X	X
	11	X	X	X	X	X	X	X	X	X
	12	X	X	X	X	X	X	X	X	X
	13	X	X	X	X	X	X	X	X	X
	14	X	X	X	X	X	X	X	X	X
	15	X		X		X	X	X		X
	16	X	X	X	X	X	X	X	X	X
	17	X	X	X	X	X	X	X	X	X
	18	18	18	18	18	18	18	18	18	18
	19	19	19a	19	19a	19a	19	19	19a	19a
	22	22a	22a	22a	22a	22a	22a	22a	22a	22a
	23	X		X			X	X		X
	25			X						
	26	X	X	X	X	X	X	X	X	X
	27	X	X	X	X	X	X	X	X	X
	28	X	X	X	X	X	X	X	X	X
	29	X	X	X	X	X	X	X	X	X
	30	X	X	X	X	X	X	X	X	X
	31	X	X	X	X	X	X	X	X	X
	32	X	X	X	X	X	X	X	X	X
	33	X								
	34		34	34		34a				
	35		X		X				X	
	36		X		X	X			X	
	37		X		X	X			X	
	38	X	X	X	X	X	X	X	X	X
Seal Repair Kit 74640		-910	-910	-910	-910	-910	-910	-910	-910	-910

Notes

Notes

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Products in this catalog are manufactured in an ISO-9001-certified site.

www.eatonhydraulics.com

Form No. 06-161
May, 1999

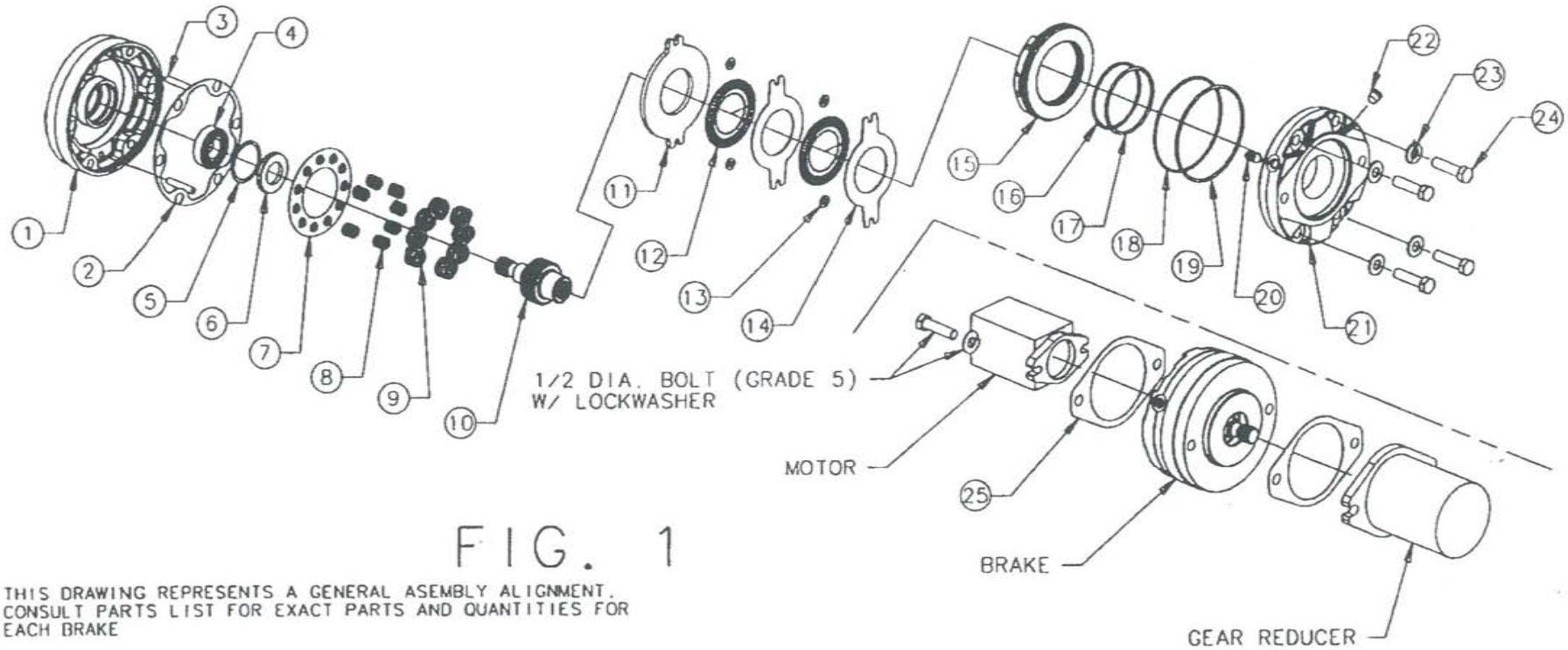


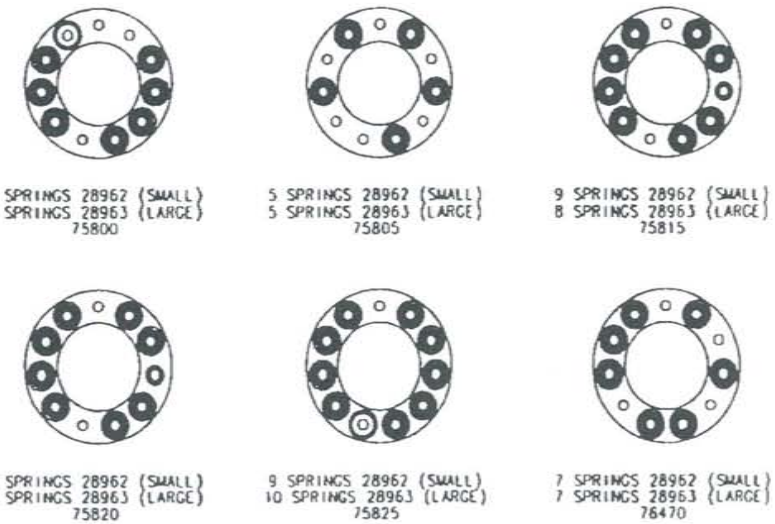
FIG. 1

THIS DRAWING REPRESENTS A GENERAL ASEMBLY ALIGNMENT. CONSULT PARTS LIST FOR EXACT PARTS AND QUANTITIES FOR EACH BRAKE

ITEM	PART NAME	BRAKE 75800		BRAKE 75805		BRAKE 75815		BRAKE 75820		BRAKE 75825		BRAKE 76470	
		REQ	PART #	REQ	PART #	REQ	PART #	REQ	PART #	REQ	PART #	REQ	PART #
1	HOUSING	1	75821	1	75822	1	75822	1	75822	1	75822	1	75822
2	GASKET	1	75093	1	75093	1	75093	1	75093	1	75093	1	75093
3	TORQUE PIN	2	37914	2	35875	2	35875	2	35875	2	35875	2	35875
4	BEARING - BALL	1	34574	1	34574	1	34574	1	34574	1	34574	1	34574
5	RETAINING RING	1	75540	1	75540	1	75540	1	75540	1	75540	1	75540
6	SEAL	1	37144	1	37144	1	37144	1	37144	1	37144	1	37144
7	SPRING RETAINER	1	74554	1	74554	1	74554	1	74554	1	74554	1	74554
8	COMPRESSION SPRING	7	28962	5	28962	9	28962	9	28962	9	28962	7	28962
9	COMPRESSION SPRING	8	28963	5	28963	8	28963	8	28963	10	28963	7	28963
10	SHAFT	1	74577	1	74579	1	74579	1	75124	1	74579	1	74579
11	PRIMARY DISC	1	74553	1	74553	1	74553	1	74553	1	74553	1	74553
12	ROTATING DISC	2	74771	4	74771	4	74771	4	74771	4	74771	4	74771
13	WAVE SPRING	4	75672	8	75672	8	75672	8	75672	8	75672	8	75672
14	STATIONARY DISC	2	74552	4	74552	4	74552	4	74552	4	74552	4	74552
15	PISTON	1	75104	1	75109	1	75109	1	75109	1	75109	1	75109
16	BACKUP RING	1	27967	1	27967	1	27967	1	27967	1	27967	1	27967
17	O-RING	1	27808	1	27808	1	27808	1	27808	1	27808	1	27808
18	BACKUP RING	1	27966	1	27966	1	27966	1	27966	1	27966	1	27966
19	O-RING	1	27777	1	27777	1	27777	1	27777	1	27777	1	27777
20	BLEEDER SCREW	1	29035	1	29035	1	29035	1	29035	1	29035	1	29035
21	POWER PLATE	1	75499	1	75499	1	75499	1	75499	1	75499	1	75499
22	PROTECTIVE PLUG	1	28435	1	28435	1	28435	1	28435	1	28435	1	28435
23	WASHER	4	74877	4	74877	4	74877	4	74877	4	74877	4	74877
24	1/2-13 BOLT	4	73594	4	73594	4	73594	4	73594	4	73594	4	73594
25	GASKET	2	28426	2	28426	2	28426	2	28426	2	28426	2	28426

FIG. 2

SPRING ORIENTATION



F76060
FCO#10969

BRAKE FUNCTION

**All the following procedures refer to the drawing on the next page.

The Fail-safe Brake is spring loaded to apply the brake and hydraulic pressure is required to release or "hold off" the brake. Normal operation is to have the brake pressurized in the released position with the vehicle hydraulic system running. Any function which reduces the hydraulic system pressure below the release pressure of the brake, will cause the brake to be applied.

The brake is designed to fit with a gear reducer and a hydraulic motor. The common mounting surfaces of the brake gear reducer, and the motor are machined to close tolerances and should be protected from damage during installation and removal.

INSTALLATION INSTRUCTIONS

1. Place the gasket (25) on the mounting face of the brake (face with the shaft projecting out).
2. Place the brake shaft (10) into the gear reducer.
3. Move the brake into position with the gear reducer maintaining proper gasket location. Align the mounting bolt holes by rotating the engaged brake into position, If this is not possible, the shaft may be rotated after pressure has been applied to the brake inlet. This will release the brake and allow it to be rotated into position.
4. Similarly, place the gasket (25) on to the flange of the motor.
5. Insert the shaft of the motor into the brake and push into position, maintaining proper gasket alignment.
6. Insert two 1/2 in. dia. bolts (grade 5) and lockwashers through the motor flange, the gasket (25), the brake, the brake gasket (25), and into the threaded holes in the gear reducer. Make sure that the bolts are not too long so they do not bottom out in the gear reducer threaded holes before clamping.
7. To prevent binding, run the bolts in alternately until snug. Then, torque the bolts to 75-85 lb-ft. NOTE: the shafts must slide together freely--DO NOT use the bolts to force the unit together.
8. With motor and brake bolted into position, remove protective plug (22) and connect inlet hydraulic line (if not during step 3) Brake inlet is 1/4" tubing, straight thread o-ring boss (7/16-20 UNF-2B).

BRAKE DISASSEMBLY PROCEDURE (Ref Fig 1)

1. With shaft protrusion downward, disassemble in the following order: bolts (24) alternately, washers (23), power plate (21), and gasket (2).
2. Remove the following parts: stationary discs (14), rotating discs (12), primary disc (11), torque pins (3), springs (8 & 9), wave springs (13), and the spring retainer (7).
3. Further disassembly is not recommended and should not be attempted unless necessary to replace the bearing (4), the seal (6), or the shaft (10). If further disassembly is

needed, proceed as follows: NOTE: if the bearing and seal are removed for any reason, both must be replaced. a) The shaft (10) may be removed by pressing on the end of the shaft with a shop press. b) Using an appropriate tool, pry the seal (6) out from the inside of the brake. Take care not to damage the bore. Remove the retaining ring (5). Tap the bearing (4) out with a plastic mallet.

4. Remove the Piston (15) from the Power Plate (21) by introducing low pressure air - 15 psi - into the hydraulic inlet and make sure piston is directed away form the operator. Remove O-rings (17 & 19) and Backup Rings (16 & 18) from the piston OD and ID grooves. **Do not remove backup rings (16 &18) unless replacement is necessary because they will be damaged.**

ASSEMBLY PROCEDURE

IMPORTANT: There may be more parts in a service kit than your brake requires. Check the parts list carefully for the exact quantity. In the case of springs, space the springs as seen on Figure 2.

*All parts must be thoroughly clean prior to reassembly.

*Use the reverse of the disassembly procedure with the following notes and additions:

1. Worn O-rings and damaged or worn Teflon backup rings must be replaced prior to reassembly.
2. Cylinder of the power plate, piston , and o-rings must be clean prior to assembly and pre-lubed with the system hydraulic fluid.
3. Assemble piston (15) into power plate (21) using a shop press, being careful not to damage the o-rings or Teflon back-up rings. Visually align the center of the cutouts in the piston with the torque pins (3) holes in the power plate (21). CAUTION: the depth the piston is installed into the power plate is critical. The surface of the piston at the cutouts must be flush to 0.120 in. below the surface of the power plate. DO NOT exceed the 0.120 depth or piston will cock resulting in a complete loss of braking.
4. Replacement of seal (6): a)Use a shop press to press the bearing (4) into the housing. Press on the outer race of the bearing only. Install retaining ring (5) into groove. b)Press the seal (6) into the housing (1) until it is flush with the face of the housing. The lip of the seal must face towards the bearing.
5. Press the shaft into the housing until it stops on the bearing. Support inner race of the bearing during press.
6. Rotating discs must be clean and dry. The lining material and mating surfaces of the stationary discs must be thoroughly clean and free of debris. Worn or scored rotating discs must be replace.
7. Install bolts (24) with washers (23) in power plate (21). Tighten sequentially, one turn at a time, until power plate is properly seated. Torque to 105-115 lb-ft.

SERVICE KITS The following kits are available as service items. All other parts may be ordered individually.

ITEM	PART	DESCRIPTION	QTY
1	78362	HOUSING	1
2	35875	TORQUE PIN	2
3	74553	PRIMARY DISC	1
4	74552	STATIONARY DISC	4
5	74771	ROTATING DISC	4
6	27966	BACKUP RING	1
7	27777	O-RING	1
8	75109	PISTON	1
9	78361	POWER PLATE	1
10	27808	O-RING	1
11	27967	BACKUP RING	1
12	75093	GASKET	1
13	28962	COMPRESSION SPRING	9
14	28963	COMPRESSION SPRING	8
15	74554	SPRING RETAINER	1
16	37144	LIP SEAL	1
B 17	74579	SHAFT	1
18	75540	SNAP RING	1
19	34574	BALL BEARING	1
20	28426	GASKET	2
21	28435	PROTECTIVE PLUG	1
22	73594	1/2-13 HEX HEAD BOLT	4
23	74877	WASHER	4
24	29035	BLEEDER SCREW	1

Parts list for 78363

MOBILE EQUIPMENT
AND WIND ENERGY SOLUTIONS

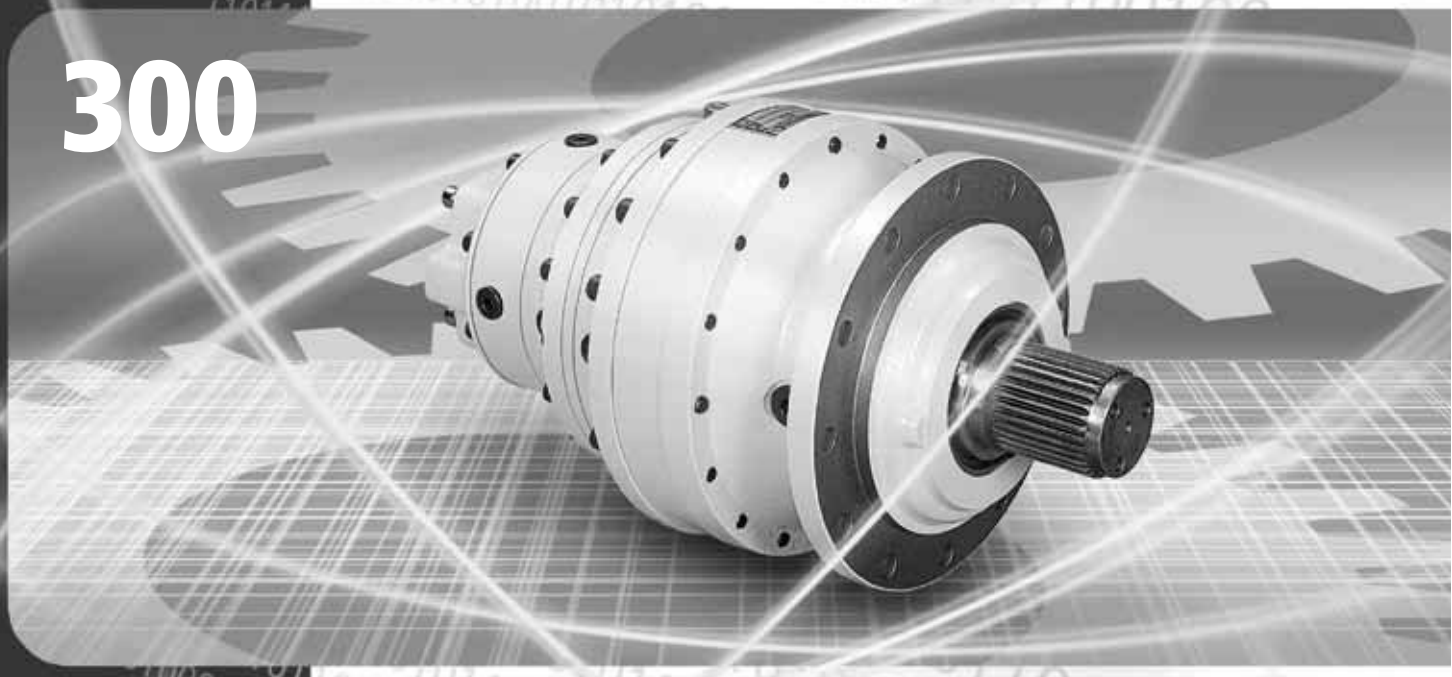
INDUSTRY PROCESS
AND AUTOMATION SOLUTIONS

BONFIGLIOLI
TRASMITAL

Installation, use and service manual

GB

300



ATEX
INCLUDED

BONFIGLIOLI

USE, INSTALLATION AND MAINTENANCE MANUAL

Revisions

The catalogue revision list is given on page 38. The most recent versions of the catalogue are available at www.bonfiglioli.com.

1.0 - GENERAL INFORMATION

1.1 - PURPOSE OF THE MANUAL

This Manufacturer's manual provides information regarding the safe transport, handling, installation, maintenance, repair, disassembly and dismantling of the gear unit.

All information for users and designers is given in the Sales Catalogue. As well as adhering to established engineering practices, the information given in this manual must be read carefully and rigorously applied.

Failure to observe the information provided herein may result in risks to personal health and safety, as well as economic damages.

This information, provided in the Manufacturer's original language (Italian), is also available in other languages to meet legal and commercial requirements.

The documentation must be stored by a person charged to do so in a suitable location so as to be always available in good condition for consultation.

In case of loss or damage, replacement documentation must be requested directly from the Manufacturer, quoting the code of this manual.

This manual reflects the state of the art at the time of commercialisation of the gear unit.

The Manufacturer reserves the right to modify, supplement and improve the manual, without the present publication being for that reason considered inadequate.

Particularly significant sections of the manual and important specifications are highlighted by symbols whose meanings are explained below.

SYMBOLS:

DANGER - WARNING

This symbol indicates situations of danger, which if ignored, may result in serious injury to the operator.

CAUTION - ATTENTION

This symbol indicates the need to adopt specific precautions to avoid personal injury and damage, as well as economic damages.

IMPORTANT

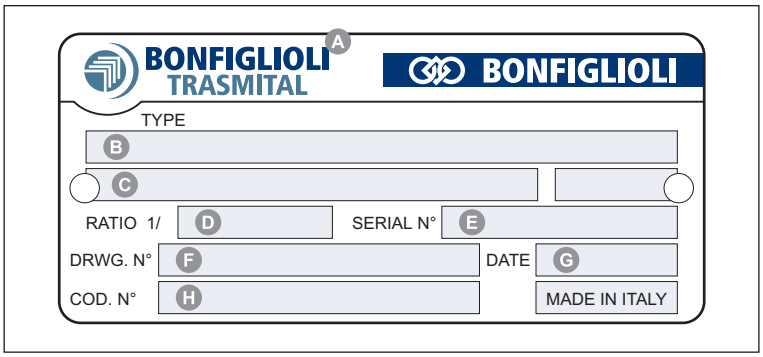
This symbol indicates important technical information.

Instructions marked by these symbols and highlighted in yellow, apply exclusively to equipment complying with "ATEX" Directive 94/9/EC.
The operations identified by these symbols must be executed by professionally qualified operators specially trained in the safety precautions required for working in potentially explosive atmospheres.
Failure to observe these instructions may result in serious safety and environmental risks.

1.2 - PRODUCT IDENTIFICATION

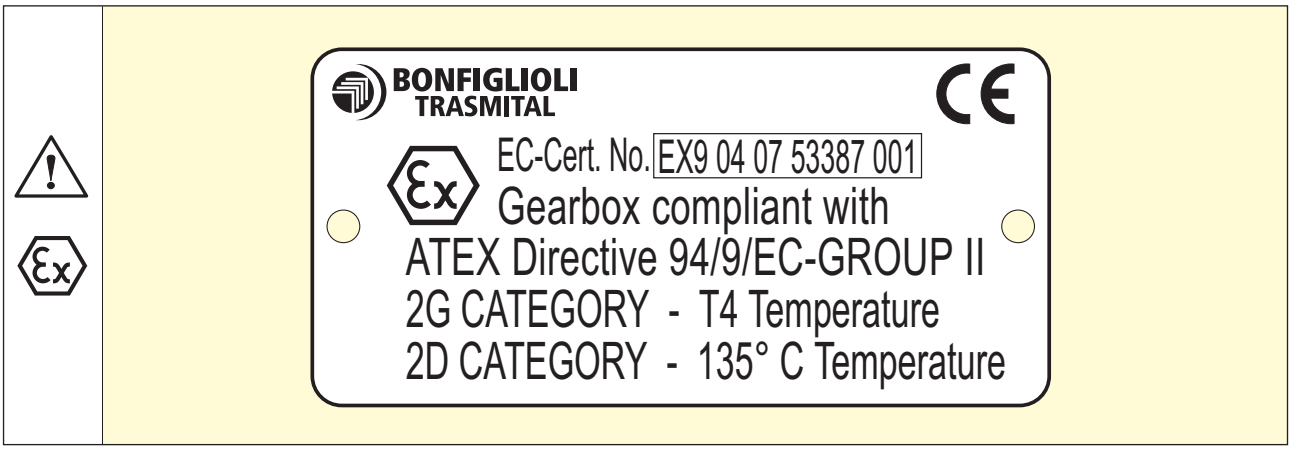
The information identifying the product is shown on its nameplate. Gearmotors are equipped with two nameplates; one on the gear unit which bears the gear unit data, and one on the motor (electric or hydraulic), bearing the motor data.
The drawing below illustrates the layout of the data.
The gear unit's identifying code is explained in the Sales Catalogue. If the gear unit is supplied fitted with an electric motor (gearmotor), all information regarding the motor is supplied in the motor manual.

Nameplate data



- A Manufacturer
- B Product identification
- C Bonfiglioli Trasmital product code
- D Reduction ratio
- E Serial number
- F Installation drawing code.
- G Date of manufacture
- H Client product code

Supplementary nameplate on ATEX-specified gear units



Readability of the nameplate

The nameplate and the information on it must be readable and, consequently must be cleaned from time to time.

Quote the nameplate data in all communications with the manufacturer, for example, when requesting spare parts, information and assistance.

1.3 - GLOSSARY AND TERMINOLOGY

Some of the frequently occurring terms used in this manual are described below to unequivocally define their meaning.

Routine maintenance
The set of operations required to preserve the functionality and efficiency of the gear unit. These operations are usually scheduled by the Manufacturer, who defines the qualifications and tasks involved.

Reactive maintenance
The set of operations required to preserve the functionality and efficiency of the gear unit. These operations are not scheduled by the Manufacturer and must be carried out by an expert maintenance technician.

Expert maintenance technician
An authorised technician with the qualifications, skills and mechanical and electrical training required to do repairs and non-routine maintenance work on the gear unit.

Overhaul
An overhaul consists in the replacement of bearings and other mechanical components which have worn to such an extent as to compromise the operation of the gear unit. An overhaul also includes verification of the condition of all gear unit components (keys, seals, gaskets, vents, etc). If any such components are damaged they must be replaced and the reason for the damage identified.

1.4 - REQUESTING TECHNICAL ASSISTANCE

For any technical service needs, contact the Manufacturer's sales network quoting the information indicated on the unit's nameplate, the approximate hours of service and the type of defect.

1.5 - MANUFACTURER'S LIABILITY

The Manufacturer declines all liability in the event of:

- use of the gear unit in contravention of local safety at work legislation
- incorrect installation, disregard or incorrect application of the instructions provided in this manual
- incorrect or defective electrical/hydraulic power supply (gearmotors)
- modifications or tampering
- work done on the unit by unqualified or unsuitable persons.

The safety of the gear unit also depends on scrupulous observance of the instructions given in this manual, and in particular:

- always operate the unit within its operating limits
- diligently observe the routine maintenance schedule
- only allow trained operators to inspect and service the unit
- only use original spare parts

- the configurations given in the gear unit catalogue are the only ones permitted
- do not attempt to use the unit in any other way
- the instructions given in this manual do not substitute but rather supplement the provisions of established safety legislation.

1.6 - CONSIGNMENT CONDITIONS

Gear units are supplied by BONFIGLIOLI TRASMITAL in the following conditions:

- Configured for installation in the mounting position specified in the purchase order.
- Not charged with lubricant and with internal components protected by a film of oil compatible with the recommended lubricant.
- All surfaces and mating parts are treated with rustproofing products.
- Mating surfaces are not painted while the unit's exterior is treated with a coat of grey water-based rustproofing primer (RAL 7042/C441). Application of a top coat is the responsibility of the Client.
- Tested to factory standards.
- Packaged suitably for the final destination.

2.0 - TECHNICAL INFORMATION

2.1 - DESCRIPTION OF THE GEAR UNIT

The gear unit, driven by an electric or hydraulic motor, has been designed and constructed for integration into an assembly of interlocking parts or mechanisms as part of a specific application.
Depending on the requirements of the application, the gear unit can be supplied in a variety of motor executions and configurations. It is capable of satisfying a range of specific requirements in the mechanical, chemical, agricultural and food industries, etc.

BONFIGLIOLI TRASMITAL supplies a range of accessories and optionals to make their products as versatile as possible. For further technical information and descriptions, refer to the corresponding Sales Catalogue.
The User is responsible for using the products recommended for installation and maintenance of

SAFETY SPECIFICATIONS OF GEAR UNITS COMPLYING WITH DIRECTIVE 94/9/EC

- unit selection must be made with a higher safety service factor
- use only synthetic lubricants (oil and grease)
- VITON® seal rings
- vent plugs with spring-loaded anti-intrusion valve
- oil plugs with aluminium washer
- oil seals with dust trap
- no metal moving parts external to the gear unit
- no plastic parts capable of building up an electrostatic charge, or, if present, duly shielded
- for installations in zones 21 and 22 the User must schedule and implement a regular cleaning programme for all surfaces and recesses to avoid dust build ups of more than 5 mm in depth.

2.2 - CONFORMITY

All gear units or gearmotors (when supplied with electric motor) are designed in compliance with the provisions of applicable Essential Health and Safety Requirements, the “Machinery Directive” 98/37/EC and, if requested, can be supplied with a Manufacturer’s Declaration - Annex IIB as provided by said Directive.
All BONFIGLIOLI gearmotor electric motors conform to the provisions of the Low Voltage Directive 73/23/EEC and the Electromagnetic Compatibility Directive 89/336/EEC.

Furthermore, if specified for use in potentially explosive atmospheres, the gear units are designed and constructed to conform with the Essential Health and Safety Requirements (EHSR) of Annex II of the ATEX Directive 94/9/EC and conform to the following classification:

- Equipment group: **II.**
- Category: Gas **2G** - Dust **2D.**
- Zone: Gas **1** - Dust **21.**
- Maximum surface temperature: temperature class **T4** for 2G and **130°C** for 2D.

2.3 - OPERATING LIMITS AND CONDITIONS

Modification of the motor execution or mounting position is only permitted if previously authorised by BONFIGLIOLI TRASMITAL’s Technical Service.

Failure to obtain said authorisation renders the ATEX certification null and void.

Ambient conditions

- Ambient temperature: min. - 20°C; max. + 40°C.
- Do not use the gear unit, if not explicitly intended for the purpose, in a potentially explosive atmosphere or where the use of explosion-proof equipment is specified.

The nameplate specifications regarding the maximum surface temperature, refer to readings taken in normal ambient and installation conditions.
Even minimal variations to said conditions (e.g. smaller mounting cabinet) may have a significant effect on the unit's heat output.

- Lighting

If the unit is to be serviced in a poorly lit area, use additional lamps and ensure that the work is done in compliance with the safety requirements of established legislation.

3.0 - SAFETY INFORMATION

3.1 - SAFETY STANDARDS

- Carefully read the instructions given in this manual and those posted directly on the gear unit, especially those regarding safety.
- Persons charged with working on the gear unit at any time in its service life must be trained specifically for the purpose with special abilities and experience in the area as well as being equipped with the appropriate tools and individual safety equipment (as per Legislative Decree 626/94). Failure to meet these requirements constitutes a risk to personal health and safety.
- The gear unit must only be used for the applications permitted by the Manufacturer. Improper use can result in risks to personal health and safety and economic damages.

The applications permitted by the Manufacturer are the industrial applications for which the gear units have been designed.

- Keep the gear unit at its maximum efficiency by following the routine maintenance schedule. Good maintenance ensures the unit's maximum performance, extended service life and continued compliance with safety regulations.
- When working on the unit in areas which are difficult to access or hazardous, ensure that adequate safety precautions have been taken for the operator and others in compliance with established legislation on health and safety at work.
- All maintenance, inspection and repairs must only be carried out by an expert maintenance technician fully familiar with the attendant hazards. It is therefore essential to implement operating procedures that address potential hazards and their prevention for the entire machine. The expert maintenance technician must always work with caution in observance of applicable safety standards.
- During operation wear only the apparel and safety equipment indicated in the User Instructions provided by the Manufacturer or stipulated by legislation on safety at work.
- Replace worn components with original spare parts. Use the lubricants (oil and grease) recommended by the Manufacturer.
- Do not dump polluting materials into the environment. Dispose of all such materials as stipulated by applicable legislation.
- After replacing lubricants clean the gear unit's surfaces and the walk-on surfaces around the work area.

If the gear unit is to be serviced in a potentially explosive atmosphere, the operator must first switch off power to the gear unit and ensure that it is out of service, as well as taking all necessary precautions against it being accidentally switched on again or its parts moving without warning.
Furthermore, all additional environmental safety precautions must be taken (e.g. elimination of residual gas or dust, etc).

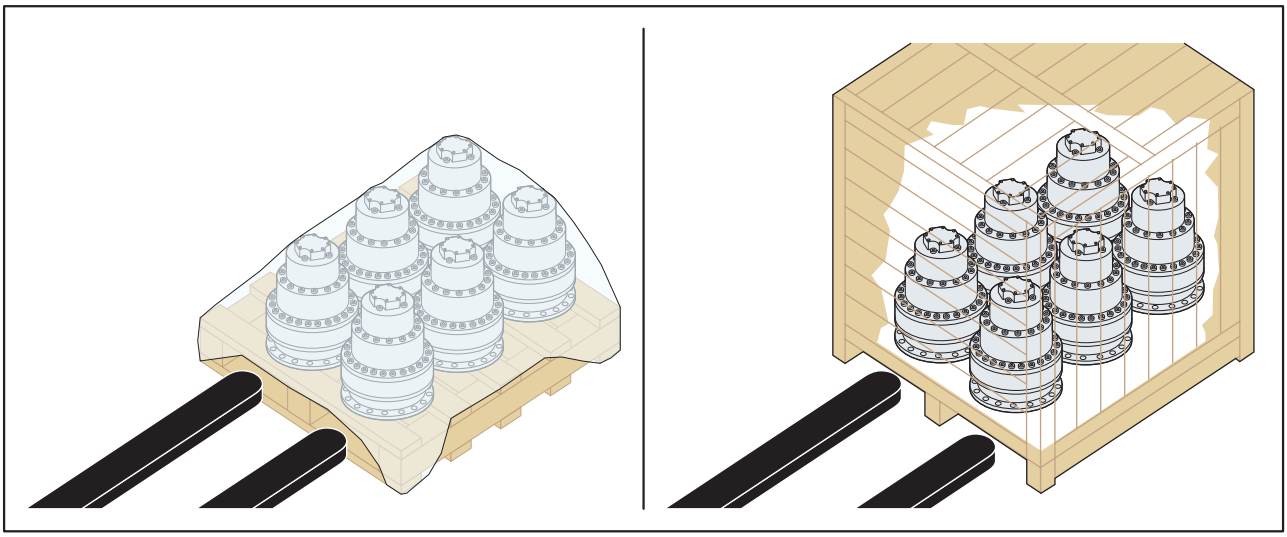
4.0 - HANDLING AND TRANSPORT

4.1 - PACKAGING

The standard packaging, if supplied and unless otherwise agreed, is not proofed against rainfall and is intended for shipping by ground and not sea, and for storage in areas which are under cover and not humid. The material can be stored in suitable conditions for a period of two years under cover at a temperature between -15 °C and +50 °C at a relative humidity not in excess of 80%. Storage in all other conditions requires specific packaging.

The most frequent types of packaging are shown in the figures below.

- Packaging on pallet with heat shrink film for ground shipping.
- Packaging in wooden crate for shipping by sea or air.



On receipt of the gear unit, make sure the delivery corresponds to the purchase order and that it is not damaged or faulty in any way.
Report any nonconformity to your BONFIGLIOLI TRASMITAL reseller.

Dispose of packaging materials as stipulated by applicable legislation.

4.2 - HANDLING INSTRUCTIONS

Handle packages as per the Manufacturer's instructions and those marked on the packages themselves. Since the weight and shape of the packages may make manual handling unfeasible, special equipment must be used to avoid damage and injury. Persons authorised for this purpose must be trained and experienced in the work in question to avoid risks to themselves and others.

The person authorised to handle the product must take all necessary precautions to safeguard his safety and that of all other persons involved.

4.2.1 - Moving the packages

- Prepare a suitable, delimited area with a level floor or surface for unloading the packages.
- Prepare the equipment required to handle the package. The lifting and handling equipment (e.g. crane or lift truck) must be of adequate capacity for the weight and size of the load, taking into account its attachment points and centre of gravity. If required, this information is indicated on the package itself. Harness heavy packages with chains, belts and steel ropes after checking that they are suitable for the weight of the load, which is always indicated.
- When handling the load keep it level to avoid tipping and instability.

4.2.2 - Moving the equipment

All the following operations must be carried out with care and caution and without sudden movements.

When lifting, use accessories such as eyebolts, screw clamps, snap hooks, straps, ropes and hooks etc. which are certified and adequate for the load in question.
The weight of the product to be lifted is given in the Sales Catalogue.

The following pages illustrate in detail the different attachment methods for the various product series, sizes and configurations described in this Manual.
The most suitable solution for lifting and handling the product in safety is indicated for each.

Symbols:

Type of lifting	**Manual**	**With mechanical equipment**	
Symbol	**M**	**A**	**B**
Approximate weight	≤ 15 Kg	> 15 Kg	
Instruction	—	Recommended method for positioning	Recommended method for handling and positioning
Warning	—	The load may be unstable	The load may sway or oscillate
Solution	—	Slide the lifting ring to align it with the load's centre of gravity as shown in the diagrams below Lock the ropes below the ring with a cable clamp or similar device so as to prevent them sliding, and lift the load Observe all precautions regarding the handling of loads	Stabilise the moving load by hand Observe all precautions regarding the handling of loads

The load must not be allowed to sway by more than 15° in any direction when being lifted.
If swaying exceeds this amount, stop and repeat the lifting operation as instructed.

Identify the attachment points for lifting the gear unit. Refer to the diagrams given below.

A 300 L ... 316 L

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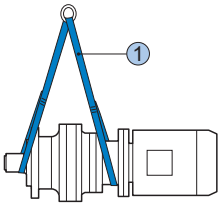

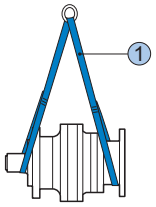

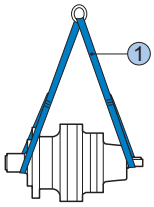

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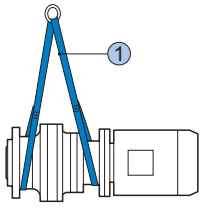

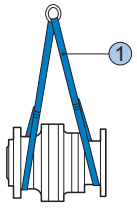

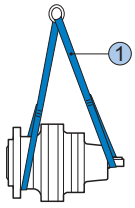

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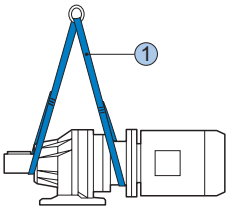

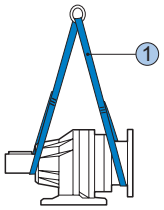

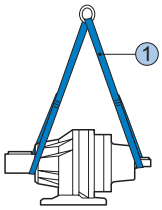

B 317 L ... 321 L

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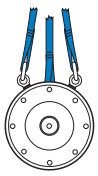

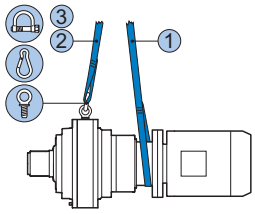

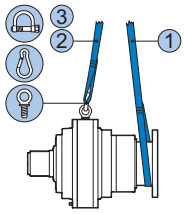

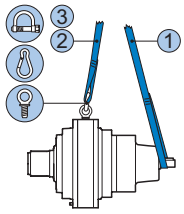

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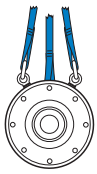

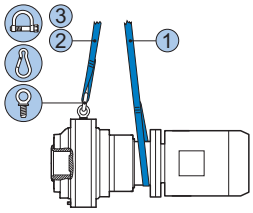

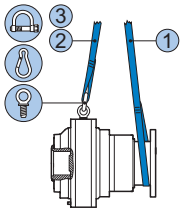

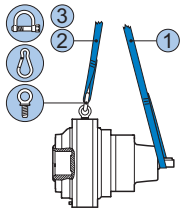

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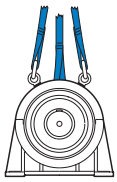
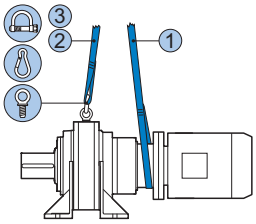
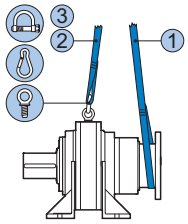
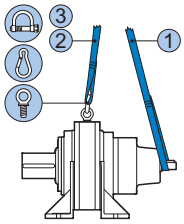








① Ring harness

② Rope and hooks

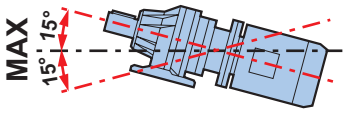
③ Open harness with eyelets

Screw clamp (use with harness)

Snap hook (use with rope)

Eyebolt (already fitted on gear units 317-321)

Maximum permissible tilt during handling: 15°



A 300 R ... 316 R

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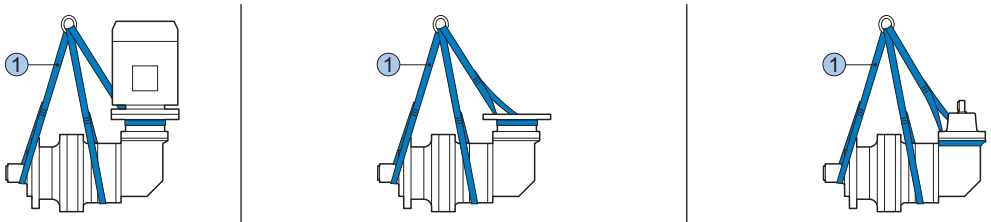

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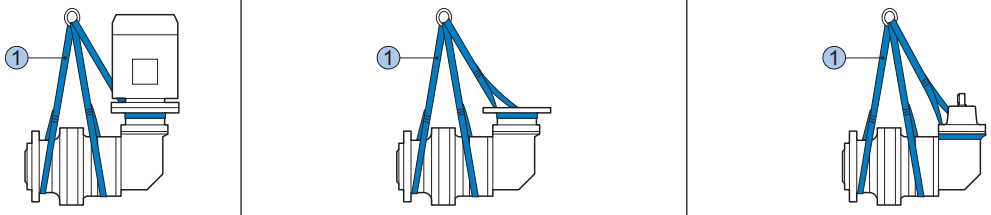

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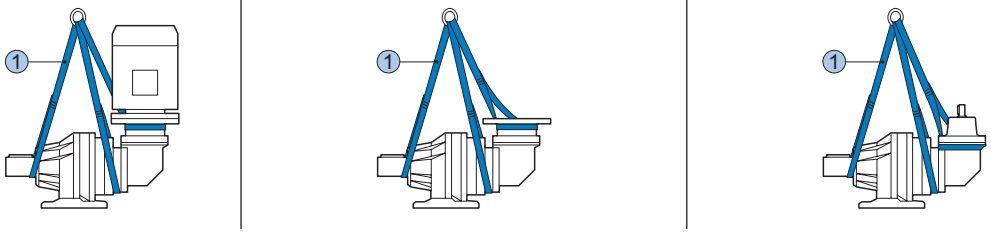

B 317 R ... 321 R

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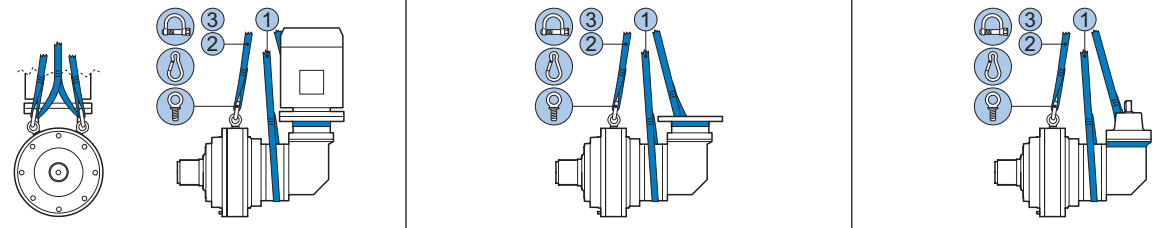

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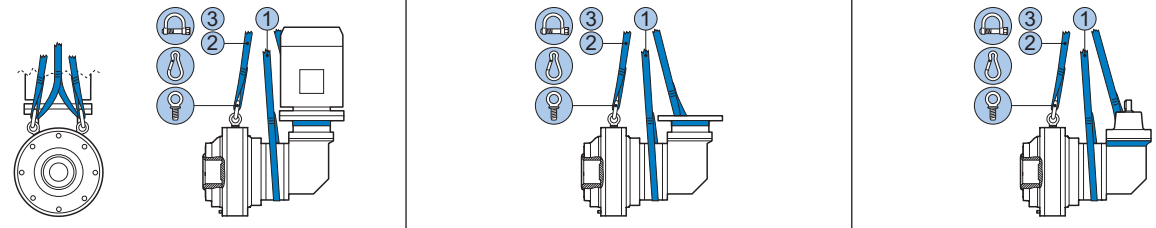

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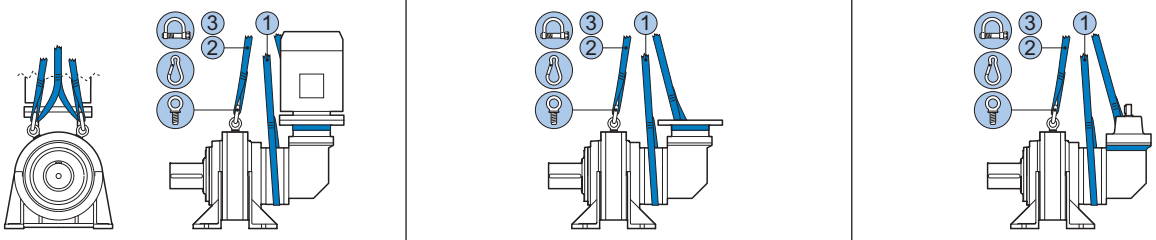


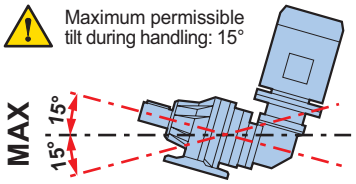
1. Ring harness
2. Rope and hooks
3. Open harness with eyelets

Screw clamp (use with harness)

Snap hook (use with rope)

Eyebolt (already fitted on gear units 317-321)

Maximum permissible tilt during handling: 15°



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A 300 R ... 316 R

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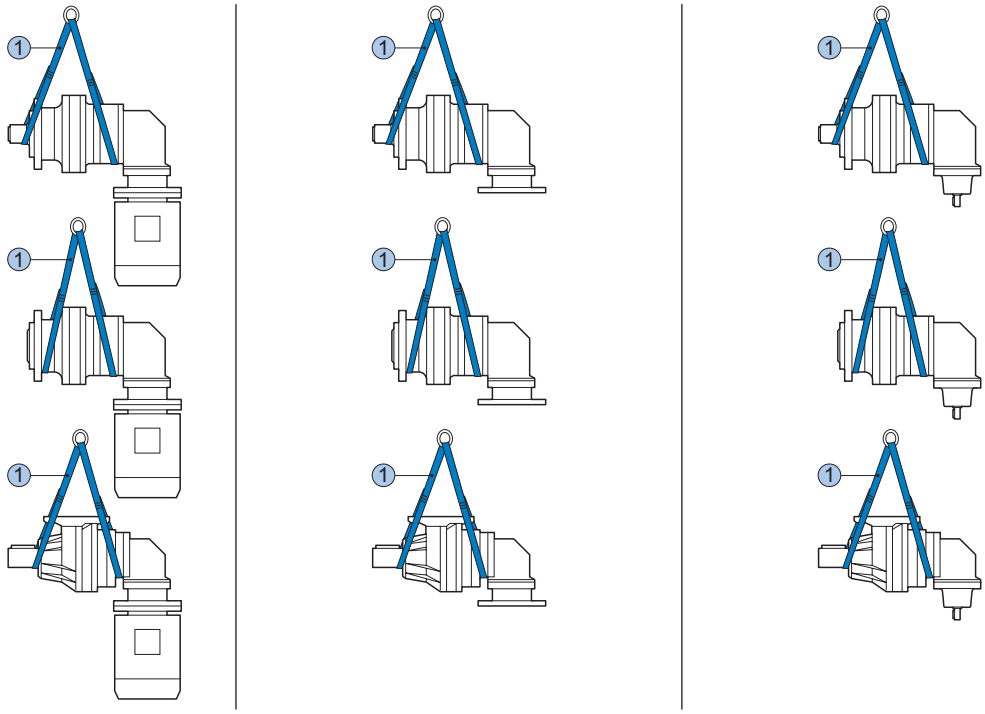

B 317 R ... 321 R

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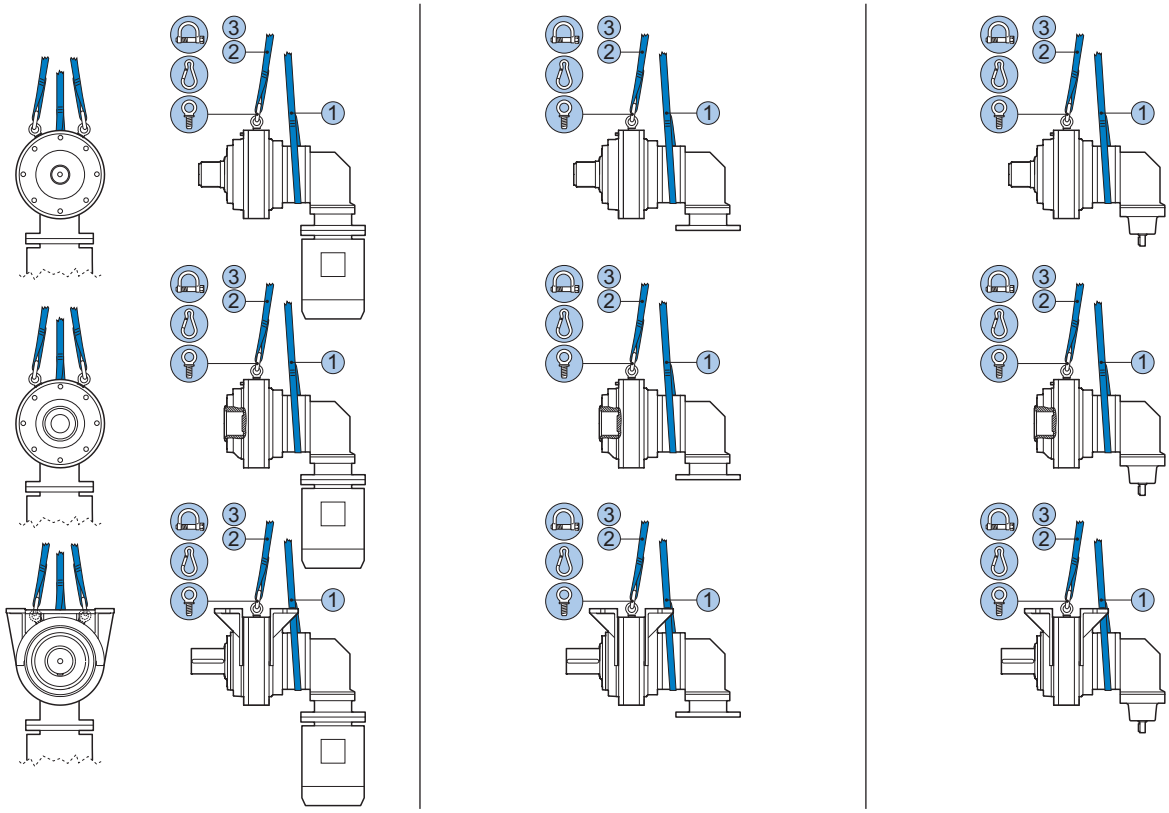

1 Ring harness

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Screw clamp (use with harness)

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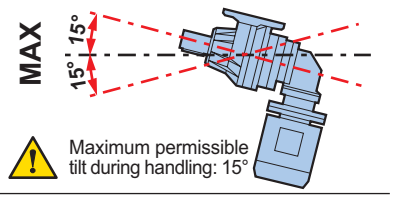

Maximum permissible tilt during handling: 15°

A 3V 00 ... 3V 16

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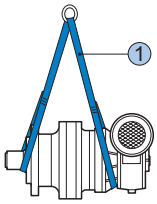

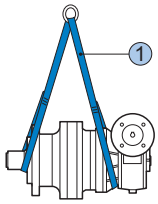

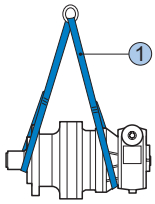

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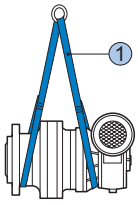

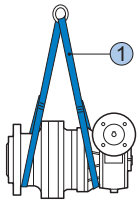

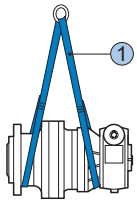

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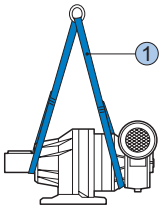

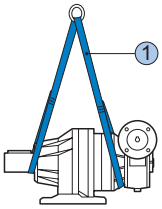

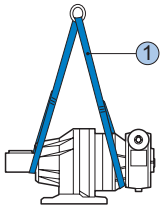

B 3V 17 ... 3V 21

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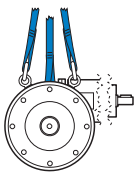

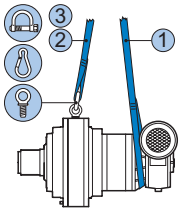

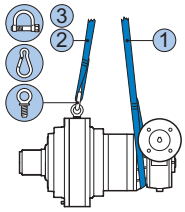

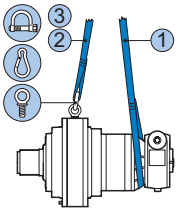

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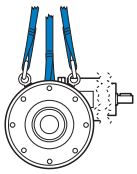

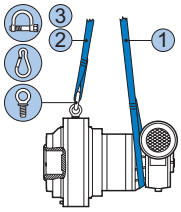

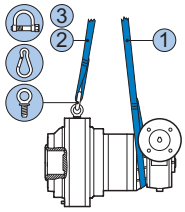

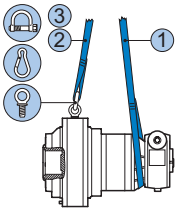

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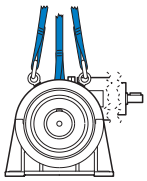
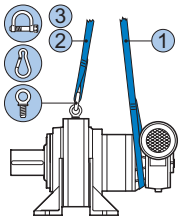
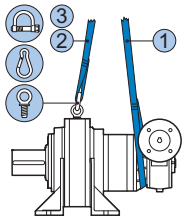
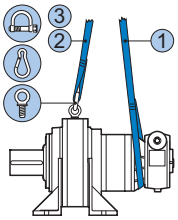








① Ring harness

② Rope and hooks

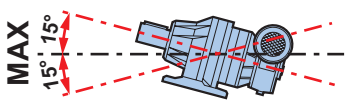
③ Open harness with eyelets

Screw clamp (use with harness)

Snap hook (use with rope)

Eyebolt (already fitted on gear units 317-321)

Maximum permissible tilt during handling: 15°



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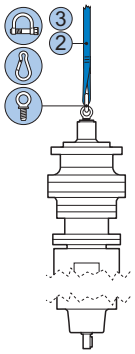
300 L ... 321 L

H□



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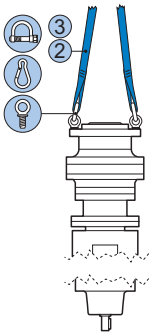

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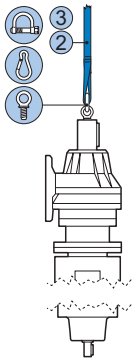
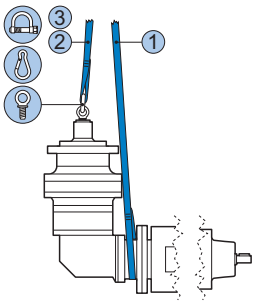


300 R ... 321 R

H□



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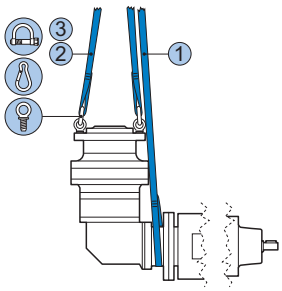

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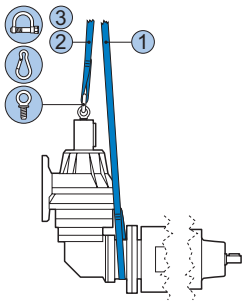
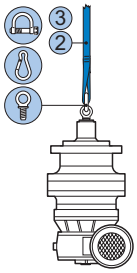


3V 00 ... 3V 21

H□



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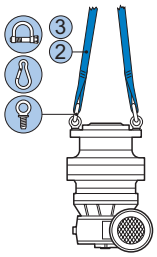

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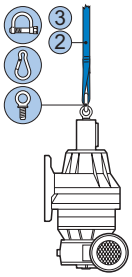


① Ring harness

② Rope and hooks

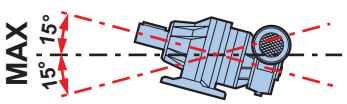
③ Open harness with eyelets

Screw clamp (use with harness)

Snap hook (use with rope)

Eyebolt (already fitted on gear units 317-321)

Maximum permissible tilt during handling: 15°



- Prepare the gear unit for lifting by attaching straps, hooks and screw clamps etc. to its attachment points. Alternatively, use a pallet to move the load. If using a crane, first lift the gear unit vertically out of its packaging.
- If using a lift truck or pallet truck, remove the packaging and insert the truck's forks at the indicated positions.
- First lift the load very slowly to check that it is stable.
- Move the gear unit to the unloading area and lower it gently into position, taking care not to tip it suddenly in transit.

If the gear unit is already equipped with an electric motor, do not use the eyebolts on the motor casing for lifting, unless expressly specified.

4.3 - STORAGE

The following recommendations should be followed when storing the gear unit.

1. Do not store the unit in excessively humid conditions or where it is exposed to the weather (do not store outdoors).
2. Do not place the gear unit directly on the ground.
3. Place the gear unit on a stable base and make sure that it is not subject to accidental displacement.
4. Store the packaged gear unit (if allowed) in accordance with the instructions on the packaging itself.

If the gear unit is to be stored for more than 6 months, the following **additional** precautions must be taken:

5. Cover all machined external surfaces with a rustproofing product such as Shell Ensis or other product with similar properties and application range.
6. Fill the unit with lubricating oil and make sure the vent plug is positioned uppermost. Before putting the unit into service, the oil used for storage must be drained and replaced with the correct quantity of recommended operating lubricant.

PRECAUTIONS to be taken when returning the gear unit to service after storage.

The output shafts and external surfaces must be thoroughly cleaned of all rustproofing product, contaminants and other impurities (use a standard commercial solvent).
Do this outside the explosion hazard area.

The solvent must not touch the seal rings as this may damage them, causing them to leak

If the oil or protective material used during storage is not compatible with the synthetic oil used during the machine's operation, the interior of the unit must be thoroughly cleaned before filling with the operating oil.

The service life of the bearing grease is reduced if the unit is stored for more than 1 year.
The bearing grease must be synthetic.

5.0 - INSTALLATION

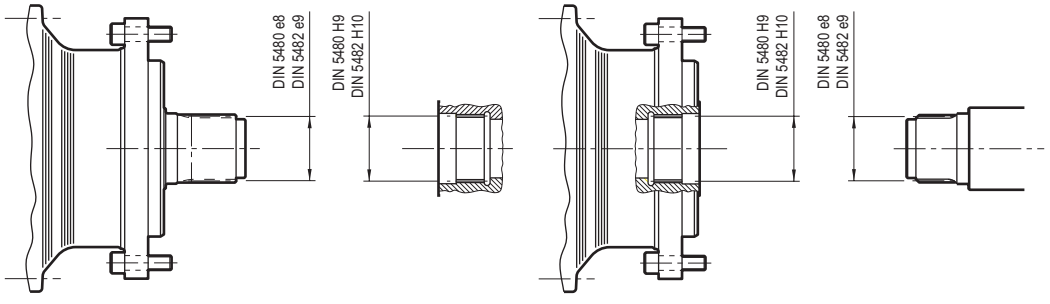
5.1 - INSTALLING THE GEAR UNIT

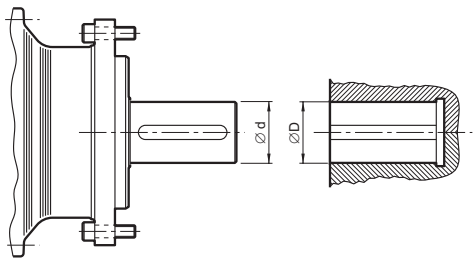
The entire installation process must be planned as early as the general design phase of the machine. The person authorised to do the work must, if necessary, set out a safety plan to protect the health and safety of all persons directly involved and apply all applicable legislation.

1. Carefully remove all packaging and protective product residue from the gear unit.
   Pay particular attention to the mating surfaces.
2. Check that the data on the nameplate correspond to those specified in the purchase order.
3. Ensure that the structure to which the gear unit is to be mounted is sufficiently robust and rigid to support its weight and operating stresses.
4. Check that the machine to which the gear unit is to be installed is switched off and cannot be accidentally switched on again.
5. Make sure all mating surfaces are flat.
6. Make sure the shaft/shaft or shaft/ bore are perfectly aligned for coupling.
7. Fit suitable guards to protect against the gear unit's external moving parts.
8. If the work environment is corrosive for the gear unit or any of its parts, follow the special precautions required for aggressive environments. In this case, contact the BONFIGLIOLI TRASMITAL sales service.
9. We recommend applying a protective paste to all gear unit/motor mating surfaces and other parts (Klüberpaste 46 MR 401 or other product with similar properties and application range) to ensure optimal coupling and protection against fretting corrosion.
10. In the case of outdoor installations fitted with an electric motor, protect the latter from direct sunlight and the weather by means of guards or a casing. Also make sure that the assembly is properly ventilated.

5.1.1 - Flanged execution

Machine the coupling counterflange on the machine to which the gear unit is to be installed.
The flanges must be plane and machined with machine tools. Connect the output shaft to the driven component as indicated in the drawings below.





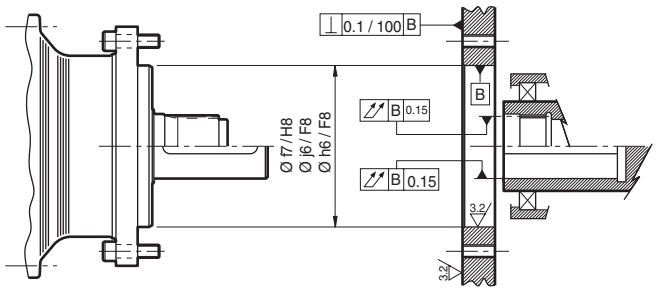
Recommended tolerances

Loose coupling		Coupling with interference	
Solid shaft	Hollow shaft	Solid shaft	Hollow shaft
Ø d h6	Ø D G7	Ø d h6	Ø D P7
Ø d k6	Ø D F7	Ø d k6	Ø D M7
Ø d m6	Ø D F7	Ø d m6	Ø D K7
Ø d r6	Ø D E7	Ø d r6	Ø D H7

For machining the spigot on the driven machine, refer to the diagrams below:

300...307 gear units - male output shaft motor execution

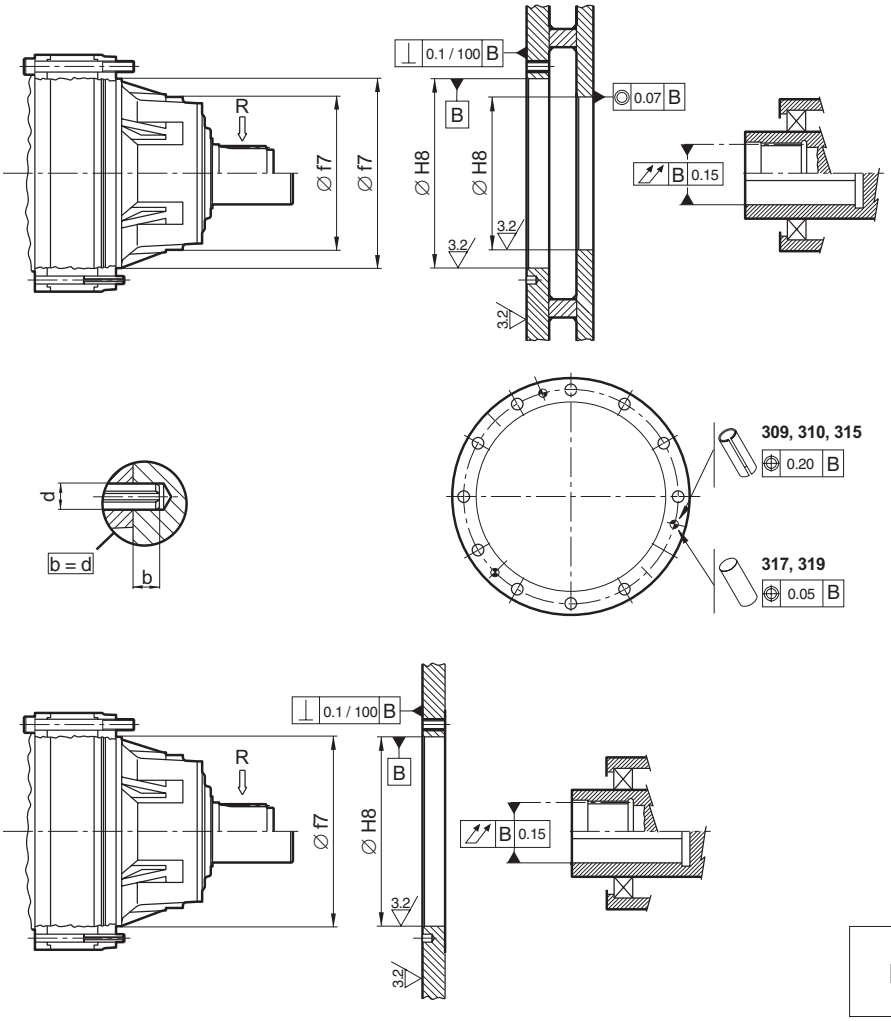
300...307



309...321 gear units - male output shaft motor execution

These gear units are fitted with two spigots. When machining the coupling flanges, one spigot may be sufficient if the output shaft is not subject to overhung loads or loads are less than 60% of the permissible load.
For heavier loads, the mounting must use both spigots on the gear unit.
If the gear unit is instead required to transmit high torque or is subject to heavy shock loads and inversions in the direction of rotation, the counterflange must be drilled to accept the spigots.
At the time of installation, move the spigots mounted on the gear unit forward into the counterflange by an amount equal to their diameter. See diagram below:

309...321

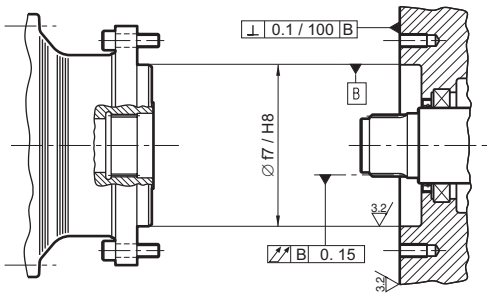


R ≥ 60% Rn

Mounting with hollow splined shaft

Ensure that the gear unit and driven shaft are aligned and that the latter is not subject to flexing during operation. See diagram below:

300...321



Flanged gear unit mounting bolts

	300	301	303	305	306	307	309	310	311	313	315	316	317	318	319	321
Bolt	M10	M10	M12	M12	M14	M16	M16	M16	M16	M20	M20	M20	M30	M24	M30	M30
Quantity	8	8	10	10	12	10	12	15	24	30	20	30	24	32	30	36
Class	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8
Tightening torque (Nm)	50	50	85	85	135	200	200	200	200	400	400	400	1400	700	1400	1400

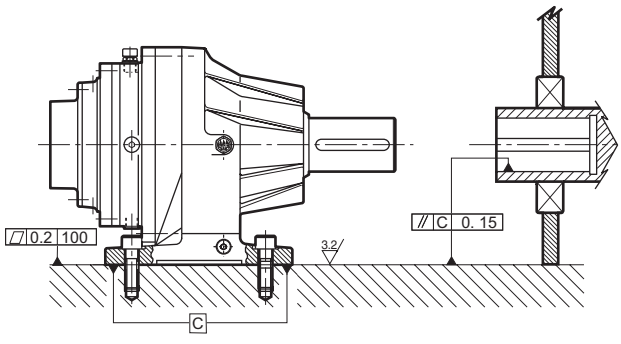
For maximum transmitted torques greater than or equal to 70% of the torque indicated as M_{2max}, and with frequent inversions of the direction of rotation, use at least class 10.9 bolts.

5.1.2 - Foot mounting

Foot-mounted motor execution

Gear units of this type must be mounted on a suitably rigid base, machined flat with a planarity error margin of no more than 0.2 mm / 100 mm.
See diagram below:

300...321



Foot-mounted gear unit mounting bolts

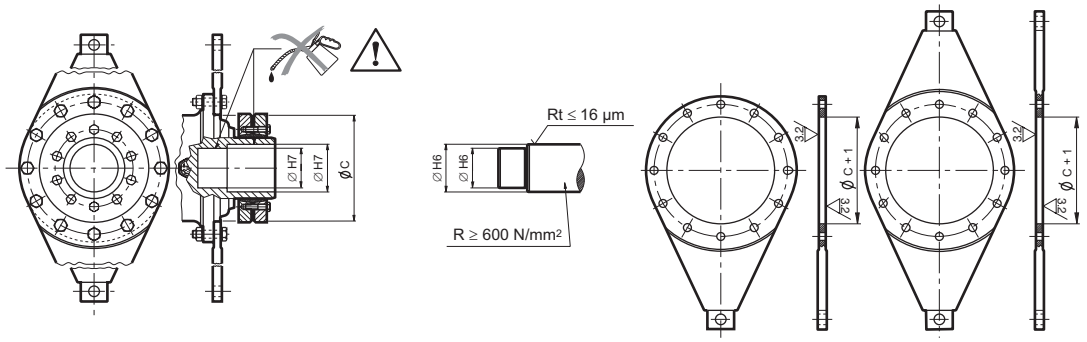
	300	301	303	305	306	307	309	310	311	313	315	316	317	318	319	321
Bolt	M16	M16	M16	M16	M20	M24	M24	M24	M30	M30	M30	M36	M30	M36	M48	M48
Quantity	4	4	4	4	4	4	4	4	4	4	8	8	8	8	4	8
Class	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8
Tightening torque (Nm)	200	200	200	200	400	700	700	700	1400	1400	1400	2500	1400	2500	6000	6000

5.1.3 - Shaft mounting

Mount the torque arm with bolts of at least class 8.8 tightened to a torque of 70% of their failure stress. Clean and degrease both the internal coupling surface of the gear unit shaft and the external coupling surface of the machine's driven shaft.
Mount the shrink disk to the gear unit's shaft after lightly lubricating its entire **outer surface**. Snug down a first set of 3 bolts located at the corners of an equilateral triangle (for example: bolts in pos. 1-5-9 of the diagram below). Fit the gear unit to the driven shaft.
Tighten down the bolts (following the triangular pattern) in a circular direction, repeating the operation several times until all bolts are tightened to the torque specified in chart 2, in accordance with the type of disk/gear unit.

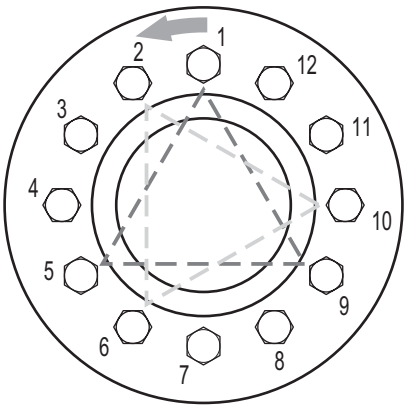
N.B.: Do not tighten down diametrically opposed bolts in sequence.

300...321



Do not use molybdenum bisulphide or any other grease, which could reduce the friction of the mating surfaces and affect the performance of the shrink disk.

300...321



Shrink disk mounting bolts

	300	301	303	305	306	307	309	310	311	313	315	316	317	318	319	321
Bolt	M6	M6	M8	M8	M10	M10	M16	M16	M16	M16	M20	M20	M20	M20	M20	M24
Quantity	8	10	12	12	9	12	8	8	10	10	12	15	18	21	24	21
Class	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9
Tightening torque (Nm)	12	12	30	30	58	58	250	250	250	250	490	490	490	490	490	840

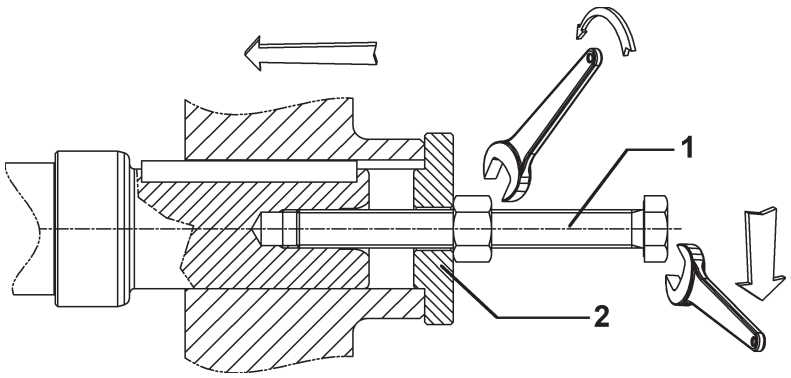
Proceed with the installation as follows:

1. Place the gear unit in the vicinity of the installation area.
2. Mount the gear unit and secure it to the structure at the points provided. The gear unit should be secured to the structure at all the mounting points (bores) on the mount provided (feet or flange).
3. Tighten down the mounting bolts and check that the service plugs are screwed down to the torques given in the chart.

Locate the closed oil plug used during shipping and replace it with the vent plug supplied in the shipment.

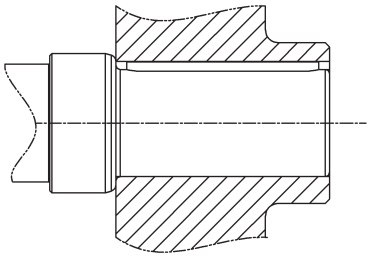
5.1.4 - Installing accessories on solid input and output shafts

Do not use hammers or other tools that might damage the gear unit's shafts or bearings when mounting external parts. Instead, proceed as illustrated in the diagram below:

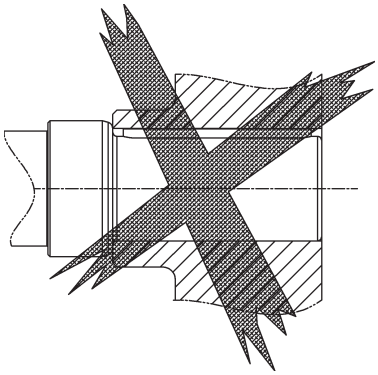


Bolt (1) and spacer (2) are not included in the consignment.

To minimise the loads on the shaft bearings, when mounting transmission mechanisms with asymmetrical hubs use the configuration shown in diagram **(A)** below:

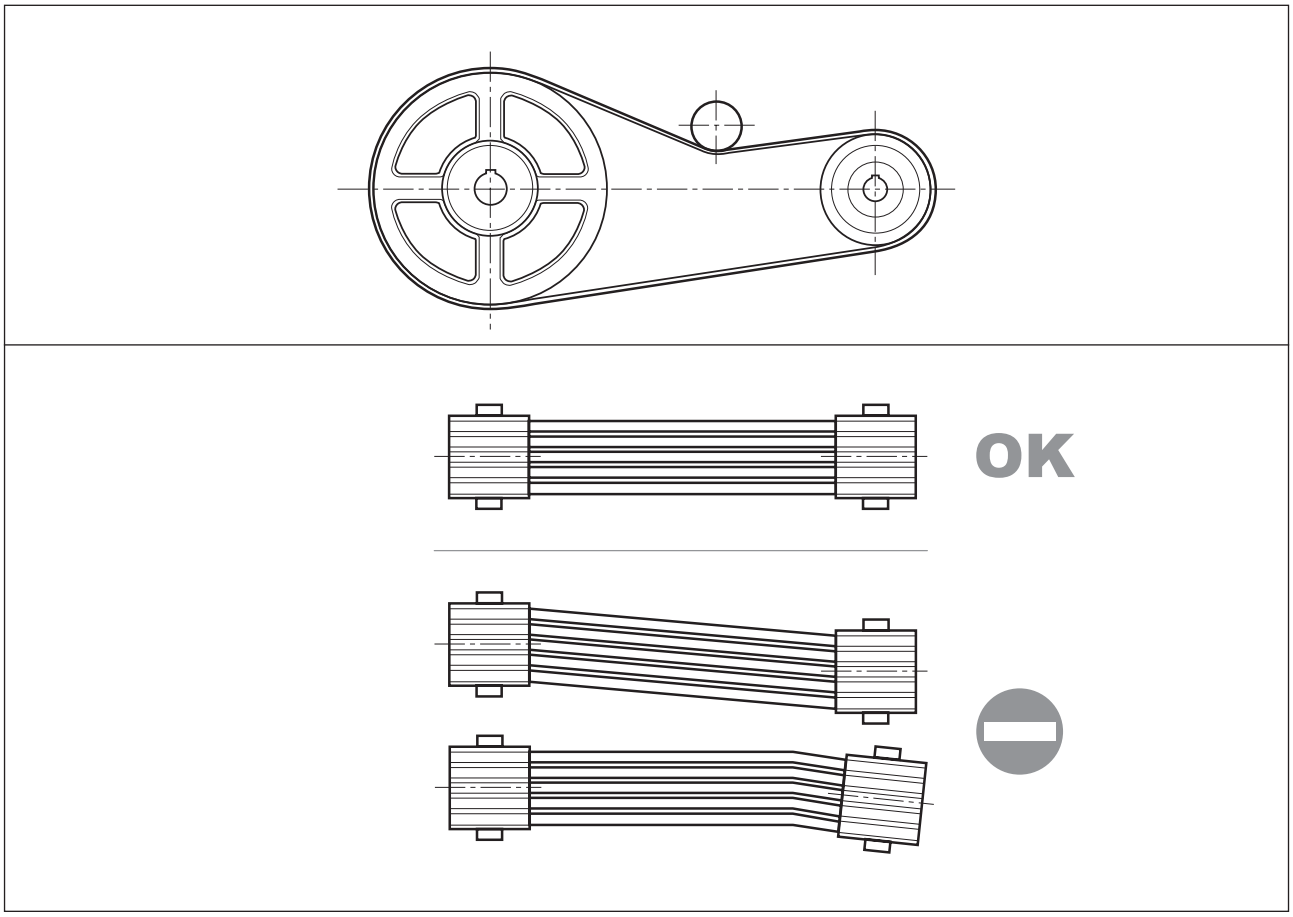


(A)

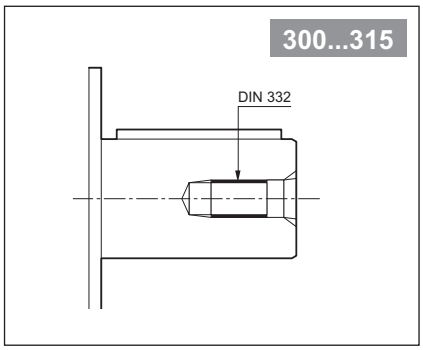


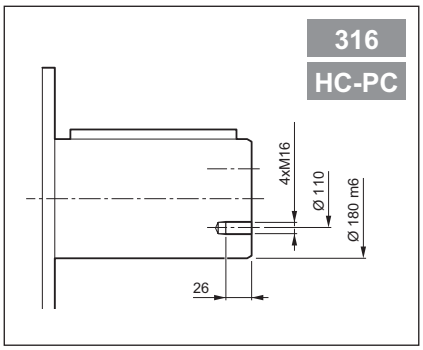
Mounting pulleys

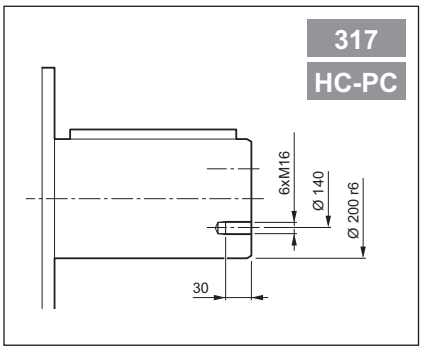
Clean all parts before installing them. When installing belt drive pulleys, the shafts must be parallel with their pulleys aligned.
Do not over tension the drive belt as this can damage the bearings.

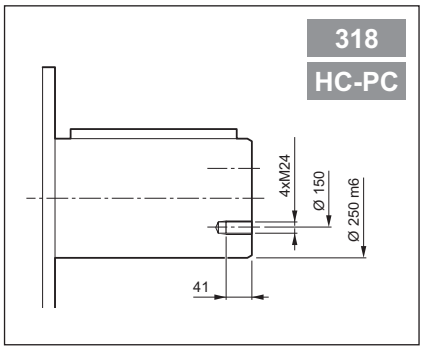


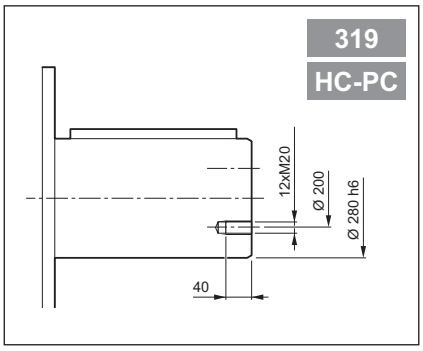
Shaft end: threads

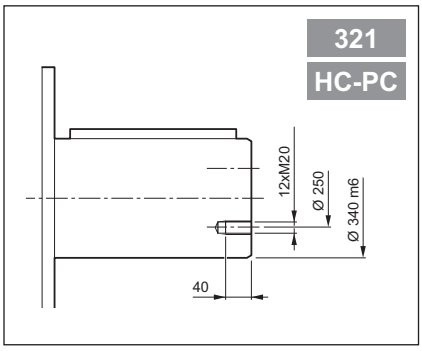








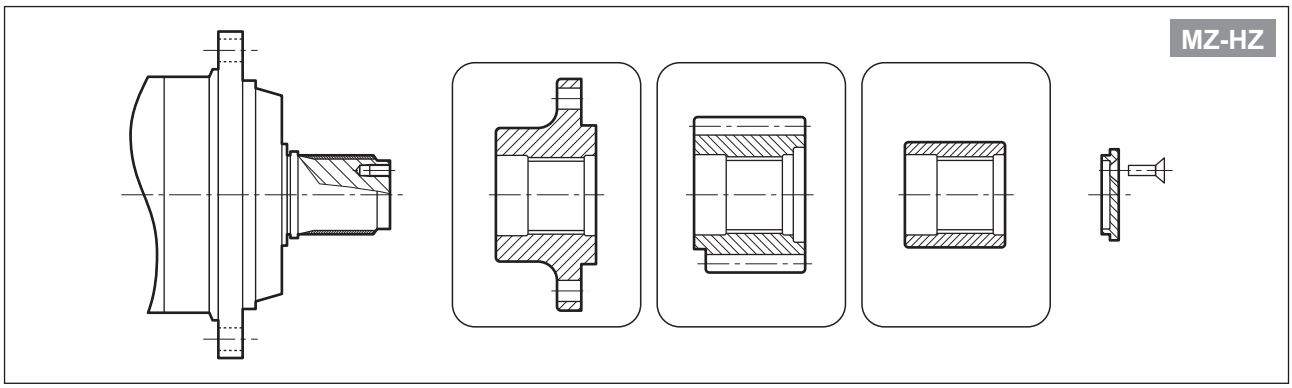




	300	301	303	305	306	307	309	310	311	313	315	316	317	318	319	321
MC	M12	M12	M20	M20	M20	M20	–	–	–	–	–	–	–	–	–	–
HC	M16	M16	M20	M20	M20	M20	M24	M24	M24	M24	M24	–	–	–	–	–
PC	M12	M16	M20	M20	M20	M20	M24	M24	M24	M24	M24	–	–	–	–	–
VK	–	–	M20	M20	M24	M24	M24	M24	M24	M30	M30	–	–	–	–	–

Installing accessories on splined shafts

Do not use hammers or other tools that might damage the gear unit's shafts or bearings when mounting external parts. Instead, proceed as illustrated in the diagram below:

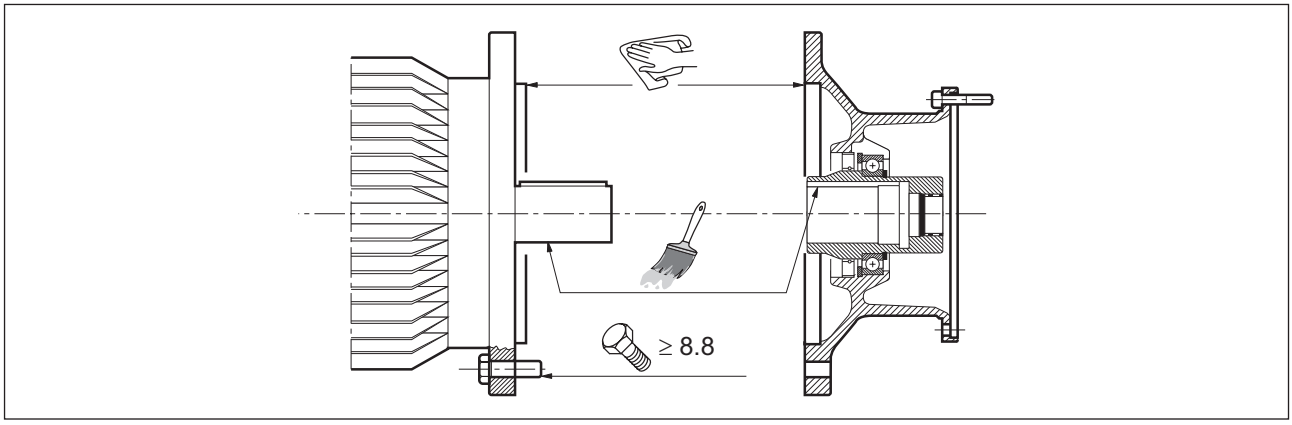


Always use the stop end plate supplied with the gear unit.

5.2 - INSTALLING THE ELECTRIC MOTOR

Further to all the precautions indicated above, when installing a standard IEC 72-1 electric motor, the following precautions must also be observed:

- Do not force the coupling and do not use inappropriate tools during assembly. Take care not to damage the flat/cylindrical coupling surfaces.
- Do not force the rotary coupling mechanisms with heavy overhung or thrust loads.
- To facilitate assembly, use a lubricating synthetic oil paste such as Klüberpaste 46 MR 401 or another product with similar properties and application range.



- **Provided all the above checks have been performed and passed and all other instructions in this manual have been strictly observed, an electric motor with ATEX rating equal to or greater than that of the gear unit may be installed, thus forming a gearmotor which itself complies with the provisions of Directive 94/9/EC.**

  If, instead, the assembly of the motor to the gear unit requires actions other than those prescribed in this Manual or one or more of the manual's prescriptions have not been satisfied, the User shall be responsible for analysing the risks attendant on this particular motor/gear unit combination. The risk analysis is in any case obligatory if the motor is powered by an inverter.

  Only in this way, and subject to self-certification by the assembler, shall the assembly, including the gear unit itself, be compliant with the requirements of Directive 94/9/EC.

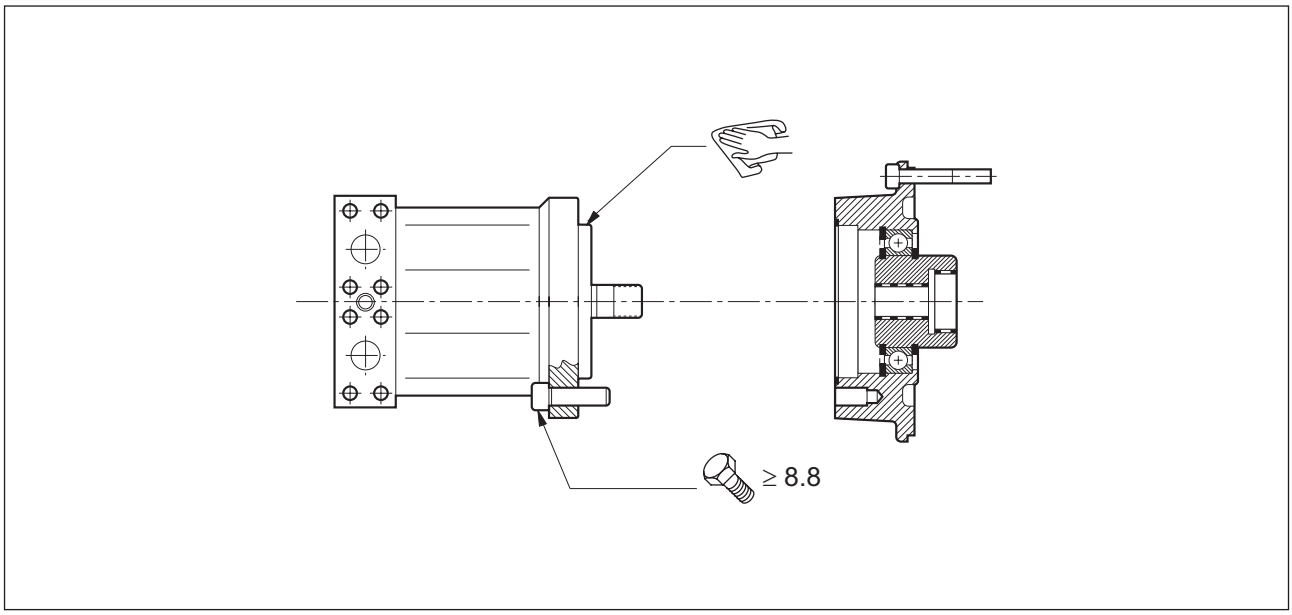
5.3 - INSTALLING THE HYDRAULIC MOTOR

Connecting the hydraulic motor

Remove the protective plug.
Hydraulic motor mountings are available in two versions:

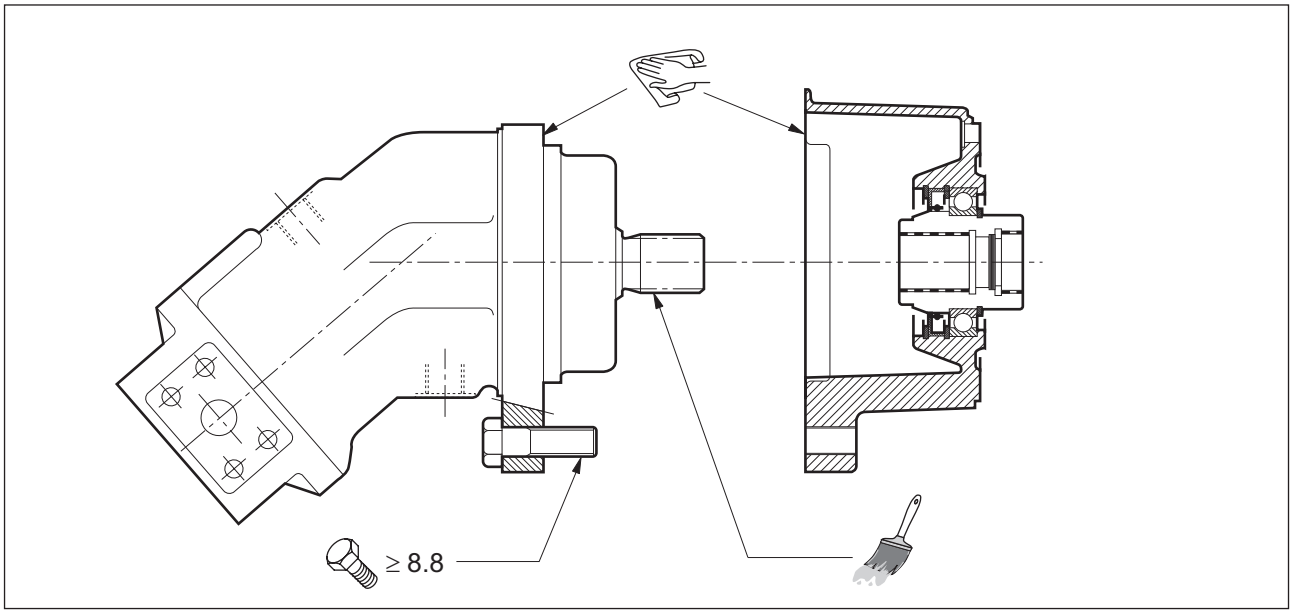
a) Version with O-ring oil gasket between motor flange and gear unit.

In this case, mount the gasket to ensure an oil tight seal between the motor and gear unit, taking care to fit it correctly in its seat without damaging it.



b) Version with gasket already mounted to the coupling.

In this case no special intervention is required to ensure an oil tight seal since this is already provided by the motor coupling. Merely smear the motor shaft with grease.
In both cases, clean the spigot and the coupling where the motor is to be fitted, fit the motor and tighten down the flange mounting bolts.
Always use bolts rated to at least class 8.8.

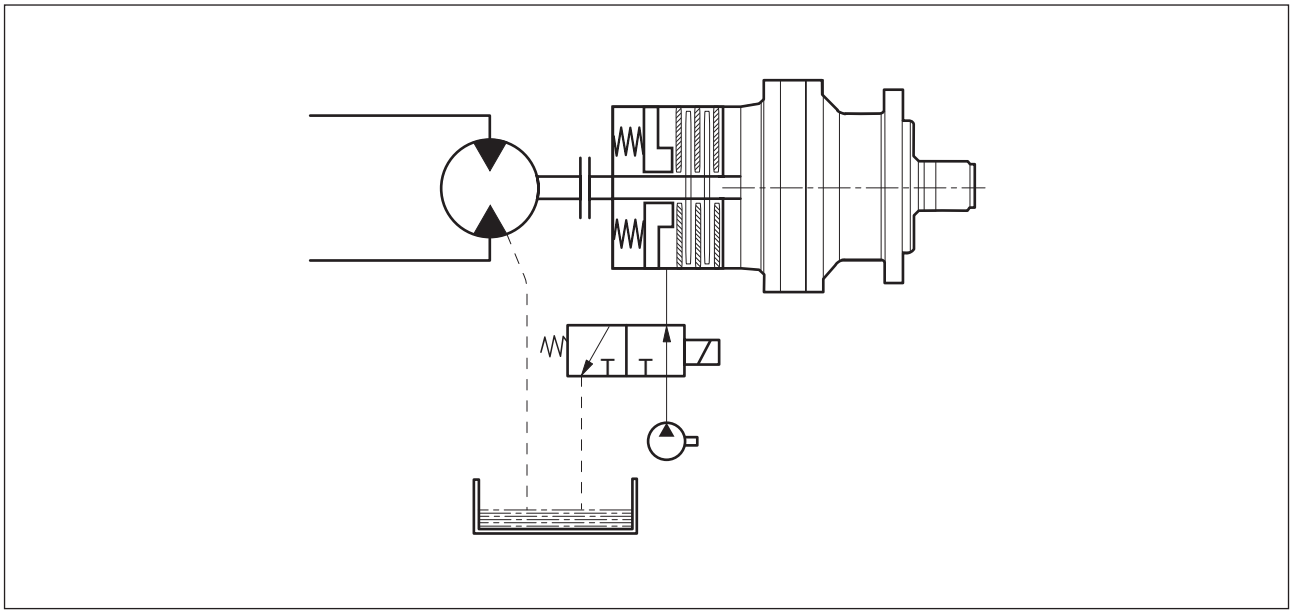


5.4 - CONNECTING THE HYDRAULIC BRAKE

On gear units designed for coupling to hydraulic motors and fitted with a brake, connect the brake control fitting to the hydraulic circuit at the time of assembly.

Start-up

The minimum pressure to release the brake (see chart) must be less than 320 bar.



Technical data

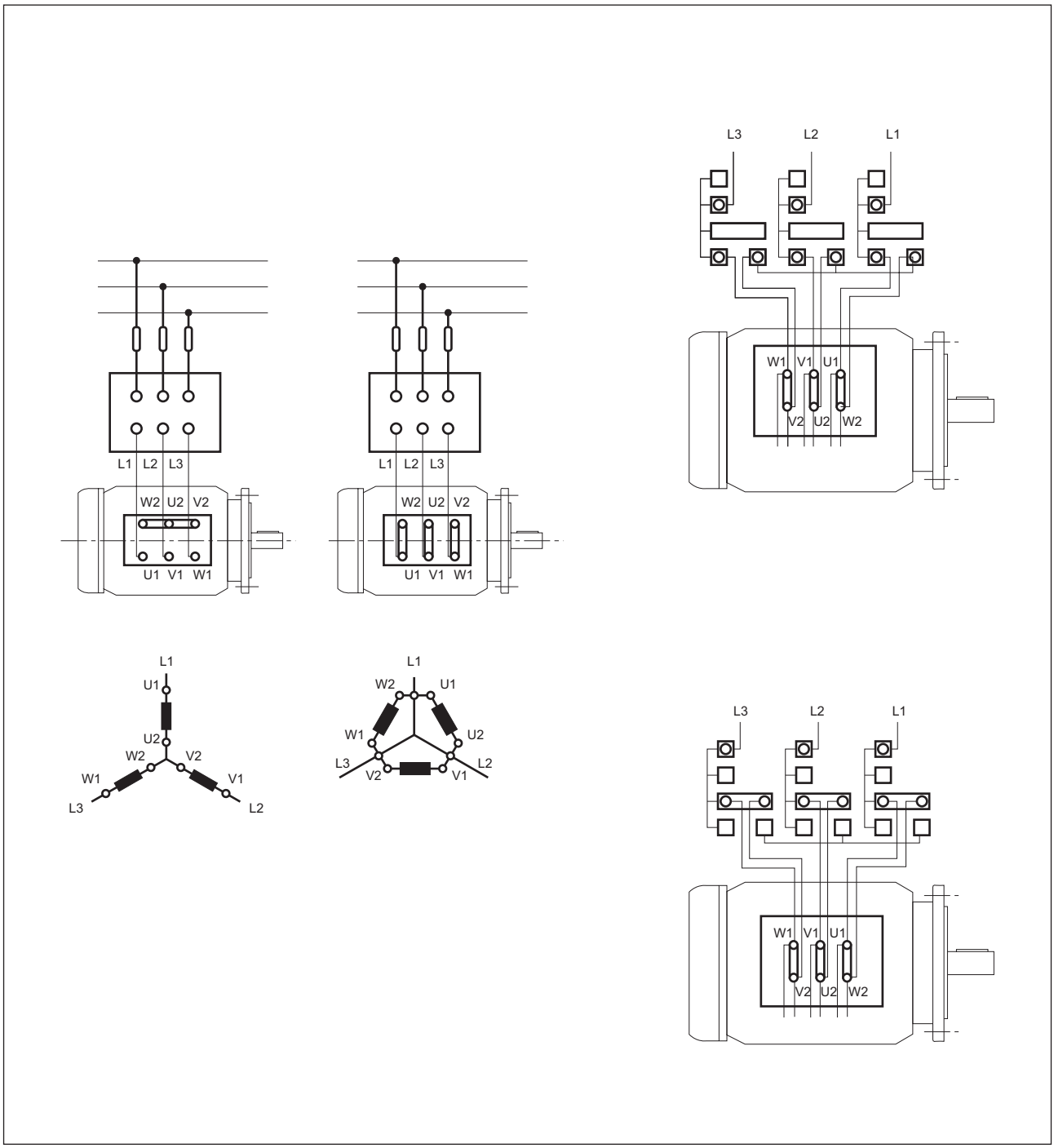
Characteristics \ Brake		4...							5...					6...					
		A	B	D	F	H	K	L	B	C	E	G	K	B	C	E	G	K	L
Braking torque	M_{bs} [daNm]	5	10	16	26	33	40	44	40	50	63	80	100	85	110	150	210	260	320
Minimum release pressure	bar	10	20	30	20	25	30	33	20	27	20	25	32	14	19	25	19	24	28
Max. pressure	bar	320																	
Weight	kg	10							18					35					

NOTE: The static torque M_{bs} is the maximum torque the brake can exert.
Under dynamic loads the braking torque is reduced. The actual M_{bs} values can vary from -5% to +15% of the rating given in the chart.

Installing the gearmotor

If a gearmotor is supplied fully assembled, follow the precautions and instructions given above when mounting to the machine.
For the electrical and hydraulic connection, refer instead to the two sample diagrams below. These are generic only since each specific installation has its own special requirements, which must be evaluated on a per case basis by the Manufacturer.

Drive with electric motor.



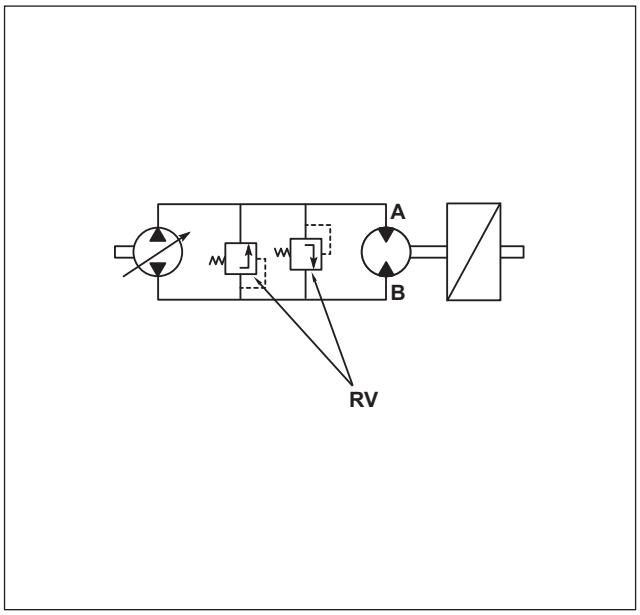
Drive with TRASMITAL MG orbital hydraulic motor

In addition to the instructions governing installation of the gear unit, the following instructions should also be observed when installing a hydraulic motor.

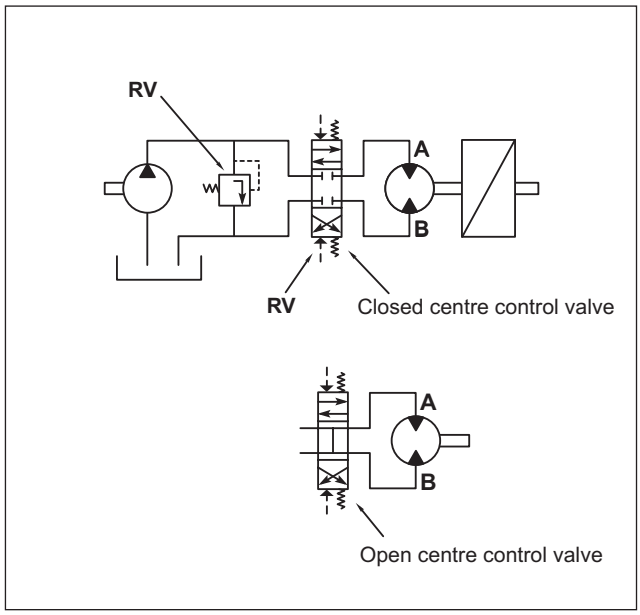
a) Connecting to the hydraulic circuit

The motor can be installed on both a closed and open loop circuit.
In the case of an open circuit installation, the solenoid valve or control valve may be of either the closed centre or open type.
The circuit line corresponding to the hydraulic motor delivery port must always be equipped with a pressure relief valve calibrated to a pressure no greater than the motor's pmax. Refer to the hydraulic circuit diagrams below.

Closed loop circuit

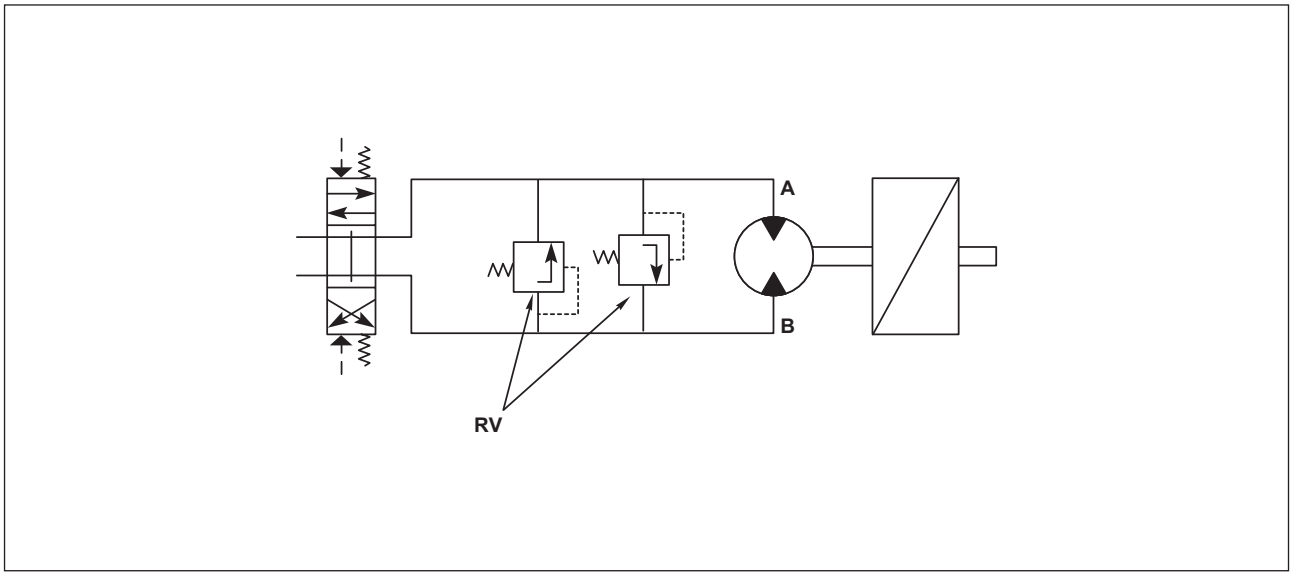


Open loop circuit



RV = pressure relief valves calibrated to pRV < pmax.

If this is not possible because the circuit must also actuate other equipment at a higher pressure, or the control valve is of the closed centre type and the motor drives components with high inertia, auxiliary pressure relief valves must be installed as close as possible to the motor.

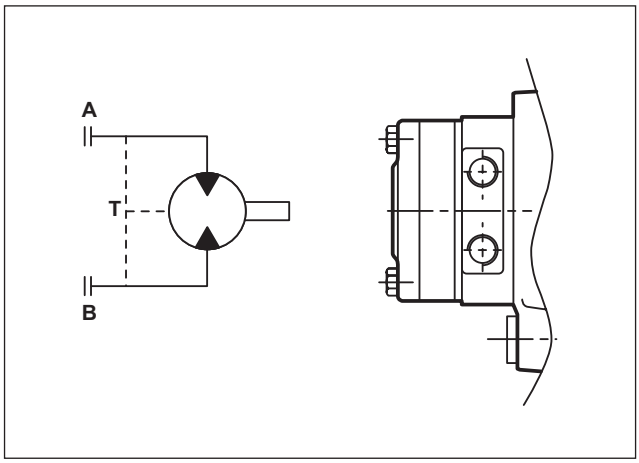


RV = pressure relief valves calibrated to pRV < pmax.

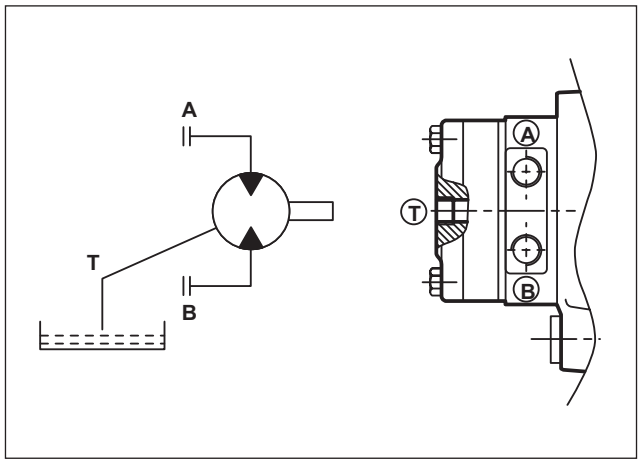
b) Connecting drain hole T

Standard motors are supplied without a drain hole. In this case the motor is equipped with internal drainage. This meets the requirements of the majority of applications with intermittent duty and an average drive pressure of less than 50% of the motor's maximum rated pressure.
When duty is continuous or intermittent with an operating percentage greater than 50% and the average drive pressure is greater than 50% of the rated maximum pressure, the motor must be ordered with external drainage and drain hole T must be connected to the tank. Refer to the diagrams below:

Internal drainage



External drainage

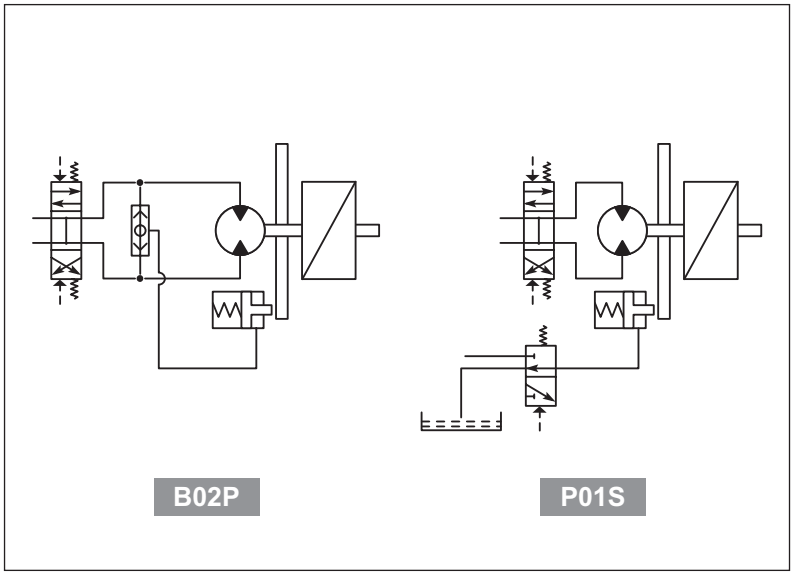


c) Brake control

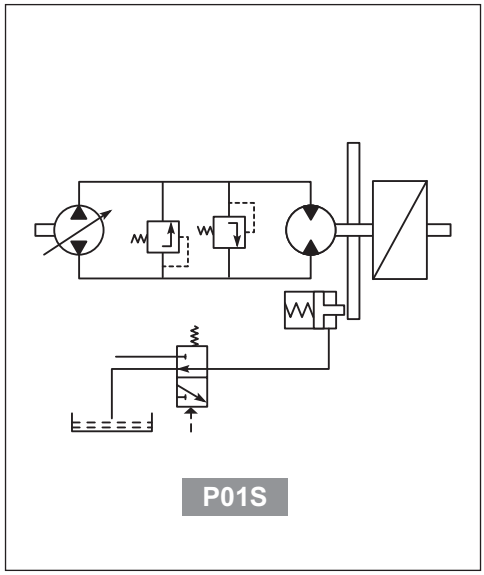
Gearmotors equipped with a brake, are available in two motor executions:
B02P or P01S.

Brake control is internal on the B02P version, and is controlled directly by the motor.
The brake control pressure must instead be supplied by an auxiliary line of the brake control circuit on the P01S version.
Refer to the diagrams below:

Closed loop circuit



Open loop circuit



d) Type of hydraulic fluid

Use hydraulic mineral fluid with viscosity ISO VG 46 (46 Cst at t = 40°C).
During operation, the fluid temperature should remain within the range +30°C to +70°C.

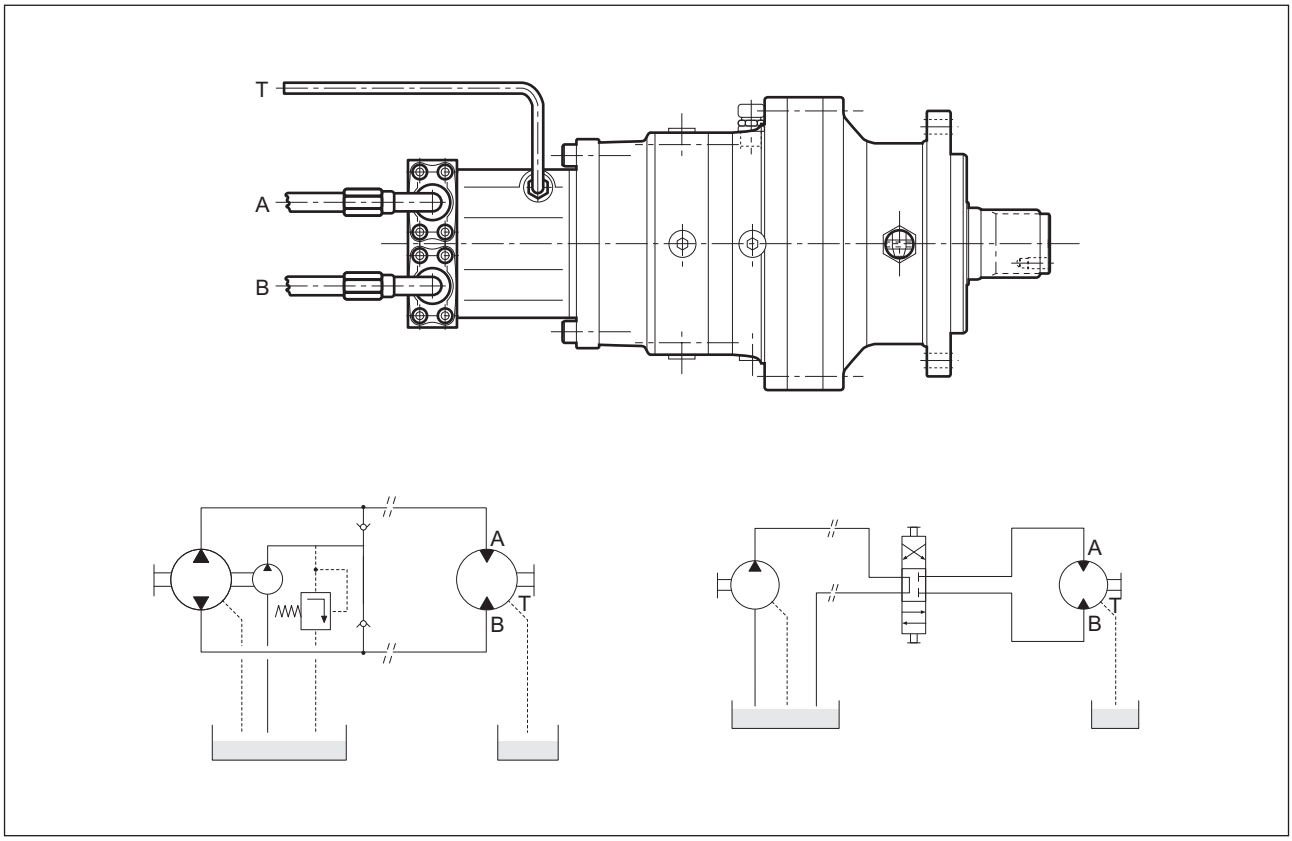
e) Filtering

To ensure the motor's reliable operation and long service life, the hydraulic circuit must be equipped with a filter capable of guaranteeing the following purity levels:

grade9 NAS 1638
grade6 SAE
grade18/15 SO DIS 4406

Drive with hydraulic motor

All motors must be charged with hydraulic fluid before being operated and during installation.
Position the drain hole so that it is positioned uppermost for charging with fluid.
Make sure the hoses are routed in such a way as to prevent the motor casing from emptying and hence, prevent air pockets from forming which may affect pump suction during operation.



A - B = Supply lines
T = Drainage

5.5 - LUBRICATION

Before starting up the gear unit, it must be charged with lubricant to the level corresponding to its specified mounting position.

The lubricant and its relative viscosity should be selected from the following chart, in accordance with the type of duty and ambient temperature.

If the gear unit is supplied ready charged with lubricant, replace the closed shipping plug with the vent plug included in the shipment before installing it.

(A1)

Plug thread	Pitch	Tightening torque [Nm]
M14	1,5	15 - 20
M16	1,5	15 - 20
M18	1,5	15 - 20
M20	1,5	20 - 30
M22	1,5	20 - 30
M24	1,5	20 - 30
M30	2	30 - 40
M42	3	40 - 50

Plug thread	Pitch	Tightening torque [Nm]
1/8"	28	10 - 15
1/4"	19	10 - 15
3/8"	19	15 - 20
1/2"	14	20 - 30
3/4"	14	20 - 30
1"	11	30 - 40

(A2)

	INDUSTRIAL INSTALLATIONS			MOBILE MACHINES	
	ISO standards .. with EP characteristics			SAE standards .. with API GL5 characteristics	
Ambient temperature	-10°C / +30°C	+10°C / +45°C	-20°C / +60°C	-20°C / +30°C	+10°C / +45°C
	ISO VG 150	**ISO VG 220**	**ISO VG 150-220**	**SAE 80W/90**	**SAE 85W/140**
AGIP	BLASIA 150	BLASIA 220	BLASIA S220	ROTRA MP	ROTRA MP
ARAL	DEGOL BG 150	DEGOL BG 220	DEGOL GS 220	GETRIEBEOL HYP	GETRIEBEOL HYP
BP-MACH	ENERGOL GR XP 150	ENERGOL GR XP 220	ENERSYN HTX 220	HYPOGEAR EP	HYPOGEAR EP
CASTROL	ALPHA SP 150	ALPHA SP 220	ALPHASYN PG 150	HYPOY	HYPOY
CHEVRON	N.L. GEAR COMPOUND 150	N.L. GEAR COMPOUND 220		UNIVERSAL GEAR LUBRICANTE	UNIVERSAL GEAR LUBRICANTE
ELF	REDUCTELF SP150	REDUCTELF SP 220	ELF ORITIS 125 MS ELF SYNTHERMA P20	TRANSELF8	TRANSELF8
ESSO	SPARTAN EP 150	SPARTAN EP 220	GLYCOLUBE 220	GEAR OIL GX	GEAR OIL GX
				PONTONIC MP	PONTONIC MP
FINA	GIRAN 150	GIRAN 220			
I.P.	MELLANA150	MELLANA220	TELESIA OIL 150	PONTIAX HD	PONTIAX HD
KLUBER	KLUBEROIL GEM1-150	KLUBEROIL GEM1-320	KLUBERSYNT GH 6-220		
Q8	GOYA 150	GOYA 220	EL GRECO 220		
MOBIL	MOBILGEAR 629	MOBILGEAR 630	SHC 630	MOBILUBE HD	MOBILUBE HD
SHELL	OMALA EP150	OMALA EP220	TIVELA OIL SA	SPIRAXHD	SPIRAX HD
TOTAL	CARTER EP 150	CARTER EP 220		TRANSMISSION TM	TRANSMISSION TM

Synthetic oil.

Brake lubrication

The hydraulic multi-disk brakes are lubricated with the same oil as the gear unit.

Only synthetic lubricants may be used on gear units conforming to European Directive 94/9/EC. Refer to the above chart for the brand and type.

6.0 - TESTING THE GEAR UNIT

The gear unit has been factory tested by the Manufacturer. Before start-up, make sure that:

- the machine incorporating the gear unit complies with the provisions of the “Machinery Directive” 98/37/EC and any other applicable safety legislation
- the gear unit’s mounting position in the installation corresponds to that prescribed and indicated on the nameplate
- the electrical power supply is suitable and operational as prescribed in EN 60204-1, and is grounded as per EN 50014
- the motor’s electric power supply corresponds to that prescribed and is within +/-5% of the rated value
- the hydraulic system is suitable and operational, and the oil in the hydraulic motor’s lubrication circuit conforms to ISO VG 46. It must be filtered with a maximum grade of 10 µm and contamination level less than or equal to class 9 as per NAS 1638 or 18/15 as per ISO/DIS 4406
- there are no signs of lubricant leaks from the plugs or gaskets
- the vent plug is not obstructed by dirt or paint
- the unit does not run noisily or with excessive vibration.

Before starting up the unit, check and make sure that:

- the unit is not assembled in a potentially explosive atmosphere (oil, acid, gas, vapour, radiation) and is free of dust build ups greater than 5 mm in depth
- during operation the gear unit is sufficiently ventilated and is not subject to radiation from external heat sources
- during operation the cooling air does not exceed 40 °C
- the oil level check and filler plugs and the vent plugs are all easily accessible
- all accessories mounted to the gear unit are ATEX certified
- gear units with hollow shafts, with or without shrink disk, have been correctly mounted as described in this manual
- the gear unit has been thoroughly cleaned after installation
- all guards are installed to prevent accidental contact between operators and the unit’s rotary moving parts, and seals are oil tight

7.0 - USING THE EQUIPMENT

Before putting the gear unit into service, the User must ensure that the plant in which it is installed complies with all applicable directives, especially those regarding health and safety at work.

The gear unit may not be used in areas and environments:

- with highly corrosive/abrasive vapours, smoke or dust.
- in direct contact with loose food products.

Danger zones and exposed persons:

The danger zone of the gear unit is the protrusion of the shaft which constitutes a hazard for exposed persons in direct contact with it (crushing, shearing, trapping). In particular, when the gear unit is operating in automatic mode in an accessible area, the shaft must be protected by a guard.

8.0 - MAINTENANCE

Maintenance and replacement work must be carried out by expert maintenance technicians trained in the observance of applicable laws on health and safety at work and the special ambient problems attendant on the installation.

Before doing any work on the unit, the operator must first switch off power to the gear unit and ensure that it is out of service, as well as taking all necessary precautions against it being accidentally switched on again or its parts moving without warning (due to suspended loads or similar external factors).
Furthermore, all additional environmental safety precautions must be taken (e.g. elimination of residual gas or dust, etc).

- Before doing any maintenance work, activate all the safety devices provided and, if necessary, inform persons working in the vicinity. Cordon off the area around the unit and prevent access to any equipment which, if activated, might be the cause of unexpected health and safety hazard.
- Replace worn components with original spare parts.
- Use the lubricants (oil and grease) recommended by the Manufacturer.
- When working on the gear unit always replace all gaskets and seals with original new ones.
- If a bearing requires replacement, it is good practice to also replace the other bearing supporting the same shaft.
- We recommend replacing the lubricating oil after all maintenance work.

The above instructions are aimed at ensuring efficient and safe operation of the gear unit.

The Manufacturer declines all liability for injury to persons and damage to components due to the use of non-original spare parts and non-routine work that modifies the safety requirements without the Manufacturer's express prior authorisation.

Refer to the specific spare parts catalogue when ordering spare parts for the gear unit.

Do not dump polluting liquids, worn parts and maintenance waste into the environment.
Dispose of all such materials as specified by applicable legislation.

- Observe the routine inspection and maintenance schedule to ensure the unit's correct operation and the effectiveness of the explosion protection.
- Always apply fresh Loctite 510 or other product with similar properties and application range to all disassembled threads.
- Before servicing or repairing internal components, allow the gear unit to cool down completely before opening the casing so as to avoid burns from parts which are still hot.
- On completion of maintenance work, make sure that all safety measures and equipment have been applied and reset.
- Clean the gear unit thoroughly after maintenance and repair work.
- On completion of maintenance, tighten all vent, filler and level plugs to their specified torques (chart A1).
- On completion of any maintenance work all seals must be refitted and sealed as prescribed.
- Regardless of the type of gear unit, whenever a seal ring is replaced its lips should be smeared with a thin layer of grease (Fluorocarbon gel 880 ITP or other product with similar properties and application range) before assembly.
- Use only original spare parts for repairs.

8.1 - ROUTINE MAINTENANCE

Keep the gear unit at its maximum efficiency by following the routine maintenance schedule. Good maintenance ensures the unit's maximum performance, extended service life and continued compliance with safety regulations.

(A3)

Frequency	Component	Type of check	Action
at start	Gear unit casing	Check that the external temperature does not exceed 75-80 °C	Stop the machine and contact Bonfiglioli Trasmital's Technical Service
after 200 hrs	Original consignment lubricant	Replace	Replace with new lubricant
	External fasteners	Check locking torque	Tighten down to specified torque
1000 hrs	External seals and gaskets	Check oil level Check for leaks by eye	Service or replace components as required
2500 hrs	Lubricant	Replace	Replace with new lubricant
5000 hrs	Gear unit seals and gaskets	Inspect carefully for wear/ageing of external seals	Replace if aged/worn

For installations in zones 21 and 22 the User must schedule and implement a regular cleaning programme for all surfaces and recesses to avoid dust build-ups of more than 5 mm in depth.

Every 1000 hrs. of operation or after 6 months:

- Measure the surface temperature at the coupling between the gear unit and motor, and at the points which are most shielded from the motor's cooling fan. The maximum temperature must not be more than 75-80°C, nor may this value be exceeded during operation.

Every 5000 hrs. of operation:

- Change the synthetic oil and bearing grease if the gear unit is not life lubricated.
- Replace all externally accessible seal rings unless this has already been done as a result of problems occurring before the scheduled maintenance deadline.

8.2 - OIL CHANGES

1. Place an adequate container under the drain plug.
2. Remove the filler and drain plugs and allow the oil to drain out.

The oil will drain better if it is warm.

3. Wait for a few minutes until all the oil has drained out, then screw the drain plug back on after first changing the plug seal.
4. Fill with new oil until it reaches the level mark. **Do not mix oils of different makes or specifications and check that the oil is highly resistant to foaming and is EP rated**.
5. Tighten down the filler plug after changing its seal.

The gear unit may be supplied with or without lubricant, as requested by the User. The quantity of charge oil required is specified in the Sales Catalogue. This specification is however, approximate, and reference must always be made to the mark on the level plug, the placement of which depends on the mounting position specified in the purchase order.

Life lubricated gear units which are not subject to external contamination do not normally require periodic lubricant changes. If the same type of oil as that already in use is not available, drain the gear unit casing completely and wash its interior thoroughly with a light solvent before refilling with the new lubricant.

If a leak is found, identify the cause of the fault and repair it before topping up the lubricant and operating the unit.

Lubricants, solvents and detergents are toxic/harmful to health:

- they may cause irritation in direct contact with the skin
- they may cause intoxication if inhaled
- they may be fatal if swallowed.

Handle them with care using suitable individual safety equipment. Do not dump them into the environment and dispose of in accordance with applicable legislation.

8.3 - CHECKING OPERATIONAL EFFICIENCY

- Remove any dust from the gear unit and motor casings.
- Check that the noise generated at continuous load does not vary. Excessive vibration or noise can indicate wear of the gear train or failure of a bearing.
- Check the power absorption and voltage against the rated values given on the motor's nameplate.
- Check the wear of the friction surfaces and braking gasket on the brake motors (if fitted) and, if necessary, adjust the gap.
- Check for lubricant leaks from the gaskets/seals, plugs and casings.
- Check all bolted couplings for wear, deformation and corrosion and tighten them down fully, but without over tightening.

8.4 - CLEANING

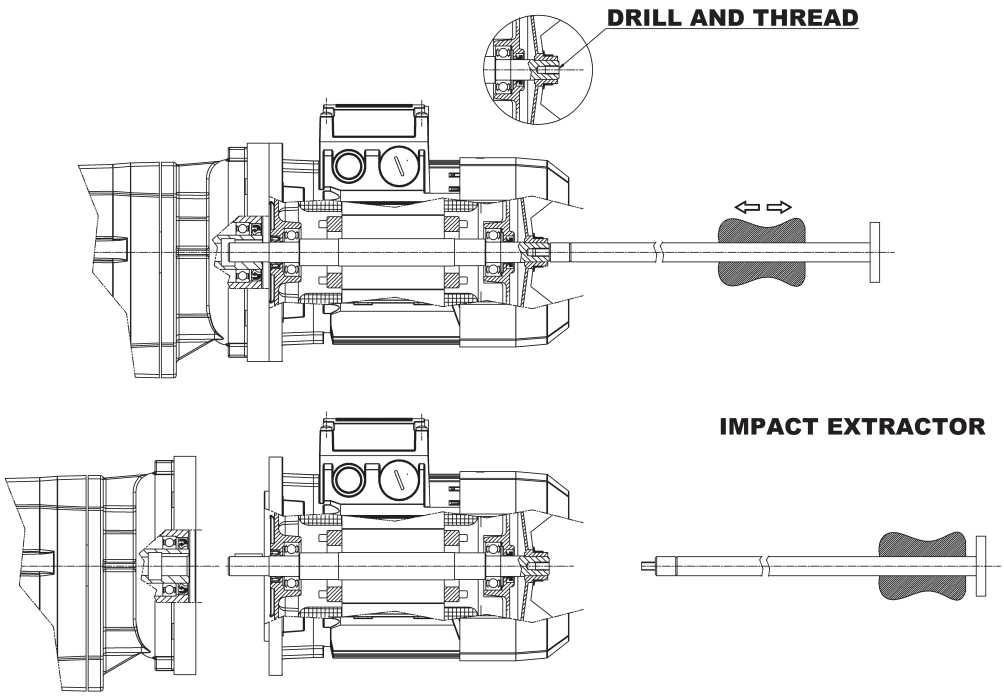
Remove all dust and process waste from the gear unit. Do not use solvents or other products that are incompatible with the unit's construction material and do not direct high pressure jets of water at the gear unit.

9.0 - REPLACING PARTS

- Immediately replace parts and components if they are not able to guarantee safe and reliable operation.
- Never improvise repairs.
- The use of non-original spare parts not only renders the warranty null and void but can jeopardise the gear unit's operation.

9.1 - REMOVING THE MOTOR

If during operation the mobile coupling between the motor and gear unit has not rusted significantly, it should be possible to remove the motor without applying excessive force.
If instead, it proves difficult to remove the motor, do not use screwdrivers or levers to apply force as this may damage the flanges and mating surfaces, but proceed as illustrated below.



1. Drill and thread the motor shaft (fan side).
2. Screw an impact extractor tool into the bore.
3. Undo the bolts fixing the motor to the gear unit.
4. Detach the motor by means of the inertial force of the extractor.

9.2 - DECOMMISSIONING THE GEAR UNIT

The unit must only be taken out of service by operators trained in the observance of applicable laws on health and safety at work.
Do not dump non-biodegradable products, lubricants and non-ferrous materials (rubber, PVC, resins, etc.) into the environment. Dispose of all such materials as stipulated by established environmental legislation.

Do not re-use parts or components which appear to be in good condition after they have been checked or replaced by qualified personnel and declared unsuitable for use.

10.0 - TROUBLESHOOTING

The following information is intended to serve as an aid in locating and eliminating defects and faults. In some cases, problems may be caused by the plant or machine to which the gear unit is assembled and hence, the cause and remedy will be described in the Manufacturer's technical documentation for the machine/plant in question.

FAULT	CAUSE	REMEDY
Bearing temperature too high	Oil level too low	Top up oil level
	Oil spent	Replace oil
	Defective bearings	Contact authorised workshop
Operating temperature too high	Oil level too high	Check oil level
	Oil spent	Replace oil
	Contaminant in oil	Replace oil
Abnormal running noise	Gears damaged	Contact authorised workshop
	Bearing axial backlash too high	Contact authorised workshop
	Bearings defective or worn	Contact authorised workshop
	Excessive load applied	Correct load to rated values given in Sales Catalogue
	Contaminant in oil	Replace oil
Abnormal noise at gear unit mounting	Mounting bolts loose	Tighten bolts to specified torque
	Mounting bolts worn	Replace bolts
Oil leaks	Oil level too high	Check oil level
	Casing/coupling seals inadequate	Contact authorised workshop
	Gaskets worn	Contact authorised workshop
Gear unit does not run or runs with difficulty	Oil viscosity too high	Replace oil (see recommended lubricant chart)
	Oil level too high	Check oil level
	Excessive load applied	Redesign drive for actual load required
Output shaft does not turn with motor running	Gears damaged	Contact authorised workshop

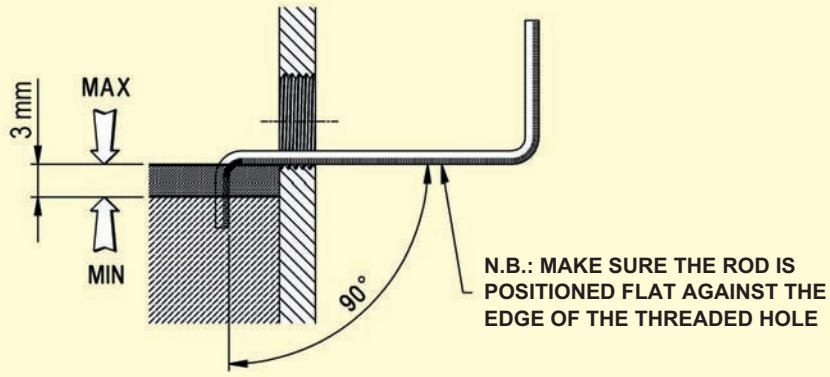
ANNEX 1 - CHECKING THE OIL LEVEL ON ATEX-SPECIFIED GEAR UNITS

Gear units are normally fitted with oil level check plugs.

To check the oil level, first identify the level plug.

- **Horizontal position**:
  Remove the plug and insert a bar of the right size in the hole and of the shape shown in the figure.
- **Vertical position**:
  Use a rod to check that the oil level is between the MIN and MAX marks, then screw the plug back in.

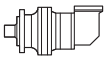
If the level is more than 3 mm below the spill level, top up and check the reason for the drop in oil level.



Gear units conforming to Directive 94/9/EC and designed for a vertical mounting position, are normally equipped with an oil expansion chamber fitted with service plugs for filling, checking the oil level and venting internal overpressure.

ANNEX 2 - LUBRICANT CHARGE QUANTITY

Type		 Mounting position		
		A	T	O
300	L1	0.6	1.0	0.9
	L2	0.9	1.3	1.2
	L3	1.2	1.6	1.5
	L4	1.5	1.9	1.8
301	L1	0.8	1.2	1.1
	L2	1.1	1.5	1.4
	L3	1.4	1.8	1.7
	L4	1.7	2.1	2.0
303	L1	1.3	2.3	2.0
	L2	1.6	2.6	2.3
	L3	1.9	2.9	2.6
	L4	2.2	3.2	2.9
305	L1	1.6	2.6	2.4
	L2	2.1	3.1	2.9
	L3	2.4	3.4	3.2
	L4	2.7	3.7	3.5
306	L1	2.5	3.5	3.2
	L2	3.3	4.3	4.0
	L3	3.6	4.6	4.3
	L4	3.9	4.9	4.6
307	L1	3.5	5.0	4.5
	L2	4.5	6.0	5.5
	L3	5.0	6.5	6.0
	L4	5.3	6.8	6.3
309	L1	4.0	5.5	5.0
	L2	5.0	6.5	6.0
	L3	5.5	7.0	6.5
	L4	5.8	7.3	6.8
310	L1	5.0	6.5	6.0
	L2	6.3	7.8	7.3
	L3	7.1	8.6	8.1
	L4	7.4	8.9	8.4
311	L1	7.0	12	10
	L2	9.0	14	12
	L3	10	15	13
	L4	10.5	15.5	13.5
313	L1	9.0	14	12
	L2	11.5	16.5	14.5
	L3	12.5	17.5	15.5
	L4	13	18	16
315	L1	15	23	19
	L2	19	27	23
	L3	21	29	25
	L4	22	30	26
316	L1	18	26	22
	L2	22	30	26
	L3	24	32	28
	L4	25	33	29
317	L1	20	35	30
	L2	26	41	36
	L3	29	44	39
	L4	30	45	40
318	L1	25	40	35
	L2	35	50	45
	L3	40	55	50
	L4	43	58	53
319	L1	35	55	45
	L2	45	65	55
	L3	50	70	60
	L4	53	73	63
321	L1	35	55	45
	L2	50	70	60
	L3	56	76	66
	L4	60	80	70

Type		 Mounting position		
		B0	U*	P*
300	R2	1.2	1.7	1.5
	R3	1.5	2.0	1.8
	R4	1.8	2.3	2.1
301	R2	1.6	2.1	1.9
	R3	1.9	2.4	2.2
	R4	2.2	2.7	2.5
303	R2	2.2	2.8	2.6
	R3	2.5	3.1	2.9
	R4	2.8	3.4	3.2
305	R2	2.5	3.1	2.9
	R3	3.0	3.6	3.4
	R4	3.3	3.9	3.7
306	R2	4.0	5.0	4.8
	R3	4.8	5.8	5.6
	R4	5.1	6.1	5.9
307	R2	6.0	8.0	7.0
	R3	7.0	9.0	8.0
	R4	7.5	9.5	8.5
309	R2	6.5	8.5	7.5
	R3	7.5	9.5	8.5
	R4	8.0	10	9
310	R3	11	13	12
	R4	12	14	13
311	R2	14	19	17
	R3	16	21	19
	R4	17	22	20
313	R2	16	21	19
	R3	19	24	22
	R4	20	25	23
315	R3	27	35	31
	R4	30	38	34
316	R3	30	38	34
	R4	33	41	37
317	R3	38	52	48
	R4	42	56	52
318	R4	48	63	58

N.B. The quantities indicated are approximate only. Fill the unit according to the position of the level plug or level rod supplied with the gear unit.

	[l]												
	AA - EA - FD			AF - EF - FE		AE - EE - FF		AD - ED - FA		TA - TE - TF - TD VA - VC - VF -IO		OA - OE - OF- OD QA - QE - QF- QD	
		input P(IEC)	input HS		input P(IEC) HS		input P(IEC) HS		input P(IEC) HS		input P(IEC) HS		input P(IEC) HS
3/V 00 L3	0.9	0.12	0.12	0.9	0.12	0.9	0.12	0.9	0.12	1.3	0.12	1.2	0.12
3/V 01 L3	1.1			1.1		1.1		1.1		1.5		1.4	
3/V 03 L3	1.6	0.25	0.25	1.6	0.31	1.6	0.31	1.6	0.38	2.6	0.31	2.3	0.25
3/V 05 L3	2.1	0.38	0.38	2.1	0.43	2.1	0.43	2.1	0.52	3.1	0.52	2.9	0.38
3/V 06 L3	3.3	0.64	0.64	3.3	0.76	3.3	0.76	3.3	0.85	4.3	0.76	4	0.76
3/V 10 L4	7.1			7.1		7.1		7.1		8.6		8.1	
3/V 07 L3	4.5	2.4	2.8	4.5	2.6	4.5	2.6	4.5	1.7	6	1.9	5.5	1.9
3/V 11 L4	10			10		10		10		15		13	
3/V 13 L4	13			13		13		13		18		16	
3/V 09 L3	5	4.3	4.5	5	3.9	5.0	3.9	5	3.0	6.5	3.5	6	3.5
3/V 10 L3	6.3			6.3		6.3		6.3		7.8		7.3	
3/V 15 L4	21			21		21		21		29		25	
3/V 16 L4	24			24		24		24		32		28	
3/V 11 L3	9	7.8	9.6	9	6.7	9	6.7	9	5.0	14	5.5	12	5.5
3/V 13 L3	12			12		12		12		17		15	
3/V 17 L4	29			29		29		29		44		39	
3/V 15 L3	19	11	15	19	8.9	19	9.4	19	7.5	27	9.5	23	9.5
3/V 16 L3	22			22		22		22		30		26	
3/V 18 L4	40			40		40		40		55		50	
3/V 19 L4	50			50		50		50		70		60	
3/V 17 L3	26	23	28	26	16.8	26	17.5	26	10.7	41	17	36	17
3/V 21 L4	56			56		56		56		76		66	

Life lubrication

	[l]											
	AA - EA - FD		TA - TE - TF - TD VA - VC - VF -IO		OA - OE - OF- OD QA - QE - QF- QD		AD - ED - FA		AF - EF - FE		AE - EE - FF	
3/A 00 L2	0.60	1.4	1.0	1.4	0.9	1.4	0.6	1.4	0.6	1.4	0.6	1.4
3/A 01 L2	0.80	2.3	1.2	2.3	1.1	2.3	0.8	2.3	0.8	2.3	0.8	2.3
3/A 03 L2	1.3	3.2	2.3	3.2	2.0	3.2	1.3	3.2	1.3	3.2	1.3	3.2
3/A 05 L2	1.6	4.0	2.6	4.1	2.4	4.1	1.6	4.7	1.6	5.2	1.6	4.4
3/A 06 L2	2.5	4.9	3.5	8.1	3.2	4.7	2.5	8.4	2.5	11	2.5	9.2
3/A 07 L2	3.5	6.8	5.0	8.1	4.5	12	3.5	15	3.5	18	3.5	15

Life lubrication

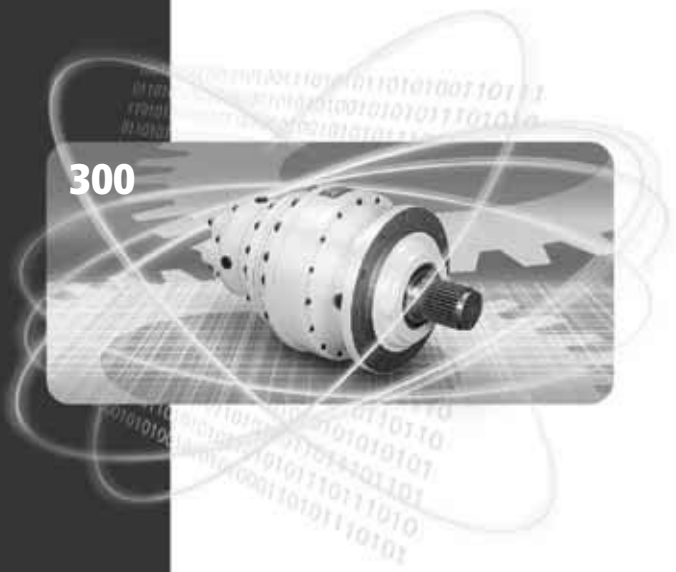
NOTE: In combined gear units, lubrication of the planetary stage is separate from that of the worm (3/V) or helical bevel (3/A) stages.

INDEX OF REVISIONS (R)

R1
31 Amended section 8.1 "Routine maintenance".

Mobile Equipment
and Wind Energy Solutions

Industry Process
and Automation Solutions



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600 - 8,000 lb. Axles & Related Components

DEXTER AXLE

www.dexteraxle.com

Introduction

This manual is designed to provide information for you to understand, use, maintain, and service your trailer running gear system. Your axles are manufactured by Dexter Axle. The Dexter product line, the most complete in the industry, is the result of over 30 years of experience in the design, testing and manufacturing of trailer axles. The Dexter running gear system consists of spindles, hubs, drums, and brakes which are engineered to provide you the finest towing and stopping performance currently available in the industry today.

Two Dexter philosophies are at work to provide you the best product available and have enabled us to maintain our position of leadership. First, we operate on the theory that "there is always a better way" for a product to operate, to be manufactured, and/or to be serviced. We are constantly striving to find that better way.

Secondly, we maintain wall-to-wall production control so that all the major components of your running gear system are manufactured in Dexter facilities under our strict quality control standards. These manufactured components include the axle beam, hubs, drums, spindles, brakes, magnets, and most of the steel stampings used in the attachment of your axle to your trailer. Dexter has the most complete, state-of-the-art manufacturing facilities which enable us to provide you, the trailer owner, with the finest product possible.

For all your running gear needs...

Look first to Dexter!

Visit us online at
www.dexteraxle.com

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Hubs/Drums/Bearings

Suspensions

Wheels and Tires

Replacement Parts/Kits

Storage

Maintenance Schedule

Warranty

Important Safety Notice

Appropriate service methods and proper repair procedures are essential for the safe, reliable operation of all running gear as well as the personal safety of the individual doing the work. This manual provides general directions for performing service and repair work with tested, effective techniques. Following these guidelines will help assure reliability.

There are numerous variations in procedures, techniques, tools, parts for servicing axles, as well as in the skill of the individual doing the work. This manual cannot possibly anticipate all such variations and provide advice or cautions as to each. Anyone who departs from the instructions provided in this manual must first establish that they neither compromise their personal safety nor the vehicle integrity by their choice of methods, tools, or parts.

Refer to your vehicle manufacturer's owners manual for additional procedures, techniques, and warnings prior to performing any maintenance or repairs.

⚠ CAUTION

This is the safety alert symbol. It is used to alert you to potential injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

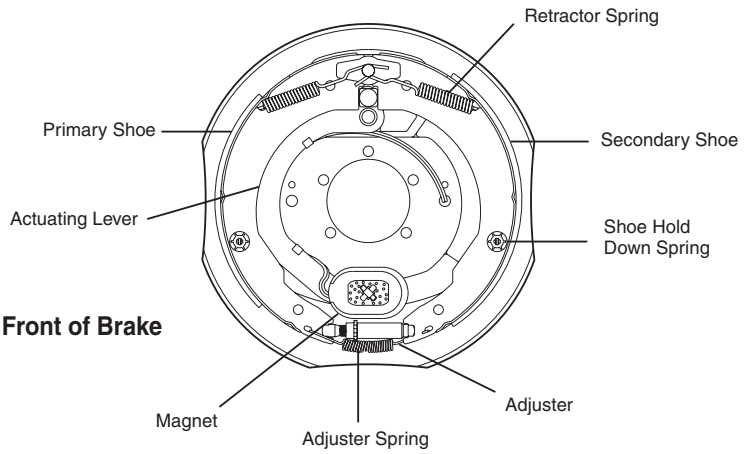
Getting Started - Setup and Adjustment

For proper performance, all new axles should have the following checked at the specified intervals:

- *Wheel Nut Torque:* at 10, 25, and 50 miles
- *Brake Adjustment:* at 200 and 3,000 miles
- *Tire pressure:* to manufacturer's requirements
- *Brake synchronization*: set brake controller per controller manufacturer’s directions

Electric Brakes

The electric brakes on your trailer are similar to the drum brakes on your automobile. The basic difference is that your automotive brakes are actuated by hydraulic pressure while your electric trailer brakes are actuated by an electromagnet. With all of the brake components connected into the system, the brake will operate as follows:



When the electrical current is fed into the system by the controller, it flows through the electromagnets in the brakes. The high capacity electromagnets are energized and are attracted to the rotating armature surface of the drums which moves the actuating levers in the direction that the drums are turning.

The resulting force causes the actuating cam block at the shoe end of the lever to push the primary shoe out against the inside surface of the brake drum. The force generated by the primary shoe acting through the adjuster moves the secondary shoe out into contact with the brake drum.

Increasing the current flow to the electromagnet causes the magnet to grip the armature surface of the brake drum more firmly. This results in increasing the pressure against the shoes and brake drums until the desired stop is accomplished.

Features

Electrically actuated brakes have several advantages over other brake actuation systems.

1. They can be manually adjusted at the controller to provide the correct braking capability for varying road and load conditions.
2. They can be modulated to provide more or less braking force, thus easing the brake load on the towing vehicle.
3. They have very little lag time from the moment the tow vehicle's brakes are actuated until the trailer brakes are actuated.
4. In an emergency situation, they can provide some braking independent of the tow vehicle.

Parking Brake Option ***(not available on all sizes)***

Dexter electric brakes with parking brake option are mechanically operated by a cable. Cable force applied to the parking lever creates a torque through the pivot pin and cam assembly. Torque transferred to the parking cam results in a spreading force between the primary and secondary shoes. The shoes, in turn, move towards the drum until contact is made. Friction generated between the drum and lining contact surface keeps the drum from rotating under normal loading conditions.

Self Adjusting Feature ***(12¼" brakes series only)***

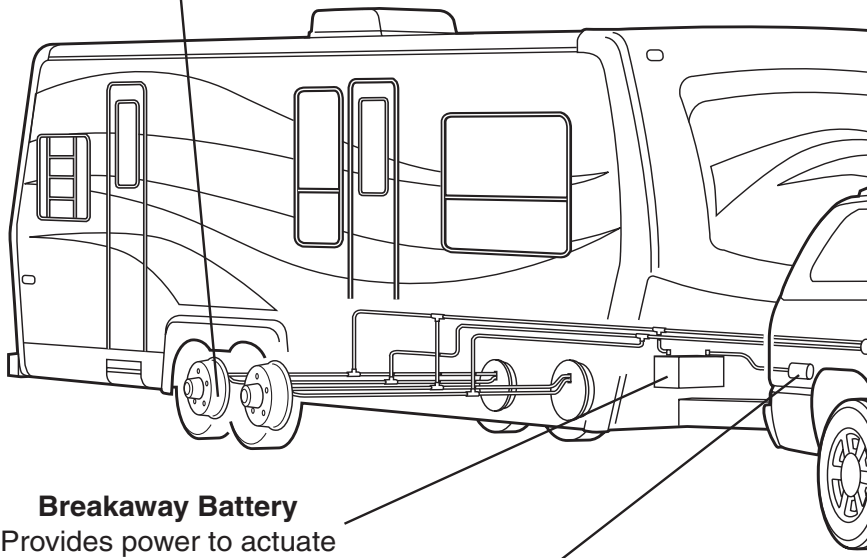
Forward self adjust electric brakes were introduced in October of 1996. This feature adjusts the brakes on both forward and reverse stops. Brake adjustment occurs when lining wear results in enough gap between the shoes and the brake drum surface. This added clearance will allow the adjuster mechanism to rotate the screw assembly at the bottom of the brake. That action expands the distance between the shoes and thus closes the gap to the drum surface.

Brake Controllers

Electric brake controllers provide power to the magnets to actuate the trailer brakes. Dexter Axle offers a state-of-the-art inertial controller called the Predator Series™ DX2. This controller features a patented pendulum design which senses the deceleration of the towing vehicle and sends a proportional voltage to the electric trailer brakes. Other features include a visual gain setting for quick and easy adjustment and a digital LED display to show the voltage output. A manual override sends full voltage to the trailer brakes, regardless of gain setting, for emergency conditions and also illuminates the brake lights to warn of an impending stop.

Most electric brake controllers provide a modulation function that varies the current to the electric brakes with the pressure on the brake pedal or amount of deceleration of the tow vehicle. Electronic or timing controllers do not provide proportional modulation. These controllers tend to be inexpensive but not the best choice for optimum braking. It is important that your brake controller provide approximately 2 volts to the braking system when the brake pedal is first depressed and gradually increases the voltage to 12 volts as brake pedal pressure is increased. If the controller "jumps" immediately to a high voltage output, even during a gradual stop, then the electric brakes will always be fully energized and will result in harsh brakes and potential wheel lockup.

Dexter Electric Brakes
Wired in parallel.

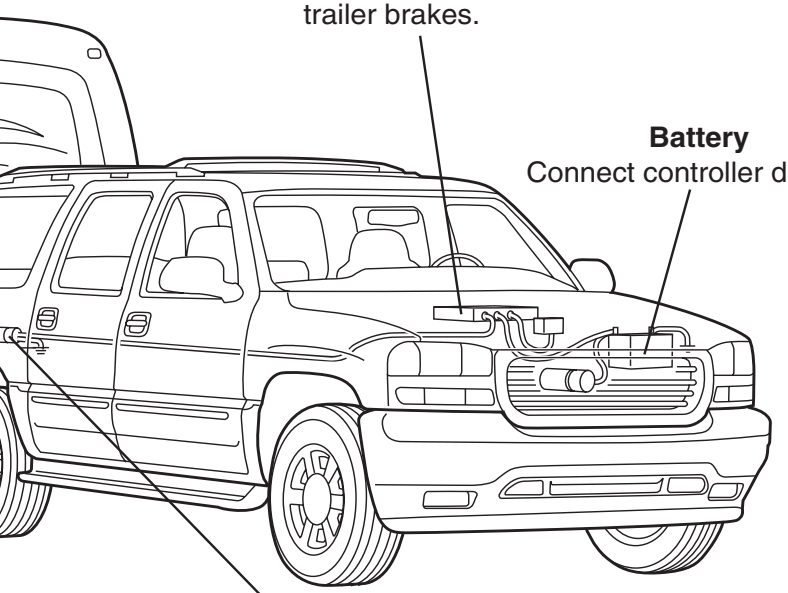


Breakaway Battery
Provides power to actuate trailer brakes in the event of trailer breakaway.

Breakaway Switch
Switches battery power to brakes if breakaway occurs.

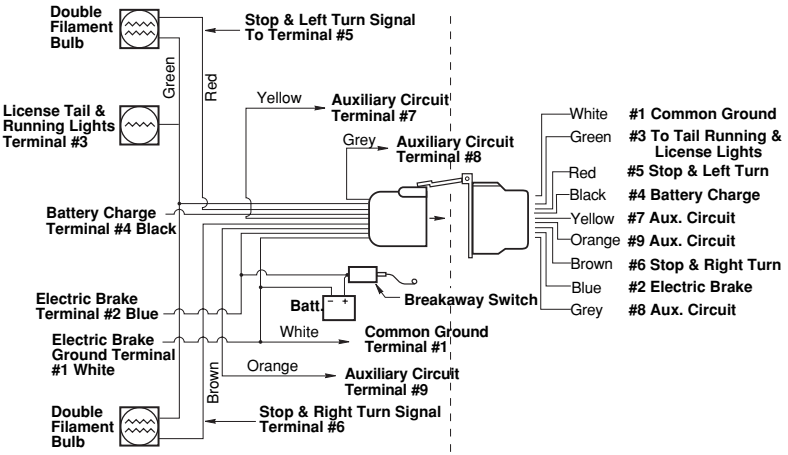
Controller
Electric brake controller provides power to the magnets to actuate the trailer brakes.

Battery
Connect controller directly.

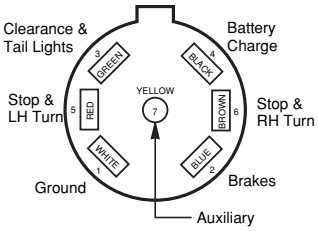


Connector
Used to connect and disconnect trailer and tow vehicle. (Always ground trailer brakes through connector).

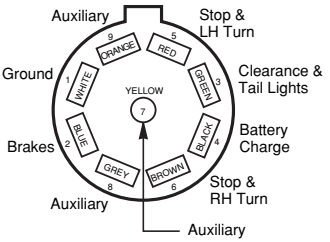
Typical Trailer Wiring



7-Circuit Receptacle



9-Circuit Receptacle



View Looking into Tow Vehicle Receptacle

How to Use Your Electric Brakes Properly

Your trailer brakes are designed to work in synchronization with your tow vehicle brakes. Never use your tow vehicle or trailer brakes alone to stop the combined load.

Your brake controller must be set up according to the manufacturer's recommendations to ensure proper synchronization between the tow vehicle and the trailer. Additionally, you may have to make small adjustments occasionally to accommodate changing loads and driving conditions.

Proper synchronization of tow vehicle to trailer braking can only be accomplished by road testing. Brake lockup, grabbiness, or harshness is quite often due to the lack of synchronization between the tow vehicle and the trailer being towed, too high of a threshold voltage (over 2 volts), or under adjusted brakes.

Before any synchronization adjustments are made, your trailer brakes should be burnished-in by applying the brakes 20-30 times with approximately a 20 m.p.h. decrease in speed, e.g. 40 m.p.h. to 20 m.p.h. Allow ample time for brakes to cool between application. This allows the brake shoes and magnets to slightly "wear-in" to the drum surfaces.

Trailer Wire Size Chart

Number of Brakes	Hitch-to-Axle Distance In Feet	Recommended Minimum Hookup Wire Size (Copper)
2		12 AWG
4	Under 30	12 AWG
4	30-50	10 AWG
6	Under 30	10 AWG
6	30-50	8 AWG

Synchronizing Your Trailer Brakes

To insure safe brake performance and synchronization, *read the brake controller manufacturer's instructions completely before attempting any synchronization procedure.*

⚠ CAUTION

Before road testing, make sure the area is clear of vehicular and pedestrian traffic. Failure to brake safely could result in an accident and personal injury to yourself and/or others.

Make several hard stops from 20 m.p.h. on a dry paved road free of sand and gravel. If the trailer brakes lock and slide, decrease the gain setting on the controller. If they do not slide, slightly increase the gain setting. Adjust the controller just to the point of impending brake lockup and wheel skid.

> *Note: Not all trailer brakes are capable of wheel lockup. Loading conditions, brake type, wheel and tire size can all affect whether a brake can lock. It is not generally considered desirable to lock up the brakes and slide the tires. This can cause unwanted flat spotting of the tires and could also result in a loss of control.*

If the controller is applying the trailer brakes before the tow vehicle brakes, then the controller adjustments should be made so the trailer brakes come on in synchronization with the tow vehicle brakes. For proper braking performance, it is recommended that the controller be adjusted to allow the trailer brakes to come on just slightly ahead of the tow vehicle brakes. When proper synchronization is achieved there will be no sensation of the trailer “jerking” or “pushing” the tow vehicle during braking.

General Maintenance - Electric Brakes

Brake Adjustment

Most Dexter 12¼" electric brakes have a self adjusting feature. If manual adjusting is required, use the following procedure:

Brakes should be adjusted (1) after the first 200 miles of operation when the brake shoes and drums have “seated,” (2) at 3,000 mile intervals, (3) or as use and performance requires. The brakes should be adjusted in the following manner:

1. Jack up trailer and secure on adequate capacity jack stands. Follow trailer manufacturer's recommendations for lifting and supporting the unit. Make sure the wheel and drum rotates freely.

⚠ CAUTION

Do not lift or support the trailer on any part of the axle or suspension system. Never go under any trailer unless it is properly supported on jack stands which have been rated for the load. Improperly supported vehicles can fall unexpectedly and cause serious injury.

2. Remove the adjusting hole cover from the adjusting slot on the bottom of the brake backing plate.
3. With a screwdriver or standard adjusting tool, rotate the starwheel of the adjuster assembly to expand the brake shoes. Adjust the brake shoes out until the pressure of the linings against the drum makes the wheel very difficult to turn.

   Note: For drop spindle axles, a modified adjusting tool may be necessary.
4. Then rotate the starwheel in the opposite direction until the wheel turns freely with a slight lining drag.
5. Replace the adjusting hole cover and lower the wheel to the ground.
6. Repeat the above procedure on all brakes. For best results, the brakes should all be set at the same clearance.

Brake Cleaning and Inspection

Your trailer brakes must be inspected and serviced immediately if a loss of performance is indicated. With normal use, servicing at one year intervals is usually adequate. With increased usage, this work should be done more frequently as required. Magnets and shoes must be changed when they become excessively worn or scored, a condition which can reduce vehicle braking.

Clean the backing plate, magnet arm, magnet, and brake shoes. Make certain that all the parts removed are replaced in the same brake and drum assembly. Inspect for any loose or worn parts, stretched or deformed springs and replace as necessary.

⚠CAUTION

POTENTIAL ASBESTOS DUST HAZARD!
Some older brake linings may contain asbestos dust, which has been linked to serious or fatal illnesses. Certain precautions need to be taken when servicing brakes:

1. **Avoid creating or breathing dust.**
2. **Avoid machining, filing or grinding the brake linings.**
3. **Do not use compressed air or dry brushing for cleaning (dust can be removed with a damp brush).**

Brake Lubrication

Before reassembling, apply a light film of grease or anti-seize compound on the brake anchor pin, the actuating arm bushing and pin, and the areas on the backing plate that are in contact with the brake shoes and magnet lever arm. Apply a light film of grease on the actuating block mounted on the actuating arm.

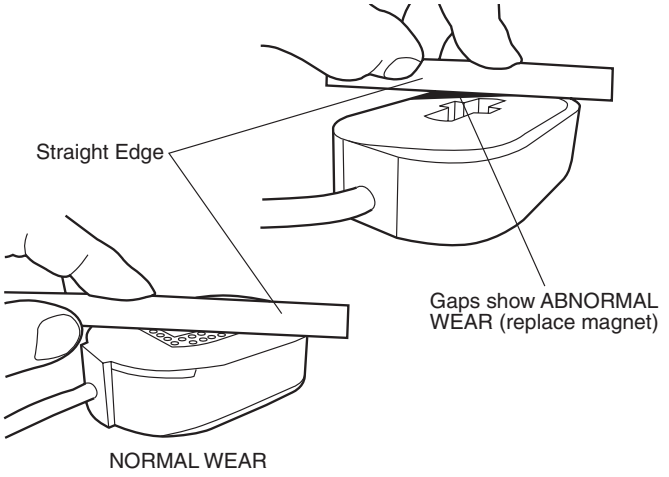
CAUTION

Do not get grease or oil on the brake linings, drums or magnets.

Magnets

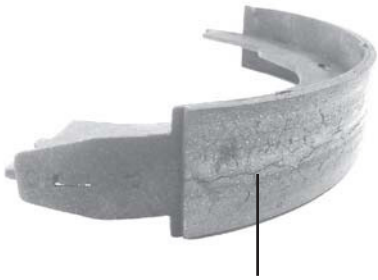
Your electric brakes are equipped with high quality electromagnets that are designed to provide the proper input force and friction characteristics. Your magnets should be inspected and replaced if worn unevenly or abnormally. As indicated below, a straightedge should be used to check magnet condition. For best results, the magnet should be flat.

Even if wear is normal as indicated by your straightedge, the magnets should be replaced if any part of the magnet coil has become visible through the friction material facing of the magnet. It is also recommended that the drum armature surface be refaced when replacing magnets (see section on Brake Drum Inspection). Magnets should also be replaced in pairs - both sides of an axle. Use only genuine Dexter replacement parts when replacing your magnets.



Shoes and Linings

A simple visual inspection of your brake linings will tell if they are usable. Replacement is necessary if the lining is worn (to within 1/16" or less), contaminated with grease or oil, or abnormally scored or gouged. Hairline heat cracks are normal in bonded linings and should not be cause for concern. When replacement is necessary, it is important to replace both shoes on each brake and both brakes of the same axle. This will help retain the "balance" of your brakes.



Acceptable Hairline Cracks

⚠ CAUTION

POTENTIAL ASBESTOS DUST HAZARD!
Some older brake linings may contain asbestos dust, which has been linked to serious or fatal illnesses. Certain precautions need to be taken when servicing brakes:

1. **Avoid creating or breathing dust.**
2. **Avoid machining, filing or grinding the brake linings.**
3. **Do not use compressed air or dry brushing for cleaning (dust can be removed with a damp brush).**

After replacement of brake shoes and linings, the brakes must be re-burnished to seat in the new components. This should be done by applying the brakes 20 to 30 times from an initial speed of 40 m.p.h., slowing the vehicle to 20 m.p.h. Allow ample time for brakes to cool between applications. This procedure allows the brake shoes to seat in to the drum surface.

Introduction to Troubleshooting

Proper brake function is critical to the safe operation of any vehicle. If problems are encountered with your trailer braking system, the following guide can be used to find the causes and remedies for some of the more common problems. If you are unsure or unable to resolve the problem, please contact your nearest repair facility for professional assistance.

Troubleshooting

Most electric brake malfunctions, that cannot be corrected by either brake adjustments or synchronization adjustments, can generally be traced to electrical system failure. Voltmeters and ammeters are essential tools for proper troubleshooting of electric brakes.

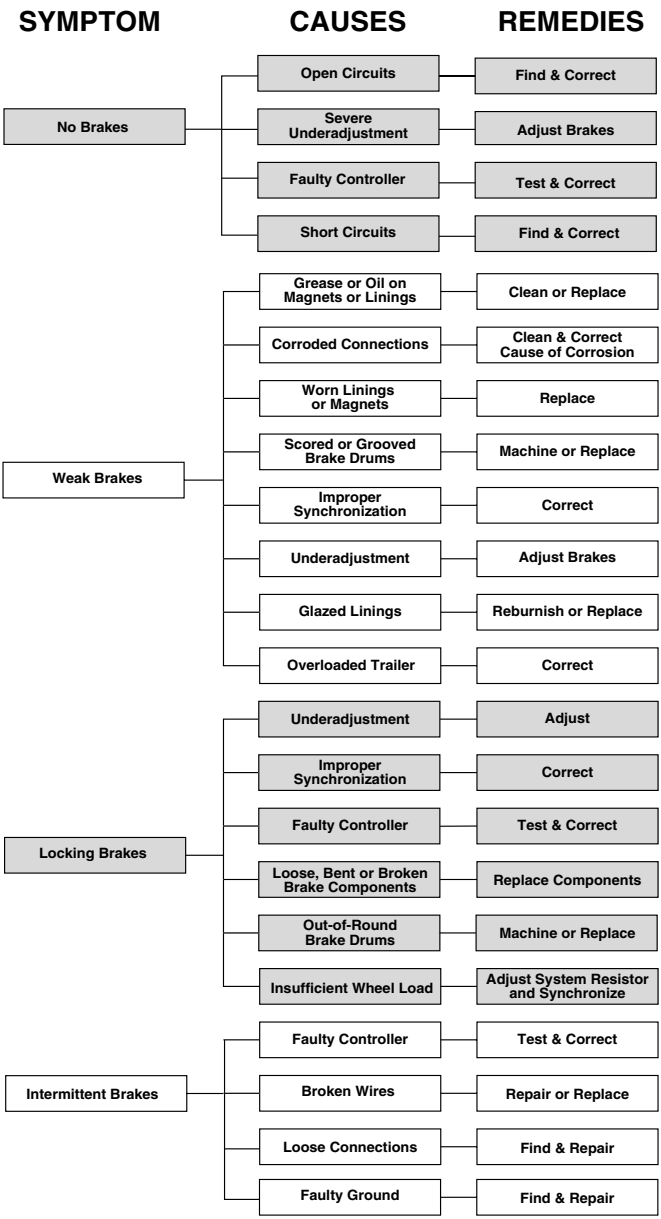
Mechanical causes are ordinarily obvious, i.e. bent or broken parts, worn out linings or magnets, seized lever arms or shoes, scored drums, loose parts, etc. Replace defective parts with genuine Dexter replacements.

Please consult the following troubleshooting charts to determine the causes and solutions for common problems found in trailer braking systems.

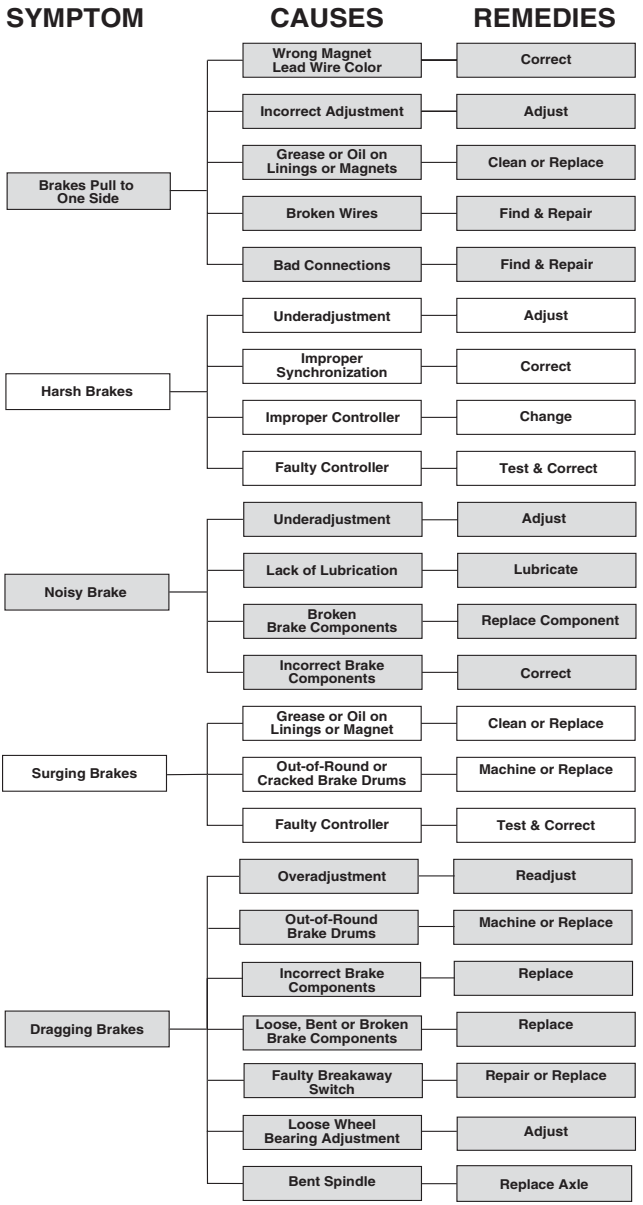
⚠ CAUTION

Best braking performance is achieved with a controller setting that is just short of wheel lock up or slide. Overly aggressive braking which results in wheel lock up and sliding, can cause a dangerous loss of control and result in personal injury or death.

Troubleshooting



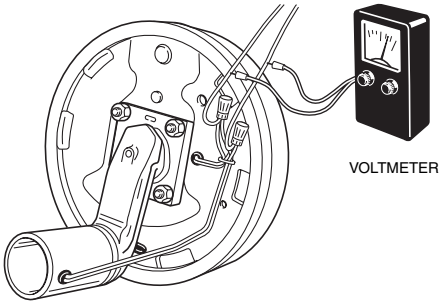
Troubleshooting



How to Measure Voltage

System voltage is measured at the magnets by connecting the voltmeter to the two magnet lead wires at any brake. This may be accomplished by using a pin probe inserted through the insulation of the wires. The engine of the towing vehicle should be running when checking the voltage so that a low battery will not affect the readings.

Voltage in the system should begin at 0 volts and, as the controller bar is slowly actuated, should gradually increase to about 12 volts. If the controller does not produce this voltage control, consult your controller manual.



The threshold voltage of a controller is the voltage applied to the brakes when the controller first turns on. Lower threshold voltage will provide for smoother braking. If the threshold voltage is too high, the brakes may feel grabby and harsh.

How to Measure Amperage

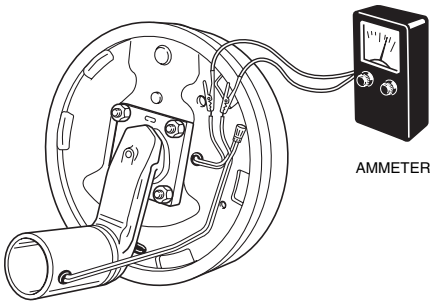
System amperage is the current flowing in the system when all the magnets are energized. The amperage will vary in proportion to the voltage. The engine of the tow vehicle should be running with the trailer connected when checking the trailer braking system.

One place to measure system amperage is at the BLUE wire of the controller which is the output to the brakes. The BLUE wire must be disconnected and the ammeter put in series into the line. System amperage draw should be as noted in the following table. Make sure your ammeter has sufficient capacity and note polarity to prevent damaging your ammeter.

Magnet Amperes Chart

Brake Size	Amps/ Magnet	Two Brakes	Four Brakes	Six Brakes	Magnet Ohms
7 x 1 1/4	2.5	5.0	10.0	15.0	3.9
10 x 1 1/2	3.0	6.0	12.0	18.0	3.2
10 x 2 1/4	3.0	6.0	12.0	18.0	3.2
12 x 2	3.0	6.0	12.0	18.0	3.2
12 1/4 x 2 1/2	3.0	6.0	12.0	18.0	3.2
12 1/4 x 3 3/8	3.0	6.0	12.0	18.0	3.2

If a resistor is used in the brake system, it must be set at zero or bypassed completely to obtain the maximum amperage reading. Individual amperage draw can be measured by inserting the ammeter in the line at the magnet you want to check. Disconnect one of the magnet lead wire connectors and attach the ammeter between the two wires. Make sure that the wires are properly reconnected and sealed after testing is completed.


AMMETER

The most common electrical problem is low or no voltage and amperage at the brakes. Common causes of this condition are:

1. Poor electrical connections
2. Open circuits
3. Insufficient wire size
4. Broken wires
5. Blown fuses (fusing of brakes is not recommended)
6. Improperly functioning controllers or resistors

Another common electrical problem is shorted or partially shorted circuits (indicated by abnormally high system amperage).

Possible causes are:

1. Shorted magnet coils
2. Defective controllers
3. Bare wires contacting a grounded object

Finding the cause of a short circuit in the system is done by isolating one section at a time. If the high amperage reading drops to zero by unplugging the trailer, then the short is in the trailer. If the amperage reading remains high with all the brake magnets disconnected, the short is in the trailer wiring.

All electrical troubleshooting procedures should start at the controller. Most complaints regarding brake harshness or malfunction are traceable to improperly adjusted or non-functioning controllers. See your controller manufacturer's data for proper adjustment and testing procedures. For best results, all the connection points in the brake wiring should be sealed to prevent corrosion. Loose or corroded connectors will cause an increase in resistance which reduces the voltage available for the brake magnets.

Hydraulic Brakes

Dexter offers several varieties of hydraulic trailer brakes. Your vehicle may be equipped with the traditional drum brakes or you may have disc brakes.

The hydraulic brakes on your trailer are much like those on your automobile or light truck. The hydraulic fluid from a master cylinder or actuation system is used to actuate the wheel cylinder which, in turn, applies force against the brake shoes and drum. The main difference between automotive hydraulic brakes and hydraulic trailer brakes is the trailers' actuation system. These systems respond to the braking signal from the tow vehicle and supply the required brake fluid volume and pressure to the trailer brakes.

In the following pages you will find a more detailed description of the hydraulic brakes and actuation system used on your trailer.

CAUTION

The operating pressure required for Dexter brakes:

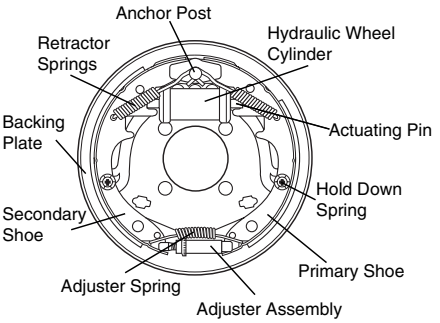
- **7" diameter drum brakes maximum operating pressure is 750 psi**
- **10" diameter and larger drum brakes maximum operating pressure is 1,000 psi**
- **Hydraulic disc brakes (all sizes) maximum operating pressure is 1,600 psi**

Hydraulic Brake Operation

Duo-Servo

The duo-servo brake uses a dual piston wheel cylinder to apply the brakes. This type of brake is typically used in a vacuum/ hydraulic, electric/hydraulic or air/hydraulic system. A description of operation of this brake is as follows:

When the brakes are applied, the double-acting wheel cylinder moves the primary and secondary shoes towards the drum. The frictional force between the brake drum and lining attempts to turn the primary shoe into the secondary shoe. The secondary shoe is forced onto the anchor pin and from this point, the secondary and primary shoes attempt to "wrap around". In essence, the brake has utilized frictional force to help the applying force on both shoes.



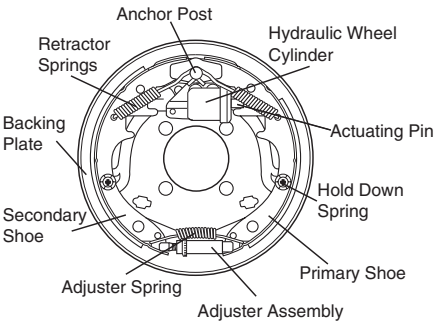
If the brakes are applied while the vehicle is backing, the shoes rotate in the direction of the drum rotation. This causes the secondary shoe to leave the anchor and causes the primary shoe to move against the anchor. Action of the brake is the same in reverse as forward.

Uni-Servo

This type of hydraulic brake utilizes a single acting cylinder. Upon actuation, the primary shoe is pressed against the brake drum, which causes the shoe to move in the direction of rotation. This movement in turn actuates the secondary shoe through the adjuster assembly. Braking in reverse is significantly less effective than in the forward direction.

Another variation is called a “free backing” brake which is commonly used on trailers with a surge hitch system. When

backing with a surge brake hitch, normal brakes are applied through the surge mechanism and if there is more brake force on the trailer than the tow vehicle can override, no backing is possible. The free backing brake was developed to allow backing in this application. This brake has a primary shoe on a pivot which allows normal application in the forward direction, but allows the primary shoe to rotate away from the drum surface when backing.



Self Adjusting Mechanism for 12¼" Hydraulic Brakes

Forward self-adjust hydraulic brakes were introduced in March, 1997. This feature adjusts the brakes on both forward and reverse stops. Brake adjustment occurs only when lining wear results in enough gap between the shoes and the drum surface. This added clearance will allow the adjuster mechanism to rotate the screw assembly at the bottom of the brake. That action expands the distance between the shoes and thus closes the gap to the drum surface.

Hydraulic Parking Brake Option

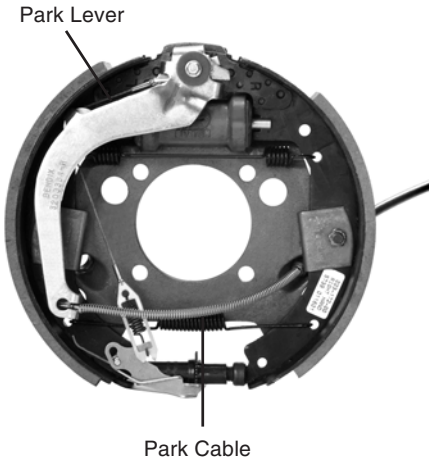
(Not Available on All Sizes)

The parking feature on Dexter hydraulic brakes is cable operated. On the 10" and 12" brakes, the parking cable body is mounted to the brake backing plate. The cable end is attached to the internal parking brake lever to actuate the brake. On Dexter 12¼" brakes manufactured before February 2002, the parking cable body mounts to a support plate which is attached to the brake mounting flange. The cable end is routed through the dust shield and the brake spider, to attach to the internal parking brake lever. For 12¼" brakes produced after February 2002, a short cable is

installed directly into the backing plate to provide a convenient means for the trailer manufacturer to attach an appropriate operating system.

The internal parking brake lever of 10" and 12" Dexter brakes, which is mounted to the secondary shoe, transfers applied cable force through a parking strut which is attached to the primary shoe. This transferred load generates a spreading force between the primary and secondary shoes. The shoes move toward the drum until contact is made. Friction generated between the drum and lining contact surface results in parking brake capability.

The internal parking brake lever of Dexter 12¼" brakes transfers the applied cable force through a cam mechanism. The cam mechanism generates a spreading force between the primary and secondary shoes. The shoes move toward the drum until contact is made. Friction generated between the drum and lining contact surface results in parking brake capability.



Disc Brakes

Dexter Axle manufactures two types of disc brakes, the floating caliper and the fixed caliper brake. With both styles, the disc brake uses friction pads astride a ventilated rotor which is attached to the wheel hub. When the brake is actuated, the pads are pressed against the sides of the rotor causing drag to slow the rotating disc. This action converts the kinetic energy (motion) into heat. The heat is dissipated rapidly by the ventilated disc.

The floating caliper brake uses piston(s) situated on one side of the brake rotor. Hydraulic fluid pressure pushes against the piston(s) to apply the inboard brake pad. As the inboard pad exerts force against the rotating rotor surface, the caliper moves laterally towards the trailer frame and in turn applies an equivalent force to the outboard brake pad against the rotor surface. As the lining material wears, the caliper will automatically maintain the proper lining to rotor clearance. The floating caliper design is used on Dexter 3,500 lb., 10,000 lb., and 12,000 lb. axle models.

The fixed caliper method uses pistons situated on both sides of the rotor. During actuation, hydraulic pressure pushes against the pistons to apply the inboard and outboard brake pads equally to decelerate the rotating rotor. The caliper is fixed and stays stationary during brake actuation and brake adjustment. Brake pad to rotor clearance is maintained as lining wear occurs via the brake piston and internal caliper seal. The fixed caliper design is used on the Dexter 6,000 lb. and 8,000 lb. axle models.

Disc brake effectiveness is the same going either in a forward or reverse direction. All Dexter disc brakes should be actuated with a braking system that is capable of providing a maximum hydraulic pressure of 1,600 psi.

Actuation Systems

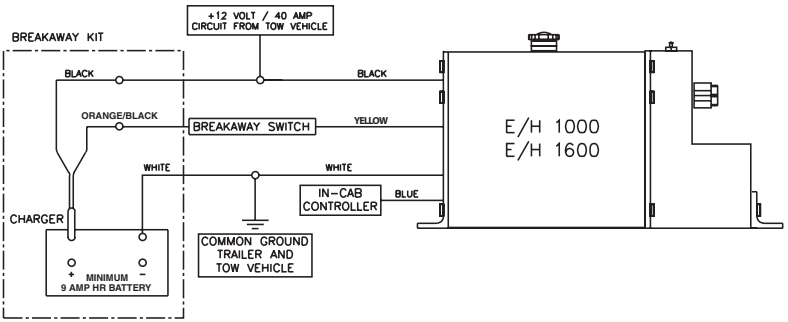
To effectively operate your hydraulic trailer brakes we recommend the Dexter E/H electro/hydraulic actuator, controlled by the Predator series DX2™ electronic brake controller. These high performance hydraulic power modules will supply pressurized brake fluid to your trailer brakes in proportion to the amount of braking effort called for by the towing vehicles' deceleration rate.

CAUTION

It is the responsibility of the end user to ensure that their in-cab electronic controller is compatible with the Dexter E/H actuator. Dexter Axle attempts to provide compatibility with most controllers available, but is unable to anticipate design changes that might be introduced by the various controller manufacturers.

The E/H 1000 will supply 1000 psi for your drum brakes and the E/H 1600 will generate 1600 psi for maximum performance from your Dexter disc brakes. The sealed, weather tight housing contains the electronics necessary to control the high pressure piston pump and proportioning valve for smooth, efficient braking.

ELECTRICAL SCHEMATIC



Troubleshooting Guide

Brakes are slow to respond

1. Re-bleed the trailer brakes and actuator.
2. If the trailer is equipped with drum brakes, readjust the drum brakes to the brake manufacture's recommended running clearance.
3. Slow response can be caused by trailer wiring that is too small.
4. For trailers where the E/H unit is located less than 10 feet from the tow vehicle, 12 gage wire is recommended for the black and white wires between the tow vehicle and the E/H unit. All other wires should be a minimum of 16 gauge.
5. For trailers where the E/H unit is located more than 10 feet from the tow vehicle, 10 gage wire is recommended for the black and white wires between the tow vehicle and the E/H unit. All other wires should be a minimum of 16 gauge.
6. Slow response can be caused by improper adjustment of the brake controller. On inertia-based electronic brake controls, adjust the pendulum (inertia sensor) to a more aggressive setting and/or increase the gain setting.

Unit will not run when the ignition is on and the brake pedal is depressed

1. Verify that the trailer and tow vehicle are wired as detailed on the electrical schematic.
2. With the ignition switch on and the brakes not applied, you should have 12-13 volts between the black and white wires on the E/H unit.
3. Clean and replace the ground between the trailer and the E/H unit.
4. Test operation of the unit using the breakaway test procedure.

Breakaway test procedure - do not leave the breakaway switch pulled for more than two minutes during any of the steps outlined below

1. Pull the breakaway switch on the trailer.
2. If the unit runs and builds pressure, that indicates the

actuator is functioning properly. The problem most likely is a defective electronic brake controller in the tow vehicle or defective wiring between the tow vehicle and the E/H unit.

3. If the unit runs but will not build pressure, the problem most likely is a defective solenoid valve in the E/H unit and the actuator should be returned for repair.
4. If the unit still does not run after the breakaway battery is fully charged, verify that the voltage between the white wire and yellow wire is at least 12 volts.
5. If the voltage is less than 12 volts, either the breakaway switch or the breakaway wiring is defective.
6. If the voltage is greater than 12 volts, the E/H unit should be returned for repair.

Trailer brakes too aggressive

1. Reduce the gain setting on the in-cab electronic brake controller.

General Maintenance - Hydraulic Brakes

Drum Brake Adjustment - Manual

Most Dexter 12¼" electric brakes have a self adjusting feature. If manual adjusting is required, use the following procedure:

Brakes should be adjusted (1) after the first 200 miles of operation when the brake shoes and drums have “seated,” (2) at 3,000 mile intervals, (3) or as use and performance requires. The brakes should be adjusted in the following manner:

1. Jack up trailer and secure on adequate capacity jack stands. Follow trailer manufacturer's recommendations for lifting and supporting the unit. Make sure the wheel and drum rotates freely.

⚠ CAUTION

Do not lift or support the trailer on any part of the axle or suspension system. Never go under any trailer unless it is properly supported on jack stands which have been rated for the load. Improperly supported vehicles can fall unexpectedly and cause serious injury or death.

2. Remove the adjusting hole cover from the adjusting slot on the bottom of the brake backing plate.
3. With a screwdriver or standard adjusting tool, rotate the starwheel of the adjuster assembly to expand the brake shoes. Adjust the brake shoes out until the pressure of the linings against the drum makes the wheel very difficult to turn.

   Note: For drop spindle axles, a modified adjusting tool may be necessary.
4. Then rotate the starwheel in the opposite direction until the wheel turns freely with a slight lining drag.
5. Replace the adjusting hole cover and lower the wheel to the ground.
6. Repeat the above procedure on all brakes. For best results, the brakes should all be set at the same clearance.

Most of the brake components are very similar to those used in electric brakes, and maintenance is comparable for the hub and drum, shoes and linings, and bearings. Specific maintenance activities are as follows:

Wheel Cylinders

Inspect for leaks and smooth operation. Clean with brake cleaner and flush with fresh brake fluid. Hone or replace as necessary.

Brake Lines

Check for cracks, kinks, or blockage. Flush with fresh brake fluid. Bleed system to remove all air. Replace as necessary.

Shoes and Linings

A simple visual inspection of your brake linings will tell if they are usable. Replacement is necessary if the lining is worn (to within $^{1}/_{16}$" or less), contaminated with grease or oil, or abnormally scored or gouged. Hairline heat cracks are normal in bonded linings and should not be cause for concern. When replacement is necessary, it is important to replace both shoes on each brake and both brakes of the same axle. This will help retain the "balance" of your brakes.

⚠ CAUTION

POTENTIAL ASBESTOS DUST HAZARD!
Some older brake linings may contain asbestos dust, which has been linked to serious or fatal illnesses. Certain precautions need to be taken when servicing brakes:

1. **Avoid creating or breathing dust.**
2. **Avoid machining, filing or grinding the brake linings.**
3. **Do not use compressed air or dry brushing for cleaning (dust can be removed with a damp brush).**

After replacement of brake shoes and linings, the brakes must be re-burnished to seat in the new components. This should be done by applying the brakes 20 to 30 times from an initial speed of 40 m.p.h., slowing the vehicle to 20 m.p.h. Allow ample time for brakes to cool between applications. This procedure allows the brake shoes to seat in to the drum surface.

Hardware

Check all hardware. Check shoe return spring, hold down springs, and adjuster springs for stretch or wear. Replace as required. Service kits are available.

Instructions for Brake Caliper Kit 3.5K Disc Hydraulic Brakes

Notice to Buyer
It is recommended that all brakes be replaced at the same time to insure balanced braking performance.

Remove the old brake caliper

1. Jack up trailer and secure on adequate capacity jack stands. Follow trailer manufacturers recommendations for lifting and supporting the unit.

⚠ CAUTION

Do not lift or support the trailer on any part of the axle or suspension system. Never go under any trailer unless it is properly supported on jack stands which have been rated for the load. Improperly supported vehicles can fall unexpectedly and cause serious injury or death.

2. Remove the wheel from the hub, leaving the brake exposed.
3. Disconnect the brake actuation system. Check that the hydraulic system has zero pressure and that the hub and rotor rotates freely.

4. Remove the hose from the caliper. Then remove the two caliper mounting bolts. Do not allow the caliper to hang from the hose.

Installing the new brake caliper

1. First inspect the brake assembly for grooves, flaking, cracks, heat checking, thickness variation, insufficient rotor thickness, and look to see that the mounting hardware is straight. Replace any component as needed (or desired) per manufacturer recommendations.
2. Install the new caliper assembly. Make sure that the bleed screw points up.
3. Remount the caliper assembly onto the caliper attaching bracket. Ensure that there is thread locking compound on the threads of the new mounting bolts. Torque mounting bolts to **40-50 Ft. Lbs.** *Note: Use two lug nuts to secure rotor against the hub face when reassembling the caliper. After the caliper is assembled remove the lug nuts.*
4. Reconnect the hose to the elbow adapter on the back of the caliper and torque to **10-12 Ft. Lbs.**
5. Reconnect the brake actuation system. Refer to your actuation systems *Operation Maintenance Service Manual* for proper operation.
6. Bleed and flush brake system per your actuation systems *Operation Maintenance Service Manual.*
7. Remount the wheel. Refer to your *Operation Maintenance Service Manual* for proper wheel nut torque procedures.

Instructions for Brake Rotor Kit 3.5K Disc Hydraulic Brakes

Notice to Buyer

It is recommended that all brakes be replaced at the same time to insure balanced braking performance.

Remove the old brake rotor

1. Jack up trailer and secure on adequate capacity jack stands. Follow trailer manufacturers recommendations for lifting and supporting the unit.

⚠ CAUTION

Do not lift or support the trailer on any part of the axle or suspension system. Never go under any trailer unless it is properly supported on jack stands which have been rated for the load. Improperly supported vehicles can fall unexpectedly and cause serious injury or death.

2. Remove the wheel from the hub, leaving the brake exposed.
3. Disconnect the brake actuation system. Check that the hydraulic system has zero pressure and that the hub and rotor rotates freely.
4. Remove the two caliper mounting bolts. Do not allow the caliper assembly to hang from the hose. Do not disconnect the hose or allow air into the hydraulic system.
5. With the caliper assembly out of the way remove the brake rotor. Save the brake mounting hardware for reinstalling the brake calipers.

Installing the new brake rotor

1. First inspect the brake assembly for grooves, flaking, cracks, heat checking, thickness variation, insufficient rotor thickness, and look to see that the mounting hardware is straight. Replace any component as needed (or desired) per manufacturer recommendations.
2. Install the new brake rotor by fitting it onto the hub flush with the hubface.
3. Remount the caliper assembly onto the caliper attaching bracket. Place thread locking compound on threads of mounting bolts. Torque mounting bolts to **40-50 Ft. Lbs.**

   Note: Use two lug nuts to secure rotor against the hub face when reassembling the calipers. After the calipers are assembled remove the lug nuts.
4. Reconnect the brake actuation system. Refer to your *Operation Maintenance Service Manual* for proper operation.
5. Remount the wheel. Refer to your *Operation Maintenance Service Manual* for proper wheel nut torque procedures.

Instructions for Brake Rotor Kit 6K or 8K Disc Hydraulic Brakes

Notice to Buyer
It is recommended that all brakes be replaced at the same time to insure balanced braking performance.

Remove the old brake rotor

1. Jack up trailer and secure on adequate capacity jack stands. Follow trailer manufacturers recommendations for lifting and supporting the unit.

⚠ CAUTION

Do not lift or support the trailer on any part of the axle or suspension system. Never go under any trailer unless it is properly supported on jack stands which have been rated for the load. Improperly supported vehicles can fall unexpectedly and cause serious injury or death.

2. Remove the wheel from the hub, leaving the brake exposed.
3. Disconnect the brake actuation system. Check that the hydraulic system has zero pressure and that the hub and rotor rotates freely.
4. Remove the four caliper mounting bolts. Do not allow the caliper assembly to hang from the hose. Do not disconnect the hose or allow air into the hydraulic system.
5. With the caliper assembly out of the way remove the brake rotor. Save the brake mounting hardware for reinstalling the brake calipers.

Installing the new brake rotor

1. First inspect the brake assembly for grooves, flaking, cracks, heat checking, thickness variation, insufficient rotor thickness, and look to see that the mounting hardware is straight. Replace any component as needed (or desired) per manufacturer recommendations.
2. Install the new brake rotor by fitting it onto the hub flush with the hubface. *Note: Use two lug nuts to secure rotor*

against the hub face when reassembling the calipers. After the calipers are assembled remove the lug nuts.

3. Remount the caliper assembly onto the caliper attaching bracket. It may be necessary to push the piston into the calipers to obtain enough clearance. Torque mounting bolts to **25-35 Ft. Lbs.**
4. Spin the rotor to ensure that there is enough clearance between the rotor and the crossover brake line.
5. Reconnect the brake actuation system. Refer to your *Operation Maintenance Service Manual* for proper operation.
6. Remount the wheel. Refer to your *Operation Maintenance Service Manual* for proper wheel nut torque procedures.
7. Spin the wheel to ensure that there is enough clearance between the wheel, crossover brake line, and rotor.

Instructions for Brake Pad Kit 6K or 8K Disc Hydraulic Brakes

Notice to Buyer
It is recommended that all brakes be replaced at the same time to insure balanced braking performance.

Remove the old brake pads

1. Jack up trailer and secure on adequate capacity jack stands. Follow trailer manufacturers recommendations for lifting and supporting the unit.

⚠ CAUTION

Do not lift or support the trailer on any part of the axle or suspension system. Never go under any trailer unless it is properly supported on jack stands which have been rated for the load. Improperly supported vehicles can fall unexpectedly and cause serious injury or death.

2. Remove the wheel from the hub, leaving the brake exposed.
3. Disconnect the brake actuation system. Check that the hydraulic system has zero pressure and that the hub and rotor rotates freely.
4. Remove the brake pad retaining bolt.
5. Remove the old pads from the caliper assembly. Save the brake pad retaining hardware for reinstalling the new pads onto the caliper.

⚠ CAUTION

POTENTIAL ASBESTOS DUST HAZARD!
Some older brake linings may contain asbestos dust, which has been linked to serious or fatal illnesses. Certain precautions need to be taken when servicing brakes:

1. **Avoid creating or breathing dust.**
2. **Avoid machining, filing or grinding the brake linings.**
3. **Do not use compressed air or dry brushing for cleaning (dust can be removed with a damp brush).**

Installing the new brake pads

1. First inspect the brake assembly for grooves, flaking, cracks, heat checking, thickness variation, insufficient rotor thickness, and look to see that the mounting hardware is straight. Replace any component as needed (or desired) per manufacturer recommendations.
2. Press the caliper pistons into the calipers until enough clearance is available to fit the new pads between the pistons and the rotor. *Note: Use two lug nuts to secure rotor against the hub face when reassembling the new pads. After the pads are assembled remove the lug nuts.*
3. Install the new brake pads by sliding them in one at a time between the caliper pistons and the rotor. The pads are the same for the inner and outer side of the rotor. Make sure the brake lining side of the pad faces the rotor, and the steel backing faces the caliper pistons.

4. Align the brake pad mounting holes with the holes in the caliper. Insert the brake pad retaining bolt and tighten nut until snug against shoulder of bolt.
5. Reconnect the brake actuation system. Refer to your *Operation Maintenance Service Manual* for proper operation.
6. Remount the wheel. Refer to your *Operation Maintenance Service Manual* for proper wheel nut torque procedures.

Instructions for Brake Caliper Kit 6K or 8K Disc Hydraulic Brakes

Notice to Buyer
It is recommended that all brakes be replaced at the same time to insure balanced braking performance.

Remove the old brake pads

1. Jack up trailer and secure on adequate capacity jack stands. Follow trailer manufacturers recommendations for lifting and supporting the unit.

⚠ CAUTION

Do not lift or support the trailer on any part of the axle or suspension system. Never go under any trailer unless it is properly supported on jack stands which have been rated for the load. Improperly supported vehicles can fall unexpectedly and cause serious injury or death.

2. Remove the wheel from the hub, leaving the brake exposed.
3. Disconnect the brake actuation system. Check that the hydraulic system has zero pressure and that the hub and rotor rotates freely.
4. Remove the hose from the caliper, then remove the four caliper mounting bolts. Do not allow the caliper to hang from the hose.

Installing the new brake caliper

1. First inspect the brake assembly for grooves, flaking, cracks, heat checking, thickness variation, insufficient rotor thickness, and look to see that the mounting hardware is straight. Replace any component as needed (or desired) per manufacturer recommendations.
2. Assemble the new caliper assembly. *Note: Use two lug nuts to secure rotor against the hub face when reassembling the calipers. After the brake is assembled remove the lug nuts.*
3. One caliper will be used on the inboard side, with the hydraulic line fitting adapter installed on the top side of the piston boss. The other caliper will be used on the outboard side with the bleed screw installed at the top of the piston boss. Install both of these calipers onto the attaching bracket. Make sure that the bleed screw points up and is located on the outboard caliper. Torque bolts to **25-35 Ft. Lbs.**
4. Connect the new crossover brake line on the bottom sides of the piston boss on both calipers. *Note: Make sure the crossover line fits snug around the calipers and rotor without touching the rotor.* Spin the rotor to ensure there is proper clearance. Torque the crossover line to **12-15 Ft. Lbs.** Torque the bleed screw and the hydraulic line fitting adapter to **60-76 Inch Lbs.**
5. Reassemble the brake pads into the disc brake. Make sure to locate the brake lining side of the pads toward the rotor surface, and the steel side of the pads toward the calipers. Align the holes in the brake pads with the ones in the calipers. Insert the brake pad retaining bolt and tighten nut until snug against shoulder of bolt.
6. Reconnect the brake actuation system. Refer to your *Operation Maintenance Service Manual* for proper operation.
7. Bleed and flush brake system per your actuation systems *Operation Maintenance Service Manual.*
8. Remount the wheel. Refer to your *Operation Maintenance Service Manual* for proper wheel nut torque procedures.
9. Spin wheel to ensure proper clearance between the wheel, crossover brake line, and the rotor.

Introduction to Troubleshooting

Proper brake function is critical to the safe operation of any vehicle. A properly installed vacuum/hydraulic, electric/hydraulic or air/hydraulic system should not require any special attention with the exception of routine maintenance as defined by the manufacturer. If problems occur, the entire tow vehicle/trailer braking system should be analyzed by a qualified mechanic. Typical problems in a hydraulic braking system are:

- Air or vacuum leaks
- Hydraulic system leaks
- Air in brake lines
- Water or other impurity in brake fluid
- Rusted or corroded master or wheel cylinders
- Actuation system malfunction

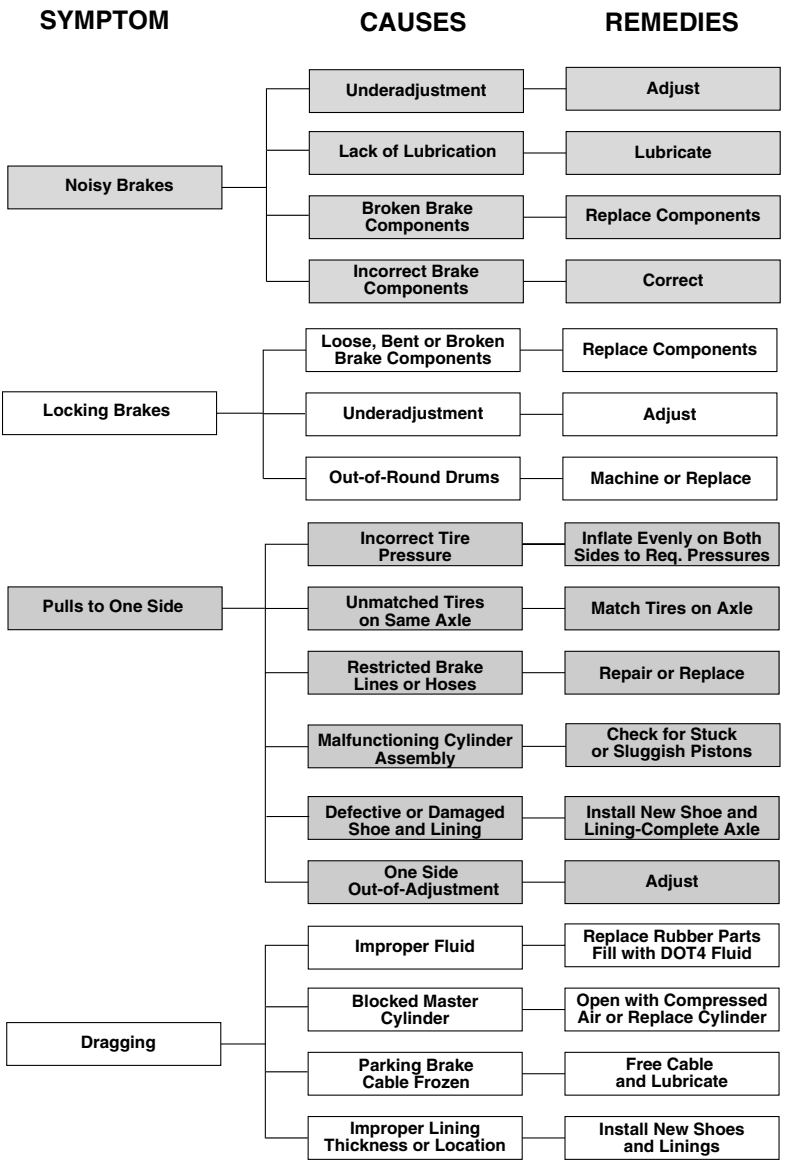
Please consult the following troubleshooting charts to determine the causes and solutions for common problems found in trailer braking systems.

CAUTION

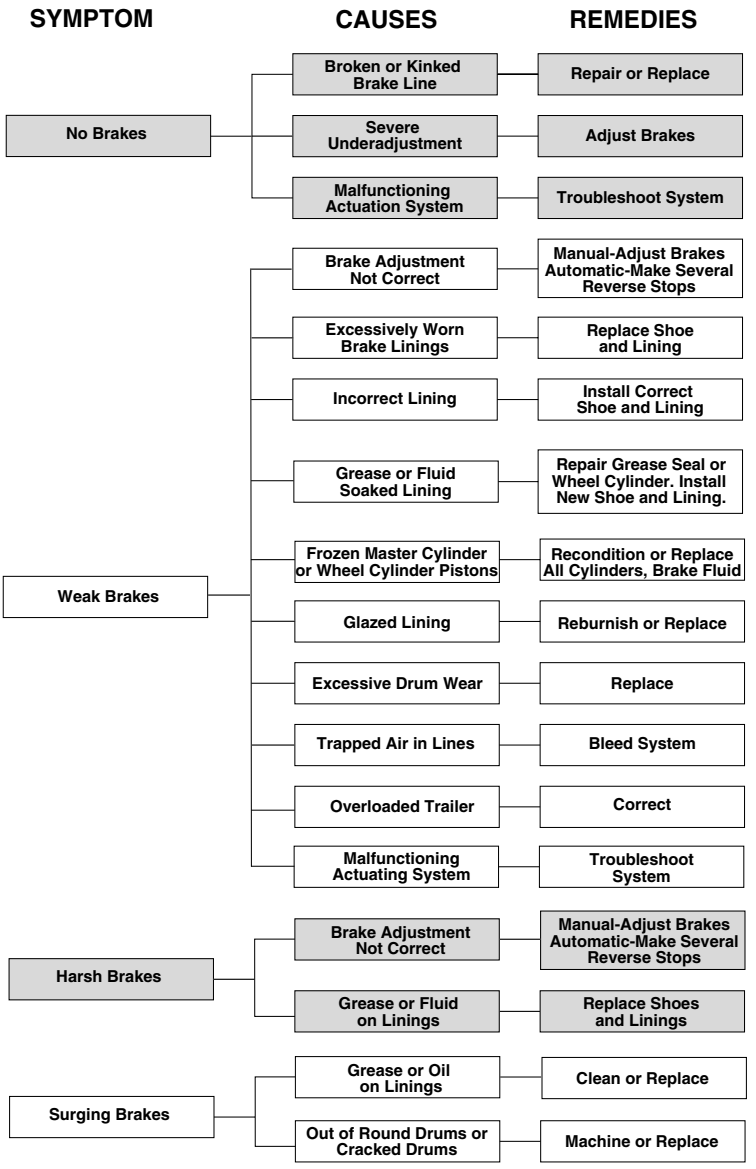
The operating pressure required for Dexter brakes:

- **7" diameter brakes**
  maximum operating pressure is 750 psi
- **10" diameter and larger**
  maximum operating pressure is 1,000 psi

Troubleshooting



Troubleshooting



Hubs/Drums/Bearings

Dexter Axle offers several types of bearing arrangements and lubrications methods.

- Dexter's standard wheel bearing configuration consists of opposed tapered roller bearing cones and cups, fitted inside of a precision machined cast hub. This method of using tapered roller bearings requires that a minimal amount of axial end play be provided at assembly. This end play is essential to the longevity of the bearings service life. This design is typically lubricated with grease, packed into the bearings. Oil lubrication is another method which is available in some of the larger axle capacities.

- E-Z Lube® is another option chosen by some trailer manufacturers. If your axle is equipped with the Dexter E-Z Lube® feature, the bearings can be periodically lubricated without removing the hubs from the axle. This feature consists of axle spindles that have been specially drilled and assembled with grease fittings in their ends. When grease is pumped into the fitting, it is channeled to the inner bearing and then flows back to the outer bearing and eventually back out the grease cap hole.

- Nev-R-Lube™ option is the latest innovation from Dexter. Nev-R-Lube™ bearings are comprised of opposed tapered roller bearing cones sealed inside of a precision ground, one piece double cup arrangement. These bearings are designed with a small amount of axial end play. This end play is essential to the longevity of the bearings service life. They are lubricated, assembled and sealed at the factory. No further lubrication is ever needed.

Before attempting any disassembly of your Dexter axle, make sure you read and follow the instructions for the appropriate axle type.

Hub Removal - Standard Bearings

Whenever the hub equipment on your axle must be removed for inspection or maintenance the following procedure should be utilized.

1. Elevate and support the trailer unit per manufacturers' instructions.

⚠ CAUTION

You must follow the maintenance procedures to prevent damage to important structural components. Damage to certain structural components such as wheel bearings can cause the wheel end to come off of the axle. Loss of a wheel end while the trailer is moving can cause you to lose control and lead to an accident, which can result in serious injury or death.

2. Remove the wheel.
3. Remove the grease cap by carefully prying progressively around the flange of the cap. If the hub is an oil lube type, then the cap can be removed by unscrewing it counterclockwise while holding the hub stationary.
4. Remove the cotter pin from the spindle nut.

   For E-Z Lube® axles produced after February 2002, a new type of retainer is used. Gently pry off retainer from the nut and set aside.
5. Unscrew the spindle nut (counterclockwise) and remove the spindle washer.
6. Remove the hub from the spindle, being careful not to allow the outer bearing cone to fall out. The inner bearing cone will be retained by the seal.
7. For 7,200 lb. and 8,000 lb. axles, a hub puller may be necessary to assist in drum removal.

Brake Drum Inspection

There are two areas of the brake drum that are subject to wear and require periodic inspection. These two areas are the drum surface where the brake shoes make contact during stopping and the armature surface where the magnet contacts (only in electric brakes).

The drum surface should be inspected for excessive wear or heavy scoring. If worn more than .020" oversized, or the drum has worn out of round by more than .015", then the drum surface should be re-machined. If scoring or other wear is greater than

.090" on the diameter, the drum must be replaced. When turning the drum surface, the maximum rebore diameter is as follows:

- 7" Brake Drum-7.090" diameter
- 10" Brake Drum-10.090" diameter
- 12" Brake Drum-12.090" diameter
- 12 1/4" Brake Drum-12.340" diameter
- 6K and 8K Rotor-1.03" minimum thickness
- 3.5K Rotor-.85" minimum thickness

The machined inner surface of the brake drum that contacts the brake magnet is called the armature surface. If the armature surface is scored or worn unevenly, it should be refaced to a 120 micro inch finish by removing not more than .030" of material. To insure proper contact between the armature face and the magnet face, the magnets should be replaced whenever the armature surface is refaced and the armature surface should be refaced whenever the magnets are replaced.

Note: It is important to protect the wheel bearing bores from metallic chips and contamination which result from drum turning or armature refacing operations. Make certain that the wheel bearing cavities are clean and free of contamination before reinstalling bearing and seals. The presence of these contaminants will cause premature wheel bearing failure.

Bearing Inspection

Wash all grease and oil from the bearing cone using a suitable solvent. Dry the bearing with a clean, lint-free cloth and inspect each roller completely.

CAUTION

Never spin the bearing with compressed air.
THIS CAN DAMAGE THE BEARING.

If any pitting, spalling, or corrosion is present, then the bearing must be replaced. The bearing cup inside the hub must be inspected.

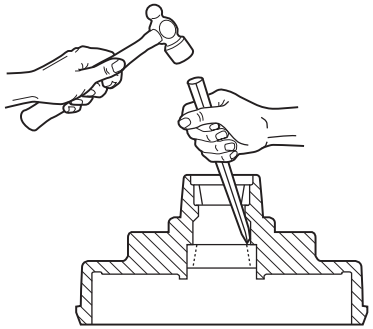
IMPORTANT: *Bearings must always be replaced in sets of a cone and a cup.*

⚠ CAUTION

Be sure to wear safety glasses when removing or installing force fitted parts. Failure to comply may result in serious eye injury.

When replacing the bearing cup proceed as follows:

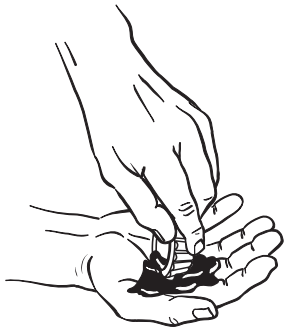
1. Place the hub on a flat work surface with the cup to be replaced on the bottom side.
2. Using a brass drift punch, carefully tap around the small diameter end of the cup to drive out.
3. After cleaning the hub bore area, replace the cup by tapping in with the brass drift punch. *Be sure the cup is seated all the way up against the retaining shoulder in the hub.*



Bearing Lubrication - Grease

Along with bearing adjustment, proper lubrication is essential to the proper function and reliability of your trailer axle. Bearings should be lubricated every 12 months or 12,000 miles. The method to repack bearing cones is as follows:

1. Place a quantity of grease into the palm of your hand.
2. Press a section of the widest end of the bearing into the outer edge of the grease pile closest to the thumb forcing grease into the interior of the bearing.



3. Repeat this while rotating the bearing from roller to roller.
4. Continue this process until you have the entire bearing completely filled with grease.
5. Before reinstalling, apply a light coat of grease on the bearing cup.

Bearing Lubrication - Oil

If your axles are equipped with oil lubricated hubs, periodically check and refill the hub as necessary with a high quality hypoid gear oil to the level indicated on the clear plastic oil cap. The oil can be filled from either the oil fill hole, if present, in the hub or through the rubber plug hole in the cap itself.

Recommended Wheel Bearing Lubrication Specifications

Grease:

Thickener Type ..... Lithium Complex
Dropping Point ..... 215°C (419°F) Minimum
Consistency ..... NLGI No. 2
Additives ..... EP, Corrosion & Oxidation Inhibitors
Viscosity Index ..... 80 Minimum

Approved Sources:

Mobil Oil ..... Mobilgrease HP, Mobilith AW2
Exxon/Standard ..... Ronex MP
Kendall Refining Co. ..... Kendall L-427 Super Blu
Ashland Oil Co. ..... Valvoline Multipurpose GM
76 Lubricants ..... 76 Multiplex EP
Citgo Petroleum ..... Lithoplex MP#2
Mystik ..... Mystik JT-6 Hi Temp Grease

Oil:

SAE 90, SAE 80W-90, SAE 75W-90

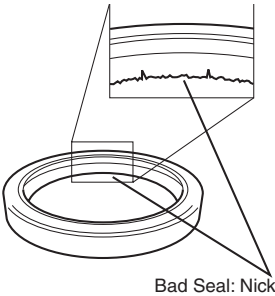
Approved Sources:

Union Oil Co. ..... Unocal MP Gear Lube
Exxon Co. USA ..... Gear Oil GX 80W-90
Mobil Oil Corp ..... Mobilube SHC 75W-90
Pennzoil Prod. Co. ..... Gear Plus 80W-90 GL-5
Gear Plus Super 75W-90

Note: The convenient lubrication provisions of the E-Z Lube® and the oil lubrication must not replace periodic inspection of the bearings.

Seal Inspection and Replacement

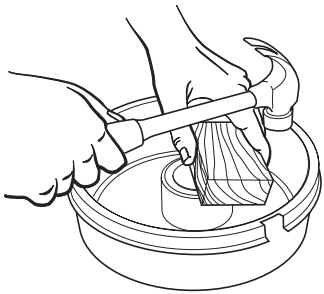
Whenever the hub is removed, inspect the seal to assure that it is not nicked or torn and is still capable of properly sealing the bearing cavity. If there is any question of condition, replace the seal. Use only the seals specified in the Seal Replacement Chart.
To replace the seal:



Bad Seal: Nicks and Tears
(REPLACE SEAL)

1. Pry the seal out of the hub with a screwdriver. Never drive the seal out with the inner bearing as you may damage the bearing.
2. Apply a PERMATEX sealant to the outside of the new seal.

   Note: Permatex sealant should not be used on rubber encased seals.
3. Tap the new seal into place using a clean wood block.



Bearing Adjustment and Hub Replacement

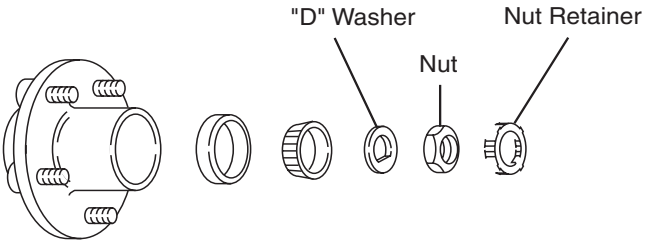
If the hub has been removed or bearing adjustment is required, the following adjustment procedure must be followed:

1. After placing the hub, bearings, washers, and spindle nut back on the axle spindle in reverse order as detailed in the previous section on hub removal, rotate the hub assembly slowly while tightening the spindle nut to approximately 50 lbs.-ft. (12" wrench or pliers with full hand force.)
2. Then loosen the spindle nut to remove the torque. *Do not rotate the hub.*
3. Finger tighten the spindle nut until just snug.
4. Back the spindle nut out slightly until the first castellation lines up with the cotter key hole and insert the cotter pin.
5. Bend over the cotter pin legs to secure the nut.
6. Nut should be free to move with only restraint being the cotter pin.

For E-Z Lube® axles using the new nut retainer:

1. Finger tighten the nut until just snug, align the retainer to the machined flat on the spindle and press the retainer onto the nut. The retainer should snap into place. Once in place, the retainer/nut assembly should be free to move slightly.
2. If the nut is too tight, remove the retainer and back the nut off approximately one twelfth of a turn and reinstall the retainer. The nut should now be free to move slightly.
3. Reinstall grease cap.

Typical E-Z Lube® After Spring 2002

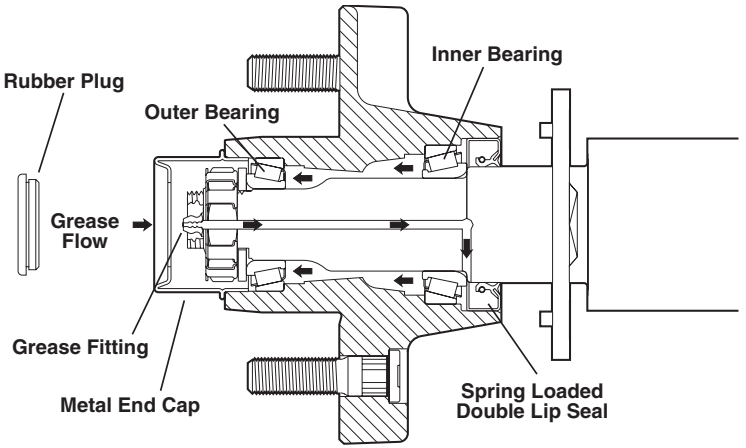


E-Z Lube® Lubrication

The procedure is as follows:

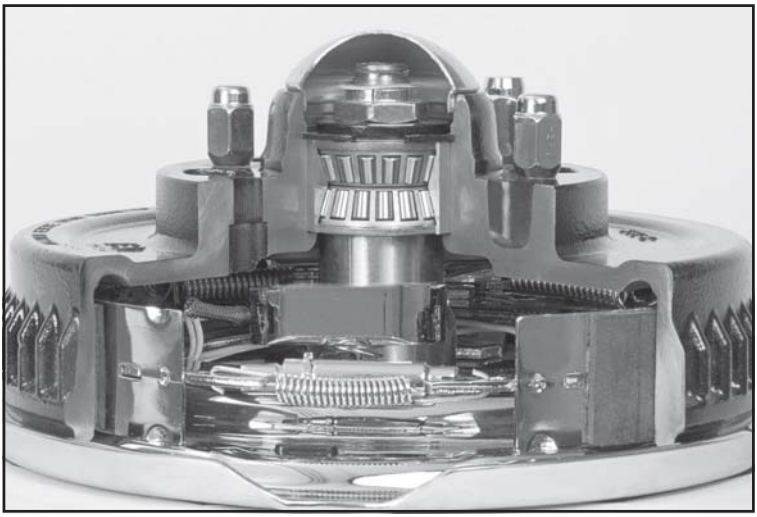
1. Remove the rubber plug from the end of the grease cap.
2. Place a standard grease gun onto the grease fitting located in the end of the spindle. Make sure the grease gun nozzle is fully engaged on the fitting.
3. Pump grease into the fitting. The old displaced grease will begin to flow back out the cap around the grease gun nozzle.
4. When the new clean grease is observed, remove the grease gun, wipe off any excess, and replace the rubber plug in the cap.
5. Rotate hub or drum while adding grease.

   Note: The E-Z Lube® feature is designed to allow immersion in water. Axles not equipped with E-Z Lube® are not designed for immersion and bearings should be repacked after each immersion. If hubs are removed from an axle with the E-Z Lube® feature, it is imperative that the seals be replaced BEFORE bearing lubrication. Otherwise, the chance of grease getting on brake linings is greatly increased.



Nev-R-Lube™ Drums/Bearings

Dexter's Nev-R-Lube™ bearings are comprised of opposed tapered roller bearing cones sealed inside of a precision ground, one piece double cup arrangement. These bearings are designed with a small amount of axial end play. This end play is essential to the longevity of the bearings service life.



Drum Removal

Whenever the hub equipment on your axle must be removed for inspection or maintenance, the following procedure should be utilized.

1. Elevate and support the trailer unit per manufacturer's instructions.

⚠ CAUTION

Do not lift or support the trailer on any part of the axle or suspension system. Never go under any trailer unless it is properly supported on jack stands which have been rated for the load. Improperly supported vehicles can fall unexpectedly and cause serious injury or death.

2. Remove the wheel.
3. Remove the grease cap from the hub by carefully prying progressively around the flange.
4. Remove snap ring on the end of the spindle. Remove “torque instruction” washer.
5. Unscrew the spindle nut (counterclockwise) and remove the spindle washer.
6. Carefully remove the hub from the spindle. The Nev-R-Lube™ bearing cartridge will remain in the hub.

   Note: Do not remove cartridge bearing from the hub bore unless replacement of the bearing cartridge is intended. Special tools and techniques are required for removal of the old bearing.

Bearing Inspection

Important:

1. Elevate and support the trailer unit per manufacturer's instructions.

⚠ CAUTION

Do not lift or support the trailer on any part of the axle or suspension system. Never go under any trailer unless it is properly supported on jack stands which have been rated for the load. Improperly supported vehicles can fall unexpectedly and cause serious injury or death.

2. Check for excessive wheel end clearance by pulling the tire assembly towards you and by pushing the assembly away from you. Slight end play is acceptable.
3. Rotate tire slowly forwards and backwards. The wheel assembly should turn freely and smoothly.
4. Excessive wheel end play, restriction to rotation, noise, or "bumpy" rotation should be remedied by replacing the bearing unit.
5. Bearing units should be inspected every year or 12,000 miles whichever comes first.

   Note: A slight amount of grease weeping from the seal area is normal. Excessive leakage may indicate abnormal bearing operation.

Nev-R-Lube™ Bearing End Play Inspection

The following lists the maximum axial end play for each of the sizes of Nev-R-Lube™ bearings and the amount of tilt that can be expected. Since there are a large number of wheel and tire combinations in use on trailers, the tilt is expressed in inches per inch. The movement as measured at the tire tread can be found by the following method:

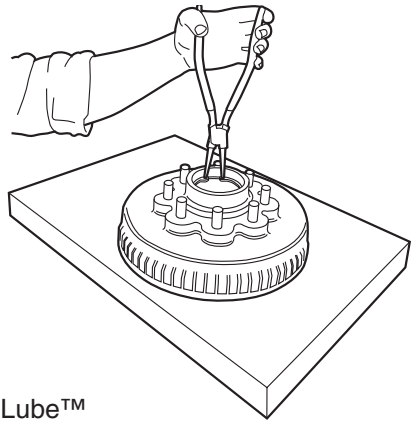
> ***Example****: if the tilt value is shown as .003" per inch and the tire measures 30" in diameter, simply multiply .003" X 15" (1/2 tire diameter) = .045" which is the total expected movement at the tires' outer diameter.*

Bearing size	End play	Resultant tilt value
35 MM	.005" axial	.003"/ per inch
42 MM	.006" axial	.005"/ per inch
50 MM	.008" axial	.004"/ per inch

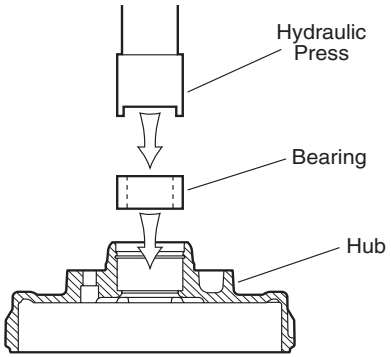
It is important to note that most mounted tires will deflect fairly easily when enough hand pressure is applied while shaking the tire. Excessive pressure will result in the perception that the bearings' tilt is greater than it actually is. This same phenomenon will occur when checking any wheel end, even those equipped with conventional bearing sets.

Bearing Replacement and Drum Installation

1. Once the drum and bearing assembly is removed from the axle, remove “internal” snap ring from the bearing bore that retains bearing.
2. Using an arbor press and mandrel, press the bearing out of the drum. Bearing will exit on the wheel side of the drum.



3. When replacing a Nev-R-Lube™ bearing pack, the bore in the hub should be cleaned and inspected for visual damage (replace as necessary).
4. Install the new bearing using an arbor press fitted with a hollow or stepped punch face to press only on the outer housing of the bearing. Failure to follow procedure will damage the bearing and/or seals during installation. Press bearing until it seats against the backup shoulder machined into the hub.



5. Install “internal” snap ring into hub.
6. Clean and inspect spindle shaft. Apply a light coating of anti-seize lubricant to the spindle shaft prior to assembling drum.
7. Install drum assembly onto spindle (*Do Not Force*).
8. Install steel washer onto spindle end.
9. Start self-locking nut onto spindle thread by hand. Complete installation using a 1½" or 1 7/16" socket and torque wrench.

Nut should be torqued to 145-155 lb.-ft. (this torque will set the internal bearing adjustment, no other adjustments are to be made).

10. Install “torque instruction” washer onto end of spindle.
11. Install “external” snap ring onto end of spindle to retain washer.
12. Inspect assembly for excessive end play, noise, and rotation restriction prior to mounting final wheel end hardware.

Suspension Systems

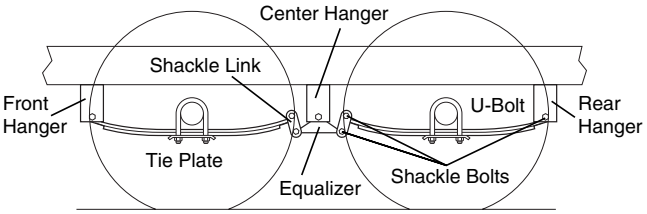
The suspension systems incorporated into Dexter axles are designed to provide the trailer owner three basic functions:

1. Attach the axle to the trailer
2. Dampen the effects of road shock
3. Cushion the cargo or load

All Dexter suspension systems are available in single and multiple axle configurations. The three types most commonly available are double eye leaf spring, slipper spring and Torflex®.

Double Eye Leaf Springs

Double eye springs have eyes formed in each end of the spring with anti-friction bushings fitted for wear resistance. The springs are held to the axle tube using a system of U-bolts and clamp plates and are attached to the trailer as shown.



Underslung Shown

Articulation of this suspension occurs when the spring becomes loaded and consequently lengthens. The double pivot action of the shackle links accommodates this articulation and allows the system to move freely.

In multiple axle installations, the action is the same with the additional movement of the equalizer assembly. This serves to transfer instantaneous loads from one axle to another in an effort to “equalize” the load between the axles.

Grease Lubricated Suspension Bushings

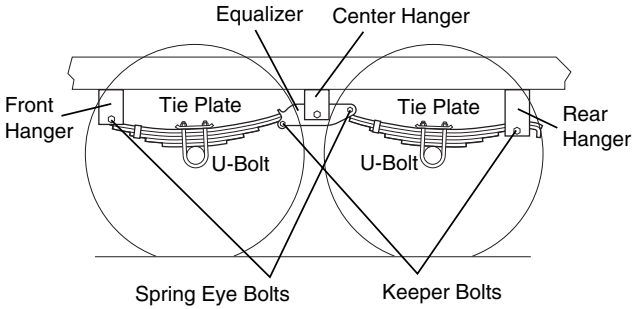
Dexter Axle offers an optional heavy duty attaching parts kit for double eye leaf spring suspensions up to 7,000 lb. axle capacity. The kit contains extra heavy shackle links, bronze bushings for the spring eyes and suspension bolts and equalizers equipped with grease fittings to provide a convenient means to lubricate all the pivot points. For availability, contact your nearest Dexter Axle facility or visit us online at **www.dexteraxle.com** for a complete listing of genuine repair parts.

Slipper Leaf Springs

Slipper springs have an eye formed in one end only with the other end formed into a reverse curve. The attachment of these springs is as follows:

1. The front eye is attached directly into the front hanger with a bolt and nut.
2. The rear end of the spring is captured in the rear hanger or equalizer with a “keeper bolt” that prevents the spring from coming out when the trailer is jacked up for service.

The articulation of this suspension occurs when the rear end of each slipper spring slides against the wear surfaces provided in the rear hangers or equalizers. This suspension is also available in single and multiple axle configurations.



Overslung Shown

Inspection and Replacement

All the components of your suspension system should be visually inspected at least every 6,000 miles for signs of excess wear, elongation of bolt holes, and loosening of fasteners. Whenever loose or replaced, the fasteners in your suspension system should be torqued as detailed in the charts below.

⚠ CAUTION

You must follow the maintenance procedures to prevent damage to important structural components. Damage to certain structural components such as wheel bearings can cause the wheel to come off of the axle. Loss of a wheel end while the trailer is moving can cause you to lose control and lead to an accident, which can result in serious injury or death.

Suspension Fastener Torque Values

Item	Torque (lbs.-ft.) Min	Max
3/8" U-Bolt	30	50
7/16" U-Bolt	45	70
1/2" U-Bolt	45	70
9/16" U-Bolt	65	95
5/8" U-Bolt	100	120
Non shoulder type with 9/16" threads Shackle Bolt Spring Eye Bolt Equalizer Bolt	Snug fit only. Parts must rotate freely. Locking nuts or cotter pins are provided to retain nut-bolt assembly.	
Shoulder Type Shackle Bolt with 7/16" threads	30	50

Worn spring eye bushings, sagging springs, or broken springs should be replaced using the following method.

1. Support the trailer with the wheels just off the ground.

⚠ CAUTION

Do not lift or support the trailer on any part of the axle or suspension system. Never go under any trailer unless it is properly supported on jack stands which have been rated for the load. Improperly supported vehicles can fall unexpectedly and cause serious injury or death.

2. After the unit is properly supported place a suitable block under the axle tube near the end to be repaired. This block is to support the weight of the axle only, so that suspension COMPONENTS can be removed.
3. Disassemble the U-bolts, nuts, and tie plates.
4. Remove the spring eye bolts and remove the spring and place on a suitable work surface.
5. If the spring eye bushings are to be replaced, drive out the old bushing using a suitable drift punch.

⚠ CAUTION

Be sure to wear safety glasses when removing or installing force fitted parts. Failure to comply may result in serious injury.

6. Drive the new bushing into the spring eye using a piloted drift punch or a close fitting bolt inserted through the bushing.
7. Reinstall repaired or replaced components in reverse order.

   Note: For multiple axle units, the weight of each axle must be supported as outlined in Step 2 before disassembly of any component of the suspension system.

If the equalizer or equalizer bushings must be replaced, follow the instructions above for lifting and supporting the trailer unit and then proceed as follows:

1. With both axles blocked up, remove the spring eye bolt, shackle bolt, and equalizer bolt from the equalizer to be repaired or replaced.
2. Take the equalizer to suitable work surface and remove the worn bushings using a suitable drift punch.
3. Drive the new bushings into place using a piloted drift punch or a close fitting bolt through the bushing.
4. Reassemble in reverse order.

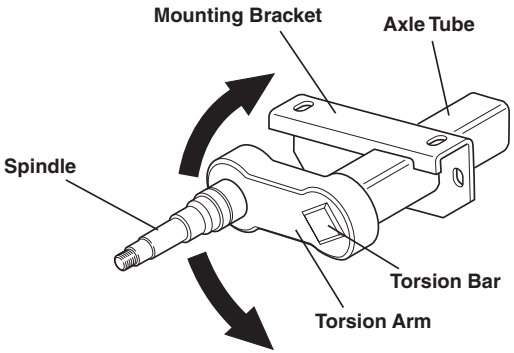
⚠ CAUTION

Be sure to wear safety glasses when removing or installing force fitted parts. Failure to comply may result in serious injury.

All of the pivot points on your standard suspension system have been fitted with anti-friction bearing materials which do not require routine lubrication. When otherwise servicing the unit, these pivot points may be lubricated if you so desire. If your trailer has been fitted with the Heavy Duty Attaching Parts Kit, you should lubricate periodically to ensure long component life.

Torflex® Suspension

The Torflex® suspension system is a torsion arm type suspension which is completely self contained within the axle tube. It attaches directly to the trailer frame using brackets which are an integral part of the axle assembly. The Torflex® axle provides improved suspension characteristics relative to leaf spring axles through the unique arrangement of a steel torsion bar



surrounded by four natural rubber cords encased in the main structural member of the axle beam.

The wheel/hub spindle is attached to a lever, called the torsion arm, which is fastened to the rubber encased bar. As load is applied, the bar rotates causing a rolling/compressive resistance in the rubber cords. This action provides the same functions as conventional sprung axles with several operating advantages including independent suspension.

Except for periodic inspection of the fasteners used to attach the Torflex® axle to the vehicle frame, no other suspension maintenance is required on Torflex® axles. They are, of course, subject to the maintenance and inspection procedures regarding brakes, hubs, bearings, seals, wheels, and tires as outlined in this manual.

CAUTION

DO NOT WELD ON THE TORFLEX® BEAM. It has rubber cords inside and the heat generated by welding could damage the cords.

Airflex™ Suspension

The Dexter Airflex™ suspension is a unique combination of Torflex® axle and conventional air suspension technology. This low maintenance suspension system carries the load on a cushion of air, usually supplied by an on-board compressor and storage tank. A load leveling valve maintains a constant ride height, regardless of load. As load is added to the trailer, the valve will automatically signal the compressor to supply more air. As loads are removed, the same valve will exhaust air to maintain the same height and ride characteristics.

The Airflex™ suspension can be supplied with a dump valve which allows the trailer to be lowered several inches to facilitate loading or leveling. Once loaded, the valve is reversed and the system is pressurized to raise the trailer back up to normal running height.

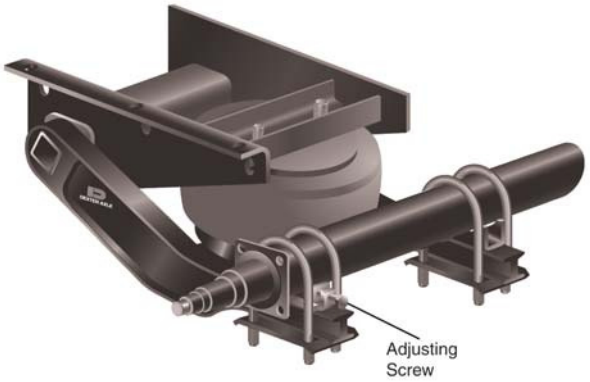
Axle Adjustment

1. Support the trailer frame on a level surface. If the wheels are already mounted, make sure they are clear of the ground. If the air actuation system has been installed, make sure the air pressure in the air bags is bled off before lifting the trailer. **CAUTION: Lifting the trailer with air system pressurized will overextend the air bags and can result in damage to the air bags**.

⚠ CAUTION

Do not lift or support the trailer on any part of the axle or suspension system. Never go under any trailer unless it is properly supported on jack stands which have been rated for the load. Improperly supported vehicles can fall unexpectedly and cause serious injury or death.

2. Measure from king pin to spindle center on each side. To simplify this process, plumb lines may be dropped from the king pin and from the centerline of each spindle end. Measurements “A” and “B” can then be taped on the floor to eliminate any miss measurement due to sagging of the tape long measurements. Compare A and B measurements (see Figure 1).
3. Loosen all the U-bolt nuts slightly and move the axle assembly with the adjusting screws, located on the front and rear of the axle seat. Move front axle to correct alignment position based on previous findings of A and B measurements. Make sure both front and rear adjusting screws are snug after axle is realigned. Then, retighten the U-bolt nuts to 100 to 120 lb ft.



4. Re-measure A and B, as before, to assure that “A” and “B” dimensions are within 1/16" of each other. If dimensions are not to specification, then repeat adjustment procedure.

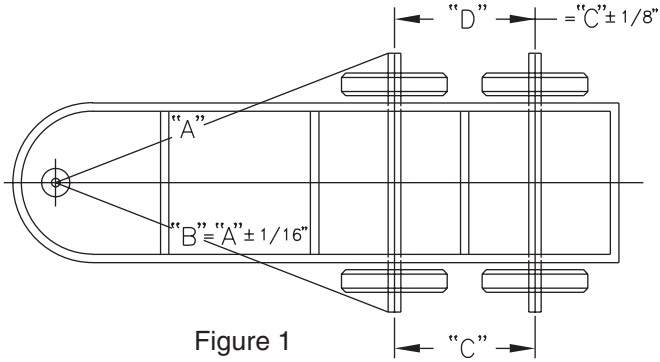


Figure 1

Tandem Axle Adjustment

1. Adjust the second axle using it's left hand spring seat adjusters to assure distances "C" and "D" are within tolerance.
2. Measure the distances "C" and "D" between the front and rear tandem axles. These distances must be within 1/8" of each other.
3. After alignment is completed make sure all nuts and bolts are tightened to their respective torque values.
4. The limits of 1/16" and 1/8" appear very small in comparison to the overall dimensions of the vehicle but they are recognized as the maximum permissible limit of misalignment. Also, the relatively small size of those limits makes accurate measurements important.

Wheels

Wheel Selection

Wheels are very important and critical components of your running gear system. When specifying or replacing your trailer wheels it is important that the wheels, tires, and axle are properly matched. The following characteristics are extremely important and should be thoroughly checked when replacement wheels are considered.

1. *Bolt Circle*. Many bolt circle dimensions are available. Some vary by so little that it might be possible to attach an improper wheel that does not match the axle hub. Be sure to match your wheel to the axle hub.
2. *Capacity*. Make sure that the wheels have enough load carrying capacity and pressure rating to match the rated load of the tire.
3. *Offset*. This refers to the relationship of the center line of the tire to the hub face of the axle. Care should be taken to match any replacement wheel with the same offset wheel as originally equipped. Failure to match offset can result in reducing the load carrying capacity of your axle.
4. *Rim Contour*.

⚠ CAUTION

Replacement tires must meet the same specifications as the originals. Mismatched tires and rims may come apart with explosive force and cause personal injury to yourself or others. Mismatched tires and rims can also blow out and cause you to lose control and have an accident which can result in serious injury or death.

⚠ CAUTION

Do not attempt to repair or modify a damaged wheel. Even minor modifications can cause a dangerous failure of the wheel and result in personal injury or death.

Torque Requirements

In June of 2004, Dexter Axle ceased production of trailer wheels. If your vehicle is equipped with Dexter steel wheels manufactured before that date, the following wheel torque information will be applicable.

If your trailer is equipped with wheels produced by other manufacturers, you must consult with the vehicle manufacturer to determine the appropriate torque level for your wheels. However, you must not exceed the limits of the wheel mounting studs on the axles.

It is extremely important to apply and maintain proper wheel mounting torque on your trailer axle. Torque is a measure of the amount of tightening applied to a fastener (nut or bolt) and is expressed as length force. For example, a force of 90 pounds applied at the end of a wrench one foot long will yield 90 lbs.-ft. of torque. Torque wrenches are the best method to assure the proper amount of torque is being applied to a fastener.

⚠ CAUTION

Wheel nuts or bolts must be tightened and maintained at the proper torque levels to prevent loose wheels, broken studs, and possible dangerous separation of wheels from your axle, which can lead to an accident, personal injuries or death.

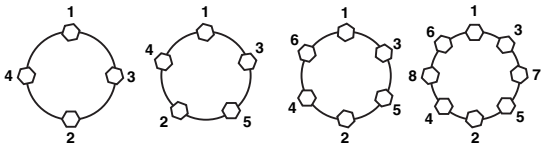
Be sure to use only the fasteners matched to the cone angle of your wheel (usually 60° or 90°). The proper procedure for attaching your wheels is as follows:

1. Start all bolts or nuts by hand to prevent cross threading.
2. Tighten bolts or nuts in the sequence shown for Wheel Torque Requirements.
3. The tightening of the fasteners should be done in stages. Following the recommended sequence, tighten fasteners per wheel torque chart below.
4. Wheel nuts/bolts should be torqued before first road use and after each wheel removal. Check and re-torque after the first 10 miles, 25 miles, and again at 50 miles. Check periodically thereafter.

Wheel Torque Requirements

(For Dexter Steel Wheels Prior to June 2004)

Wheel Size	Torque Sequence 1st Stage	2nd Stage	3rd Stage
12"	20-25	35-40	50-75
13"	20-25	35-40	50-75
14"	20-25	50-60	90-120
15"	20-25	50-60	90-120
16"	20-25	50-60	90-120
16.5" x 6.75"	20-25	50-60	90-120
16.5" x 9.75"	55-60	120-125	175-225
14.5" Demount.	Tighten sequentially to		85-95
17.5" Hub Pilot Clamp Ring & Cone Nuts	50-60	100-120	190-210
17.5" Hub Pilot 5/8" Flange Nuts	50-60	90-200	275-325



Maximum Wheel Fastener Torque

The wheel mounting studs used on Dexter axles conform to the SAE standards for grade 8. The maximum torque level that can be safely applied to these studs is listed in the following chart:

Stud Size	Max. Torque
1/2"-20 UNF, class 2A	120 lb ft.
9/16"-18 UNF, class 2A	170 lb ft.
5/8"-18 UNF, class 2A	325 lb ft.

⚠ CAUTION

Exceeding the above listed torque limits can damage studs and/or nuts and lead to eventual fractures and dangerous wheel separation.

Tires

Before mounting tires onto the wheels, make certain that the rim size and contour is approved for the tire as shown in the Tire and Rim Association Yearbook or the tire manufacturers catalog. Also, make sure the tire will carry the rated load. If the load is not equal on all tires due to trailer weight distribution, use the tire rated for the heaviest wheel position.

Note: The capacity rating molded into the sidewall of the tire is not always the proper rating for the tire if used in a trailer application. Use the following guidelines:

1. LT and ST tires. Use the capacity rating molded into the tire.
2. Passenger Car Tires. Use the capacity rating molded into the tire sidewall **divided by 1.10** for trailer use.

Use tire mounting procedures as outlined by the Rubber Manufacturer's Association or the tire manufacturers.

Tire inflation pressure is the most important factor in tire life. Inflation pressure should be as recommended by the manufacturer for the load. Pressure should be checked cold before operation. Do not bleed air from tires when they are hot. Check inflation pressure weekly during use to insure the maximum tire life and tread wear. The following tire wear diagnostic chart will help you pinpoint the causes and solutions of tire wear problems.

CAUTION

Tire wear should be checked frequently because once a wear pattern becomes firmly established in a tire it is difficult to stop, even if the underlying cause is corrected.

Tire Wear Diagnostic Chart

Wear Pattern		Cause	Action
	**Center Wear**	Over Inflation	Adjust pressure to particular load per tire catalog
	**Edge Wear**	Under Inflation	Adjust pressure to particular load per tire catalog
	**Side Wear**	Loss of camber or overloading	Make sure load doesn't exceed axle rating. Align at alignment shop.
	**Toe Wear**	Incorrect toe-in	Align at alignment shop.
	**Cupping**	Out-of-balance	Check bearing adjustment and balance tires.
	**Flat Spots**	Wheel lockup & tire skidding	Avoid sudden stops when possible and adjust brakes.

Replacement Parts/Kits

Magnet Replacement Kits

Brake Size	Magnet Kit No. (one magnet per kit)	Wire Color	Nut Torque Brake Mounting
7 x 1 1/4	K71-057-00	White	45-70
10 x 2 1/4	K71-104-00	Green	45-70
12 x 2	K71-105-00	White	25-50
12 x 2	K71-125-00 (7K)	Black	25-50
12 1/4 x 2 1/2	K71-441-00	Red	55-80
12 1/4 x 3 3/8	K71-375-00 oval magnet	White	55-80

Brake Shoe Replacement Kits

Brake Size	Shoe and Lining Replacement (1 Brake) *Electric*	*Hydraulic*
7 x 1 1/4	K71-045-00	N/A
7 x 1 3/4	N/A	K71-466-00
10 x 2 1/4	K71-047-00	K71-267-00
Free Backing		K71-393-00
Corrosion Resistant		K71-423 -00
12 x 2 (5.2K)	K71-048-00	K71-268-00
12 x 2 (7K)	K71-127-00	K71-269-00 LH K71-270-00 RH
Free Backing		K71-394-00 LH K71-395-00 RH
Free Backing, Corrosion Resistant		K71-427-00 LH K71-428-00 RH
12 1/4 x 2 1/2	K71-497-00LH K71-496-00RH	N/A
12 1/4 x 3 3/8	K71-499-00LH K71-498-00RH	K71-165-00 LH K71-166-00 RH
12 1/4 x 3 3/8	K71-049-00LH K71-050-00RH	Stamped Backing Plate (prior to April 2000)
3.5K Disc	N/A	K71-623-00 (1 axle set)
6.0K Disc	N/A	K71-629-00 (1 axle set)
8.0K Disc	N/A	K71-629-00 (1 axle set)

Bearing Replacement Chart

Brake Size	Hub Size	Bearings	Dexter Kit Number	Industry Part # Cup /Cone	Axle Capacity
7 x 1 1/4	4 or 5 Bolt	Inner	K71-306-00	L44610 / L44649	2K
		Outer	K71-306-00	L44610 / L44649	
10 x 1 1/2	4 or 5 Bolt	Inner	K71-307-00	LM67010 / LM67048	2.8K
		Outer	K71-306-00	L44610 / L44649	
10 x 2 1/4	4 or 5 Bolt	Inner	K71-390-00	L68111 / L68149	3.5K
		Outer	K71-306-00	L44610 / L44649	
12 x 2	6 Bolt	Inner	K71-308-00	25520 / 25580	5.2K
		Outer	K71-307-00	LM67010 / LM67048	
12 x 2	5 Bolt Demount	Inner	K71-308-00	25520 / 25580	6K
		Outer	K71-309-00	15245 / 15123	
12 x 2*	6 Bolt	Inner	K71-308-00	25520 / 25580	6K
		Outer	K71-309-00	15245 / 15123	
12 x 2	8 Bolt	Inner	K71-308-00	25520 / 25580	7K
		Outer	K71-310-00	14145A / 14276	
12 1/4 x 2 1/2	8 Bolt	Inner	K71-308-00	25520 / 25580	7.2K
		Outer	K71-415-00	02420 / 02475	
12 1/4 x 3 3/8	8 Bolt	Inner	K71-308-00	25520 / 25580	8K
		Outer	K71-415-00	02420 / 02475	

* Special Application

Seal Replacement Reference

Brake Size	Hub Size	Seal Part No. Std.	E-Z Lube®	Oil
7 x 1 1/4	4 or 5 Bolt	010-009-00	K71-301-00	NA
10 x 2 1/4	4, 5 or 6 Bolt	010-004-00	K71-303-00	NA
12 x 2**	5 Bolt Demount; 6 or 8 Bolt	010-054-00	K71-305-00	K71-305-00
12 1/4 x 2 1/2	8 Bolt	K71-386-00	K71-386-00	K71-386-00
12 1/4 x 3 3/8	8 Bolt	K71-386-00	K71-386-00	K71-386-00

** 2.12" diameter seal journal prior to 10/97
2.25" diameter seal journal after 10/97

Storage

Storage Preparation

If your trailer is to be stored for an extended period of time or over the winter, it is important that the trailer be prepared properly.

1. Remove the emergency breakaway battery and store inside, out of the weather. Charge the battery at least every 90 days.
2. Jack up the trailer and place jack stands under the trailer frame so that the weight will be off the tires. Follow trailer manufacturer's guidelines to lift and support the unit. Never jack up or place jack stands on the axle tube or on the equalizers.

⚠ CAUTION

Do not lift or support the trailer on any part of the axle or suspension system. Never go under any trailer unless it is properly supported on jack stands which have been rated for the load. Improperly supported vehicles can fall unexpectedly and cause serious injury or death.

3. Lubricate mechanical moving parts such as the hitch, and suspension parts, that are exposed to the weather.
4. Boat trailer axles are subject to repeated immersion. Before storing, remove brake drums; clean, dry and re-lubricate moving brake components; inspect bearings - clean and re-lubricate.
5. On oil lubricated hubs the upper part of the roller bearings are not immersed in oil and are subject to potential corrosion. For maximum bearing life, it is recommended that you revolve your wheels periodically (every 2-3 weeks) during periods of prolonged storage.

After Prolonged Storage - Inspection Procedures

Before removing trailer from jack stands:

1. Remove all wheels and hubs or brake drums. Note which spindle and brake that the drum was removed from so that it can be reinstalled in the same location.
2. Inspect suspension for wear.
3. Check tightness of hanger bolt, shackle bolt, and U-bolt nuts per recommended torque values.
4. Check brake linings, brake drums and armature faces for excessive wear or scoring.
5. Check brake magnets with an ohmmeter. The magnets should check 3.2 ohms. If shorted or worn excessively, they must be replaced.
6. Lubricate all brake moving parts using a high temperature brake lubricant (LUBRIPLATE or Equivalent).

CAUTION

Do not get grease or oil on brake linings or magnet face.

7. Remove any rust from braking surface and armature surface of drums with fine emery paper or crocus cloth. Protect bearings from contamination while so doing.
8. Inspect oil or grease seals for wear or nicks. Replace if necessary.
9. Lubricate hub bearings. Refer to procedure in manual.
10. Reinstall hubs and adjust bearings per instructions in manual.
11. Mount and tighten wheels per instructions in manual.

Trip Preparation Checklist

There are a number of simple rules to follow in caring for your trailer axle assembly that can add to its life and in the case of some of these rules, you may be protecting your own life as well. Using the following checklist before starting a trip with your trailer is highly recommended. Some of these items should be checked 2-3 weeks prior to a planned trip to allow sufficient time to perform maintenance.

1. Check your maintenance schedule and be sure you are up-to-date.
2. Check hitch. Is it showing wear? Is it properly lubricated?
3. Fasten safety chains and breakaway switch actuating chain securely. Make certain the breakaway battery is fully charged.
4. Inspect towing hookup for secure attachment.
5. Load your trailer so that approximately 10% of the trailers total weight is on the hitch. For light trailers this should be increased to 15%.
6. *Do Not Overload.* Stay within your gross vehicle rated capacity (consult your trailers identification plate).
7. Inflate tires according to manufacturer's specifications; inspect tires for cuts, excessive wear, etc.
8. Check wheel mounting nuts/bolts with a torque wrench. Torque, in proper sequence, to the levels specified in this manual.
9. Make certain brakes are synchronized and functioning properly.
10. Check tightness of hanger bolt, shackle bolt, and U-bolt nuts per torque values specified in manual.
11. Check operation of all lights.
12. Check that your trailer is towing in a level position and adjust hitch height if required.

Maintenance Schedule

Item	Function Required	Weekly	3 Months or 3000 Miles	6 Months or 6000 Miles	12 Months or 12000 Miles
Brakes	Test that they are operational.		***At Every Use***		
Brake Adjustment	Adjust to proper operating clearance.		●		
Brake Magnets	Inspect for wear and current draw.			●	
Brake Linings	Inspect for wear or contamination.				●
Brake Controller	Check for correct amperage & modulation.			●	
Brake Cylinders	Check for leaks, sticking.				●
Brake Lines	Inspect for cracks, leaks, kinks.				●
Trailer Brake Wiring	Inspect wiring for bare spots, fray, etc.				●
Breakaway System	Check battery charge and switch operation.		***At Every Use***		
Hub/Drum	Inspect for abnormal wear or scoring.				●
Wheel Bearings & Cups	Inspect for corrosion or wear. Clean & repack.				●
Seals	Inspect for leakage. Replace if removed.				●
Springs	Inspect for wear, loss of arch.				●
Suspension Parts	Inspect for bending, loose fasteners, wear.			●	
Hangers	Inspect Welds.				●
Wheel Nuts and Bolts	Tighten to specified torque values.		●		
Wheels	Inspect for cracks, dents or distortion.			●	
Tire Inflation Pressure	Inflate tires to mfg's. specifications.	●			
Tire Condition	Inspect for cuts, wear, bulging, etc.		●		

Dexter Axle Limited Warranty

WHAT PRODUCTS ARE COVERED

All Dexter trailer axles, suspensions, and brake control systems excluding Dexter 6000 series Manufactured Housing Axles.

LIMITED 2 YEAR WARRANTY

Dexter Axle warrants to the original purchaser that its axles, suspension systems, and E/H hydraulic brake actuators shall be free from defects in material and workmanship for a period of two (2) years from the date of first sale of the trailer incorporating such components.

LIMITED 5 YEAR WARRANTY

Dexter Axle warrants to the original purchaser that its Nev-R-Lube™ bearings and the suspension components only of its Torflex® axles shall be free from defects in material and workmanship for a period of five years from the date of first sale of the trailer incorporating such components.

LIMITED 7 YEAR WARRANTY

Dexter Axle warrants to the original purchaser that its Predator Series™ electric brake controllers shall be free from defects in material and workmanship for a period of seven (7) years from the date of purchase.

EXCLUSIVE REMEDY

Dexter Axle will, at its option, repair or replace the affected components of any defective axle, repair or replace the entire defective axle, or refund the then-current list price of the axle. In all cases, a reasonable time period must be allowed for warranty repairs to be completed. Allowance will only be made for installation costs specifically approved by Dexter Axle.

WHAT YOU MUST DO

In order to make a claim under these warranties:

1. You must be the original purchaser of the vehicle in which the Spring Suspension Axles or Torflex® Axles were originally installed.
2. You must promptly notify us within the warranty period of any defect and provide us with the axle serial number and any substantiation which may include, but is not limited to, the return of parts(s) that we may reasonably request.
3. The axles or suspensions must have been installed and maintained in accordance with good industry practice and any specific Dexter Axle recommendations, including those specified in Dexter Axle's publication "Operation Maintenance Service Manual."

EXCLUSIONS

These warranties do not extend to or do not cover defects caused by:

1. The connecting of brake wiring to the trailer wiring or trailer wiring to the towing vehicle wiring.
2. The attachment of the running gear to the frame.
3. Hub imbalance, or any damage caused thereby.
4. Parts not supplied by Dexter Axle.
5. Any damage whatever caused by or related to any alteration of the axle including welding supplemental brackets to the axle.
6. Use of an axle on a unit other than the unit to which it was originally mounted.
7. Normal wear and tear.
8. Alignment.
9. Improper installation.
10. Unreasonable use (including failure to provide reasonable and necessary maintenance as specified in Dexter Axle's publication "Operation Maintenance Service Manual" including required maintenance after "Prolonged Storage").
12. Improper wheel nut torque.
13. Cosmetic finish or corrosion.

LIMITATIONS

1. **In all cases, Dexter Axle reserves the right to fully satisfy its obligations under the Limited Warranties by refunding the then-current list price of the defective axle (or, if the axle has been discontinued, of the most nearly comparable current product).**
2. Dexter Axle reserves the right to furnish a substitute or replacement component or product in the event an axle or any component of the axle is discontinued or is otherwise unavailable.
3. These warranties are nontransferable.

GENERAL

THE FOREGOING WARRANTIES ARE EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES EXCEPT THAT OF TITLE, WHETHER WRITTEN, ORAL OR IMPLIED, IN FACT OR IN LAW (INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE).

These warranties give you specific legal rights, and you may also have other rights which vary from state to state.

THE DURATION OF ANY IMPLIED WARRANTIES, INCLUDING THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE LIMITED TO THE DURATION OF THE EXPRESS WARRANTIES HEREIN. DEXTER AXLE HEREBY EXCLUDES INCIDENTAL AND CONSEQUENTIAL DAMAGES, INCLUDING LOSS OF TIME, INCONVENIENCE, LOSS OF USE, TOWING FEES, TELEPHONE CALLS OR COST OF MEALS, FOR ANY BREACH OF ANY EXPRESS OR IMPLIED WARRANTY, INCLUDING THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

Some states do not allow limitations on how long an implied warranty lasts, or the exclusion or limitation of incidental or consequential damages, so the above exclusion or limitation may not apply to you.

Inquiries regarding these warranties should be sent to:

Dexter Axle
P.O. Box 250
Elkhart, Indiana 46515

Dexter Online Parts Store

From magnet and seal kits to complete brake and hub kits, Dexter offers a complete line of genuine replacement parts for your trailer. Most products are available in-stock and ready to ship within 24 hours direct to you from the factory. With dedicated customer support, quick turnaround and a 30-day money back guarantee, the Dexter Online Parts Store helps keep your trailer going.

- Hub Components
- Brake Components
- Suspension Components
- Complete Hub Kits
- Brake Assemblies & Kits
- Brake Controllers & Actuators

Ready for Immediate Shipment Direct to Your Door

Visit us online at www.dexteraxle.com

Service Record

Date	Service Performed	Mileage

Service Record

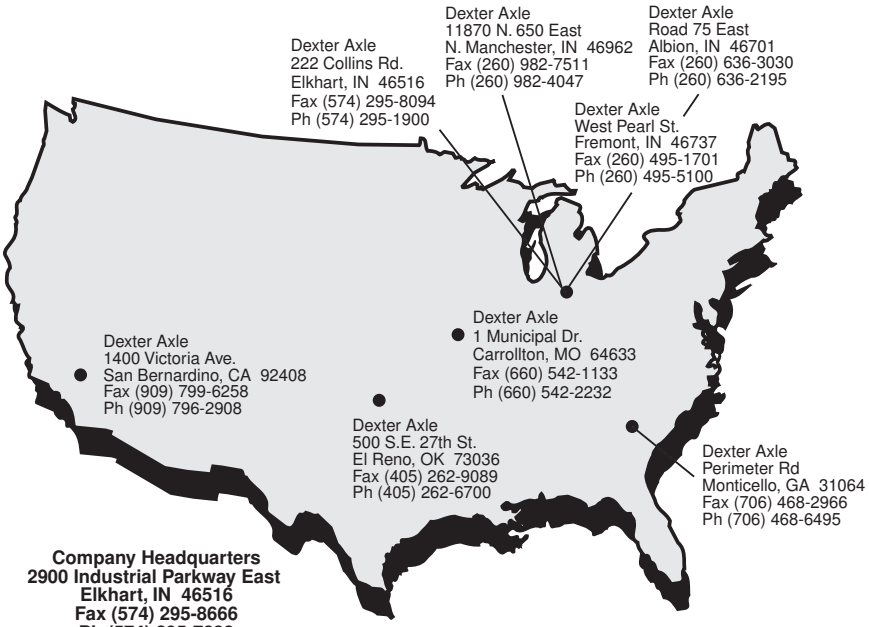
Date	Service Performed	Mileage

Service Record

Date	Service Performed	Mileage

Genuine Dexter axles and components are available nationwide from our plant locations listed below or through our network of distributors. Check our website for the distributor nearest you.

Visit us online at: www.dexteraxle.com



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