Form No. 13203SL Rev G

Count on it.

Service Manual

Groundsmaster®4100-D & 4110-D

(Models 30602, 30604, 30606, 30608, 30643 and 30644)

8111 Lyndale Avenue South
Bloomington, MN 55420

Original Instructions (EN)
Contact us at www.Toro.com.

Revision History

Revision	Date	Description
–	2014	Initial Issue
A	03/2018	Updated Engine chapter, Electrical chapter and Foldout Drawings. Added revision history.
B	05/2018	Added VA02 series planetary information.
C	06/2019	Update rear axle service drawings
D	02/2020	Updated Hydraulic, Electrical, Chassis and Operator Cab chapters.
E	06/2020	Updated Hydraulic chapter and Foldout drawings.
F	01/2021	Corrected traction pump plumbing error.
G	06/2021	Updated Hydraulic chapter and Foldout drawings.

Reader Comments

The Toro Company Technical Assistance Center maintains a continuous effort to improve the quality and usefulness of its publications. To do this effectively, we encourage user feedback. Please comment on the completeness, accuracy, organization, usability, and readability of this manual by an e-mail to servicemanuals@toro.com

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NOTES

Preface

The purpose of this publication is to provide the service technician with information for troubleshooting, testing and repair of major systems and components on the Groundsmaster 4100-D (Model 30604 and 30608) and 4110-D (Model 30602, 30606, 30643 and 30644).

Refer to the *Operator's Manuals* for installing, operating, maintenance, and adjustment instructions. Keep a copy of the *Operator's Manuals* and *Parts Catalogs* for your machine and its accessories with this *Service Manual* for reference. Additional copies of the *Operator's Manuals* and *Parts Catalogs* are available at www.toro.com.

The Toro Company reserves the right to change the product specifications or this publication without notice.

DANGER

This safety symbol means danger. When you see this symbol, carefully read the instructions that follow. Failure to obey the instructions could kill or cause serious permanent injury or disability.

WARNING

This safety symbol means warning. When you see this symbol, carefully read the instructions that follow. Failure to obey the instructions can result in serious injury.

CAUTION

This safety symbol means caution. When you see this symbol, carefully read the instructions that follow. Failure to obey the instructions can result in minor to moderate injury.

IMPORTANT

The *Important* notice will give the important instructions which you must follow to prevent damage to the systems or components on the machine.

Note: A **Note** will give the general information about the correct operation, maintenance, service, testing, or repair of the machine.

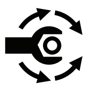
Service Procedure Icons

The following icons appear throughout this Service Manual to bring attention to specific important details of a service procedure.

Critical Process

This icon is used to highlight:

- installing safety equipment (shields, guards, seat belts, brakes and R.O.P.S. components) that may have been removed.
- dimensions or settings that must be maintained for proper machine operation.
- a specific fastener tightening sequence.
- component orientation that may not be obvious.



Critical Torque

This icon is used to highlight an assembly torque requirement that is different than what is recommended in the Standard Torque Tables; refer to Torque Specifications (page 2–9).

Fluid Specifications

This icon is used to highlight fluid specifications and capacities that are less common, and may not appear on the machine service decal or in the machine *Operator's Manual*.

Note: Refer to the service decal on the machine and the machine *Operator's Manual* for commonly used fluid specifications and capacities.

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Additional Reference Materials

Yanmar TNV (Tier 4i) Series Service Manual
Yanmar TNV (Tier 4i) Series Troubleshooting Manual
Yanmar TNV (Tier 4) Series Service Manual
Yanmar TNV (Tier 4) Series Troubleshooting Manual
Danfoss H1 Closed Circuit Axial Piston Pumps Service Manual
Danfoss H1 Closed Circuit Axial Pistonpumps Repair Instructions
Danfoss K And L Frame Variable Motors Service Manual
Danfoss Steering Unit Type OSPM Service Manual
Danfoss MP1 Closed Circuit Axial Piston Pumps Service Manual
Eaton Parts And Repair Information: 5 Series Steering Control Units
Sanden SD Compressor Service Guide
Badger Compressor Service Manual

Safety

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Safety Instructions

The Groundsmaster 4100-D and 4110−D are tested and certified by Toro for compliance with existing safety standards and specifications. Although hazard control and accident prevention partially are dependent upon the design and configuration of the machine, these factors are also dependent upon the awareness, concern and proper training of the personnel involved in the operation, transport, maintenance and storage of the machine. Improper use or maintenance of the machine can result in injury or death.

WARNING

To reduce the potential of injury or death, comply with the following safety instructions as well as information found in the *Operator's Manuals* and the *Operator and Safety Training Videos* found on www.toro.com.

Before Operating the Machine

- Review and understand the contents of the *Operator's Manuals* before starting and operating the machine. Become familiar with the controls and know how to stop the machine and engine quickly. Additional copies of the *Operator's Manuals* are available at www.toro.com.
- Never allow children to operate the machine. Never allow adults to operate the machine without proper instructions.
- Become familiar with the controls and know how to stop the machine and tractor engine quickly.
- Keep all the shields, safety devices, and decals in place. If a shield, safety device, or decal is illegible or damaged, repair or replace it before operating the machine.
- Always wear substantial shoes. Do not operate machine while wearing sandals, tennis shoes or sneakers. Do not wear loose fitting clothing which could get caught in moving parts and cause personal injury.
- Wearing safety glasses, safety shoes, long pants and a helmet is advisable and required by some local safety and insurance regulations.
- Make sure work area is clear of objects which might be picked up and thrown by the attachments.
- Keep everyone, especially children and pets, away from the areas of operation.
- Ensure that the interlock switches are adjusted correctly so the engine cannot be started unless traction pedal is in NEUTRAL and cutting decks are DISENGAGED.
- Since the fuel is highly flammable; handle it carefully.
  - Use an approved fuel container.
  - Do not remove cap from fuel tank when engine is hot or running.
  - Do not smoke while handling fuel.
  - Fill fuel tank outdoors and no higher than to the bottom of filter screen. Do not overfill fuel tank.
  - Wipe up any spilled fuel.

While Operating the Machine

1. Sit on the seat when starting and operating the machine.
2. Before starting the engine:
   A. Apply the parking brake.
   B. Make sure traction pedal is in neutral and the PTO switch is OFF (disengaged).
3. After engine is started, release parking brake and keep foot off traction pedal. Machine must not move. If movement is evident, there may be a problem with traction pedal calibration or the piston (traction) pump that needs to be corrected before using the machine.
4. Do not touch engine, radiator or exhaust system while engine is running or soon after it is stopped. These areas could be hot enough to cause burns.
5. Do not touch the engine, muffler or exhaust pipe while engine is running or soon after it has stopped because these areas are hot enough to cause burns.
6. Before getting off the seat:
   A. Ensure that traction pedal is in neutral.
   B. Fully lower and disengage cutting decks. Wait for blades to stop.
   C. Apply the parking brake.
   D. Stop engine and remove key from switch.
7. Toro recommends that anytime the machine is parked (short or long term), the cutting decks should be lowered to the ground. This relieves hydraulic pressure from the deck lift circuit and eliminates the risk of the cutting decks unexpectedly lowering to the ground.
8. Do not park on slopes unless wheels are chocked or blocked.

Maintenance and Service

1. Before servicing or making adjustments, lower decks, stop engine, apply parking brake and remove key from the key switch.
2. Make sure machine is in safe operating condition by keeping all nuts, bolts and screws tight.
3. Never store the machine or fuel container inside where there is an open flame, such as near a water heater or furnace.
4. Make sure all hydraulic connectors are tight and all hydraulic hoses and lines are in good condition before applying pressure to the hydraulic system.
5. Keep body and hands away from pin hole leaks in hydraulic lines that eject high pressure hydraulic fluid. Use cardboard or paper to find hydraulic leaks. Hydraulic fluid escaping under pressure can penetrate skin and cause injury. Fluid accidentally injected into the skin must be surgically removed within a few hours by a doctor familiar with this form of injury or gangrene may result.
6. Before disconnecting or performing any work on the hydraulic system, all pressure in system must be relieved by lowering cutting decks to the ground and stopping engine.
7. If major repairs are ever needed or assistance is desired, contact an Authorized Toro Distributor.
8. To reduce potential fire hazard, keep engine area free of excessive grease, grass, leaves and dirt. Clean protective screen on machine frequently.
9. If engine must be running to perform maintenance or an adjustment, keep hands, feet, clothing and other parts of the body away from cutting decks and other moving parts. Keep bystanders away.
10. To assure safety and accuracy, check maximum engine speed.
11. Shut engine off before checking or adding oil to the crankcase.
12. Disconnect battery before servicing the machine. Disconnect negative cable first and positive cable last. If battery voltage is required for troubleshooting or test procedures, temporarily connect the battery. Reconnect positive cable first and negative cable last.
13. Battery acid is poisonous and can cause burns. Avoid contact with skin, eyes and clothing. Protect your face, eyes and clothing when working with a battery.
14. Battery gases can explode. Keep cigarettes, sparks and flames away from the battery.
15. At the time of manufacture, the machine conformed to the safety standards for riding mowers. To assure optimum performance and continued safety certification of the machine, use genuine Toro replacement parts and accessories. Replacement parts and accessories made by other manufacturers may result in non-conformance with the safety standards and the warranty may be voided.
16. When changing attachments, tires or performing other service, use correct supports, hoists and jacks. Make sure machine is parked on a solid level surface such as a concrete floor. Prior to raising the machine, remove any attachments that may interfere with the safe and proper raising of the machine. Always chock or block wheels. Use appropriate jack stands to support the raised machine. If the machine is not properly supported by jack stands, the machine may move or fall, which may result in personal injury (see Jacking Instructions (page 1–7)).

Maintenance and Service (continued)

17. When welding on machine, disconnect all battery cables to prevent damage to machine electronic equipment. Disconnect negative battery cable first and positive cable last. Also, disconnect wire harness connector from both of the TEC controllers, disconnect and remove the engine ECM and disconnect the terminal connector from the alternator. Attach welder ground cable no more than two (2) feet (0.6 meters) from the welding location.
18. Make sure to dispose of potentially harmful waste (e.g. fuel, oil, engine coolant, filters, battery) in an environmentally safe manner. Follow all local codes and regulations when recycling or disposing of waste.

Jacking Instructions

CAUTION

When changing attachments, tires or performing other service, use correct jacks and supports. Make sure machine is parked on a solid, level surface such as a concrete floor. Prior to raising machine, remove any attachments that may interfere with the safe and proper raising of the machine. Always chock or block wheels. Use jack stands to support the raised machine. If the machine is not properly supported by jack stands, the machine may move or fall, which may result in personal injury.

Jacking the Front End (Figure 1)

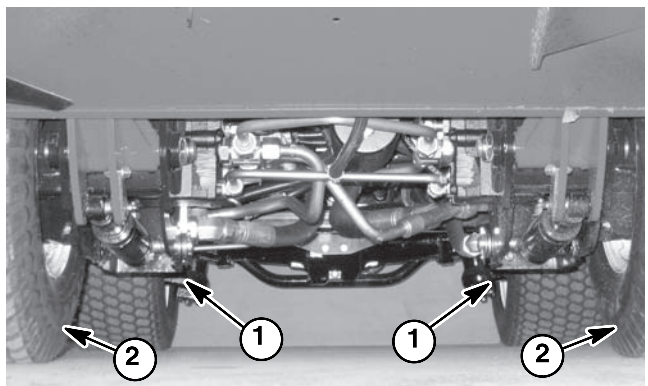

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Figure 1

1. Front jacking point
2. Front tire

1. Set parking brake and chock both rear tires to prevent the machine from moving.
2. Position jack securely under the frame, just to the inside of the front tire. Jack front wheel off the ground.
3. Once the machine is raised, position jack stand under the frame as close to the wheel as possible to support the machine.

Jacking the Rear End (Figure 2)

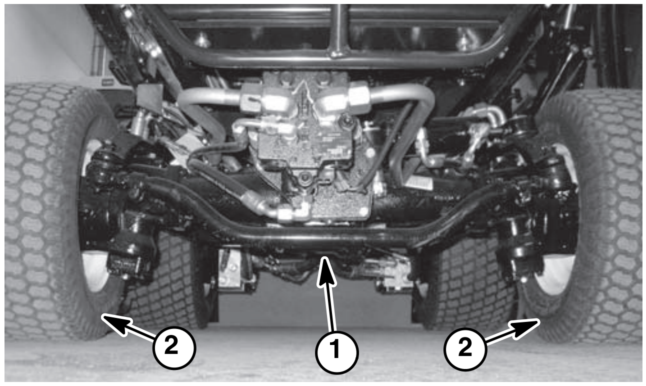

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Figure 2

1. Rear axle jacking point
2. Rear tire

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1. Set parking brake and chock both front tires to prevent the machine from moving.
2. Place jack securely under the center of rear axle. Jack rear of machine off the ground.
3. Once the machine is raised, use jack stands under the axle to support the machine.

Safety and Instructional Decals

Numerous safety and instruction decals are affixed to the traction unit and cutting units of your Groundsmaster. If any decal becomes illegible or damaged, install a new decal. Decal part numbers are listed in your *Parts Catalog*. Order replacement decals from Authorized Toro Distributor.

TORO

Chapter 2

Specifications and Maintenance

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Specifications

Overall Dimensions

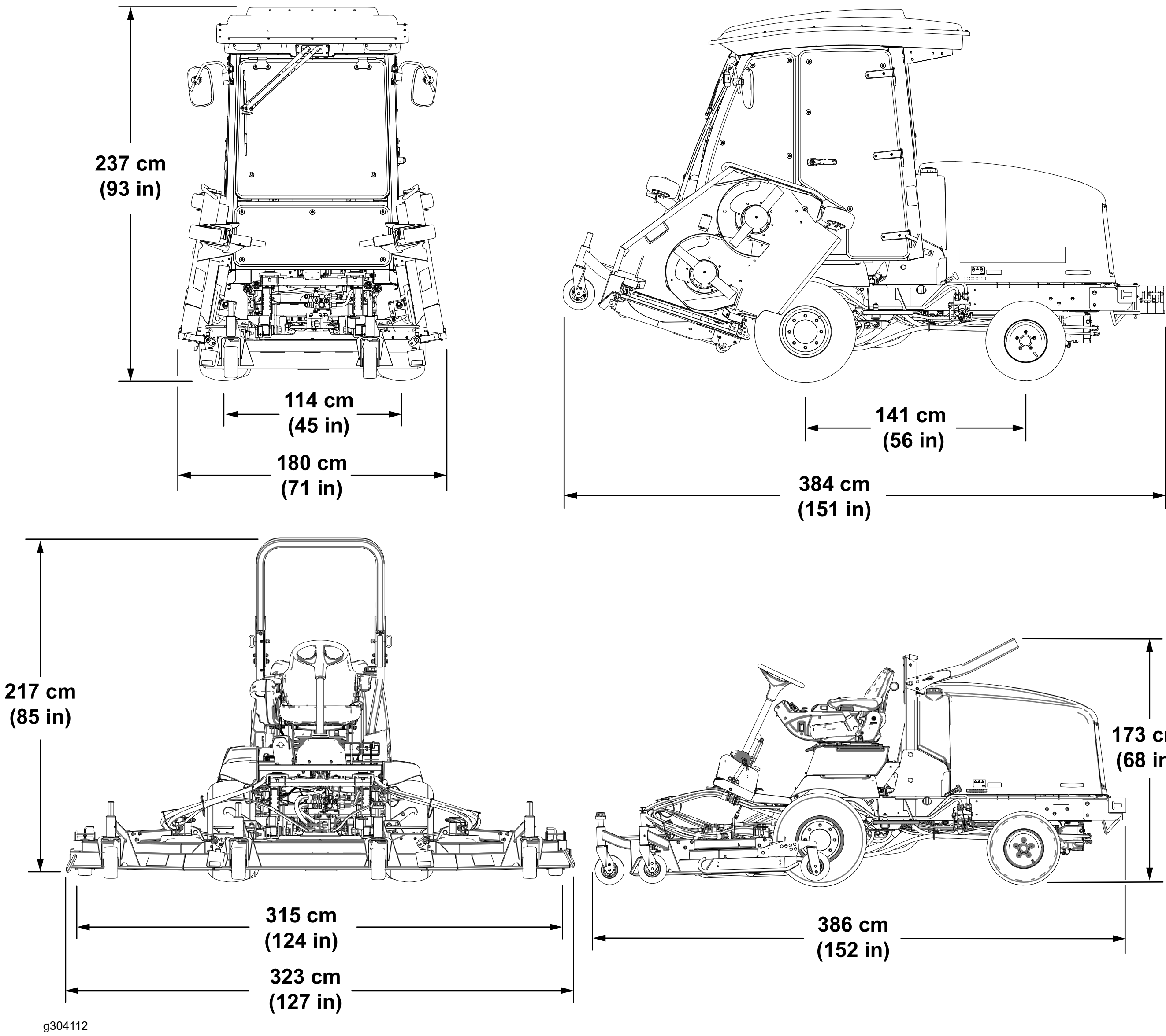

Figure 3

Groundsmaster 4100

Overall Dimensions (continued)

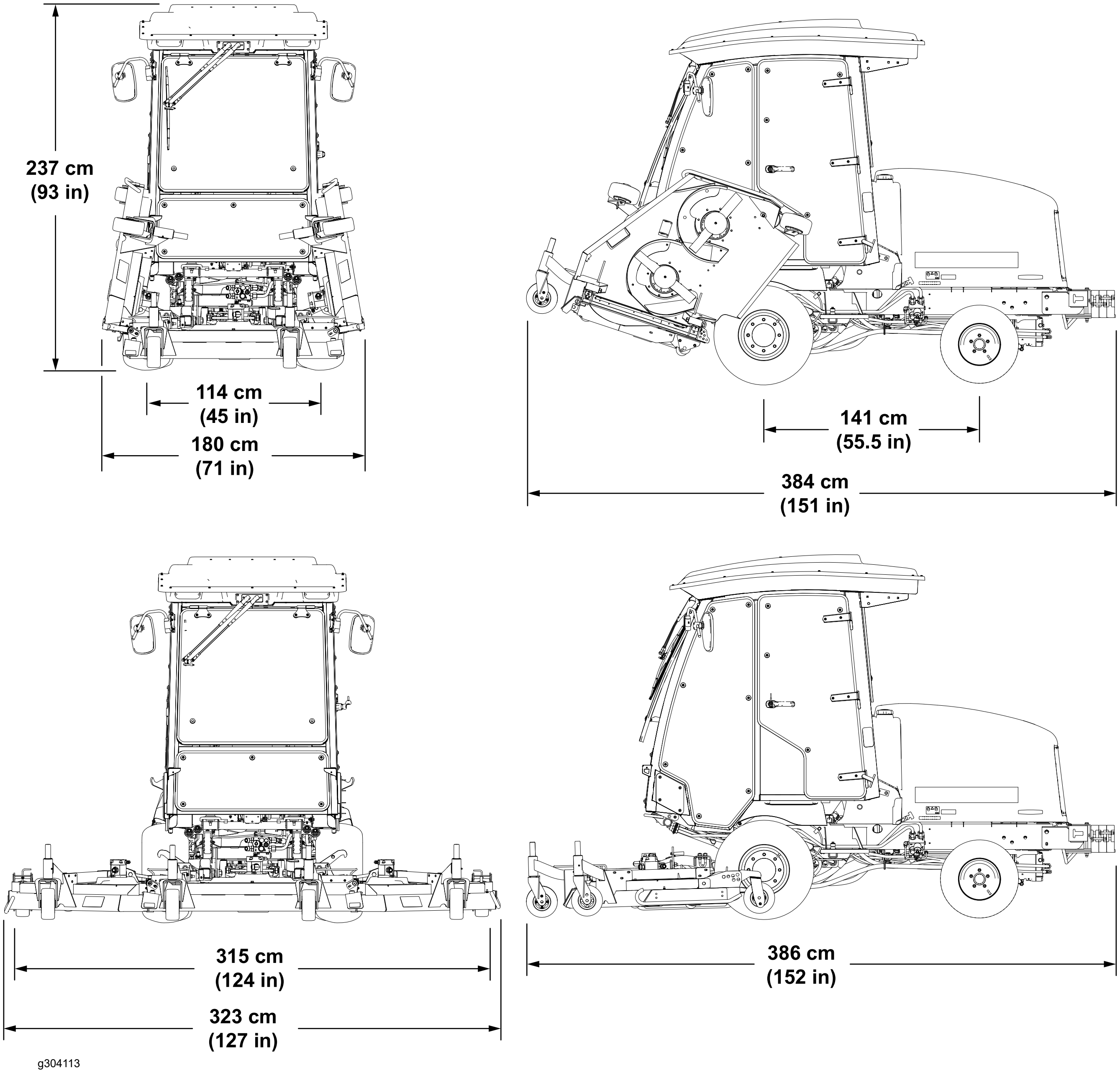

Figure 4

Groundsmaster 4110

Engine (Models 30602, 30604 and 30643)

Item	Description
Make / Designation	Yanmar Model 4TNV84T−ZMTR: 4−Cycle, 4 Cylinder, Water Cooled, Turbocharged, Tier 4i Diesel Engine
Bore	84 mm (3.307 in)
Stroke	90 mm (3.543 in)
Total Displacement	1995 cc (121.7 in^3)
Firing Order	1 (closest to flywheel end) − 3 − 4 (farthest from flywheel) − 2
Direction of Rotation	Counterclockwise (viewed from flywheel)
Fuel	Diesel or Biodiesel (up to B20) Fuel with Low or Ultra Low Sulfur Content
Fuel Tank Capacity	79.5 liters (21 U.S. gallons)
Fuel Injection Pump	Yanmar MP2 Distributor Type Pump
Fuel Injection Type	Direct Injection
Starting Aid	Intake Air Heater
Governor	Electronic All Speed
Low Idle (no load)	1200 RPM
High Idle (no load)	2600 RPM
Engine Oil	API CH−4, CI−4 or higher
Engine Oil Viscosity	See *Operator's Manual*
Crankcase Oil Capacity	5.7 liters (6 U.S. quarts) with Filter
Oil Pump	Trochoid Type
Coolant Capacity	
Groundsmaster 4100−D	8.5 liters (9 U.S. quarts)
Groundsmaster 4110−D	13.7 liters (14.5 U.S. quarts)
Alternator/Regulator	12 VDC, 80 amp
Engine Weight (Dry)	170 kg (375 U.S. pounds)

Engine (Models 30606, 30608 and 30644)

Item	Description
Make / Designation	Yanmar Model 4TNV86CT−DTR: 4−Cycle, 4 Cylinder, Water Cooled, Turbocharged, Tier 4 Diesel Engine
Bore	86 mm (3.386 in)
Stroke	90 mm (3.543 in)
Total Displacement	2090 cc (127.5 in^3)
Firing Order	1 (closest to flywheel end) − 3 − 4 (farthest from flywheel) − 2
Direction of Rotation	Counterclockwise (viewed from flywheel)
Fuel	Diesel or Biodiesel (up to B7) Fuel with Ultra Low Sulfur Content
Fuel Tank Capacity	79.5 liters (21 U.S. gallons)
Fuel Injection Pump	Yanmar Supply Pump
Fuel Injection Type	Common Rail with Direct Injection
Governor	Electronic All Speed
Low Idle (no load)	1000 RPM
High Idle (no load)	2700 RPM
Engine Oil	API CJ−4 or higher
Engine Oil Viscosity	See *Operator's Manual*
Crankcase Oil Capacity	5.7 liters (6 U.S. quarts) with Filter
Oil Pump	Trochoid Type
Coolant Capacity	
Groundsmaster 4100−D	8.5 liters (9 U.S. quarts)
Groundsmaster 4110−D	13.7 liters (14.5 U.S. quarts)
Alternator/Regulator	12 VDC, 80 Amp
Groundsmaster 4100−D	40 amp
Groundsmaster 4110−D	80 amp
Engine Weight (Dry)	225 kg (496 U.S. pounds)

Hydraulic System

Item	Description
Piston (Traction)	Sauer−Danfoss Variable Displacement Axial Piston Pump
Maximum Displacement (per revolution)	45 cc (2.75 in^3)
System Relief Pressure: Forward	300 bar (4350 PSI)
System Relief Pressure: Reverse	345 bar (5000 PSI)
Charge Pressure	17 bar (250 PSI)
Front Wheel Motors	Sauer−Danfoss 2−Position Axial Piston Motors
Displacement (per revolution)	23 cc (1.40 in^3) Maximum / 13 cc (0.79 in^3) Minimum
Rear Axle Motor	Sauer−Danfoss 2−Position Axial Piston Motor with Loop Flushing Valve
Displacement (per revolution)	35 cc (2.14 in^3) Maximum / 19 cc (1.16 in^3) Minimum
Gear Pump	Casappa 4 Section, Positive Displacement Gear pump
Section P1/P2 Displacement (per revolution)	22.46 cc (1.37 in^3)
Section P3 Displacement (per revolution)	6.6 cc (0.40 in^3)
Section P4 Displacement (per revolution)	4.96 cc (0.30 in^3)
Steering Control Valve	Eaton Steering Unit, Series 5
Displacement (per revolution)	100 cc (6.1 in^3)
Steering Circuit Relief Pressure	93 bar (1350 PSI)
Lift/Lower Circuit Relief Pressure	172 bar (2500 PSI)
Cutting Deck Motors	Gear Motor
Displacement (per revolution)	19.2 cc (1.17 in^3)
PTO Circuit Relief Pressure	
Front and Left Side	207 bar (3000 PSI)
Right Side	138 bar (2000 PSI)
Engine Cooling Fan Motor	Casappa Gear Motor
Displacement (per revolution)	8.4 cc (0.51 in^3)
Engine Cooling Fan Circuit Relief Pressure	207 bar (3000 PSI)
Hydraulic Filters	Spin−on Cartridge Type
In−line Suction Strainer	100 Mesh (In Reservoir)
Hydraulic Reservoir	29.3 Liters (7.75 U.S. Gallons)
Hydraulic Oil	See *Operator's Manual*

Note: The pressure specifications listed above are component settings. When using pressure gauges to measure circuit pressures, values may be different than these specifications. See the Testing section of hydraulic test procedures and expected test results.

Axles, Planetaries and Brakes

Item	Description
Tire pressure (front and rear)	172 to 207 kPa (25 to 30 PSI)
Rear wheel toe−in	6 mm (0.250 in)
Planetary Drive Lubricant Capacity (each wheel)	SAE 85W−140 wt. Gear Lube 0.65 liters (22 fl. oz.)
Rear axle lubricant System gear lube capacity	SAE 85W−140 wt. gear lube 2.4 liters (80 fl. oz.)
Rear axle gear box lubricant System gear lube capacity	SAE 85W−140 wt. gear lube 0.5 liters (16 fl. oz.)
Wheel lug nut torque	115 to 135 N·m (85 to 100 ft−lb), front and rear in a crossing pattern
Steering cylinder castle nut torque	107 to 113 N·m (79 to 84 ft−lb)
Brake Assembly and Wheel Motor Mounting Screw Torque	
OPH−2 series planetary	81 N·m (60 ft−lb)
VA02 series planetary	101 to 115 N·m (75 to 85 ft−lb)

Cutting Decks

MOUNTING:	Cutting deck is supported by lift arms controlled with individual lift switches for complete deck, right wing deck and left wing deck.
CONSTRUCTION:	Deck chamber is welded 12 gauge steel construction reinforced with channels and plates.
HEIGHT−OF−CUT RANGE:	25.4 mm to 127 mm (1 to 5 in) in 12.7 mm (1/2 in) increments. Center deck height-of-cut adjustment is achieved by changing spacers on castor wheels and adjusting length of deck support chains. Wing deck adjustment is achieved by changing spacers on castor wheels, re-positioning the castor wheel axles in the castor forks and securing the castor wheel bracket to the correct height-of-cut bracket holes.
DECK DRIVE:	Closed loop hydraulic system operates hydraulic motor on each cutting deck section. Motor drives one deck spindle directly with remaining deck section spindle(s) driven by B section kevlar v-belt(s). Blade spindles are 31.7 mm (1.250 in) shafts supported by greaseable, tapered roller bearings.
CUTTING BLADE:	Cutting blade dimensions are 483 mm (19 in) long, 64 mm (2.500 in) wide and 6.4 mm (0.250 in) thick. Anti−scalp cup installed on each cutting blade. Center deck includes three (3) blades and each wing deck includes two (2) blades.
WIDTH OF CUT:	Center deck provides 1372 mm (54 in) width of cut. Each side deck has 940 mm (37 in) width of cut. Each wing deck has 940 mm (37 in) width of cut. Total width of cut is 3150 mm (124 in).
DISCHARGE:	Clippings are discharged from the rear of the cutting deck.
SUSPENSION SYSTEM:	A fully floating suspension with hydraulic counterbalance. Front deck is suspended from lift arms and has six (6) castor wheels, two (2) adjustable skids and five (5) anti-scalp rollers.

Torque Specifications

The recommended fastener torque values are listed in the following tables. For critical applications, as determined by Toro, either the recommended torque or a torque that is unique to the application is clearly identified and specified in this *Service Manual*.

These torque specifications for the installation and tightening of the fasteners will apply to all the fasteners which do not have a specific requirement identified in this *Service Manual*. The following factors must be considered when applying the torque: cleanliness of the fastener, use of a thread sealant (e.g., Loctite), degree of lubrication on the fastener, presence of a prevailing torque feature (e.g., Nylocknut), hardness of the surface underneath the head of the fastener, or similar condition which affects the installation.

As noted in the following tables, the torque values should be reduced by 25% for the lubricated fasteners to achieve the similar stress as a dry fastener. The torque values must be reduced when the fastener is threaded into the aluminum or brass. The specific torque value should be determined based on the aluminum or brass material strength, fastener size, length of thread engagement, etc.

The standard method of checking the torque can be performed by marking a line on the fastener (head or nut) and mating part, then back off the fastener 1/4 of a turn. Measure the torque necessary to tighten the fastener until the lines match up.

Calculating the Torque Values When Using a Drive-Adapter Wrench

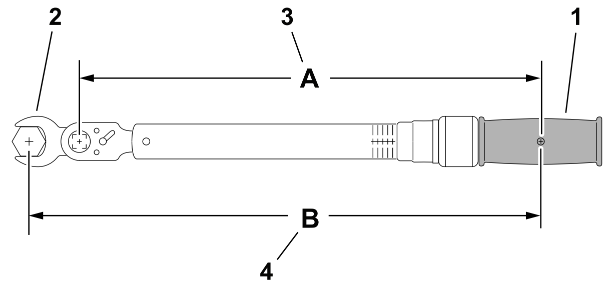

Figure 5

Torque Conversion Factor = A / B

1. Torque wrench
2. Drive-adapter wrench (crowsfoot)
3. A (effective length of torque wrench)
4. B (effective length of torque wrench and drive-adapter wrench)

Using a drive-adapter wrench (e.g., crowfoot wrench) in any position other than 90° and 270° to the frame of the torque wrench will affect the torque value measured by the torque wrench because of the effective length (lever) of the torque wrench changes. When using a torque wrench with a drive-adapter wrench, multiply the listed torque recommendation by the calculated torque conversion factor (Figure 5) to determine proper tightening torque. When using a torque wrench with a drive-adapter wrench, the calculated torque will be lower than the listed torque recommendation.

Example: The measured effective length of the torque wrench (distance from the center of the handle to the center of the square drive) is **457 mm (18 inches)**.

The measured effective length of the torque wrench with the drive-adapter wrench installed (distance from the center of the handle to the center of the drive-adapter wrench) is **483 mm (19 inches)**.

The calculated torque conversion factor for this torque wrench with this drive-adapter wrench would be 18/19 = 0.947.

If the listed torque recommendation for a fastener is **103 to 127 N·m (76 to 94 ft-lb)**, the proper torque when using this torque wrench with a drive-adapter wrench would be **98 to 121 N·m (72 to 89 ft-lb)**.

Identifying the Fastener

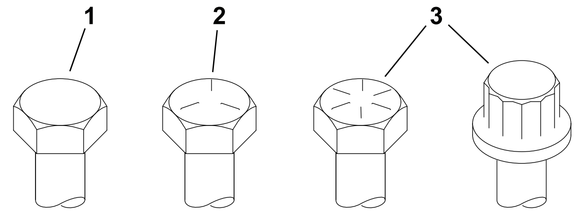

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Figure 6

Inch Series Bolts and Screws

1. Grade 1
2. Grade 5
3. Grade 8

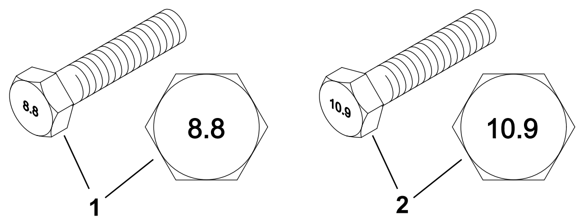

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Figure 7

Metric Bolts and Screws

1. Class 8.8
2. Class 10.9

Fasteners with a Locking Feature

IMPORTANT

If a fastener with a locking feature or previously applied thread locking compound is reused, clean the fastener threads and apply new thread locker to the fastener during installation.

Locking features are designed to create friction and prevent a fastener from loosening. Locking features can be found on externally or internally threaded fasteners. Common examples are plastic inserts incorporated into the fastener and pre-applied “dry” thread locking compound. Keep in mind, a fastener with a locking feature usually means there will be friction during initial installation and during removal.

Toro recommends replacing fasteners with a locking feature once they have been removed because the effectiveness of the locking feature diminishes with each reuse. If it is necessary to reuse a fastener with a locking feature; apply a thread locking compound (Loctite for example) to the fastener during installation. Use the appropriate strength and type of thread locking compound based on application, fastener size or information found in the product *Operators Manual*, *Service Manual* or *Installation Instructions*.

Standard Torque for Dry, Zinc Plated, and Steel Fasteners (Inch Series)

Thread Size	Grade 1, 5 and 8 with Thin Height Nuts	SAE Grade 1 Bolts, Screws, Studs, and Sems with Regular Height Nuts (SAE J995 Grade 2 or Stronger Nuts)		SAE Grade 5 Bolts, Screws, Studs, and Sems with Regular Height Nuts (SAE J995 Grade 2 or Stronger Nuts)		SAE Grade 8 Bolts, Screws, Studs, and Sems with Regular Height Nuts (SAE J995 Grade 2 or Stronger Nuts)	
	in-lb	**in-lb**	**N·cm**	**in-lb**	**N·cm**	**in-lb**	**N·cm**
# 6 - 32 UNC	10 ± 2	13 ± 2	147 ± 23	15 ± 2	169 ± 23	23 ± 3	262 ± 34
# 6 - 40 UNF				17 ± 2	192 ± 23	25 ± 3	282 ± 34
# 8 - 32 UNC	13 ± 2	25 ± 5	282 ± 56	29 ± 3	328 ± 34	41± 5	463 ± 56
# 8 - 36 UNF				31 ± 4	350 ± 45	43 ± 5	486 ± 56
# 10 - 24 UNC	18 ± 2	30 ± 5	339 ± 56	42 ± 5	475 ± 56	60 ± 6	678 ± 68
# 10 - 32 UNF				48 ± 5	542 ± 56	68 ± 7	768 ± 79
1/4 - 20 UNC	48 ± 7	53 ± 7	599 ± 79	100 ± 10	1130 ± 113	140 ± 15	1582 ± 169
1/4 - 28 UNF	53 ± 7	65 ± 10	734 ± 113	115 ± 12	1299 ± 136	160 ± 17	1808 ± 192
5/16 - 18 UNC	115 ± 15	105 ± 15	1186 ± 169	200 ± 25	2260 ± 282	300 ± 30	3390 ± 339
5/16 - 24 UNF	138 ± 17	128 ± 17	1146 ± 192	225 ± 25	2542 ± 282	325 ± 33	3672 ± 373
	ft-lb	**ft-lb**	**N·m**	**ft-lb**	**N·m**	**ft-lb**	**N·m**
3/8 - 16 UNC	16 ± 2	16 ± 2	22 ± 3	30 ± 3	41 ± 4	43 ± 5	58 ± 7
3/8 - 24 UNF	17 ± 2	18 ± 2	24 ± 3	35 ± 4	47 ± 5	50 ± 6	68 ± 8
7/16 - 14 UNC	27 ± 3	27 ± 3	37 ± 4	50 ± 5	68 ± 7	70 ± 7	95 ± 9
7/16 - 20 UNF	29 ± 3	29 ± 3	39 ± 4	55 ± 6	75 ± 8	77 ± 8	104 ± 11
1/2 - 13 UNC	30 ± 3	48 ± 7	65 ± 9	75 ± 8	102 ± 11	105 ± 11	142 ± 15
1/2 - 20 UNF	32 ± 4	53 ± 7	72 ± 9	85 ± 9	115 ± 12	120 ± 12	163 ± 16
5/8 - 11 UNC	65 ± 10	88 ± 12	119 ± 16	150 ± 15	203 ± 20	210 ± 21	285 ± 28
5/8 - 18 UNF	75 ± 10	95 ± 15	129 ± 20	170 ± 18	230 ± 24	240 ± 24	325 ± 33
3/4 - 10 UNC	93 ± 12	140 ± 20	190 ± 27	265 ± 27	359 ± 37	375 ± 38	508 ± 52
3/4 - 16 UNF	115 ± 15	165 ± 25	224 ± 34	300 ± 30	407 ± 41	420 ± 43	569 ± 58
7/8 - 9 UNC	140 ± 20	225 ± 25	305 ± 34	430 ± 45	583 ± 61	600 ± 60	813 ± 81
7/8 - 14 UNF	155 ± 25	260 ± 30	353 ± 41	475 ± 48	644 ± 65	667 ± 66	904 ± 89

Note: Reduce the torque values listed in the table above by 25% for lubricated fasteners. Lubricated fasteners are defined as threads coated with a lubricant, such as engine oil, or a thread sealant, such as Loctite.

Note: The torque values must be reduced when installing the fasteners into threaded aluminum or brass. The specified torque value should be determined based on the aluminum or base material strength, fastener size, length of thread engagement, etc.

Note: The nominal torque values listed above for Grade 5 and 8 fasteners are based on 75% of the minimum proof load specified in SAE J429. The tolerance is approximately ± 10% of the nominal torque value. The thin height nuts include jam nuts.

Standard Torque for Dry, Zinc Plated, and Steel Fasteners (Metric Fasteners)

Thread Size	Class 8.8 Bolts, Screws, and Studs with Regular Height Nuts (Class 8 or Stronger Nuts)		Class 10.9 Bolts, Screws, and Studs with Regular Height Nuts (Class 10 or Stronger Nuts)	
M5 X 0.8	57 ± 6 in-lb	644 ± 68 N·cm	78 ± 8 in-lb	881 ± 90 N·cm
M6 X 1.0	96 ± 10 in-lb	1085 ± 113 N·cm	133 ± 14 in-lb	1503 ± 158 N·cm
M8 X 1.25	19 ± 2 ft-lb	26 ± 3 N·m	28 ± 3 ft-lb	38 ± 4 N·m
M10 X 1.5	38 ± 4 ft-lb	52 ± 5 N·m	54 ± 6 ft-lb	73 ± 8 N·m
M12 X 1.75	66 ± 7 ft-lb	90 ± 10 N·m	93 ± 10 ft-lb	126 ± 14 N·m
M16 X 2.0	166 ± 17 ft-lb	225 ± 23 N·m	229 ± 23 ft-lb	310 ± 31 N·m
M20 X 2.5	325 ± 33 ft-lb	440 ± 45 N·m	450 ± 46 ft-lb	610 ± 62 N·m

Note: Reduce the torque values listed in the table above by 25% for lubricated fasteners. Lubricated fasteners are defined as threads coated with a lubricant, such as engine oil, or a thread sealant, such as Loctite.

Note: The torque values must be reduced when installing the fasteners into threaded aluminum or brass. The specified torque value should be determined based on the aluminum or base material strength, fastener size, length of thread engagement, etc.

Note: The nominal torque values listed above are based on 75% of the minimum proof load specified in SAE J1199. The tolerance is approximately ± 10% of the nominal torque value.

Other Torque Specifications

SAE Grade 8 Steel Set Screws

Thread Size	Recommended Torque	
	Square Head	Hex Socket
1/4 - 20 UNC	140 ± 20 in-lb	73 ± 12 in-lb
5/16 - 18 UNC	215 ± 35 in-lb	145 ± 20 in-lb
3/8 - 16 UNC	35 ± 10 ft-lb	18 ± 3 ft-lb
1/2 - 13 UNC	75 ± 15 ft-lb	50 ± 10 ft-lb

Thread Cutting Screws
(Zinc Plated Steel)

Type 1, Type 23 or Type F	
Thread Size	Baseline Torque**
No. 6 - 32 UNC	20 ± 5 in-lb
No. 8 - 32 UNC	30 ± 5 in-lb
No. 10 - 24 UNC	38 ± 7 in-lb
1/4 - 20 UNC	85 ± 15 in-lb
5/16 - 18 UNC	110 ± 20 in-lb
3/8 - 16 UNC	200 ± 100 in-lb

Wheel Bolts and Lug Nuts

Thread Size	Recommended Torque*	
7/16 - 20 UNF Grade 5	65 ± 10 ft-lb	88 ± 14 N·m
1/2 - 20 UNF Grade 5	80 ± 10 ft-lb	108 ± 14 N·m
M12 X 1.25 Class 8.8	80 ± 10 ft-lb	108 ± 14 N·m
M12 X 1.5 Class 8.8	80 ± 10 ft-lb	108 ± 14 N·m

*For steel wheels and non-lubricated fasteners

Thread Cutting Screws
(Zinc Plated Steel)

Thread Size	Threads per Inch		Baseline Torque**
	Type A	Type B	
No. 6	18	20	20 ± 5 in-lb
No. 8	15	18	30 ± 5 in-lb
No. 10	12	16	38 ± 7 in-lb
No. 12	11	14	85 ± 15 in-lb

**The hole size, material strength, material thickness, and material finish must be considered when determining the specified torque values. All the torque values are based on the non-lubricated fasteners.

Conversion Factors

in-lb X 11.2985 = N·cm

ft-lb X 1.3558 = N·m

N·cm X 0.08851 = in-lb

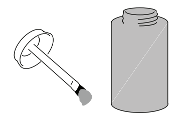
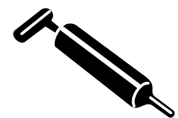
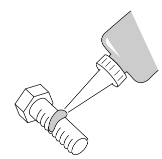
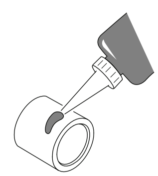
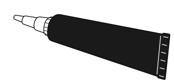
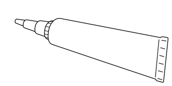
N·m X 0.7376 = ft-lb

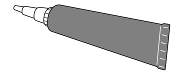
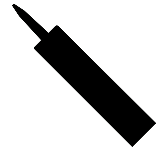
Shop Supplies

The procedures found in this *Service Manual* may recommend the use of commonly used shop supplies (lubricants, sealants and adhesives). A symbol denoting the use of a shop supply may appear in figures that support a procedure. Always refer to the written procedure for specific information regarding the type and the application of a shop supply.

IMPORTANT

Always follow manufacturers instructions when using or storing shop supplies.

ANTI-SEIZE LUBRICANT Used to prevent corrosion, galling and seizure between metal parts. Most often applied to shafts and bores during assembly. Unless otherwise specified, high viscosity regular grade lithium-graphite based anti-seize lubricant should be used.	
GREASE Can be used to pre-fill (pack) bearings, boots and seals prior to assembly, ease installation of components during assembly, or fill cavities between moving parts through grease fittings after assembly. Unless otherwise noted, refer to the machine *Operator's Manual* or *Installation Instructions* for grease specifications.	
THREAD LOCKING COMPOUND (Thread Locker) Used to lock threaded fasteners in position. Available in low, medium and high strength for various size fasteners and applications. Most thread locking compounds are applied immediately prior to fastener installation. Some thread locking compounds use a "Wicking" feature, and can be applied after fastener installation. Most thread locking compounds allow the fastener to be removed with standard tools once cured. High strength thread locking compounds may require applying heat to the fastener and the surrounding area to allow fastener removal. **Note:** Some fasteners have a dry thread locking compound pre-applied (Patch-Loc) so no additional thread locking compound is necessary when installing a "new" fastener. These fasteners are designed to be removed and re-installed only once before applying additional thread locking compound is necessary.	
RETAINING COMPOUND (bearings and sleeves) An adhesive used to secure bearings, bushings and cylindrical parts into housings or onto shafts. When cured, bearing and sleeve retaining compound fills the gap between mating parts with a hard resin that increases load distribution and protects against corrosion.	
ADHESIVE Used to secure a variety of components immediately prior to assembly. May be recommended for installing new components or when reusing a component that had a pre-applied adhesive such as hood seals, mouldings and weather-stripping.	
THREAD SEALANT Used to seal threaded fittings and sensors from air, fuel and oil pressure leaks and prevent galling and seizure between threaded parts. A thread sealant in paste firm is preferred over sealant tape. The sealant should remain semi-pliable to allow for component removal with standard tools. Some thread sealants may require the use of a cleaner or primer prior to use.	

GASKET COMPOUND Used to create a seal between mating parts. Gasket compounds may be used with or without the presence of a pre-formed gasket. Gasket compounds may be solvent or silicone based, and cure when exposed to air or designed to cure in an air-less environment (anaerobic). Most gasket compounds are designed to be applied to clean surfaces free of oil, chemical residue and previously used gaskets or gasket compounds.	
SILICONE SEALANT Designed for a broad variety of sealing and bonding requirements, silicone sealants are usually room temperature vulcanizing (RTV) which form a flexible silicone rubber that bonds to a wide variety of smooth or porous materials when cured. Standard silicone sealants are designed to perform in temperatures from -51 to 232 º C (-60 to 400 ºF), while high temperature variants can preform in temperatures up to 343 ºC (650 ºF).	

Special Tools

You can order these special tools from your Toro Distributor. Some tools may also be available from a local tool supplier.

Hydraulic Pressure Testing Kit

K Line Part No. TOR47009

Use this kit to take various pressure readings for diagnostic tests. Quick disconnect fittings are provided to attach directly to the mating fittings on the machine test ports without the tools. A high-pressure hose is given for remote readings. Contains 1 each: 6,900 kPa (1,000 psi), 34,500 kPa (5,000 psi), and 69,000 kPa (10,000 psi) gauges.

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57 LPM (15 GPM) Hydraulic Tester Kit

K Line Part No. TOR214678

Use this tester to test the hydraulic circuits and components for flow and pressure capacities. The tester flow measurement maximum is 57 LPM (15 GPM). This tester includes the following:

Inlet Hose – This hose connects the system circuit to the inlet side of the hydraulic tester.

Load Valve – Turn the valve to restrict the flow to create a simulated working load in the circuit.

Pressure Gauge – A glycerine filled pressure gauge 0 to 34,500 kPa (0 to 5,000 psi) to provide operating circuit pressure.

Flow Meter – This meter measures the actual fluid flow in the operating circuit with a gauge rated at 5 to 55 LPM (1 to 15 GPM).

Outlet Hose – A hose from the outlet side of the hydraulic tester that connects to the hydraulic system circuit.

Fittings – An assortment of hydraulic fittings are included with this kit.

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150 LPM (40 GPM) Hydraulic Tester

K line Part No. AT40002

Use this tester to test the hydraulic circuits and components for flow and pressure capacities. The tester flow measurement maximum is 151 LPM (40 GPM). This tester includes the following:

Load Valve – Turn the valve to restrict the flow to create a simulated working load in the circuit.

Pressure Gauge – A glycerine filled pressure gauge 0 to 34,500 kPa (0 to 5,000 psi) to provide operating circuit pressure.

Flow Meter – This meter measures the actual fluid flow in the operating circuit with a gauge rated at 20 to 150 LPM (4 to 40 GPM).

Note: This tester does not include any hydraulic hoses or fittings; refer to Hydraulic Hose Kit K Line Part No. TOR6007 and Hydraulic Test Fitting Kit K Line Part No. TOR4079.

Hydraulic O-Ring Kit

Toro Part No. 117-2727

This kit includes O-rings in a variety of sizes for the face seal and port seal hydraulic connections. To help prevent a hydraulic leak, replace the O-rings when you open the hydraulic connection.

Hydraulic Hose Kit

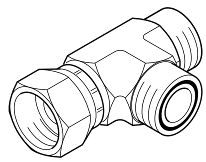
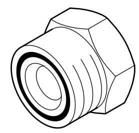
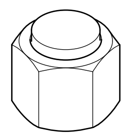
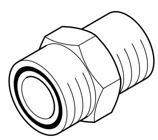
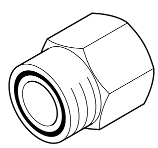
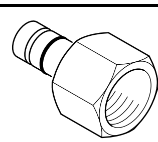
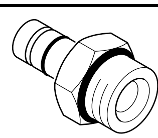
K Line Part No. TOR6007

This kit includes the fittings and hoses that are used to connect high flow hydraulic filter kit (TOR6011) to the machine hydraulic traction system components.

Hydraulic Test Fitting Kit

K Line Part No. TOR4079

This kit includes a variety of O-ring face seal fittings to let you connect the test gauges into the system.

FITTING TYPE	SIZE	K LINE PART NUMBER
 SWIVEL NUT RUN TEE (2 each)	4 ORFS (9/16–18) 6 ORFS (11/16–16) 8 ORFS (13–16–16) 10 ORFS (1–14)	TOR4079–3 TOR4079–12 TOR4079–4 TOR4079–5
 PLUG (2 each)	4 ORFS (9/16–18) 6 ORFS (11/16–16) 8 ORFS (13–16–16) 10 ORFS (1–14)	TOR4079–13 TOR4079–14 TOR4079–15 TOR4079–16
 CAP (2 each)	4 ORFS (9/16–18) 6 ORFS (11/16–16) 8 ORFS (13–16–16) 10 ORFS (1–14)	TOR4079–17 TOR4079–18 TOR4079–19 TOR4079–20
 UNION (1 each)	6 ORFS (11/16–16) to 8 SAE-ORB (3/4–16) 8 ORFS (13–16–16) to 8 SAE-ORB (3/4–16) 10 ORFS (1–14) to 8 SAE-ORB (3/4–16)	TOR4079–8 TOR4079–9 TOR4079–2
 REDUCER (1 each)	10 ORFS (1–14) to 8 SAE-ORB (3/4–16) 12 ORFS (1 3/16–12) to 8 SAE-ORB (3/4–16)	TOR4079–7 TOR4079–6
 TEST CONNECTOR – FEMALE THREAD (2 each)	4 ORFS (9/16–18) 6 ORFS (11/16–16) 8 ORFS (13/16–16) 10 ORFS (1–14)	TOR4079–10 TOR4079–11 TOR4079–21 TOR4079–1
 TEST CONNECTOR – MALE THREAD (2 each)	4 SAE-ORB (7/16–20) 1/8 NPTF	TOR4079–22 TOR4079–23

High Flow Hydraulic Filter Kit

K Line Part Number: TOR6011

The high flow hydraulic filter kit is designed with large flow (150 LPM or 40 GPM) and high pressure (34,500 kPa or 5,000 psi) capabilities. This kit provides for bidirectional filtration which prevents filtered unwanted material from entering into the circuit regardless of the flow direction.

If a component failure occurs in the closed-loop traction circuit, contamination from the damaged part will remain in the circuit until you remove it. Install a high flow hydraulic-fluid filter into the circuit when you connect the hydraulic test gauges in order to test the traction circuit components or after you replace a failed traction circuit component (e.g., piston pump or wheel motor). This filter removes contamination from the hydraulic fluid in the traction circuit, thereby preventing additional component damage.

Note: This kit does not include the hydraulic hoses; refer to Hydraulic Hose Kit (page 2–18).

Note: The replacement filter element is K Line Part No. TOR6012. The filter element canister tightening torque is **34 N·m (25 ft-lb)**.

Measuring Container

K Line Part Number: TOR4077

Use this container to test hydraulic motor efficiency (motors with case drain lines only). Limit the outlet flow from the motor and measure the leakage from the case drain line to measure the efficiency of a hydraulic motor while the hydraulic system pressurizes the motor.

The table gives the gallons per minute (gpm) conversion for the measured milliliter or ounce motor case drain leakage.

GPM	mL/15 seconds	oz/15 seconds
0.1	95	3.2
0.2	189	6.4
0.3	284	9.6
0.4	378	12.8
0.5	473	16.0
0.6	568	19.2
0.7	662	22.4
0.8	756	25.6
0.9	852	28.8
1.0	946	32.0

Remote Starter Switch

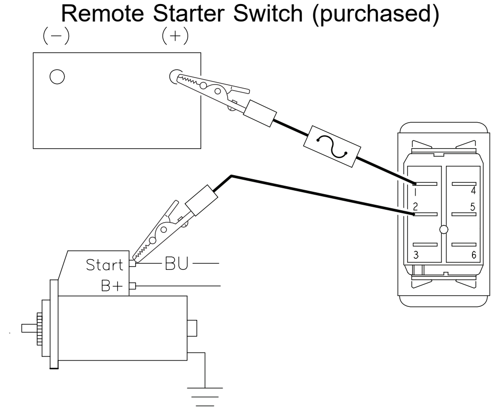
After flushing the hydraulic system or replacing a hydraulic component (e.g. gear pump, piston pump, drive motor), it is necessary to prime the hydraulic pumps. A remote starter switch can be used for this purpose. A remote starter switch can be purchased locally or fabricated as follows.

IMPORTANT: When using a remote starter switch, it is highly recommended to include a 20 amp in−line fuse between the battery and switch connector for circuit protection.

A remote stater switch can also be constructed using Toro switch #106−2027, a length of 14 gauge wire, a 20 amp in−line fuse, two (2) alligator clips and necessary connectors. Connecting the wire to switch terminals 1 and 2 will allow the momentary switch contacts to be used for the remote starter switch.

Note: For information on using the remote starter switch to prime the hydraulic pumps.

Remote Starter Switch (purchased)



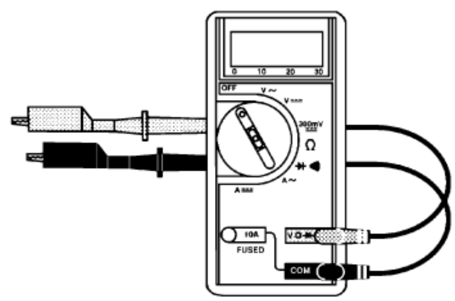
Remote Starter Switch (fabricated)

Multimeter

Obtain this tool locally

The meter can test the electrical components and circuits for current, resistance, or voltage.

Note: Use a digital multimeter when testing the electrical circuits. The high impedance (internal resistance) of a digital meter in the voltage mode ensures that the excess current is not allowed through the meter. This excess current can damage the circuits that are not designed to carry it.



Battery Terminal Protector

Toro Part No. 107-0392

Use this aerosol spray on the battery terminals, ring terminals, and fork terminals to reduce corrosion problems. Apply the terminal protector to the connection after you secure the battery cable, ring terminal, or fork terminal.

Dielectric Gel

Toro Part No. 107-0342

Use the dielectric gel to prevent corrosion of unsealed connection terminals. To ensure complete coating of the terminals, liberally apply the gel to the component and wire harness connector, plug the connector into the component, unplug the connector, apply the gel to both surfaces again, and connect the harness connector to the component again. The connectors must be fully packed with gel for effective results.

Note: Do not use the dielectric gel on the sealed connection terminals as the gel can unseat the connector seals during assembly.

Battery Hydrometer

Use the battery hydrometer when measuring the specific gravity of the battery electrolyte. You can get this tool locally.

Chapter 3

Troubleshooting

Table of Contents

GEARS – The Systematic Approach to Defining, Diagnosing and Solving Problems

1. **Gather Information**
   - Information reported by the customer
   - Information observed by you
   - Establish the what, where and when of the issue
2. **Evaluate Potential Causes**
   - Consider possible causes of the problem to develop a hypothesis
   - Narrow down the focus of the problem
3. **Assess Performance**
   - Ensure that you have all the necessary tools for testing
   - Test all potential causes of the failure
   - Reevaluate and create a new hypothesis if necessary
4. **Repair**
   - Return the unit to service by repairing, rebuilding or replacing
5. **Solution Confirmation**
   - Did the issue go away
   - Was the root cause of the issue correctly repaired
   - Are there any other new symptoms

General Hydraulic System Problems

The charts that follow contain suggestions that can be used to assist in diagnosing hydraulic system performance issues. The suggestions are not all−inclusive. Also, consider that there may be more than one cause for a machine problem.

Review the hydraulic schematic and information on hydraulic system operation in the Hydraulic Flow Diagrams section of this Chapter. This information will be useful during the hydraulic troubleshooting process.

Refer to the Testing (page 5–36) for precautions and specific hydraulic test procedures.

Problem	Possible Cause
Hydraulic oil leaks from machine.	Fitting(s), hose(s) or tube(s) is (are) loose or damaged. O−ring(s) or seal(s) is (are) missing or damaged.
Hydraulic system operates hot. **Note:** An indication that the hydraulic system is operating at excessive temperatures would be frequent reversing of the cooling fan and a normal engine coolant temperature.	Engine RPM is too low. Brakes are applied or sticking. Hydraulic reservoir oil level is low. Hydraulic oil is contaminated or the wrong type. Piston pump by-pass valve is open or damaged. Cooling system is not operating properly. Charge pressure is low. Traction circuit pressure is incorrect. Pump(s) or motor(s) are damaged.
Hydraulic oil in reservoir foams.	Hydraulic reservoir oil level is low. Wrong type of oil is in the hydraulic system. Air is leaking into a pump suction line.

Traction Circuit Problems

Problem	Possible Cause
Machine operates in one direction only.	Piston (traction) pump by−pass valve is open or damaged. Traction relief valve is leaking or faulty. Piston (traction) pump servo control valve orifices or screens are plugged or damaged. Problem with TEC output to piston (traction) pump servo control exists (see Chapter 6: Electrical System (page 6–1)).
Traction pedal response is sluggish.	Traction pedal components are stuck or binding. Traction charge pressure is low. Piston (traction) pump servo control valve orifices are plugged or damaged.
Machine travels too far before stopping when the traction pedal is released.	Traction pedal components are stuck or binding. Traction charge pressure is low. Adjustment of relief valve (RV) in rear traction manifold is incorrect. Piston (traction) pump servo control valve orifices are plugged or damaged.
Traction power is lost or machine will not operate in either direction.	Hydraulic reservoir oil level is low (Other hydraulic systems are affected as well). Piston (traction) pump by-pass valve is open or damaged. Traction charge pressure is low. Traction circuit pressure is low. Traction pedal position sensor is not plugged in or is faulty (see Chapter 6: Electrical System (page 6–1)). Problem with TEC output to piston (traction) pump servo control exists (see Chapter 6: Electrical System (page 6–1)).
LOW traction speed (mow) will not engage. **Note:** LOW (mow) will not engage when the cutting decks are lowered.	Electrical problem exists that prevents solenoid valve S12 from being de-energized (see Chapter 6: Electrical System (page 6–1)). Solenoid valve (S12) in combination manifold is faulty.
LOW traction speed (mow) will not disengage.	Electrical problem exists that prevents solenoid valve S12 from being energized (see Chapter 6: Electrical System (page 6–1)). Solenoid valve (S12) in combination manifold is faulty.

Mow Circuit Problems

Problem	Possible Cause
None of the cutting decks will operate.	Electrical problem exists that prevents PRV solenoid valve in PTO manifolds from being energized (see Chapter 6: Electrical System (page 6–1)).
Note: To engage the mow circuit, the seat must be occupied, the cutting deck(s) must be fully lowered the traction speed must be in the LOW (mow) position and the PTO switch must be on.	Front two (2) gear pump sections for mow circuits are worn or damaged.
One cutting deck will not operate.	Electrical problem (e.g. solenoid coil in PTO manifold, cutting deck position switch) exists (see Chapter 6: Electrical System (page 6–1)).
	Cutting deck problem exists (e.g. drive belt, deck spindle).
	System pressure to the affected cutting deck is low.
	Woodruff key on affected deck motor is damaged.
	Proportional relief valve (PRV) in PTO manifold for affected deck is faulty.
	Cartridge valve in PTO manifold for affected deck is damaged or sticking.
	Deck motor for affected deck is damaged (NOTE: if appropriate, transfer a suspected damaged motor to another cutting deck. If problem follows the motor, motor is faulty and needs repair or replacement).
	Gear pump section for affected deck is worn or damaged.
All cutting decks operate slowly.	Engine RPM is low.
	All deck motors are worn or damaged.
	Front two (2) gear pumps sections for mow circuits are worn or damaged.
Cutting deck stops under load.	Proportional relief valve in PTO manifold for affected deck is by− passing.
	Deck motor has internal leakage (by−passing oil).
	Gear pump section for affected deck is worn or damaged.

Lift Circuit Problems

Problem	Possible Cause
Cutting decks will not raise. **Note:** Seat must be occupied in order to raise the cutting decks.	Engine RPM is too low. Hydraulic oil level in reservoir is low (NOTE: Other hydraulic systems are affected as well). Solenoid valve (S1) in combination manifold is faulty. Electrical problem exists (see Chapter 6: Electrical System (page 6–1)). Lift arm pivots are binding. Lift/lower relief valve in combination manifold is stuck. Lift cylinder(s) is (are) damaged. Gear pump section for lift circuit is worn or damaged (NOTE: A worn or damaged gear pump section will also affect the steering, engine cooling fan motor and traction charge circuits).
Cutting decks raise, but will not stay up. **Note:** Lift cylinders cannot provide an absolutely perfect seal. A cutting deck will eventually lower if left in the raised position during storage.	Lift circuit hydraulic lines or fittings are leaking. Combination manifold cartridge valve(s) for lift/lower circuits has damaged seals or is faulty. Lift cylinder for affected deck is damaged.
Cutting decks will not lower. **Note:** To lower a cutting deck, the seat must be occupied and the traction speed must be in the LOW (mow) position.	Lift arm pivots are binding. Electrical problem exists (see Chapter 6: Electrical System (page 6–1)). Solenoid valve (S1) in combination manifold is faulty. Counterbalance pressure is excessive. Lift cylinder for affected deck is damaged.

Steering Circuit Problems

Problem	Possible Cause
Steering inoperative or sluggish.	Steering components (e.g. tie rods, steering cylinder ends) are worn or binding. Steering cylinder is binding. Oil level in hydraulic reservoir is low (Note: Other hydraulic systems are affected as well). Steering relief valve (RV1) in combination manifold is stuck or damaged. The pressure compensator valve (EC) in combination manifold is stuck or damaged. Steering cylinder leaks internally. Steering control valve is worn or damaged. Gear pump section is worn or damaged (Note: A worn or damaged gear pump section will also affect the lift/lower, engine cooling fan motor and traction charge circuits).

Engine Cooling Fan Circuit Problems

Problem	Possible Cause
Cooling fan runs only in forward direction (fan does not run in reverse direction).	Solenoid cartridge valve (S10) in combination control manifold is faulty. Electrical problem exists that prevents combination control manifold solenoid valve (S10) operation (see Chapter 6: Electrical System (page 6–1)).
Cooling fan does not rotate.	Cooling fan motor is worn or damaged. Proportional relief valve (PRV) in combination manifold is stuck or damaged. Gear pump section for engine cooling fan circuit is worn or damaged (NOTE: A worn or damaged gear pump section will also affect the steering, lift/lower and traction charge circuits).
Cooling fan always rotates at slow speed.	Combination manifold cartridge valve seals are leaking. Check valve in combination manifold is not seating. Proportional relief valve (PRV) in combination manifold is stuck or damaged. Hydraulic fan motor is worn or damaged.
Cooling fan always rotates at fast speed.	Proportional relief valve (PRV) in combination manifold is faulty. Electrical problems exists that prevents correct operation of combination manifold proportional relief valve (PRV) (see Chapter 6: Electrical System (page 6–1)).

Operator Advisories

CAUTION

Remove all jewelry, especially rings and watches, before doing any electrical troubleshooting or testing. Also, disconnect the battery cables unless the test requires battery voltage.

For effective troubleshooting and repairs, you must have a good understanding of the electrical circuits and components used on this machine (see Appendix A (page A–1)).

If the machine has any interlock switches by−passed, reconnect the switches for safety and efficient troubleshooting.

Note: Check the InfoCenter Display for possible operator advisories or faults whenever diagnosing machine electrical problems.

The list below identifies the operator advisories that are generated by the TEC controller. An advisory will be displayed on the InfoCenter Display. Typically, an advisory can be eliminated with a change in machine controls by the operator.

Advisory	Advisory Description
160	Inhibit start
161	Inhibit PTO
162	Inhibit cutting unit lower
163	Inhibit traction HIGH speed range
164	Inhibit traction LOW speed range
165	Inhibit traction
166	Inhibit cruise control
167	Derate traction setting
168	Inhibit traction teach (traction pedal calibration)
169	Engine shutdown
170	Recycle key switch (key switch)
171	Auto idle engaged
172	Calibrate (traction pedal)
173	Master address claim (front TEC controller)
174	Slave address claim (rear TEC controller)
175	Derate engine
180	Master restart
183	Regen complete
184	Regen failed
185	Regen required
186	Regen set full throttle
188	Parked regen required

Advisory	Advisory Description
189	Parked regen required with no PTO
190	Recovery regen required with no PTO
192	Slope warning
193	Slope alarm
194	Slope uncalibrated
195	Slope calibrating
196	Slope calibrated

Fault Codes

The list below identifies the fault codes that are generated by the TEC controller to identify an electrical system malfunction (fault) that occurred during machine operation. Use the InfoCenter Display for fault retrieval.

Note: The following list of fault codes identifies electrical problems that typically will prevent normal machine operation. The InfoCenter Display will identify existing faults if they should occur. Fault codes 13 through 25 identify problems with inputs (e.g. switches, sensors) to the TEC controllers. For input problems, use the InfoCenter Display to check the different switch positions before removing or replacing the component.

Note: Fault codes 26 through 62 identify problems with outputs (e.g. solenoid coils, light bulbs) from the TEC controllers. These output problems might involve issues with the wire harness or the actual output device (solenoid coil or bulb).

Fault Code	Fault Description
1	Excessive engine coolant temperature (above 105 °C) caused PTO to disengage
2	Excessive engine coolant temperature (above 115 °C) caused engine to stop
3	One of the TEC output fuses (7.5 Amp) is faulty
4	IPE voltage too low indicating that TEC controller is faulty
5	Main power relay is faulty
6	Key switch was held in the START position for more than 30 seconds or the key switch is faulty
7	TEC software needs to be reprogrammed (contact Toro Distributor)
8	Alternator charging is too high
9	Alternator charging is too low
10	Engine has not been seen on CAN−bus for 10 seconds
11	Rear TEC controller has not been seen on CAN−bus for 1 second
12	InfoCenter has not been seen on CAN−bus for 1 second
13	Key switch is faulty (check key switch)
14	Traction pedal position sensor is faulty (check traction sensor)
15	Engine speed switch is faulty (check engine speed switch)
16	Traction system HI/LOW speed switch is faulty (check HI/LOW speed switch)
17	Traction pedal position sensor is out of range
18	Hydraulic temperature sensor circuit has open or short
21	Center cutting deck lift switch is faulty (check center lift switch)
22	Left cutting deck lift switch is faulty (check left lift switch)
23	Right cutting deck lift switch is faulty (check right lift switch)
25	Cruise control switch is faulty (check cruise control switch)
26	Engine START output has open or short to ground
27	Engine RUN output has open or short to ground
28	Traction system HIGH range output has open or short to ground
29	RH turn/warning light output has open or short to ground
30	LH turn/warning light output has open or short to ground
31	Brake/RH turn light output has open or short to ground

Fault Code	Fault Description
32	Brake/LH turn light output has open or short to ground
33	Forward piston (traction) pump output has open or short to ground
34	Reverse piston (traction) pump output has open or short to ground
35	Reverse engine cooling fan output (solenoid valve S10) has open or short to ground
36	Disable dual engine cooling fan output (solenoid valve S11) has open or short to ground
38	Center PTO output has open or short to ground
39	LH PTO output has open or short to ground
40	RH PTO output has open or short to ground
41	Solenoid valve S1 (lift/lower enable) output has open or short to ground
42	Solenoid valve S2 (LH deck raise) output has open or short to ground
43	Solenoid valve S3 (LH deck lower) output has open or short to ground
44	Solenoid valve S4 (LH deck float) output has open or short to ground
45	Solenoid valve S5 (center deck raise) output has open or short to ground
46	Solenoid valve S6 (center deck float) output has open or short to ground
47	Solenoid valve S7 (RH deck raise) output has open or short to ground
48	Solenoid valve S8 (RH deck lower) output has open or short to ground
49	Solenoid valve S9 (RH deck float) output has open or short to ground
52	Engine cooling fan output has open or short to ground
63	Traction pedal position sensor is returning a voltage higher than 4.75 V or lower than 0.25 V (replace the traction pedal position sensor)
64	Traction pedal position sensor neutral switches do not align with calibrated sensor values (recalibrate traction pedal position sensor)
65	Traction pedal position sensor forward/reverse switches are indicating the pedal is in both positions at the same time (replace the traction pedal position sensor)
66	TEC controller over current in traction circuit
67	Traction current validation failure: make sure TEC forward traction output is connected to the piston pump forward traction solenoid coil. If circuit is connected, replace the front TEC controller.
68	Forward traction circuit failure: make sure TEC forward traction output is connected to the piston pump forward traction solenoid coil. If circuit is connected, replace the front TEC controller.
69	Reverser traction circuit failure: make sure TEC forward traction output is connected to the piston pump forward traction solenoid coil. If circuit is connected, replace the front TEC controller.
70	Invalid model number: update the machine firmware with ToroDiag.
71	Address contention: inspect the machine to ensure that the two TECs are installed on the machine and are not programmed as masters. Reprogram the machine with ToroDiag.
72	Slope sensor communication failed: verify the slope sensor connection, check 12 V power supply at slope sensor, verify the Settings menu, check the CAN resistance. Replace the faulty slope sensor.

Fault Code	Fault Description
73	Slope sensor configuration failed: verify the slope sensor connection, check 12 V power supply at slope sensor, verify the Settings menu, check the CAN resistance. Replace the faulty slope sensor.
74	Slope sensor malfunctioning: verify the slope sensor connection, check 12 V power supply at slope sensor, check the CAN resistance. Replace the faulty slope sensor.

Starting Problems

Note: Check InfoCenter Display for possible operator advisories or faults whenever diagnosing machine electrical problems.

Problem	Possible Cause
No electrical power to machine.	The battery is discharged. The battery cables are loose or corroded. Fuse F−D1 (2 Amp) is faulty. Fuse F−D2 (2 Amp) is faulty. Fuse M1 (60 Amp) is faulty. A faulty ground connection exists on machine. The key switch or circuit wiring is faulty.
Starter solenoid clicks, but starter will not crank. **Note:** If the solenoid clicks, the problem is not in the interlock circuit.	The battery is discharged. The battery cables are loose or corroded. The fusible links at starter motor are loose or corroded. A ground wire or cable is loose or corroded. The wiring at the starter motor is faulty. The starter solenoid is faulty. The starter motor is faulty. The engine crankshaft seized.
No “click”, no “crank”, no ”start” happens when start attempt is made. InfoCenter display operates with the key switch in the RUN position. **Note:** Use InfoCenter Display to assist with identifying problem.	Traction pedal position sensor is out of adjustment. Traction pedal position sensor or circuit wiring is faulty. The seat switch or circuit wiring is faulty. The traction pedal is not in the neutral position. The operator seat is unoccupied OR the parking brake is not applied. The PTO switch is ON (engaged). The key switch or circuit wiring is faulty. Fuses for TEC are faulty. The parking brake switch or circuit wiring is faulty. The start relay or circuit wiring is faulty. The starter solenoid or starter motor is faulty. The engine or fuel system is malfunctioning (see *Yanmar Service Manual*). The wiring harness connectors, fuses and relays are faulty (see Appendix A (page A–1)).

Problem	Possible Cause
Starter cranks, but should not, when the traction pedal is depressed.	Traction pedal position sensor is out of adjustment. Traction pedal position sensor or circuit wiring is faulty.
Engine cranks, but does not start.	The fuel tank is empty. The battery charge is low, voltage drop in start circuit cables. The fuel pump or circuit wiring is faulty. The engine or fuel system is malfunctioning (see *Yanmar Service Manual*).

General Run and Transport Problems

Note: Check InfoCenter Display for possible operator advisories or faults whenever diagnosing machine electrical problems.

Problem	Possible Cause
Engine continues to run, but should not, when the key switch is turned off.	The key switch or circuit wiring is faulty. The engine or fuel system is malfunctioning (see *Yanmar Service Manual*).
Machine continues to move without an InfoCenter Advisory, but should not, when the traction pedal is depressed with no operator in the seat.	The seat switch or circuit wiring is faulty. Traction pedal position sensor is out of adjustment. Traction pedal position sensor or circuit wiring is faulty.
Engine stops during operation, but is able to restart. **Note:** Excessive engine coolant temperature will cause the cutting decks to be disengaged and can lead to engine shutdown. If excessive coolant temperature causes engine shutdown, the operator can restart the engine to allow the machine to be moved a short distance. After a restart in this condition, the engine will run for approximately ten (10) seconds before the engine shuts down again.	The operator is lifting off the seat switch while mowing. The seat switch or circuit wiring is faulty. The key switch or circuit wiring is faulty. The engine coolant temperature is excessive. Machine is being operated on a slope with a low fuel level. The engine or fuel system is malfunctioning (see *Yanmar Service Manual*).
Battery does not charge. **Note:** Charging system faults will be actively displayed if the charging system voltage is not detected by the Yanmar ECU.	Loose, corroded or broken wire(s) exist in charging circuit. The engine alternator belt is out of adjustment. The battery is faulty. The alternator is faulty.

Cutting Deck Operating Problems

Note: Check InfoCenter Display for possible operator advisories or faults whenever diagnosing machine electrical problems.

Note: To engage the mow circuit, the operator must be in the operator seat, the traction speed must be in the LOW speed (mow) position, the PTO switch must be ON and the cutting deck(s) must be fully lowered and in float.

Problem	Possible Cause
The cutting decks remain engaged, but should not, with no operator in the seat.	The seat switch or circuit wiring is faulty. A hydraulic problem in the mow circuit exists (see Mow Circuit Problems (page 3–5)). The TEC controller is faulty.
Cutting deck runs, but should not, when raised. Decks shut off with PTO switch.	The deck position switch or circuit wiring is faulty. A hydraulic problem in the mow circuit exists (see Mow Circuit Problems (page 3–5)). The TEC controller is faulty.
Cutting decks run, but should not, when raised. Decks do not shut off with the PTO switch.	Both the deck position switch or circuit wiring and PTO switch or circuit wiring are faulty. A hydraulic problem in the mow circuit exists (see Mow Circuit Problems (page 3–5)).
Cutting decks run, but should not, when lowered with PTO switch in the OFF (disengage) position.	The PTO switch or circuit wiring is faulty. The TEC controller is faulty.
Cutting deck(s) do not operate.	The operator is lifting off the seat switch. The cutting decks are not fully lowered. Traction circuit is not in LOW speed (mow) mode. High temperature of engine coolant or hydraulic oil has disabled the cutting decks. Fuse is faulty preventing PTO manifold solenoids from being energized. The seat switch or circuit wiring is faulty. The PTO switch or circuit wiring is faulty. The deck position switch or circuit wiring is faulty. The HI/LOW speed switch or circuit wiring is faulty. The TEC controller is faulty. Hydraulic valve solenoid(s) or circuit wiring to the affected deck(s) is faulty. A hydraulic problem in the mow circuit exists (see Mow Circuit Problems (page 3–5)). The engine is due for stationary regeneration.

Problem	Possible Cause
Wing cutting deck does not operate.	The wing cutting deck is not fully lowered. The wing deck position switch or circuit wiring is faulty. Hydraulic valve solenoid(s) or circuit wiring to the affected wing deck manifold is faulty. A hydraulic problem in the mow circuit exists (see Mow Circuit Problems (page 3–5)). The TEC controller is faulty.

Cutting Deck Lift/Lower Problems

Note: Check InfoCenter Display for possible operator advisories or faults whenever diagnosing machine electrical problems.

Note: To lower a cutting deck, the operator must be in the operator seat and the traction speed must be in the LOW speed (mow) position. To raise a cutting deck, the operator must be in the operator seat.

Problem	Possible Cause
None of the cutting decks or wing decks will lower.	The HI/LOW speed switch is in the HI speed position. Operator is not fully depressing the seat switch. TEC fuse(s) are faulty. The seat switch or circuit wiring is faulty. The HI/LOW speed switch or circuit wiring is faulty. Combination control manifold solenoid coil S1 or circuit wiring is faulty. A hydraulic problem in the lift/lower circuit exists (see Lift Circuit Problems (page 3–6)). The TEC controller is faulty.
None of the cutting decks will raise.	TEC fuse(s) are faulty. Combination control manifold solenoid coil S1 or circuit wiring is faulty. A hydraulic problem in the lift/lower circuit exists (see Lift Circuit Problems (page 3–6)). The TEC controller is faulty.
Front cutting deck will not raise or lower, but both side cutting decks will raise and lower.	The center deck lift switch or circuit wiring is faulty. Combination control manifold solenoid coils S5 or S6 or circuit wiring is faulty. A hydraulic problem in the lift/lower circuit exists (see Lift Circuit Problems (page 3–6)). The TEC controller is faulty.
Right side wing cutting deck will not raise or lower, but the center and left side cutting decks will raise and lower.	The RH deck lift switch or circuit wiring is faulty. Fuse is faulty. Combination control manifold solenoid coils S7, S8 or S9 or circuit wiring is faulty. A hydraulic problem in the lift/lower circuit exists (see Lift Circuit Problems (page 3–6)). The TEC controller is faulty.
Left side wing cutting deck will not raise or lower, but the center and right side cutting decks will raise and lower.	The LH deck lift switch or circuit wiring is faulty. Combination control manifold solenoid coils S2, S3 or S4 or circuit wiring is faulty. A hydraulic problem in the lift/lower circuit exists (see Lift Circuit Problems (page 3–6)). The TEC controller is faulty.

Aftercut Appearance

There are a number of factors that can contribute to unsatisfactory quality of cut, some of which may be turf conditions. Turf conditions such as excessive thatch, uneven ground conditions, “sponginess” or attempting to cut off too much grass height may not always be overcome by adjusting the machine.

Remember that the “effective” or actual height−of−cut depends on cutting deck weight, tire pressures, hydraulic counterbalance settings and turf conditions. Effective height−of−cut will be different than the bench set height− of−cut.

Factors That Can Affect Quality of Cut

Factor	Possible Problem/Correction
Maximum governed engine speed	Check maximum governed engine speed. Adjust speed to specifications if necessary.
Blade speed	All deck blades should rotate at the same speed.
Tire pressure	Check air pressure of each tire including castor tires. Adjust to pressures specified in *Operator’s Manual*.
Blade condition	Sharpen blades if their cutting edges are dull or nicked. Inspect blade sail for wear or damage. Replace blade if needed.
Mower housing condition	Make sure that cutting chambers are in good condition. Keep underside of deck clean. Debris buildup will reduce cutting performance.
Height−of−cut	Make sure all cutting decks are set at the same height−of−cut. Set decks as specified in the *Operator’s Manual*.
Cutting deck alignment and ground following	Check lift arms and cutting deck pivot linkages for wear, damage or binding. Also, inspect for bent or damaged pivot shafts. Check and adjust the Counterbalance Pressure (Using Pressure Gauge) (page 5–45). Check the cutting deck rake or blade plane. Refer to *Operator’s Manual* for adjusting the front and side cutting decks pitch.
Roller and castor wheel condition	All rollers and caster wheels should rotate freely. Replace bearings if worn or damaged.
Grass conditions	Mow when grass is dry for best cutting results. Also, remove only 25 mm (1 in) or 1/3 of the grass blade when cutting.

Yanmar Diesel Engine

Table of Contents

Additional Reference Materials

Yanmar TNV (Tier 4i) Series Service Manual
Yanmar TNV (Tier 4i) Series Troubleshooting Manual
Yanmar TNV (Tier 4) Series Service Manual
Yanmar TNV (Tier 4) Series Troubleshooting Manual

General Information

This Chapter gives information about specifications and repair of the diesel engine used in Groundsmaster 4100−D and 4110−D machines.

General maintenance procedures are described in your *Operator's Manual*. Information on engine troubleshooting, testing, disassembly and reassembly is identified in the *Yanmar Service Manual*.

Most repairs and adjustments require tools which are commonly available in many service shops. Special tools are described in the Yanmar Service Manual. The use of some specialized test equipment is explained. However, the cost of the test equipment and the specialized nature of some repairs may dictate that the work be done at an engine repair facility.

Service and repair parts for Yanmar engines are supplied through your Authorized Toro Distributor. If no parts list is available, be prepared to provide your distributor with the Toro model and serial number of your machine.

Operator's Manual

The *Operator's Manual* provides information regarding the operation, general maintenance and maintenance intervals for your Groundsmaster machine. The Yanmar *Operator's Manual* includes information specific to the engine used in your Groundsmaster. Refer to these publications for additional information when servicing the machine.

Yanmar Service and Troubleshooting Manuals

The engine that powers your Groundsmaster machine is either a Yanmar model 4TNV84T−Z (used on Groundsmaster models 30602, 30604 and 30643) (Tier 4i) or a Yanmar model 4TNV86CT (used on Groundsmaster models 30606, 30608 and 30644) (Tier 4). Both the Yanmar Service Manual and Yanmar Troubleshooting Manual are available for these engines. Make sure that the correct engine manuals are used when servicing the engine on your Groundsmaster.

Stopping the Engine

IMPORTANT

After mowing or full load operation on machines with a turbo−charged engine, cool the turbo- charger by allowing the engine to run at low idle speed for five (5) minutes before stopping the engine. Avoid or don't shut down the engine as speeds greater than idle. Failure to do so may lead to premature internal wear/damage to turbo-charger.

Engine Electronic Control Unit (ECU)

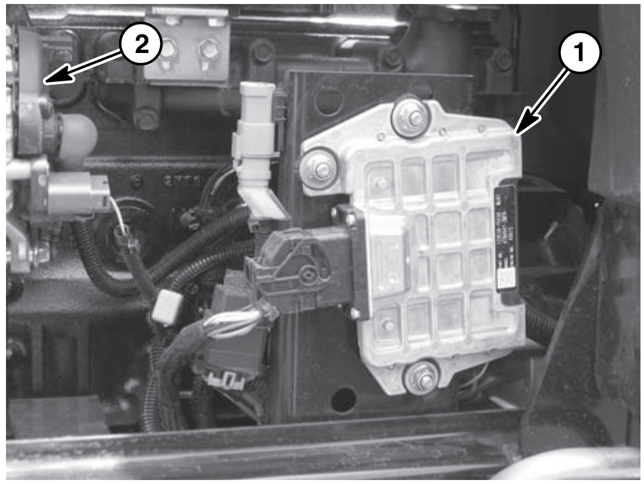


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Figure 8

(Tier 4i)

1. Electronic control unit (30602/30604/30643)
2. Alternator

The Yanmar engine that powers your Groundsmaster uses an electronic control unit (ECU) for engine management and also to communicate with the machine TEC controllers and the operator InfoCenter display on the machine. All wire harness electrical connectors should be plugged into the engine ECU before the machine key switch is moved from the OFF position to either the ON or START position.

Note: On models 30606, 30608 and 30644 a ground wire is used to ground the engine ECU to the machine frame. The ground wire is connected to the ECU with one of the mounting screws and is connected to the frame at the engine mount.

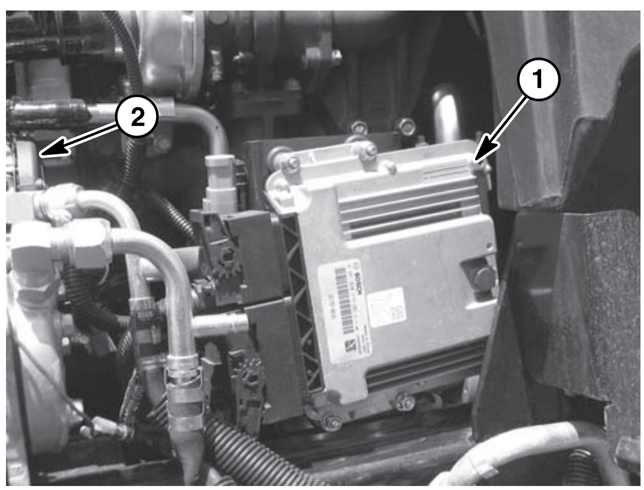

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Figure 9

(Tier 4)

1. Electronic control unit (30606 / 30608 / 30644)
2. Alternator

The engine electrical components (e.g. engine ECU, fuel injectors, EGR, exhaust DPF) are identified and matched in the engine ECU program. If engine electrical components are replaced on the engine, the Yanmar electronic tool must be used to update the engine ECU program which will ensure correct engine operation.

If the engine ECU identifies that an engine problem exists, the engine speed may be reduced or the engine might stop. The Yanmar electronic tool and troubleshooting manual should be used to provide assistance in identifying the cause of the problem and the repairs that are necessary. Contact your Toro distributor for assistance in Yanmar engine troubleshooting.

IMPORTANT

Do not plug or unplug the engine ECU for minimum period of thirty (30) seconds after the machine key switch is turned OFF. The ECU may remain energized even though the key switch is OFF.

If the engine ECU is to be disconnected for any reason, make sure that the key switch is in the OFF position with the key removed before disconnecting the engine ECU. Also, to prevent possible ECU damage when welding on the machine, disconnect and remove the engine ECU from the machine before welding.

Yanmar Engine: Models 30602, 30604 and 30643

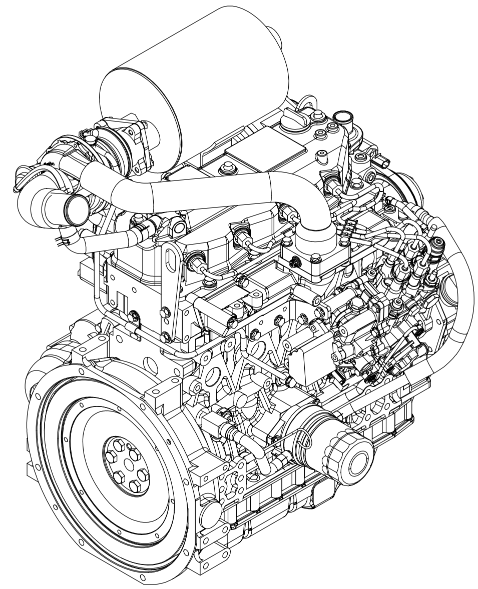

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Figure 10

The engine used on Groundsmaster models 30602, 30604 and 30643 is a Yanmar TNV Series, turbocharged, diesel engine that complies with EPA interim Tier 4 emission regulations. The T4i engine features include an electronic control unit (ECU) controlled direct fuel injection and electronic governor. An air heater in the intake system is used to assist starting the engine. Numerous engine sensors are used to allow the engine electronic control unit (ECU) to monitor and control engine operation for optimum engine performance.

During machine operation, if an engine fault occurs, the machine InfoCenter display can be used to identify the fault. Also, the Yanmar SMARTASSIST−Direct electronic control diagnostics service system is available to confirm real−time engine running status and to offer timely technical services.

Yanmar Engine: Models 30606, 30608 and 30644

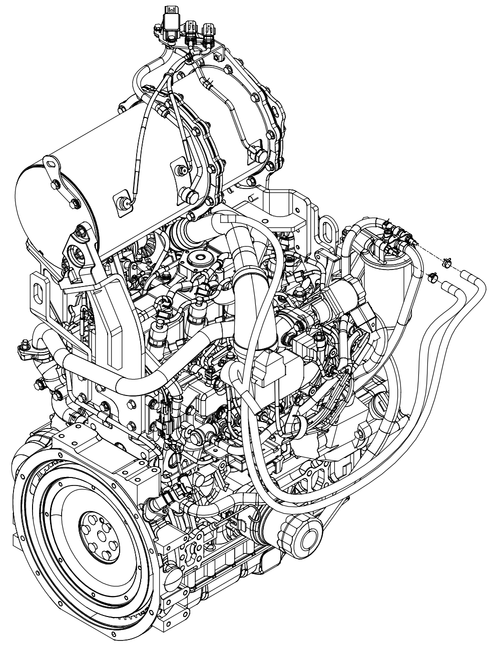

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Figure 11

The engine used on Groundsmaster models 30606, 30608 and 30644 is a Yanmar TNV Series, turbocharged, diesel engine that complies with EPA Tier 4 final emission regulations. The T4 engine features include an electronic control unit (ECU) that controls a common rail, direct fuel injection system, water−cooled exhaust gas recirculation (EGR), an exhaust system diesel oxidation catalyst (DOC) and an exhaust diesel particulate filter (DPF) with active regeneration. Glow plugs are used to assist starting the engine. Numerous engine sensors are used to allow the engine ECU to monitor and control engine operation for optimum engine performance.

During the operation of the engine, if conditions warrant, the engine ECU may generate an engine fault. Use the machine InfoCenter to identify the engine fault; refer to the *Yanmar Troubleshooting Manual*, or contact an Authorized Toro Distributor for assistance.

Diesel Particulate Filter

The diesel particulate filter (DPF) used on Yanmar Tier 4 compliant engines is designed to breakdown the hazardous elements in the exhaust and prevent the discharge of unburned fuel or oil known as particulate matter or soot. The DPF includes a Diesel Oxidation Catalyst (DOC), a Soot Filter (SF), 2 temperature sensors, and a pressure differential sensor. Additional information regarding the Diesel Particulate Filter (DPF) can be found in the *Yanmar Operation Manual* – Industrial Engines TNV supplied with your machine.

Regeneration

The engine ECU monitors the exhaust pressure before and after the soot filter in the DPF to determine if soot is accumulating. If soot is accumulating during normal engine operation, the pressure differential will increase. The increase in pressure will signal the engine to begin a process called regeneration. Regeneration increases the exhaust temperature and the length of time the engine operates at a higher than normal exhaust temperature, incinerating the built up soot and turning it into ash. The different types of regeneration used are listed in order based on the amount of particulate matter in the soot filter (least to most).

Note: The user interface and InfoCenter displays for DPF regeneration changed with machine software 120-6372P. Use the InfoCenter About screen to verify the software installed on the machine.

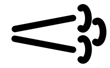
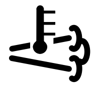
- **For machines with software 120-6372A thru O:** Complete DPF regeneration instructions can be found in the updated traction unit *Operator's Manual* for the specific machine. Visit www.toro.com to download the updated traction unit *Operator's Manual* for the machine or contact an Authorized Toro Distributor for assistance.
- **For machines with software 120-6372P and up:** Complete DPF regeneration instructions can be found in the traction unit *Operator's Manual* for Models 30609 and 30636 machine serial number 401420001 and up documentation. Visit www.toro.com to download the traction unit *Operator's Manual* with the correct DPF regeneration instructions for the machine.

Types of regeneration that are performed automatically (while the machine is operating)

Type	Conditions	Description
Passive	Occurs during normal operation of the machine at high engine speed or high engine load.	The DPF processes high heat exhaust gasses, oxidizing harmful emissions and incinerating soot to ash. The InfoCenter does not display an icon during passive regeneration.

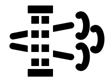
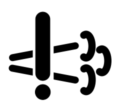
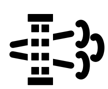
Regeneration (continued)

Types of regeneration that are performed automatically (while the machine is operating) (continued)

Assist	Occurs because of prolonged operation at low engine speed, low engine load, or when the engine ECU detects the soot filter is becoming obstructed.	The engine ECU adjusts the intake throttle to raise the exhaust temperature.  **For software 120-6372A thru O only:** the InfoCenter displays the assist regeneration icon.
Reset	Occurs every 100 hours of engine operation. Occurs after an assist regeneration if the engine ECU determines the assist regeneration did not sufficiently reduce the soot level. **Note:** Reset regeneration may be temporarily delayed if high exhaust temperatures would create an unsafe condition (the machine is operating indoors or outdoors around trees, brush, tall grass, or other temperature-sensitive plants or materials). Refer to Setting the Inhibit Regen in the traction unit *Operators Manual* for additional information.	The engine ECU adjusts the engine setting to raise the exhaust temperature.  **For all software revisions:** the InfoCenter displays the high exhaust temperature icon. **For software 120-6372P and up:** the InfoCenter will display Operator Advisories 185, 186 if the regeneration is in standby when the regen process is interrupted by low engine speed.

Regeneration (continued)

Types of regeneration that are performed manually (while the machine is stationary)

Type	Conditions	Description
Parked	Occurs when exhaust back pressure in the DPF increases due to continued soot buildup. May be caused by prolonged operation at low engine speed, low engine load, or the use of incorrect fuel or engine oil. May occur if the InfoCenter is set to inhibit regen (preventing a Reset Regeneration) and machine operation is continued. Can be initiated when prompted by the engine ECU or after a minimum of 50 hours of engine operation. **For software 120-6372P and up:** if a parked regeneration is ignored, the machine mow function (PTO) will be disabled approximately 2 hours after the first notification.	Manually initiate a parked regeneration as soon as possible. A parked regeneration requires 30 to 60 minutes and should not be started with less than 1/4 tank of fuel. The machine must remain stationary (cannot be operated) during the entire parked regeneration process. The engine ECU adjusts the exhaust intake throttle to raise the exhaust temperature.  **For all software revisions:** the InfoCenter displays advisory #188 and/or the stationary regeneration icon .
Recovery	Occurs when exhaust back pressure in the DPF increases due to soot buildup reaching a critical level. Can only be initiated when prompted by the engine ECU. **For software 120-6372P and up:** the machine mow function (PTO) will be disabled at first notification.	Manually initiate a recovery regeneration as soon as possible. A recovery regeneration will take approximately 3 hours and should not be started with less than 1/2 tank of fuel. The machine must remain stationary (cannot be operated) during the entire recovery regeneration process. Use the InfoCenter About screen to verify the software installed on the machine. • **Machines with software 120-6372A thru O:** Recovery regeneration must be initiated by an Authorized Toro Distributor service technician using Yanmar SMARTASSIST-Direct. • **Machines with software 120-6372P and up:** Recovery regeneration can be initiated from the machine InfoCenter.  **For software 120-6372A thru O only:** the InfoCenter displays the recovery regeneration icon.  **For software 120-6372P and up:** the InfoCenter displays advisory #190 and/or the stationary regeneration icon. **Note:** If the recovery regeneration is not responding, verify the model and serial number of the engine installed in the machine. 4TNV86CT-DTR engine serial number below 03789 cannot run a recovery regeneration without first reprogramming the engine ECU. Contact an Authorized Toro Distributor for assistance.

Soot Accumulation

If the types of regeneration that are performed automatically (while the machine is operating) are bypassed or not allowed to complete before shutting off the engine, soot will continue to accumulate in the soot filter. When enough soot accumulates, the engine ECU will generate an engine fault to prompt a parked or recovery regeneration. In addition to an engine fault appearing on the InfoCenter, the engine output power will be reduced.

Ash Accumulation

Ash is a result of the regeneration processes. The lighter ash is discharged through the exhaust system, while the heavier ash collects in the soot filter. When enough ash accumulates in the soot filter, the engine ECU will generate two engine faults to prompt servicing the DPF. First fault for should service the DPF and the second for must service the DPF. In addition to an engine fault appearing on the InfoCenter, the engine output power and speed will be reduced.

Service and Repairs

Air Cleaner System

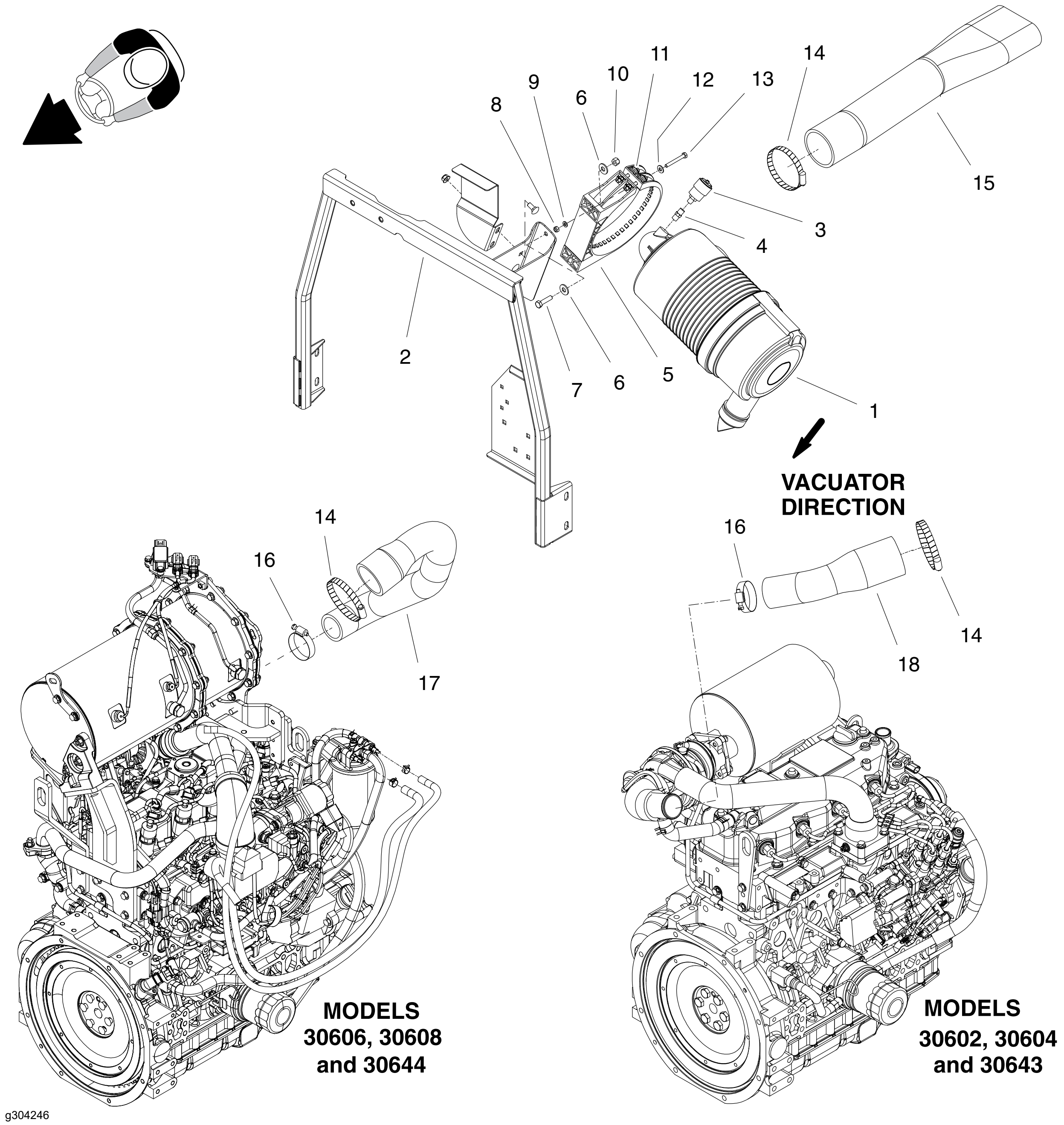


Figure 12

1. Air cleaner assembly
2. Tank support
3. Indicator
4. Adapter
5. Air cleaner strap
6. Flat washer (4 used)
7. Cap screw (2 used)
8. Lock nut (2 used)
9. Flat washer (2 used)
10. Lock nut (2 used)
11. Spring (2 used)
12. Flat washer (2 used)
13. Socket head screw (2 used)
14. Hose clamp
15. Air cleaner inlet hose
16. Hose clamp
17. Air cleaner outlet hose (tier 4)
18. Air cleaner outlet hose (tier 4i)

Removal (Figure 12)

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the key switch.
2. Raise and support hood.
3. Remove air cleaner components as needed using Figure 12 as a guide.

Installation (Figure 12)

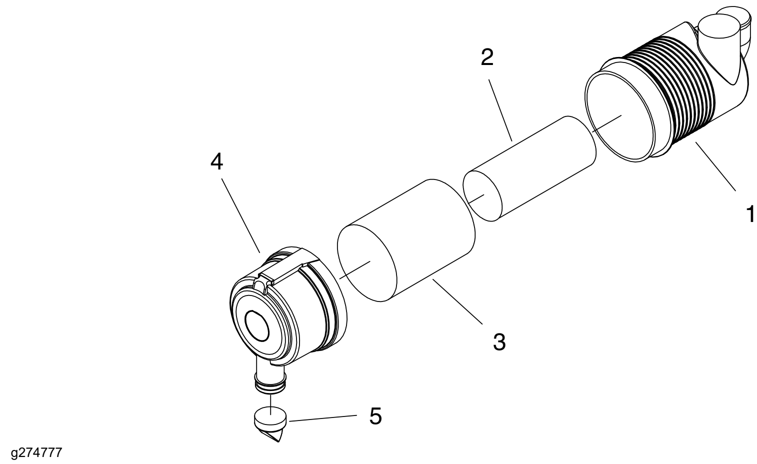


Figure 13

1. Air cleaner housing
2. Safety filter element
3. Air filter element
4. Air cleaner cover
5. Vacuator valve

IMPORTANT

Any leaks in the air cleaner system will cause serious engine damage. Make sure that all air cleaner components are in good condition and are properly secured during assembly.

---

1. Assemble air cleaner system using Figure 12 as a guide.

   A. If service indicator (item 4 in Figure 12) and adapter (item 15 in Figure 12) were removed from air cleaner housing, apply thread sealant to adapter threads before installing adapter and indicator to housing. Install adapter so that grooves in adapter hex and adapter filter element are installed toward service indicator (shown in Figure 14). Torque indicator from **1.4 to 1.6 N·m (12 to 15 in−lb)**.

Installation (Figure 12) (continued)

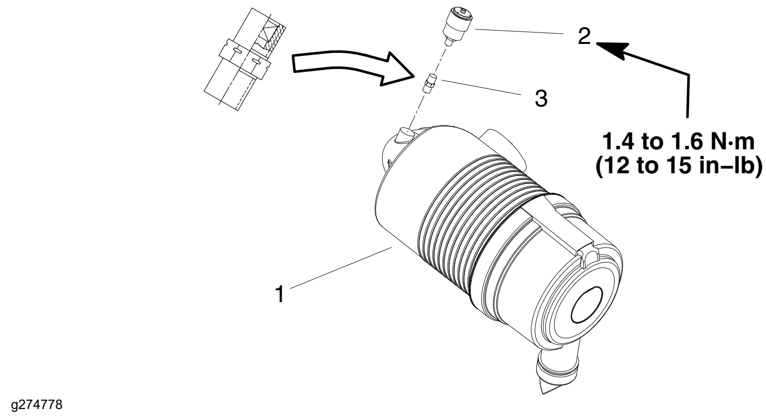


Figure 14

1. Air cleaner assembly
2. Service indicator
3. Adapter

B. When installing air cleaner, orientate the vacuator valve on the air cleaner cover so that the valve is pointing in a downward position and between 5:00 to 7:00 (approximate clock position) when viewed from the end.

C. When securing air cleaner in air cleaner strap, tighten cap screws (item 14) only enough to prevent air cleaner from rotating in strap.

D. When installing air cleaner outlet hose between air cleaner and engine, position hose to allow maximum clearance between air cleaner hose and muffler bracket.

E. Make sure that air cleaner hoses do not contact the engine or exhaust system after assembly. To ensure clearance, move and/or rotate air cleaner body in air cleaner strap if necessary.

2. After all air cleaner components have been installed, lower and secure hood.

Fuel System

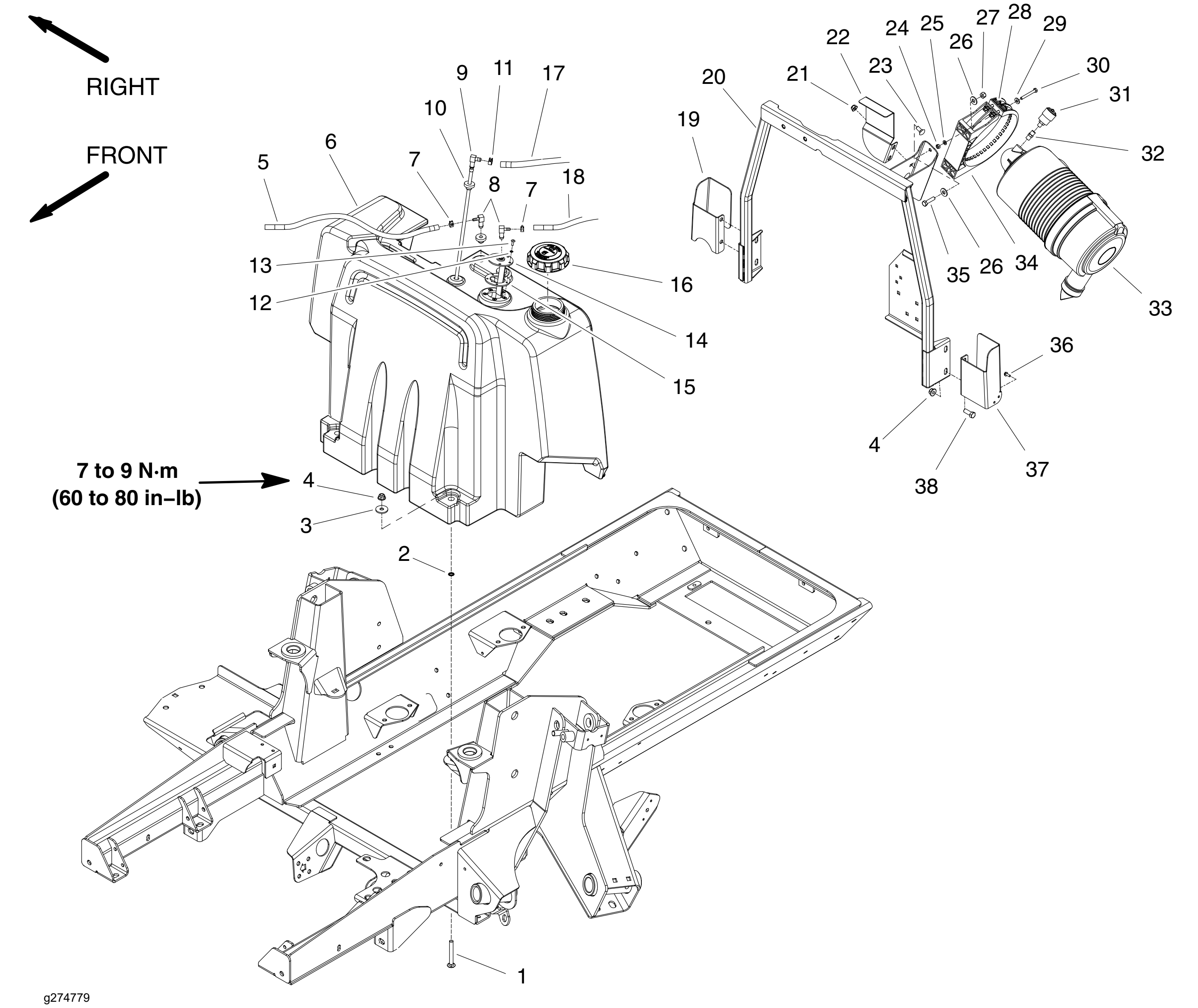


Figure 15

1. Carriage screw (2 used)
2. Retaining ring (2 used)
3. Flat washer (2 used)
4. Flange nut (6 used)
5. Vent hose
6. Fuel tank
7. Hose clamp (2 used)
8. Elbow fitting (2 used)
9. Stand pipe
10. Grommet (3 used)
11. Hose clamp
12. Lock washer (5 used)
13. Phillips head screw (5 used)
14. Fuel sender
15. Gasket
16. Fuel cap
17. Fuel supply hose
18. Fuel return hose
19. RH latch bracket
20. Tank support assembly
21. Flange nut (2 used)
22. Fuel tank bracket
23. Carriage screw (2 used)
24. Lock nut (2 used)
25. Flat washer (2 used)
26. Flat washer (4 used)
27. Lock nut (2 used)
28. Spring (2 used)
29. Flat washer (2 used)
30. Socket head screw (2 used)
31. Indicator
32. Adapter
33. Air cleaner assembly
34. Air cleaner strap
35. Cap screw (2 used)
36. Screw (4 used)
37. LH latch bracket
38. Cap screw (4 used)

DANGER

Because diesel fuel is flammable, use caution when storing or handling it. Do not smoke while filling the fuel tank. Do not fill fuel tank while engine is running, hot or when machine is in an enclosed area. Always fill fuel tank outside and wipe up any spilled diesel fuel before starting the engine. Store fuel in a clean, safety−approved container and keep cap in place. Use diesel fuel for the engine only; not for any other purpose.

Check Fuel Lines and Connections

Check fuel lines and connections periodically as recommended in the *Operator's Manual*. Check lines for deterioration, damage, leaking or loose connections. Replace hoses, clamps and connections as necessary.

Empty and Clean Fuel Tank

Empty and clean the fuel tank periodically as recommended in the *Operator's Manual*, if the fuel system becomes contaminated or if the machine is to be stored for an extended period.

IMPORTANT

Follow all local codes and regulations when recycling or disposing waste fuel.

To clean fuel tank, flush tank out with clean diesel fuel. Make sure tank is free of contaminates and debris.

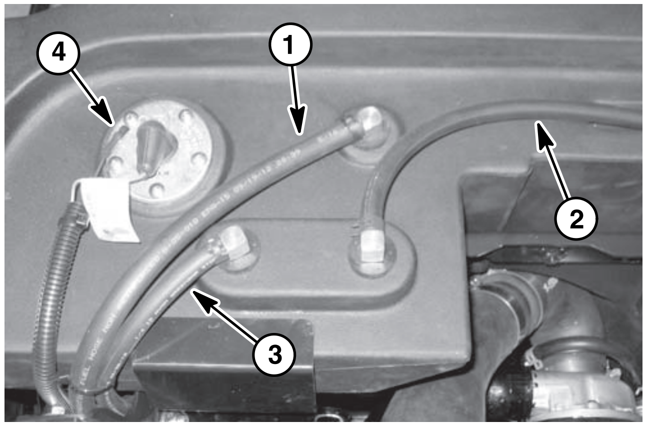
Priming the Fuel System

The fuel system needs to be primed before starting the engine for the first time, after running out of fuel or after fuel system maintenance (e.g. draining the filter/water separator, replacing a fuel hose). To prime the fuel system, make sure that the fuel tank has fuel in it. Then, turn the key switch to the RUN position for 10 to 15 seconds which allows the fuel pump to prime the fuel system. **DO NOT** use the engine starter motor to crank the engine in order to prime the fuel system.

Fuel Tank Removal (Figure 15)

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the key switch.
2. Raise and support operator seat and hood.
3. Use a fuel transfer pump to remove fuel from the fuel tank and into a suitable container.

Fuel Tank Removal (Figure 15) (continued)



g274780

Figure 16

1. Fuel supply hose
2. Vent hose
3. Return hose
4. Fuel sender

Note: Fuel sender may have two (2) wire harness terminals (shown in Figure 16) or a single harness connector.

4. Disconnect wire harness connections from the fuel sender (item 14).
5. Disconnect fuel supply, vent and return hoses from elbow fittings in top of tank (Figure 16).
6. Remove fuel tank using Figure 15 as a guide. Tank is secured to frame with fasteners (items 1, 2, 3 and 4) on the forward side and bracket (item 22) on the rear side.

Fuel Tank Installation (Figure 15)

1. Install fuel tank using Figure 15 as a guide. When securing tank to frame, follow the following sequence:
   A. Loosely install fasteners on front of tank (items 1, 2, 3 and 4).
   B. Install and tighten bracket (item 22) at rear of tank.
   C. Torque two (2) flange nuts (item 4) from **7 to 9 N·m (60 to 80 in−lb)**.
2. Connect fuel supply hose to the standpipe and vent and return hoses to the elbow fittings (Figure 16). Secure hoses with clamps.
3. Secure wire harness connector(s) to fuel sender. On senders with two (2) wire harness terminals, apply skin over grease (see Special Tools (page 2–17)) to harness terminals after installation.
4. Lower and secure operator seat and hood.
5. Fill fuel tank with new fuel.
6. Prime the fuel system (see above).
7. Before returning machine to operation, make sure that no fuel leaks exist.

Radiator and Oil Cooler Assembly

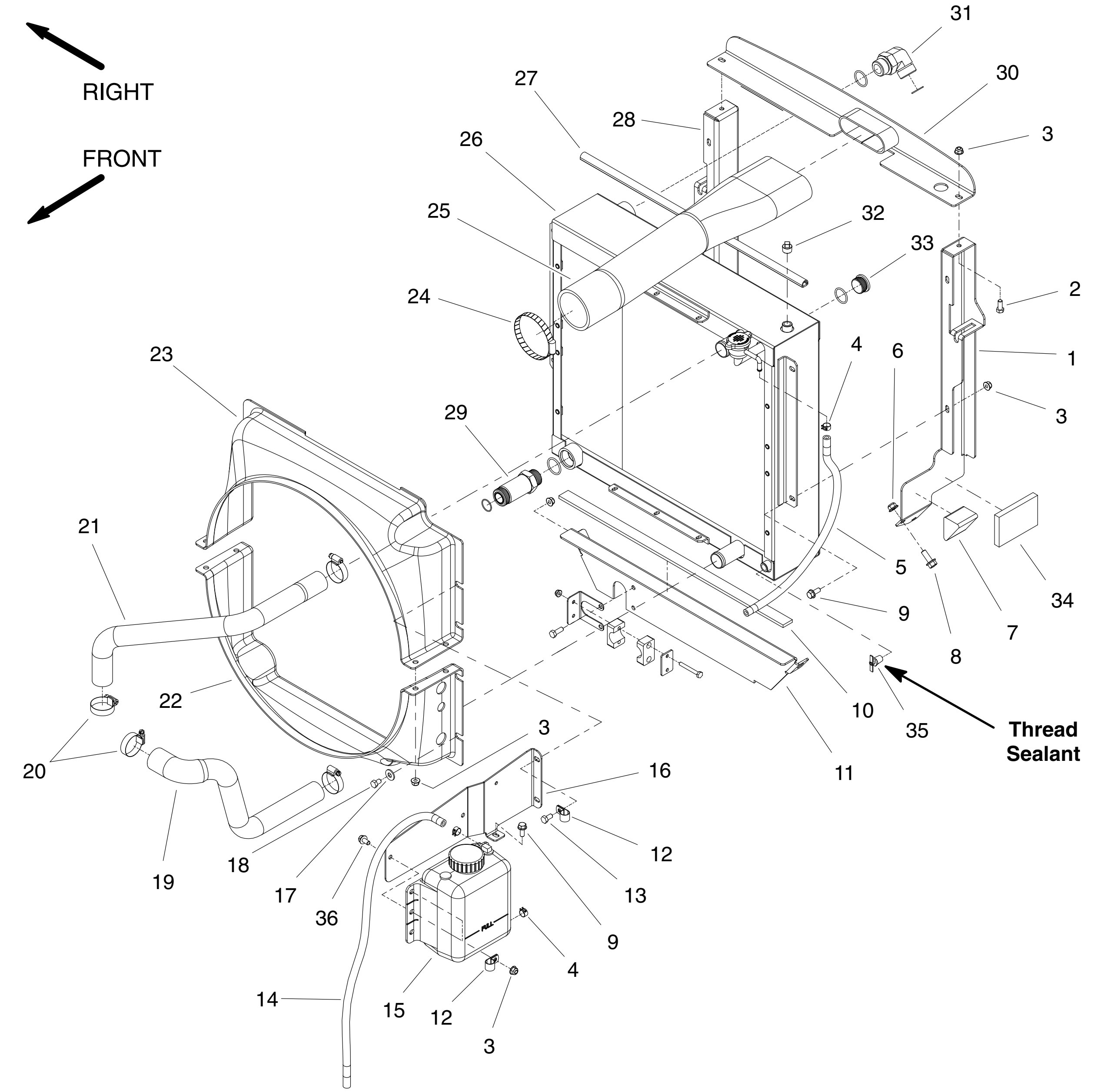


Figure 17

1. LH radiator support
2. Cap screw (2 used)
3. Flange nut (12 used)
4. Hose clamp (3 used)
5. Hose
6. Flange nut (6 used)
7. Foam plug (2 used)
8. Flange head screw (6 used)
9. Flange head screw (9 used)
10. Foam strip
11. Hose bracket
12. R−clamp (2 used)
13. Cap screw (2 used)
14. Hose
15. Coolant reservoir
16. Tank mount
17. Flat washer (7 used)
18. Cap screw (6 used)
19. Lower radiator hose
20. Hose clamp (4 used)
21. Upper radiator hose
22. Lower radiator shroud
23. Upper radiator shroud
24. Hose clamp
25. Air cleaner inlet hose
26. Radiator/hydraulic oil cooler
27. Bulb seal
28. RH radiator support
29. Straight hydraulic fitting
30. Intake bracket
31. 90° hydraulic fitting
32. Pipe plug
33. Hex plug with O−ring
34. Foam pad (2 used)
35. Draincock
36. Cap screw (2 used)

Removal (Figure 17)

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the key switch. Open and support hood.

CAUTION

Do not open radiator cap or drain coolant if the radiator or engine is hot. Pressurized, hot coolant can escape and cause burns.

Ethylene−glycol antifreeze is poisonous. Dispose of coolant properly or store it in a properly labeled container away from children and pets.

2. Drain radiator into a suitable container either by using the draincock (item 35) near the lower left side corner of the radiator or by removing the lower radiator hose from the radiator.

IMPORTANT

Follow all local codes and regulations when recycling or disposing engine coolant.

MODEL 30606 (WITH TIER 4 ENGINE)

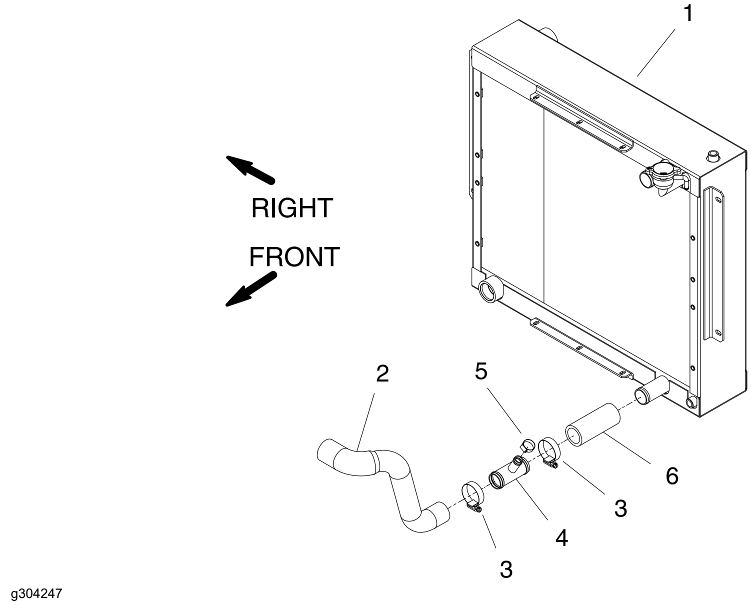


Figure 18

1. Radiator/oil cooler
2. Lower radiator hose
3. Hose clamp
4. Radiator fitting
5. Hose clamp
6. Radiator hose

3. Disconnect radiator hoses from the radiator. Groundsmaster 4110−D machines with a Tier 4 compliant engine (model 30606 and 30644) use the lower radiator hose assembly shown in Figure 18.
4. Remove air cleaner inlet hose (item 25).
5. Read the General Precautions for Removing and Installing Hydraulic System Components (page 5–83).

Removal (Figure 17) (continued)

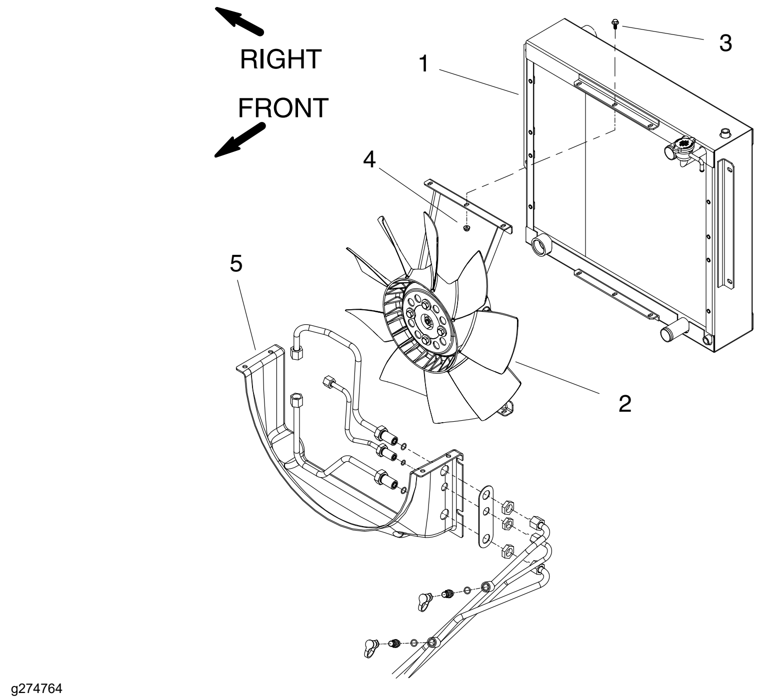


Figure 19

1. Radiator/oil cooler
2. Motor and fan assembly
3. Cap screw (6 used)
4. Flange nut (6 used)
5. Lower radiator shroud

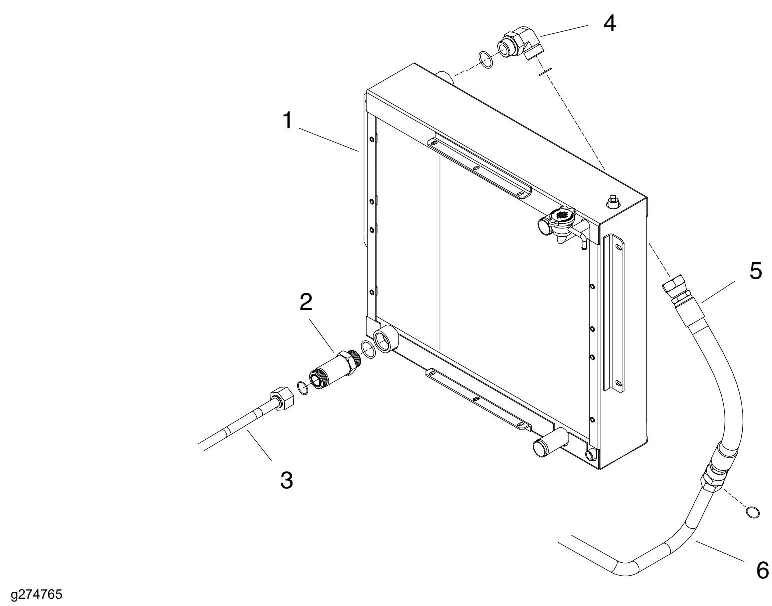


Figure 20

1. Radiator/oil cooler
2. Straight fitting
3. Hydraulic tube
4. 90° fitting
5. Hydraulic hose
6. Hydraulic tube

6. Thoroughly clean hydraulic lines at lower radiator shroud (Figure 19) and oil cooler ports (Figure 20). Disconnect hydraulic lines and put caps or plugs on lines to prevent contamination. Label disconnected hydraulic lines for proper installation.

Removal (Figure 17) (continued)

7. Disconnect hood rods from hood and radiator supports (see Hood (page 8–32)).
8. Remove flange head screws (item 8) and flange nuts (item 6) that secure the radiator supports (items 1 and 28) to the frame.
9. Carefully raise radiator assembly with shrouds, fan motor assembly and supports from the machine.
10. Disassemble radiator/oil cooler assembly as needed using Figure 17 and Figure 19 as guides.
11. If necessary, remove hydraulic fittings (items 29 and 31) from oil cooler and discard O−rings.
12. Plug all radiator and hose openings to prevent contamination.

Installation (Figure 17)

1. Inspect seals (items 7, 10, 27 and 34) around radiator location for wear or damage. Replace seals if necessary.
2. Remove all plugs placed during the removal procedure.
3. If hydraulic fittings (items 29 and 31) were removed from oil cooler, lubricate and place new O−rings onto fittings. Install fittings into port openings and tighten fittings (see Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings) (page 5–10)).
4. Assemble radiator/oil cooler using Figure 17 and Figure 19 as guides.
   A. If fan motor bracket was removed, position bracket as far as possible from radiator to maximize distance between radiator and fan motor location.
   B. Make sure that clearance between radiator shrouds and cooling fan is at least **4.6 mm (0.180 in)** at all points.
5. Carefully lower radiator assembly with shrouds, fan motor assembly and supports to the machine frame.
6. Secure radiator supports (items 1 and 28) to the frame with flange head screws (item 8) and flange nuts (item 6).
7. Connect hydraulic lines to fittings in oil cooler ports (Figure 20) and at lower radiator shroud (Figure 19) (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–8)).
8. Connect upper and lower radiator hoses to the radiator.
9. Install and secure air cleaner inlet hose (item 25).
10. Make sure radiator draincock is closed. Fill radiator with coolant.
11. Connect hood rods to radiator supports and hood (see Hood (page 8–32)).
12. Close and secure hood.

Engine

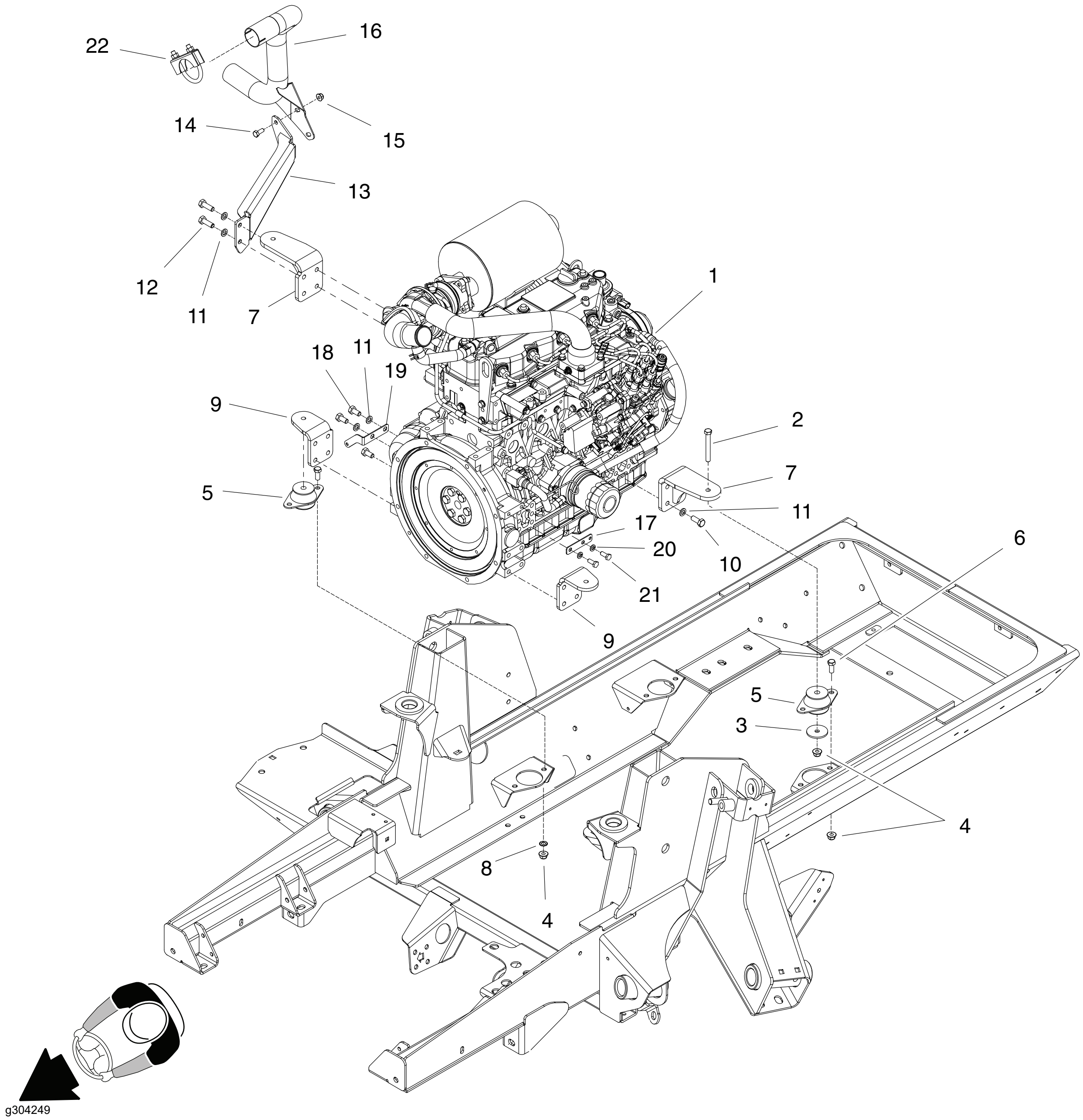


Figure 21
MODEL 30604 SHOWN

1. Engine (model 30602 shown)
2. Cap screw (4 used)
3. Rebound washer (4 used)
4. Flange nut (12 used)
5. Engine mount (4 used)
6. Cap screw (2 used per mount)
7. Engine mount bracket (2 used)
8. Lock washer
9. Engine mount bracket (2 used)
10. Cap screw (14 used)
11. Lock washer (18 used)
12. Cap screw (2 used)
13. Exhaust bracket
14. Cap screw (2 used)
15. Flange nut (2 used)
16. Exhaust pipe
17. Wire harness bracket
18. Cap screw (3 used)
19. Wire harness bracket
20. Lock washer (2 used)
21. Cap screw (2 used)
22. Clamp assembly

Engine Removal (Figure 21)

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the key switch.
2. Disconnect negative battery cable from battery terminal and then disconnect positive cable from battery (see Battery Service (page 6–91)).
3. Raise and support hood.

CAUTION

Do not open radiator cap or drain coolant if the radiator or engine is hot. Allow the engine and exhaust system to cool before working on the engine. Pressurized, hot coolant can escape and cause burns.

Ethylene−glycol antifreeze is poisonous. Dispose of coolant properly or store it in a properly labeled container away from children and pets.

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4. Drain coolant from the radiator into a suitable container (see Radiator and Oil Cooler Assembly (page 4–17)). Disconnect upper and lower hoses from the radiator.
5. Remove air cleaner assembly from engine (see Air Cleaner System (page 4–11)).
6. Remove exhaust pipe (item 16 in Figure 21) and exhaust bracket (item 13 in Figure 21 or item 6 in Figure 26) from engine.

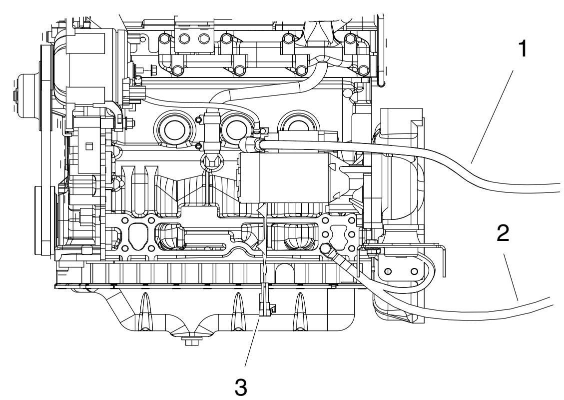

Figure 22

1. Positive battery cable
2. Negative battery cable
3. Fusible link harness

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7. Note location of cable ties used to secure wire harness to the machine. Disconnect wires and/or electrical connections from the following electrical components:
   A. The engine wire harness from the machine wire harness.
   B. The positive battery cable from the engine starter motor (Figure 22).
   C. The fusible link harness from the main wire harness (Figure 22).
   D. The negative battery cable at the engine block (Figure 22).
8. Carefully disconnect engine wire harness connector from engine ECU.

Engine Removal (Figure 21) (continued)

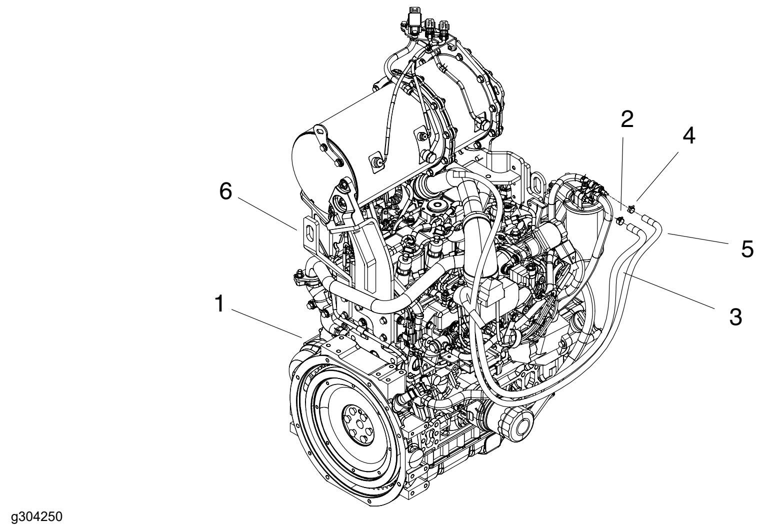

Figure 23
MODELS 30606 and 30608

1. Tier 4 engine
2. Hose clamp
3. Fuel supply hose
4. Hose clamp
5. Fuel return hose
6. Front lift bracket

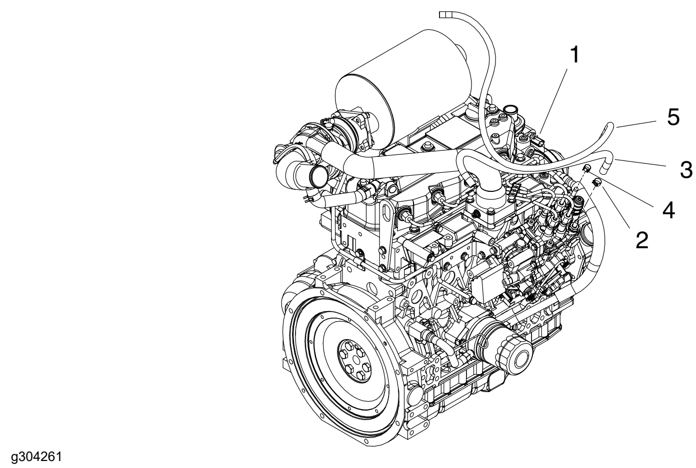

Figure 24
MODELS 30602 and 30604

1. Tier 4i engine
2. Hose clamp
3. Fuel supply hose
4. Hose clamp
5. Fuel return hose

9. Disconnect fuel supply and return hoses from engine (Figure 23 or Figure 24). Position fuel hoses away from engine.
10. Remove fasteners that secure the coolant reservoir tank mount to the radiator and radiator shrouds (Figure 25). Position and support coolant reservoir with mount away from the engine.
11. On machines with a Tier 4 compliant engine (models 30606, 30608 and 30644):
    A. Remove fuel tank to allow engine to be raised from machine (see Fuel System (page 4–14)).

Engine Removal (Figure 21) (continued)

B. Install lift bracket to front of engine cylinder head (item 6 in Figure 23). Front lift bracket was included with new machine or is available as a service part (refer to *Parts Catalog* for part number).

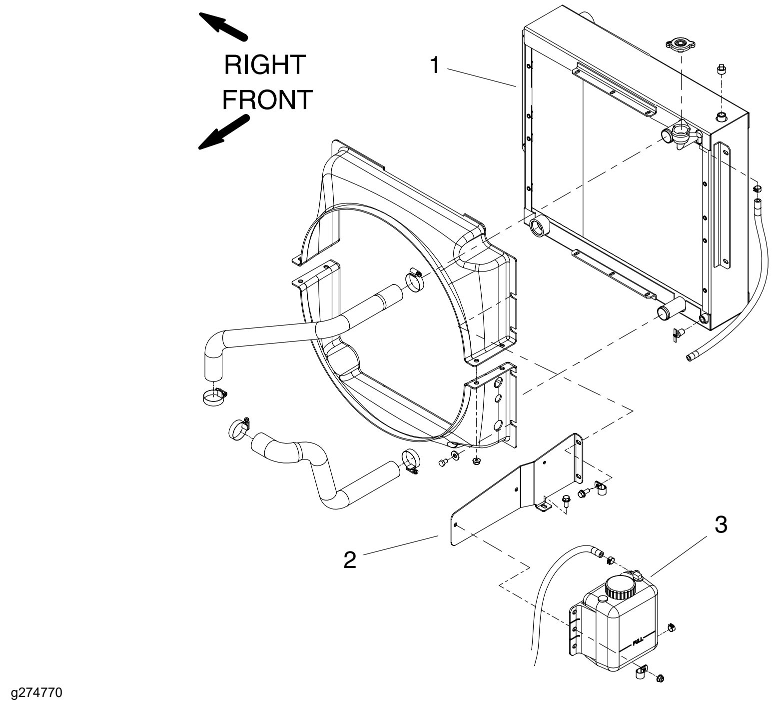

Figure 25

1. Radiator/oil cooler
2. Tank Mount
3. Coolant reservoir

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12. On Groundsmaster 4110−D machines:

    A. Remove air conditioning compressor from compressor mount (see Air Conditioning Compressor (page 11–6)). Position compressor away from engine taking care to not damage compressor or AC hoses. Support compressor to make sure it will not fall during engine removal.

    B. Disconnect coolant hoses from fittings on engine water flange. On Groundsmaster 4110−D machines with a Tier 4 compliant engine (model 30606 and 30644), disconnect coolant hose from fitting on lower radiator hose assembly. Label coolant hoses for proper assembly.

IMPORTANT

The hydraulic pump assembly can remain in machine during engine removal. To prevent pump from shifting or falling, make sure to support pump assembly before the fasteners that secure pump assembly to engine are removed.

13. Support hydraulic pump assembly. Remove fasteners that secure pump assembly to engine (see Gear Pump (page 5–97)).
14. Note location of all cable ties securing the wire harness, fuel lines and hydraulic hoses to the engine for assembly purposes. Remove cable ties as needed for engine removal.
15. Connect lift or hoist to the lift brackets on engine.

Engine Removal (Figure 21) (continued)

16. Remove flange nuts, rebound washers and cap screws that secure the engine mount brackets to the engine mounts.

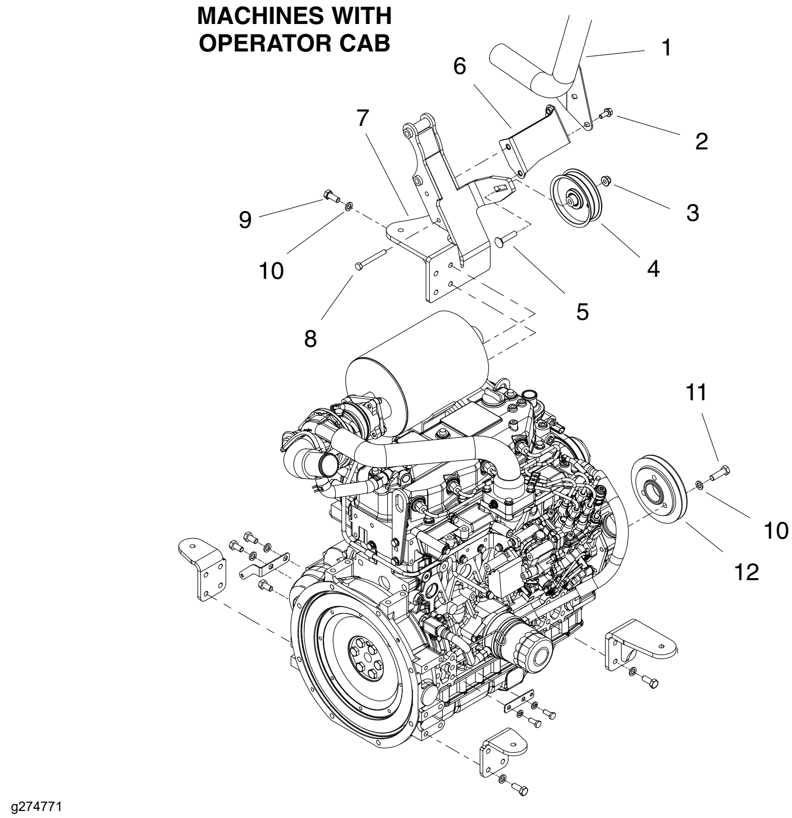

Figure 26

1.	Exhaust pipe	7.	Compressor mount
2.	Flange screw (2 used)	8.	Cap screw (2 used)
3.	Flange nut	9.	Cap screw (4 used)
4.	Idler pulley	10.	Lock washer
5.	Carriage screw	11.	Cap screw (3 used)
6.	Exhaust bracket	12.	Pulley

CAUTION

One person should operate lift or hoist while a second person guides the engine out of the machine.

IMPORTANT

Make sure to not damage the engine, radiator assembly, fuel lines, hydraulic lines, electrical wire harness or other components while removing the engine.

17. Slowly move the engine assembly away from the hydraulic pump assembly to allow the pump input shaft to slide out of the spring coupler on the engine flywheel. Once the engine has cleared the pump input shaft, carefully remove the engine from the machine.

Engine Removal (Figure 21) (continued)

18. If necessary, remove engine mount brackets from the engine using Figure 21 or Figure 26 as a guide.

Engine Installation (Figure 21)

1. Make sure that all parts removed from the engine during maintenance or rebuilding are installed to the engine.
2. If removed, install engine mount brackets to the engine using Figure 21 or Figure 26 as a guide.
3. Connect lift or hoist to the engine lift brackets.

CAUTION

One person should operate lift or hoist while a second person guides the engine into the machine.

IMPORTANT

Make sure to not damage the engine, radiator assembly, fuel lines, hydraulic lines, electrical wire harness or other components while installing the engine.

---

4. Carefully lower engine into the machine. Slowly move the engine assembly toward the hydraulic pump assembly to allow the pump input shaft to slide into the spring coupler on the engine flywheel.
5. Align engine to the engine mounts. Secure engine to engine mounts with cap screws, rebound washers and flange nuts.
6. Secure hydraulic pump assembly to engine (see Gear Pump (page 5–97)).
7. On machines with a Tier 4 compliant engine (models 30606, 30608 and 30644):
   A. Remove lift bracket from front of engine cylinder head (item 6 in Figure 23). The bracket must be removed before fuel tank installation. Retain lift bracket and fasteners for future use.
   B. Install and secure fuel tank to machine (see Fuel System (page 4–14)).
8. Position coolant reservoir with mount to the radiator. Secure reservoir tank mount to the radiator and radiator shrouds with removed fasteners.
9. Connect fuel supply and return hoses to the engine fittings (Figure 23 or Figure 24).
10. On Groundsmaster 4110−D machines:
    A. Install air conditioning compressor to compressor mount (see Air Conditioning Compressor (page 10–5)). Make sure that drive belt is properly tensioned.
    B. Connect coolant hoses to fittings on engine water flange.
11. Connect wires and/or electrical connections to engine locations.
    A. The engine wire harness from the machine wire harness.
    B. The positive battery cable from the engine starter motor (Figure 22).
    C. The fusible link harness from the main wire harness (Figure 22).
    D. The negative battery cable at the engine block (Figure 22).

Engine Installation (Figure 21) (continued)

12. Carefully connect engine wire harness connector to engine ECU.
13. Install and secure exhaust bracket (item 13 in Figure 21 or item 6 in Figure 26) and exhaust pipe (item 16 in Figure 21) from engine.
14. Install air cleaner assembly to the engine (see Air Cleaner System (page 4–11)).
15. Connect coolant hoses to the radiator. Make sure radiator draincock is closed. Fill radiator and coolant reservoir with coolant.
16. Secure the wire harness, fuel lines and hydraulic hoses to the engine with cable ties as noted during engine removal.
17. Check position of electrical wires, fuel lines and hydraulic lines for proper clearance with rotating, high temperature and moving components.
18. Connect positive battery cable to positive battery terminal first and then connect negative cable to battery (see Battery Service (page 6–91)).
19. Check and adjust engine oil as needed.
20. Bleed air from the cooling system. Check and adjust the coolant levels accordingly.
21. Check and adjust oil level in hydraulic reservoir as needed.
22. Prime the fuel system (see Fuel System (page 4–14)).
23. Start engine and operate hydraulic controls to properly fill hydraulic system (see Charge Hydraulic System (page 5–91)).
24. Close and secure hood.

Spring Coupler

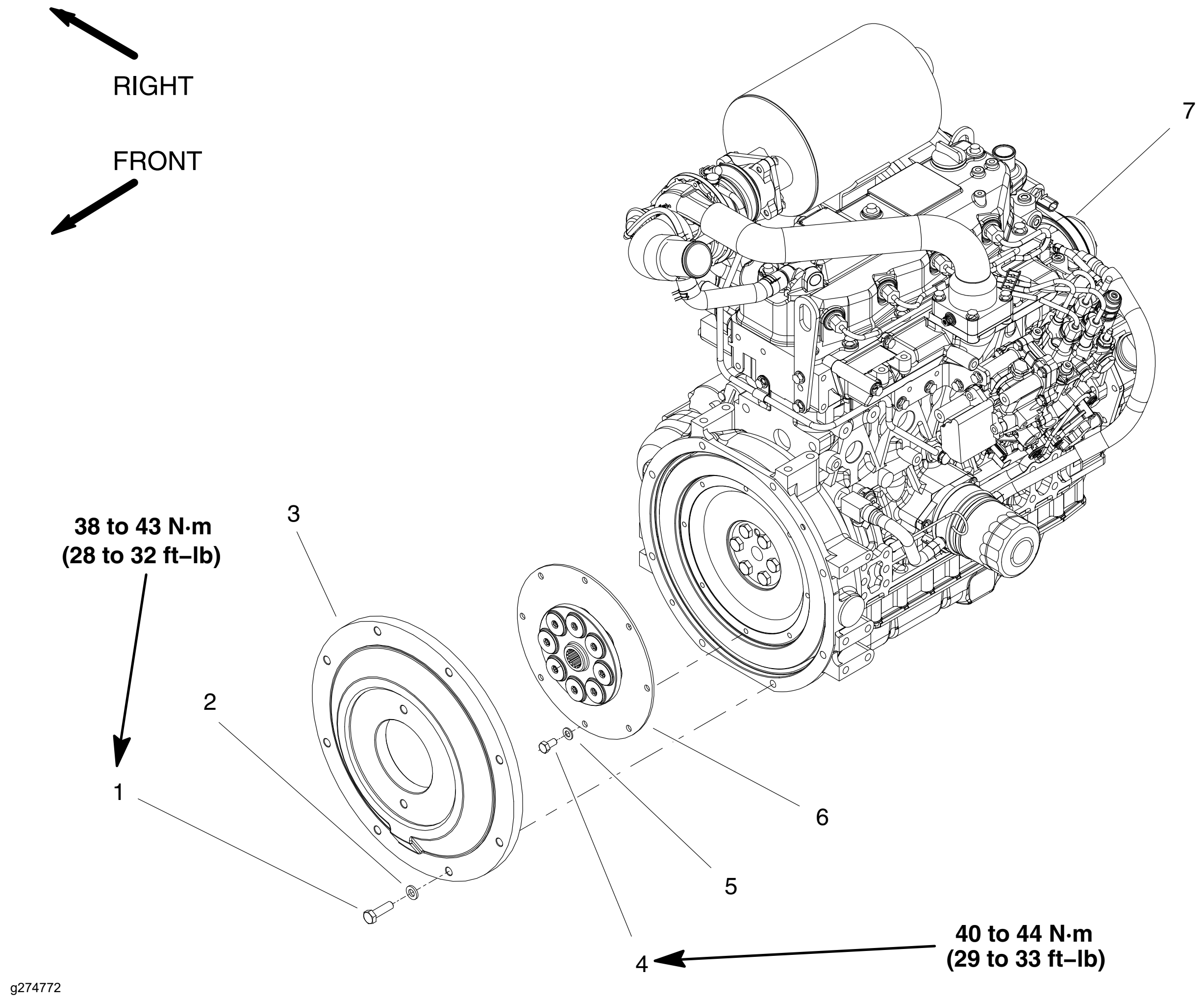

Figure 27

1. Cap screw (8 used)
2. Washer (8 used)
3. Flywheel plate
4. Cap screw (8 used)
5. Washer (8 used)
6. Spring coupler
7. Engine (model 30604 shown)

Coupler Removal (Figure 27)

Note: The hydraulic pump assembly needs to be removed from engine before coupler can be removed.

1. If engine is in machine, remove hydraulic pump assembly from machine (see Piston (Traction) Pump (page 5–105)).
2. Remove flywheel plate and spring coupler from engine using Figure 27 as a guide.

Coupler Installation (Figure 27)

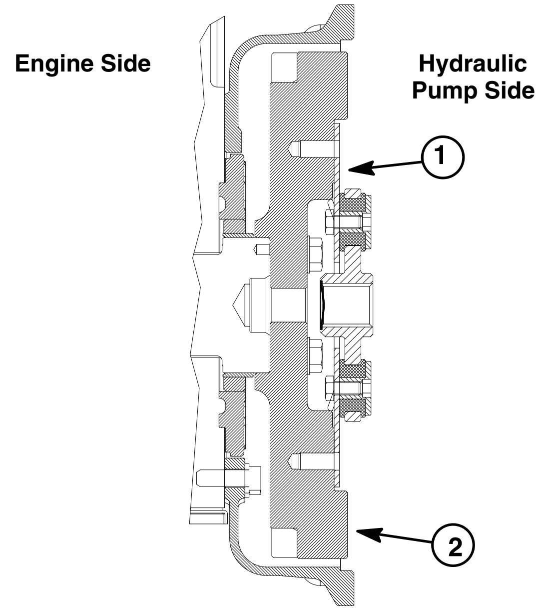

Figure 28

1. Coupler
2. Engine flywheel

---

1. Position spring coupler to engine flywheel and align mounting holes. Make sure that coupling hub is away from engine flywheel (Figure 28).
2. Secure coupler to flywheel with eight (8) cap screws and washers. Torque cap screws in a crossing pattern from **40 to 44 N·m (29 to 33 ft−lb)**.
3. Position flywheel plate to engine. Secure flywheel plate with eight (8) cap screws (item 1) and washers using a crossing pattern tightening procedure. Torque cap screws in a crossing pattern from **38 to 43 N·m (28 to 32 ft−lb)**.
4. If engine is in machine, install hydraulic pump assembly to machine (see Piston (Traction) Pump (page 5–105)).

Exhaust System (Models 30606, 30608 and 30644)

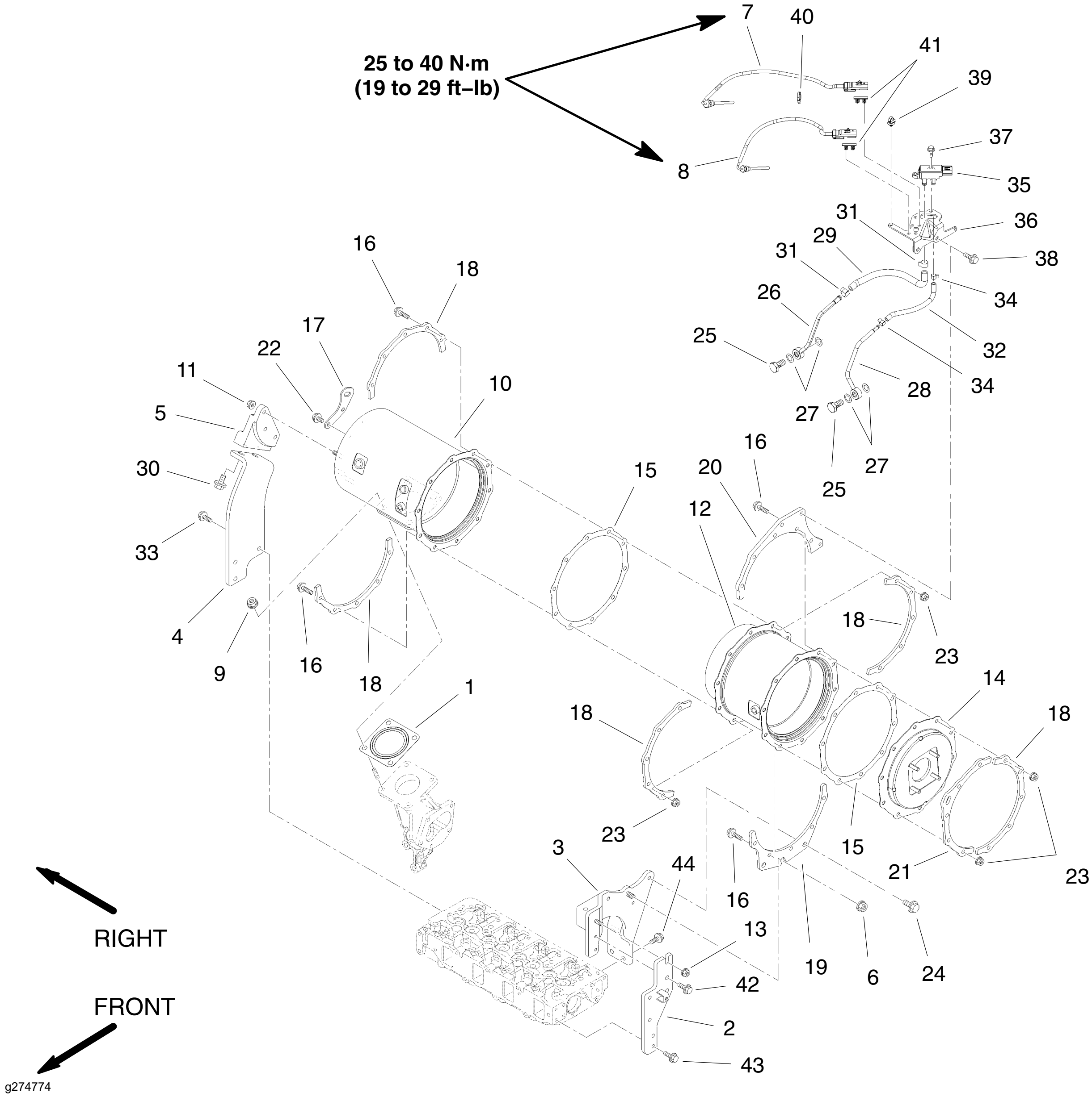

Figure 29

1. Gasket
2. Exhaust assembly stay
3. Exhaust assembly stay
4. Exhaust assembly stay
5. Exhaust assembly stay
6. Nut
7. DOC temp sensor (inlet)
8. DOC temp sensor (outlet)
9. Nut (4 used)
10. DOC assembly
11. Nut (3 used)
12. DPF assembly
13. Nut
14. Outlet flange
15. DPF gasket (2 used)
16. Bolt (20 used)
17. DPF lifter
18. DPF stiffener (5 used)
19. DPF stiffener
20. DPF stiffener
21. DPF stiffener
22. Bolt (2 used)
23. Nut (20 used)
24. Bolt (2 used)
25. Pipe joint bolt (2 used)
26. Exhaust pressure pipe (DPF inlet)
27. Sensor gasket (4 used)
28. Exhaust pressure pipe (DPF outlet)
29. Exhaust hose
30. Bolt (2 used)
31. Hose clip (2 used)
32. Hose
33. Bolt (3 used)
34. Hose clip (2 used)
35. Pressure sensor
36. Sensor bracket
37. Bolt (2 used)
38. Bolt (2 used)
39. Clip band
40. Band
41. Connector clip (2 used)
42. Bolt (2 used)
43. Bolt (2 used)
44. Bolt (2 used)

Groundsmaster models that are powered by a diesel engine that complies with EPA Tier 4 emission regulations are equipped with an exhaust system that includes a diesel oxidation catalyst (DOC) and a diesel particulate filter (DPF). These exhaust components require service or component replacement at intervals identified in your *Operator's Manual*. Additionally, the exhaust assembly uses two (2) temperature sensors and a pressure differential sensor which are used as inputs for the engine ECU to monitor the operation of the exhaust system.

The diesel particulate filter (DPF) is cleaned periodically through a regenerative process that is controlled by the engine ECU (see Yanmar Engine: Models 30606, 30608 and 30644 in the General Information section of this chapter). The InfoCenter display will identify the status of DPF regeneration. At recommended intervals, DPF reconditioning is necessary which will require exhaust system disassembly, DPF removal and DPF reconditioning by a company that has the necessary equipment. Once the DPF has gone through the reconditioning process, it can be re−installed in the exhaust system. Contact your Toro Distributor for information on reconditioning the DPF.

The diesel oxidation catalyst (DOC) has a service life expectancy and requires replacement at recommended intervals. Replacement of the DOC will require exhaust system disassembly, removal of the existing DOC and installation of the new DOC. Contact your Toro Distributor for information.

Refer to the *Parts Catalog* to identify individual components for the exhaust system on your Groundsmaster. Contact your Toro Distributor for information.

Removal (Figure 29 and Figure 30)

Note: The exhaust system DPF and DOC can be removed from the exhaust system without removing the entire exhaust from the engine. Certain engine service procedures (e.g. rocker cover removal for valve clearance adjustment) will require removal of the exhaust system assembly.

⚠ CAUTION ⚠

The muffler and exhaust pipe may be hot. To avoid possible burns, allow the engine and exhaust system to cool before working on the exhaust system.

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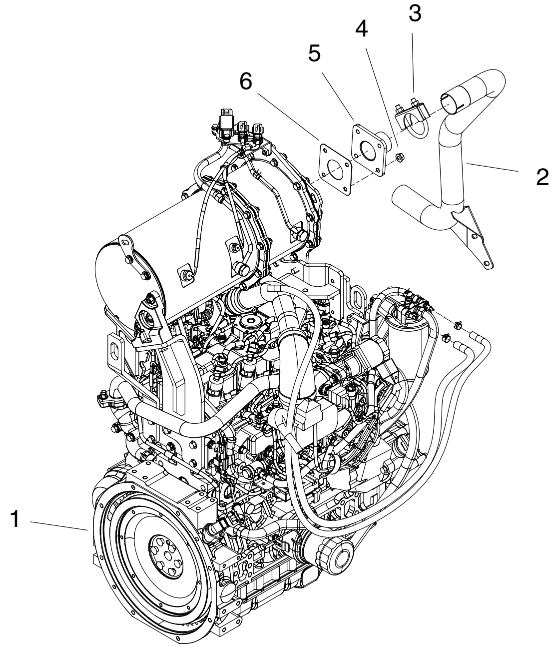
1. Raise and support hood to gain access to exhaust system. Allow engine and exhaust to cool before doing any disassembly of exhaust system components.

Removal (Figure 29 and Figure 30) (continued)



g274775

Figure 30

1. Engine
2. Exhaust pipe
3. Clamp assembly
4. Flange nut (4 used)
5. Exhaust flange
6. Exhaust gasket

---

2. Remove exhaust system components from the engine as necessary using Figure 29 and Figure 30 as guides. Discard all removed gaskets (items 1 and 15 in Figure 29 or item 6 in Figure 30).

Installation (Figure 29 and Figure 30)

Note: Make sure that all exhaust system flanges and sealing surfaces are free of debris or damage that may prevent a tight seal.

1. Make sure to install new gaskets in place of all gaskets that were removed. Do not use any type of gasket sealant on gasket or flange surfaces.
2. Assemble all removed exhaust system components using Figure 29 and Figure 30 as guides.

   A. If exhaust sensors (items 7 and 8 in Figure 29) were removed, torque sensors from **25 to 40 N·m (19 to 29 ft−lb)**.

   B. If exhaust pressure pipes (items 26 and 28 in Figure 29) were removed, replace sensor gaskets (item 27) on both sides of the pressure pipe fitting.

   C. If DPF stiffeners (items 18, 19, 20 and 21 in Figure 29) were loosened or removed, tighten fasteners that secure stiffeners before tightening fasteners that secure exhaust system to DPF stays.

Chapter 5

Hydraulic System

Table of Contents

Additional Reference Materials

Danfoss H1 Closed Circuit Axial Piston Pumps Service Manual

Danfoss H1 Closed Circuit Axial Pistonpumps Repair Instructions

Danfoss K And L Frame Variable Motors Service Manual

Danfoss Steering Unit Type OSPM Service Manual

Danfoss MP1 Closed Circuit Axial Piston Pumps Service Manual

Eaton Parts And Repair Information: 5 Series Steering Control Units

General Information

Operator's Manual

The *Operator's Manual* provides information regarding the operation, general maintenance and maintenance intervals for your Groundsmaster machine. Refer to that publication for additional information when servicing the machine.

Check Hydraulic Fluid

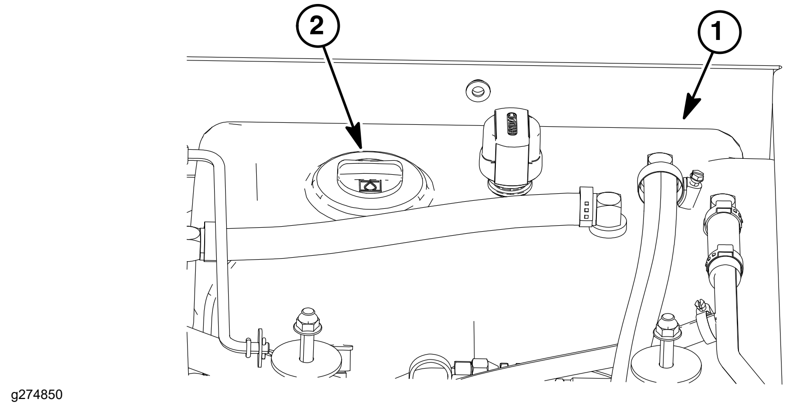


Figure 31

1. Hydraulic reservoir
2. Reservoir cap

The Groundsmaster hydraulic system is designed to operate on anti−wear hydraulic fluid. The hydraulic reservoir located beneath the operator seat holds approximately 29.3 liters (7.75 U.S. gallons) of hydraulic fluid. Check level of hydraulic fluid daily. See *Operator's Manual* for fluid level checking procedure and oil recommendations.

Relieving Hydraulic System Pressure

Before disconnecting or performing any work on the hydraulic system, all pressure in the hydraulic system must be relieved. Park machine on a level surface, make sure that PTO switch is OFF, lower cutting decks fully, stop engine and engage parking brake. Wait for all moving parts to come to a complete stop.

System pressure in lift circuit is relieved when the cutting decks are fully lowered.

System pressure in mow circuit is relieved when the PTO switch is disengaged.

To relieve hydraulic pressure in traction circuit, turn key switch to ON (engine not running) and move traction pedal to both forward and reverse directions. Turn key switch to OFF after relieving traction circuit pressure.

To relieve hydraulic pressure in steering circuit, rotate steering wheel in both directions.

After all hydraulic system pressures have been relieved, remove key from key switch.

Towing Traction Unit

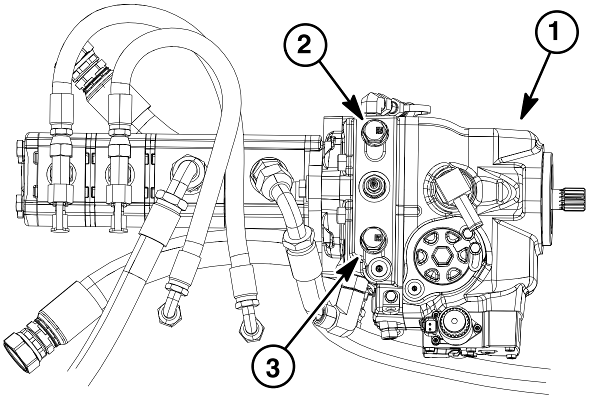


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Figure 32

(For machines serial number below 400000000)

1. Piston pump
2. Relief valve (forward)
3. Relief valve (reverse)

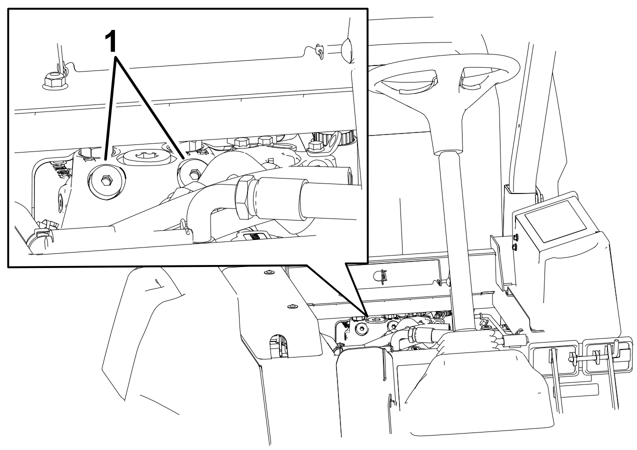

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Figure 33

(For machines serial number above 400000000)

1. Relief valves

IMPORTANT

If towing limits are exceeded, severe damage to the piston (traction) pump may occur.

If it becomes necessary to tow (or push) the machine, tow (or push) in a forward direction only and at a speed below 5 kph (3 mph). The piston (traction) pump relief valves (both forward and reverse) need to be loosened three (3) revolutions to allow the machine to be moved (Figure 32 and Figure 33). To prevent leakage from relief valves, do not loosen them more than three (3) revolutions. Refer to your *Operator's Manual* for additional towing instructions.

IMPORTANT

Do not loosen relief valves when engine is running.

Towing Traction Unit (continued)

Before returning machine to service, tighten both of the relief valves until seated. Then, torque relief valves to **70 N·m (52 ft−lb)**.

IMPORTANT

If the machine must to be pushed or towed in reverse, the check valve in the rear traction manifold must also be bypassed. To bypass this check valve, connect a hydraulic hose assembly to the reverse traction pressure test port, located on the piston (traction) pump, and on the port located in−between ports M8 and P2 on the rear traction manifold which is located behind the front tire. Use Toro part numbers 95−8843 (hydraulic hose), 95−0985 (quantity 2) (coupler fitting) and 340−77 (quantity 2) (hydraulic fitting).

Traction Circuit Component Failure

The traction circuit on Groundsmaster 4100−D and 4110−D machines is a closed loop system that includes the piston (traction) pump, two (2) front wheel motors and the rear axle motor. If a component in the traction circuit should fail, debris and contamination from the failed component will circulate throughout the traction circuit. This contamination can damage other components in the circuit so it must be removed to prevent additional component failure.

The recommended method of removing traction circuit contamination would be to temporarily install the Toro high flow hydraulic filter (see Special Tools (page 2–17)) into the circuit. This filter should be used when connecting hydraulic test gauges in order to test traction circuit components or after replacing a failed traction circuit component (e.g. traction (piston) pump or wheel motor). The filter will ensure that contaminates are removed from the closed loop and thus, do not cause additional component damage.

Once the Toro high flow hydraulic filter kit has been placed in the circuit, raise and support the machine with all wheels off the ground. Then, operate the traction circuit to allow oil flow throughout the circuit. The filter will remove contamination from the traction circuit during operation. Because the Toro high flow filter is bi−directional, the traction circuit can be operated in both the forward and reverse direction. The filter should be removed from the machine after contamination has been removed from the traction circuit. See Filtering Closed−Loop Traction Circuit (page 5–89) for additional information on using the Toro high flow hydraulic filter.

The alternative to using the Toro high flow hydraulic filter kit after a traction circuit component failure would be to disassemble, drain and thoroughly clean all components, hydraulic tubes and hydraulic hoses in the traction circuit. If any debris remains in the traction circuit and the machine is operated, the debris can cause additional circuit component failure.

Hydraulic Hoses

The hydraulic hoses are subject to extreme conditions such as pressure differentials during operation and exposure to weather, sun, chemicals, very warm storage conditions, in addition to mishandling during operation and maintenance. These conditions can cause damage to the hose or deterioration to the hose material. Some hoses are more susceptible to these conditions than others. Examine all of the hydraulic hoses of the machine frequently and repair or replace them as necessary. Hoses that move during normal machine operation should be replaced every 2 years. Check hydraulic hoses for the following signs of deterioration or damage:

- Hydraulic hoses should not be hard, cracked, cut, abraded, charred, leaking, or otherwise damaged.
- Hydraulic hoses should not be kinked, crushed, flattened, or twisted.
- Hydraulic hose covers should not be blistered, soft, degraded, or loose.
- Hydraulic hose fittings should not be cracked, damaged, or badly corroded.

WARNING

Release all pressure in the hydraulic system before performing any work on the hydraulic system:

- **Keep your body and hands away from pin-hole leaks or nozzles that eject hydraulic fluid under high pressure.**
- **Do not use your hands to search for leaks; use a piece of paper or cardboard.**
- **Hydraulic fluid escaping under pressure can have sufficient force to penetrate the skin and cause serious injury.**
- **If hydraulic fluid is injected into your skin, the fluid damage to your body must be surgically removed within a few hours by a doctor familiar with this form of injury or gangrene may result.**

When you replace a hydraulic hose, ensure that the hose is straight (not twisted) before you tighten the fittings. Observe the imprint (lay line) on the hose to do this. Using two wrenches, hold the hose straight with one wrench and tighten the hose swivel nut onto the fitting with the other wrench; refer to Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–8).

Note: If the hose has an elbow at one end, tighten the swivel nut on the elbow end before you tighten the nut on the straight end of the hose.

For more hydraulic hose information, refer to the Toro Basics Series Training Book *Hydraulic Hose Servicing* (Part No. 94813SL).

Installing Hydraulic Hoses and Tubes (O-Ring Face Seal)

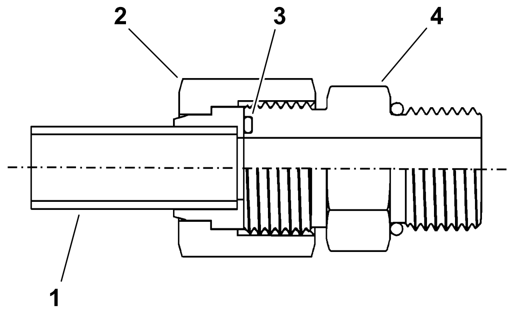

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Figure 34

1. Tube or hose
2. Swivel nut
3. O-ring
4. Fitting body

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1. Ensure that all the threads, the sealing surfaces of the hose/tube, and the fitting are free of burrs, nicks, scratches, or unwanted material.
2. To help prevent a hydraulic leak, replace the face seal O-ring when you open the connection. Ensure that the O-ring is installed and correctly seated in the groove of the fitting. Lightly lubricate the O-ring with clean hydraulic fluid.
3. Align the hose/tube against the body of the fitting so that the flat face of the hose/tube sleeve fully touches the O-ring in the fitting (Figure 34).
4. Use your hand to thread the swivel nut onto the fitting. While you hold the hose/tube in alignment with a wrench, use a torque wrench to tighten the swivel nut to the recommended torque value within the specified range of torque values; refer to the Hose/Tube Installation Torque Table (page 5–9). This procedure to tighten the swivel nut requires a drive-adapter wrench (e.g., crowfoot wrench).

   Note: It may be necessary to use a drive-adapter wrench (e.g., crowfoot wrench) to install a hydraulic fitting; refer to Calculating the Torque Values When Using a Drive-Adapter Wrench (page 2–10).

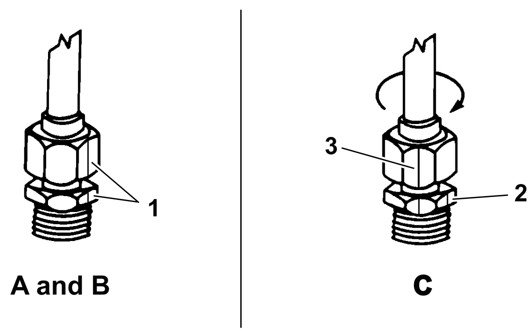

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Figure 35

1. Mark swivel nut and fitting body
2. Initial position
3. Final position

Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (continued)

Hose/Tube Installation Torque Table

Fitting Dash Size	Hose/Tube Side Thread Size (inch)—threads per inch)	Installation Torque
4	9/16—18	25 to 29 N·m (18 to 22 ft-lb)
6	11/16—16	37 to 44 N·m (27 to 33 ft-lb)
8	13/16—16	51 to 63 N·m (37 to 47 ft-lb)
10	1—14	82 to 100 N·m (60 to 74 ft-lb)
12	1–3/16—12	116 to 142 N·m (85 to 105 ft-lb)
16	1–7/16—12	150 to 184 N·m (110 to 136 ft-lb)
20	1–11/16—12	190 to 233 N·m (140 to 172 ft-lb)

Flats From Wrench Resistance Table

Size	FFWR
4 (1/4 inch nominal hose or tubing)	1/2 to 3/4
6 (3/8 inch)	1/2 to 3/4
8 (1/2 inch)	1/2 to 3/4
10 (5/8 inch)	1/2 to 3/4
12 (3/4 inch)	1/3 to 1/2
16 (1 inch)	1/3 to 1/2

5. If a torque wrench is not available or if space at the swivel nut prevents the use of a torque wrench, use the alternative procedure Flats From Wrench Resistance (FFWR) given below.

   A. Use a wrench to tighten the swivel nut onto the fitting until you feel light resistance with the wrench-approximately **3.39 N·m (30 in-lb)**.

   B. Put a mark on the swivel nut and body of the fitting (item 1 in Figure 35). If connecting a hose, hold the hose in alignment with a wrench to prevent the hose from turning.

   C. Use a wrench to tighten the nut to the correct Flats From Wrench Resistance (compare items 2 and 3 in Figure 35).

Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings)

Installing a Non-Adjustable Fitting

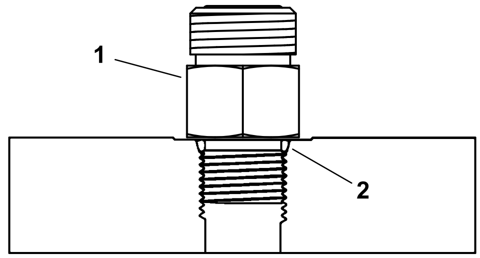

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Figure 36

1. Fitting
2. O-ring

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1. Ensure that all the threads, the sealing surfaces of fitting, and the component port are free of burrs, nicks, scratches, or unwanted material.
2. To help prevent a hydraulic leak, replace the O-ring when you open the connection.
3. Lightly lubricate the O-ring with clean hydraulic fluid. Ensure that the threads of the fitting are clean with no lubricant applied.

IMPORTANT

Before tightening the fitting, determine the material used for the port the fitting is being installed in. Installing a fitting into an aluminum port requires reducing the installation torque.

4. Install the fitting into the port, then use a torque wrench and socket to tighten the fitting to the recommended torque value within the specified range of torque values; refer to the Fitting Installation Torque Table (page 5–12).

   Note: It may be necessary to use a drive-adapter wrench (e.g., crowfoot wrench) to install a hydraulic fitting; refer to Calculating the Torque Values When Using a Drive-Adapter Wrench (page 2–10).

5. If a torque wrench is not available or if space at the port prevents the use of a torque wrench, use the Flats From Finger Tight (FFFT) procedure given below:

   A. Install the fitting into the port and tighten the fitting down full length until finger-tight.

   B. If the port material is steel, tighten the fitting to the listed value; refer to the Flats From Finger Tight (FFFT) Table (page 5–12).

   C. If the port material is aluminum, tighten the fitting to 60% of the listed value; refer to the Flats From Finger Tight (FFFT) Table (page 5–12).

Installing an Adjustable Fitting

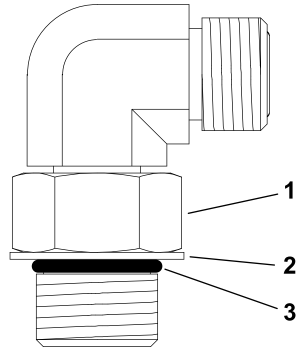

Figure 37

1. Locknut
2. Back-up washer
3. O-ring

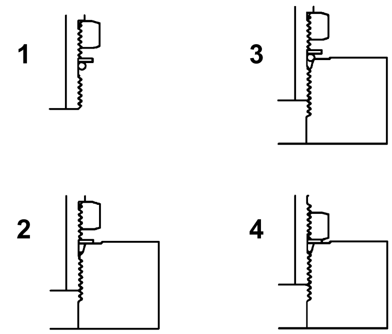

Figure 38

1. Step 1: clearance the lock nut
2. Step 2: seat the back-up washer
3. Step 3: align the fitting
4. Step 4: tighten the lock nut

1. Ensure that all the threads, the sealing surfaces of fitting, and the component port are free of burrs, nicks, scratches, or unwanted material.
2. To help prevent a hydraulic leak, replace the O-ring when you open the connection.
3. Lightly lubricate the O-ring with clean hydraulic fluid. Ensure that the threads of the fitting are clean with no lubricant applied.
4. Turn back the lock nut as far as possible. Ensure that the back-up washer is not loose and it is pushed up as far as possible (Step 1 in Figure 38).
5. Install the adjustable fitting into the port by hand until the washer contacts the face of the port (Step 2 in Figure 38).
6. If the adjustable fitting needs to align with another component, rotate the fitting counterclockwise until it is aligned to the desired position (Step 3 in Figure 38). Do not rotate the adjustable fitting more than 1 turn counterclockwise.

IMPORTANT

Before tightening the fitting, determine the material used for the port the fitting is being installed in. Installing a fitting into an aluminum port requires reducing the installation torque.

7. Tighten the fitting lock nut (Step 4 in Figure 38):

   A. Hold the fitting in the correct alignment with a wrench and use a torque wrench and tighten the lock nut to the recommended torque value within the specified range of torque values; refer to the Fitting Installation Torque Table (page 5–12). This tightening procedure requires a drive-adapter wrench (e.g., crowfoot wrench); refer to Calculating the Torque Values When Using a Drive-Adapter Wrench (page 2–10).

   B. If a torque wrench is not available or if space at the port prevents the use of a torque wrench, hold the fitting in the correct alignment with a wrench and tighten the lock nut with a second wrench.

   C. If the port material is steel, tighten the fitting to the listed Flats From Finger Tight (FFFT) value; refer to the Flats From Finger Tight (FFFT) Table (page 5–12).

   D. If the port material is aluminum, tighten the fitting to 60% of the listed FFFT value; refer to the Flats From Finger Tight (FFFT) Table (page 5–12).

Fitting Installation Torque Table

Fitting Dash Size	Fitting Port Side Thread Size (inch)—threads per inch)	Installation Torque Into Steel Port	Installation Torque Into Aluminum Port
4	7/16—20	21 to 25 N·m (15 to 19 ft-lb)	13 to 15 N·m (9 to 11 ft-lb)
5	1/2—20	25 to 29 N·m (18 to 22 ft-lb)	15 to 20 N·m (11 to 15 ft-lb)
6	9/16—18	47 to 56 N·m (34 to 42 ft-lb)	28 to 35 N·m (20 to 26 ft-lb)
8	3/4—16	79 to 97 N·m (58 to 72 ft-lb)	48 to 58 N·m (35 to 43 ft-lb)
10	7/8—14	135 to 164 N·m (99 to 121 ft-lb)	82 to 100 N·m (60 to 74 ft-lb)
12	1–1/16—12	182 to 222 N·m (134 to 164 ft-lb)	110 to 134 N·m (81 to 99 ft-lb)
14	1–3/16—12	217 to 265 N·m (160 to 196 ft-lb)	131 to 160 N·m (96 to 118 ft-lb)
16	1–5/16—12	274 to 336 N·m (202 to 248 ft-lb)	165 to 202 N·m (121 to 149 ft-lb)
20	1–5/8—12	335 to 410 N·m (247 to 303 ft-lb)	202 to 248 N·m (149 to 183 ft-lb)

Flats From Finger Tight (FFFT) Table

Size	FFFT
4 (1/4 inch nominal hose or tubing)	1.00 ± 0.25
6 (3/8 inch)	1.50 ± 0.25
8 (1/2 inch)	1.50 ± 0.25
10 (5/8 inch)	1.50 ± 0.25
12 (3/4 inch)	1.50 ± 0.25
16 (1 inch)	1.50 ± 0.25

Hydraulic Schematic

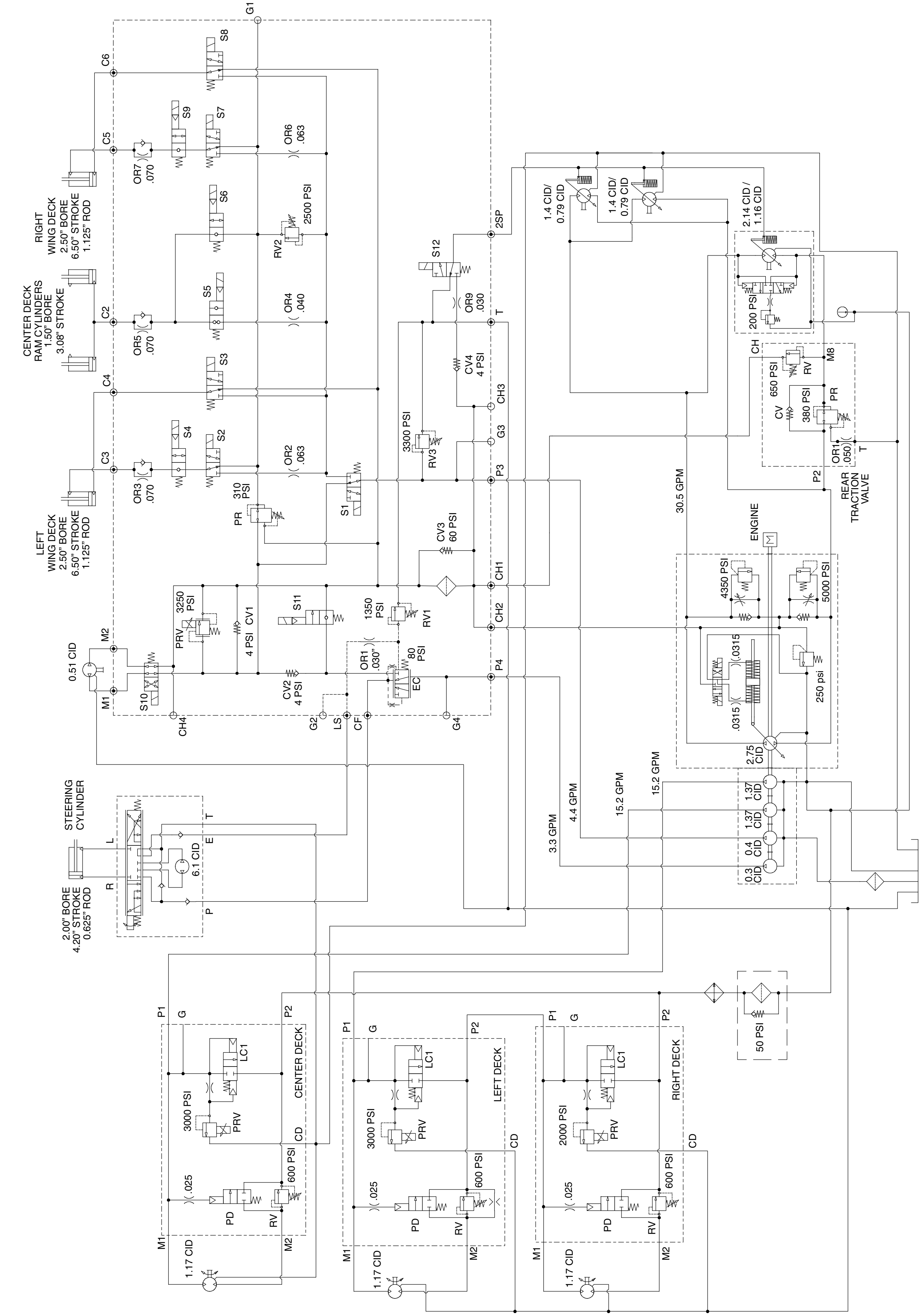

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Figure 39

Hydraulic Flow Diagrams

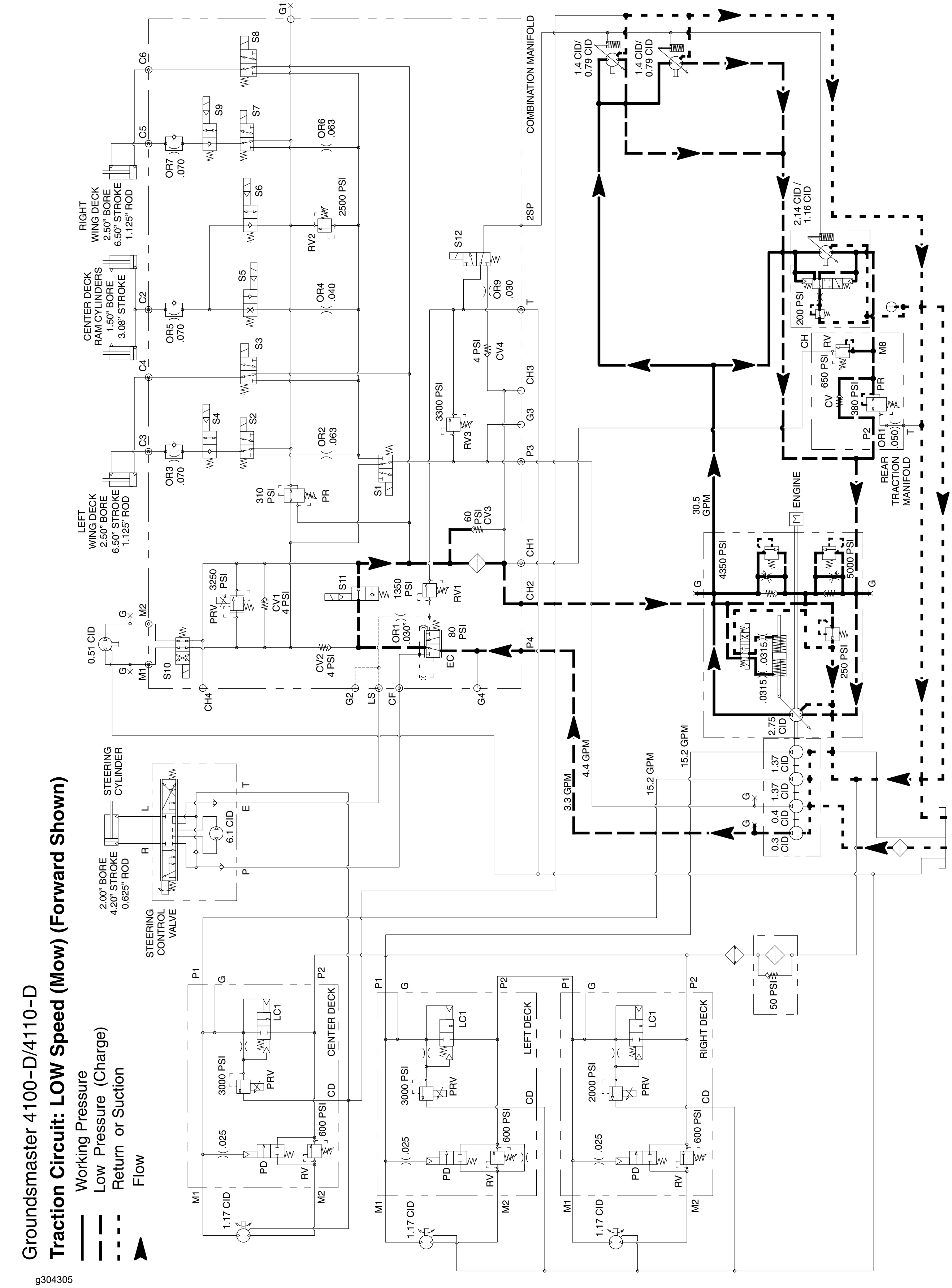

Figure 40

Traction Circuit: LOW Speed (Mow)

The traction circuit piston pump is a variable displacement pump that is directly coupled to the engine flywheel. This pump utilizes an integral electro−hydraulic servo piston assembly that controls the rate and direction of hydraulic flow. Pressing the traction pedal rotates a potentiometer that provides an input to the machine TEC controller. The controller in turn sends a corresponding PWM (Pulse Width Modulation) output to the electronic pump control to rotate the pump swash plate accordingly to control pump output and direction. Traction circuit oil is directed to the dual displacement front wheel and rear axle motors. Operating pressure on the high pressure side of the closed traction circuit loop is determined by the amount of load developed at the wheel and axle motors. As the traction load increases, circuit pressure can increase to relief valve settings: 300 bar (4350 PSI) in forward and 345 bar (5000 PSI) in reverse. If traction circuit pressure exceeds the relief setting, oil flows through the piston pump relief valve to the low pressure side of the closed loop traction circuit. Traction circuit pressure can be measured at test ports attached to the sides of the piston pump. The forward traction port is on the right side of the pump and the reverse traction port is on the left side.

Front wheel and rear axle motors are positive displacement, two speed variable motors that allow operation in either LOW (mow) or HI (transport) speed. The motors are spring biased to maximum displacement for LOW speed and are hydraulically shifted to minimum displacement for HI speed. The rear axle motor includes a flushing valve that bleeds off a small amount of hydraulic oil for cooling of the closed loop traction circuit. The charge circuit replaces oil that is bled from the circuit by the flushing valve.

The Smart Power™ feature prevents the engine from slowing down in heavy load conditions (e.g. cutting tall grass) by automatically decreasing the traction speed if necessary. With a reduced traction speed, the cutting blades can continue to be at optimum speed.

Traction circuit components use small amounts of hydraulic oil for internal lubrication. Fluid is designed to leak across traction pump and motor components into the case drain. This leakage results in the loss of hydraulic oil from the closed loop traction circuit that is replaced by the charge circuit. The gear pump sections that supply the steering, cooling fan and lift/lower circuits also provide charge circuit oil.

Gear pump flow for the charge circuit is directed through the oil filter and to the low pressure side of the closed loop traction circuit. Charge pressure is limited to 17 bar (250 PSI) by a relief valve located in the piston pump.

An optional traction circuit flow divider splits traction pump hydraulic flow between the front wheel motors (approximately 43%) and rear axle motor (approximately 57%) to prevent excessive circuit flow going to a spinning wheel.

Forward Direction

With the armrest console HI/LOW speed switch in the LOW speed (mow) position, solenoid valve (S12) in the combination manifold is not energized which keeps the front wheel motors and rear axle motor at their maximum displacement. With the motors at maximum displacement, a lower traction speed is available for mowing conditions.

When the HI/LOW switch is in the LOW speed (mow) position and the traction pedal is pushed in the forward direction, oil from the piston pump passes through the front traction manifold. Oil flow for the front wheel motors leaves front traction manifold port M1 to drive the front wheel motors in the forward direction and then returns to the piston pump. Oil flow from front traction manifold port M2 is directed to drive the rear axle motor in the forward direction. Oil returning from the axle motor enters the rear traction manifold at the M8 port. Flow bypasses the PR cartridge through the CV check valve, out manifold port P2 and returns to the piston pump.

When going down a hill, the tractor becomes an over− running load that drives the front wheel and rear axle motors. In this condition, the rear axle motor could lock up as the oil pumped from the motor increases pressure as it returns to the piston pump. To prevent rear wheel lock up, an adjustable relief valve (RV) in the rear traction manifold reduces rear axle motor pressure created in down hill, dynamic braking conditions.

Reverse Direction

The traction circuit operates essentially the same in reverse LOW speed (mow) as it does in the forward direction. However, the flow through the circuit is reversed. Oil flow from the piston pump is directed to the front wheel motors and also to the rear traction manifold. The oil to the front wheel motors drives them in the reverse direction and then returns to the piston pump through the front traction manifold. The oil to the rear traction manifold enters the manifold at port P2 and flows through pressure reducing valve (PR) which limits the down stream pressure to the rear axle motor to 26 bar (380 PSI) so the rear wheels will not scuff the turf during reverse operation. This reduced pressure flow is directed out rear traction manifold port M8 to drive the rear axle motor in reverse. Return oil from the rear motor returns to the piston pump.

Traction Circuit: HI Speed (Transport)

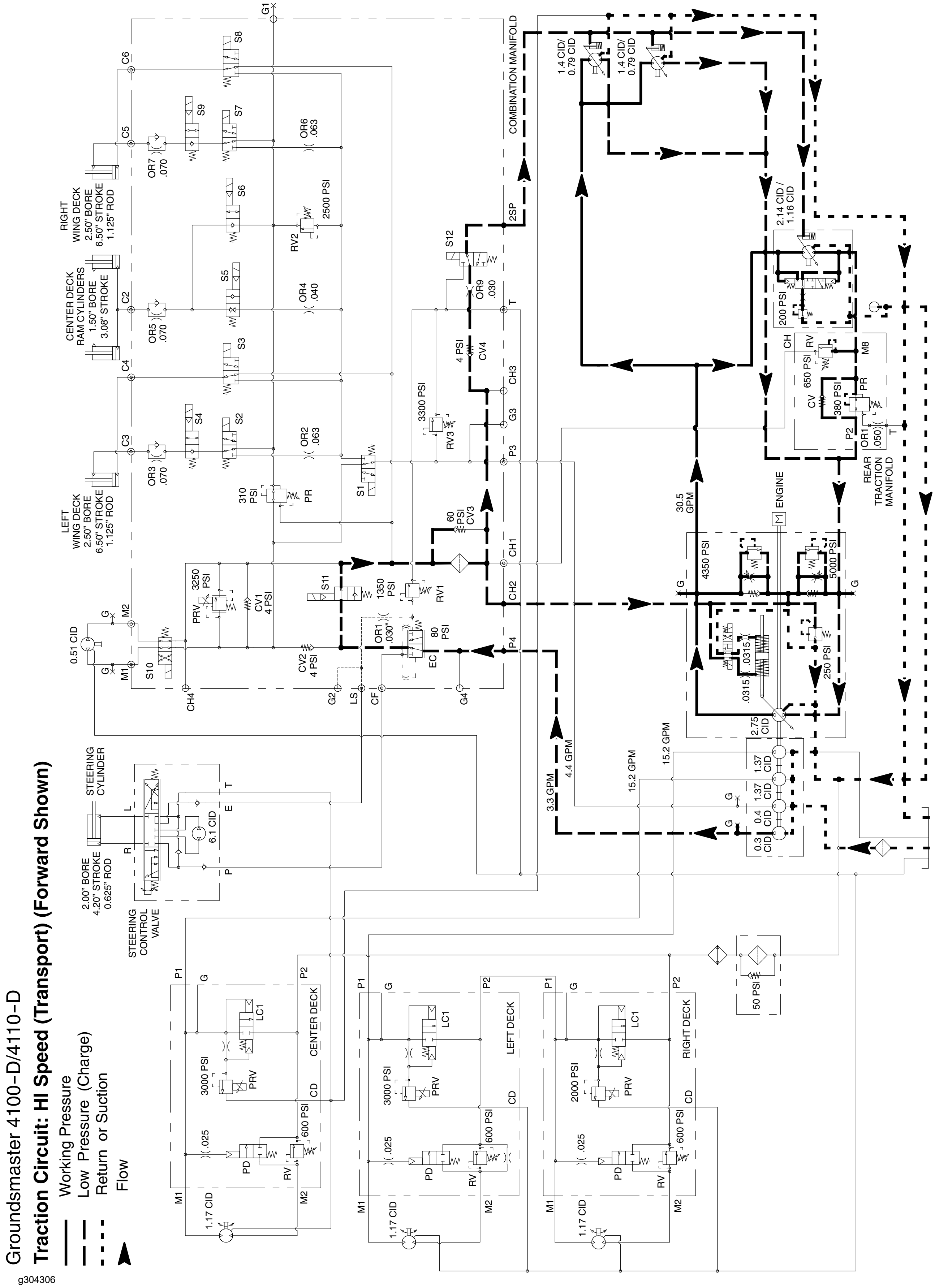

Figure 41

The traction circuit piston pump is a variable displacement pump that is directly coupled to the engine flywheel. This pump utilizes an integral electro−hydraulic servo piston assembly that controls the rate and direction of hydraulic flow. Pressing the traction pedal rotates a potentiometer that provides an input to the machine TEC controller. The controller in turn sends a corresponding PWM (Pulse Width Modulation) output to the electronic pump control to rotate the pump swash plate accordingly to control pump output and direction. Traction circuit oil is directed to the dual displacement front wheel and rear axle motors. Operating pressure on the high pressure side of the closed traction circuit loop is determined by the amount of load developed at the wheel and axle motors. As the traction load increases, circuit pressure can increase to relief valve settings: 300 bar (4350 PSI) in forward and 345 bar (5000 PSI) in reverse. If traction circuit pressure exceeds the relief setting, oil flows through the piston pump relief valve to the low pressure side of the closed loop traction circuit. Traction circuit pressure can be measured at test ports attached to the sides of the piston pump. The forward traction port is on the right side of the pump and the reverse traction port is on the left side.

Front wheel and rear axle motors are positive displacement, two speed variable motors that allow operation in either LOW (mow) or HI (transport) speed. The motors are spring biased to maximum displacement for LOW speed and are hydraulically shifted to minimum displacement for HI speed. The rear axle motor includes a flushing valve that bleeds off a small amount of hydraulic oil for cooling of the closed loop traction circuit. The charge circuit replaces oil that is bled from the circuit by the flushing valve.

Traction circuit components use small amounts of hydraulic oil for internal lubrication. Fluid is designed to leak across traction pump and motor components into the case drain. This leakage results in the loss of hydraulic oil from the closed loop traction circuit that is replaced by the charge circuit. The gear pump sections that supply the steering, cooling fan and lift/lower circuits also provide charge circuit oil.

Gear pump flow for the charge circuit is directed through the oil filter and to the low pressure side of the closed loop traction circuit. Charge pressure is limited to 17 bar (250 PSI) by a relief valve located in the piston pump.

An optional traction circuit flow divider splits traction pump hydraulic flow between the front wheel motors (approximately 43%) and rear axle motor (approximately 57%) to prevent excessive circuit flow going to a spinning wheel.

Forward Direction

With the armrest console HI/LOW speed switch in the HI speed (transport) position, solenoid valve (S12) in the combination manifold is energized. The energized solenoid valve directs charge pressure to shift the front wheel motors and rear axle motor to their minimum displacement. With the motors at their minimum displacements, a higher traction speed is available for transport.

When the HI/LOW switch is in the HI speed (transport) position and the traction pedal is pushed in the forward direction, oil from the piston pump is directed to the front wheel motors and rear axle motor through a parallel system. Oil flow to the front wheel motors drives the motors in the forward direction and then returns to the piston pump. Oil flow to the rear axle motor drives the motor in the forward direction. Oil returning from the axle motor enters the rear traction manifold at the M8 port. Flow bypasses the PR cartridge through the CV check valve, out manifold port P2 and returns to the piston pump.

Forward Direction (continued)

When going down a hill, the tractor becomes an over-running load that drives the front wheel and rear axle motors. In this condition, the rear axle motor could lock up as the oil pumped from the motor increases pressure as it returns to the piston pump. To prevent rear wheel lock up, an adjustable relief valve (RV) in the rear traction manifold reduces rear axle motor pressure created in down hill, dynamic braking conditions.

Reverse Direction

The traction circuit operates essentially the same in reverse HI speed (transport) as it does in the forward direction. However, the flow through the circuit is reversed. Oil flow from the piston pump is directed to the front wheel motors and also to the rear traction manifold. The oil to the front wheel motors drives them in the reverse direction and then returns to the piston pump through the front traction manifold. The oil to the rear traction manifold enters the rear traction manifold at port P2 and flows through pressure reducing valve (PR) which limits the down stream pressure to the rear axle motor to 26 bar (380 PSI) so the rear wheels will not scuff the turf during reverse operation. This reduced pressure flow is directed out rear traction manifold port M8 to drive the rear axle motor in reverse. Return oil from the rear motor returns to the piston pump.

Lower Cutting Deck

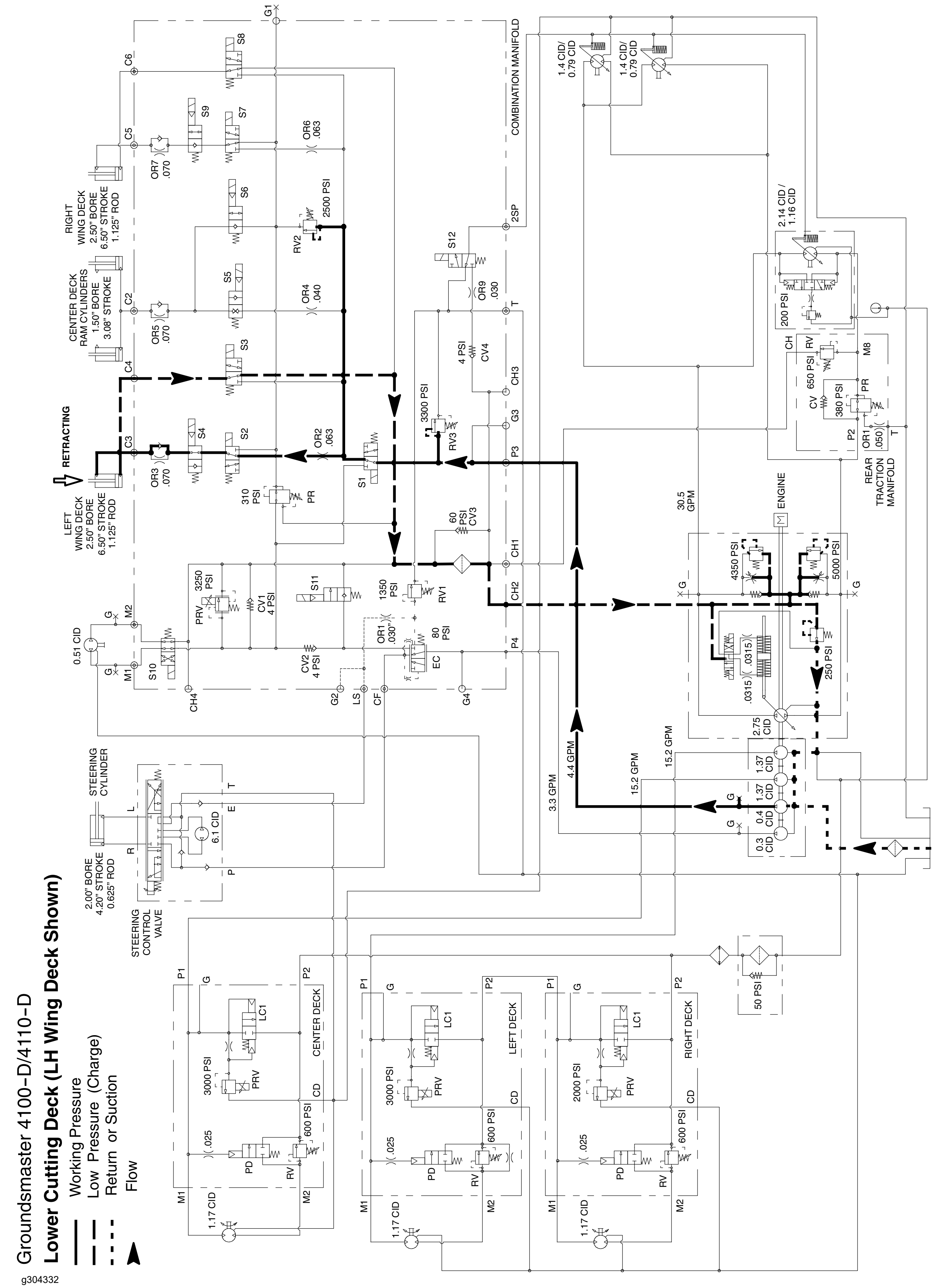

Figure 42

A four section gear pump is coupled to the piston (traction) pump. The third gear pump section supplies hydraulic flow to the lift/lower circuit, the engine cooling fan circuit and the traction charge circuit.

Each of the cutting decks (center, right and left) can be lowered independently with the use of three (3) switches on the armrest console. Pressing the front of a lift switch provides an input for the TEC controller to lower a cutting deck. The controller provides electrical outputs to solenoids in the combination manifold to allow appropriate manifold valve shift that causes a cutting deck to lower.

A relief valve (RV2) located in the combination manifold limits lift/lower circuit pressure to 110 bar (1600 PSI). An adjustable pressure relieving valve (PR) in the combination manifold maintains back pressure (counterbalance) on the deck lift cylinders to allow some of the cutting deck weight to be transferred to the traction unit to improve traction.

When the lift/lower circuit is not being used (all lift switches in the neutral position), solenoid valve S1 in the combination manifold is not energized and gear pump section oil flow is directed toward the engine cooling fan motor.

Note: To lower a cutting deck, the operator must be in the operator seat and the traction speed must be in the LOW speed (mow) position.

Lower Cutting Deck

To lower the center cutting deck, the front of the center console lift switch is depressed. The switch signal is an input to the TEC controller which provides an electrical output to solenoid valve S6 in the combination manifold. The energized solenoid valve shifts to allow a passage for oil flow from the barrel end of the center deck lift cylinders. The weight of the cutting deck causes the center deck lift cylinders to retract and lower the center cutting deck. Check orifice OR5 (.070) under the manifold fitting in port C2 controls the lowering speed of the cutting deck. Oil from the retracting cylinders is directed to pressure reducing valve (PR). As return oil pressure increases, the PR valve will shift to direct circuit oil to the oil filter and then to the traction charge circuit.

Lower Right Wing Deck

To lower the right wing deck, the front of the right console lift switch is pushed as an input to the TEC controller. The controller provides an electrical output to solenoid valves S1, S8 and S9 in the combination manifold. The energized solenoid valves shift to allow a passage for circuit oil flow to the rod end of the right deck lift cylinder. Shifted S1 allows gear pump section oil flow to be available for the lift/lower circuits. Shifted S8 allows an oil path to the rod end of the right lift cylinder to retract the lift cylinder and lower the right cutting deck. Check orifice OR7 (.070) controls the lowering speed of the cutting deck. Oil from the retracting cylinder is directed through energized S9, de−energized S7 and then to pressure reducing valve (PR). As return oil pressure increases, the PR valve will shift to direct circuit oil to the oil filter and then to the traction charge circuit.

Lower Left Wing Deck

To lower the left wing deck, the front of the left console lift switch is pushed as an input to the TEC controller. The controller provides an electrical output to solenoid valves S1, S3 and S4 in the combination manifold. The energized solenoid valves shift to allow a passage for circuit oil flow to the left deck lift cylinder rod end. Shifted S1 allows gear pump section oil flow to be available for the lift/lower circuits. Shifted S3 allows an oil path to the rod end of the left lift cylinder to retract the lift cylinder and lower the left cutting deck. Check orifice OR3 (.070) controls the lowering speed of the cutting deck. Oil from the retracting cylinder is directed through energized S4, de−energized S2 and then to pressure reducing valve (PR). As return oil pressure increases, the PR valve will shift to direct circuit oil to the oil filter and then to the traction charge circuit.

Cutting Deck Float

Cutting deck float allows the fully lowered cutting decks to follow ground surface contours. Combination manifold solenoid valves S4 (left deck), S6 (center deck) and S9 (right deck) are energized when the decks are fully lowered. These energized solenoids provide an oil passage to and from the lift cylinders to allow cylinder and cutting deck movement while mowing. Counterbalance pressure (PR) will affect deck float operation.

Note: If a deck is already fully lowered when the key switch is moved from OFF to RUN, the deck will not be in float until the appropriate deck lift/lower switch is momentarily pressed to lower.

Raise Cutting Deck

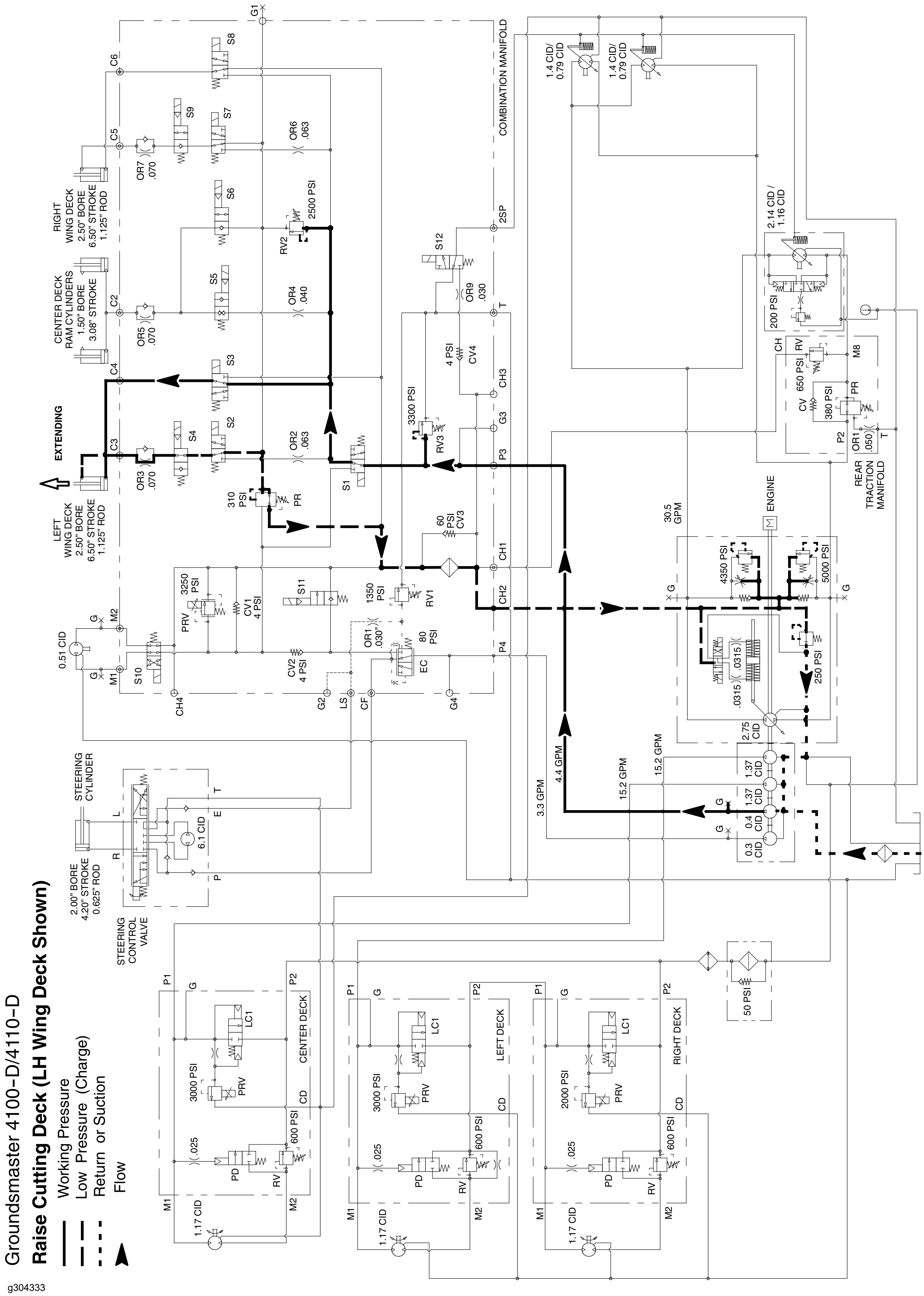

Figure 43

A four section gear pump is coupled to the piston (traction) pump (Figure 44). The third gear pump section supplies hydraulic flow to the lift/lower circuit, the engine cooling fan circuit and the traction charge circuit.

Each of the cutting deck sections (main, right wing and left wing) can be raised independently with the use of three (3) switches on the armrest console. Pressing the rear of a lift switch provides an input for the TEC controller to raise the cutting deck or wing deck. The controller provides electrical outputs to solenoids in the combination control manifold to allow appropriate manifold valve shift that causes a cutting deck to raise.

A relief valve (RV2) located in the combination control manifold limits lift/lower circuit pressure to 172 bar (2500 PSI). An adjustable pressure relieving valve (PR) in the combination manifold maintains back pressure (counterbalance) on the deck lift cylinders to allow some of the cutting deck weight to be transferred to the traction unit to improve traction.

When the lift/lower circuit is not being used (all lift switches in the neutral position), solenoid valve S1 in the combination manifold is not energized and gear pump section oil flow is directed toward the engine cooling fan motor.

Note: To raise a cutting deck, the operator must be in the operator seat.

Raise Center Cutting Deck

To raise the center cutting deck, the rear of the center console lift switch is depressed. The switch signal is an input to the TEC controller which provides an electrical output to solenoid valves S1 and S5 in the combination manifold. The energized solenoid valves shift to allow a passage for circuit oil flow to the barrel end of the center deck lift cylinders. Shifted S1 allows gear pump section oil flow to be available for the lift/lower circuits. Shifted S5 allows an oil path to the barrel end of the front lift cylinders causing the lift cylinders to extend and raise the center cutting deck. Check orifice OR5 under the fitting in manifold port C2 allows oil flow to bypass the orifice when the center deck is raising. An orifice in manifold port OR4 (.040) exists to control the raise speed of the cutting deck.

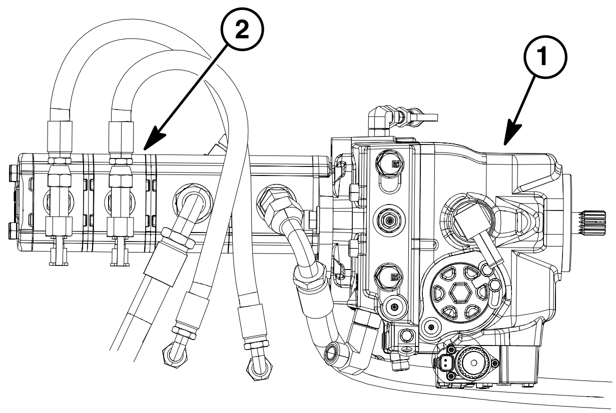

Figure 44

1. Piston (traction) pump
2. 3rd gear pump section

Raise Right Wing Deck

To raise the right wing deck, the rear of the right console lift switch is depressed as an input to the TEC controller. The controller provides an electrical output to solenoid valves S1, S7 and S9 in the combination manifold. The energized solenoid valves shift to allow a passage for circuit oil flow to the barrel end of the right wing deck lift cylinder. Shifted S1 allows gear pump section oil flow to be available for the lift/lower circuits. Shifted S7 and S9 allow an oil path to the barrel end of the right lift cylinder to extend the lift cylinder and raise the right wing deck. Orifice OR6 (.063) controls the raising of the wing deck. Check orifice OR7 is bypassed when raising the right wing deck. Oil from the extending cylinder is directed through S8 (de-energized), to the oil filter and then to the traction charge circuit.

Raise Left Wing Deck

To raise the left deck, the rear of the left console lift switch is depressed as an input to the TEC controller. The controller provides an electrical output to solenoid valves S1, S2 and S4 in the combination manifold. The energized solenoid valves shift to allow a passage for circuit oil flow to the barrel end of the left deck lift cylinder. Shifted S1 allows gear pump section oil flow to be available for the lift/lower circuits. Shifted S2 and S4 allow an oil path to the barrel end of the right lift cylinder to extend the lift cylinder and raise the right cutting deck. Orifice OR2 (.063) controls the raising of the cutting deck. Check orifice OR3 is bypassed when raising the left cutting deck. Oil from the extending cylinder is directed through S3 (de−energized), to the oil filter and then to the traction charge circuit.

Mow Circuit

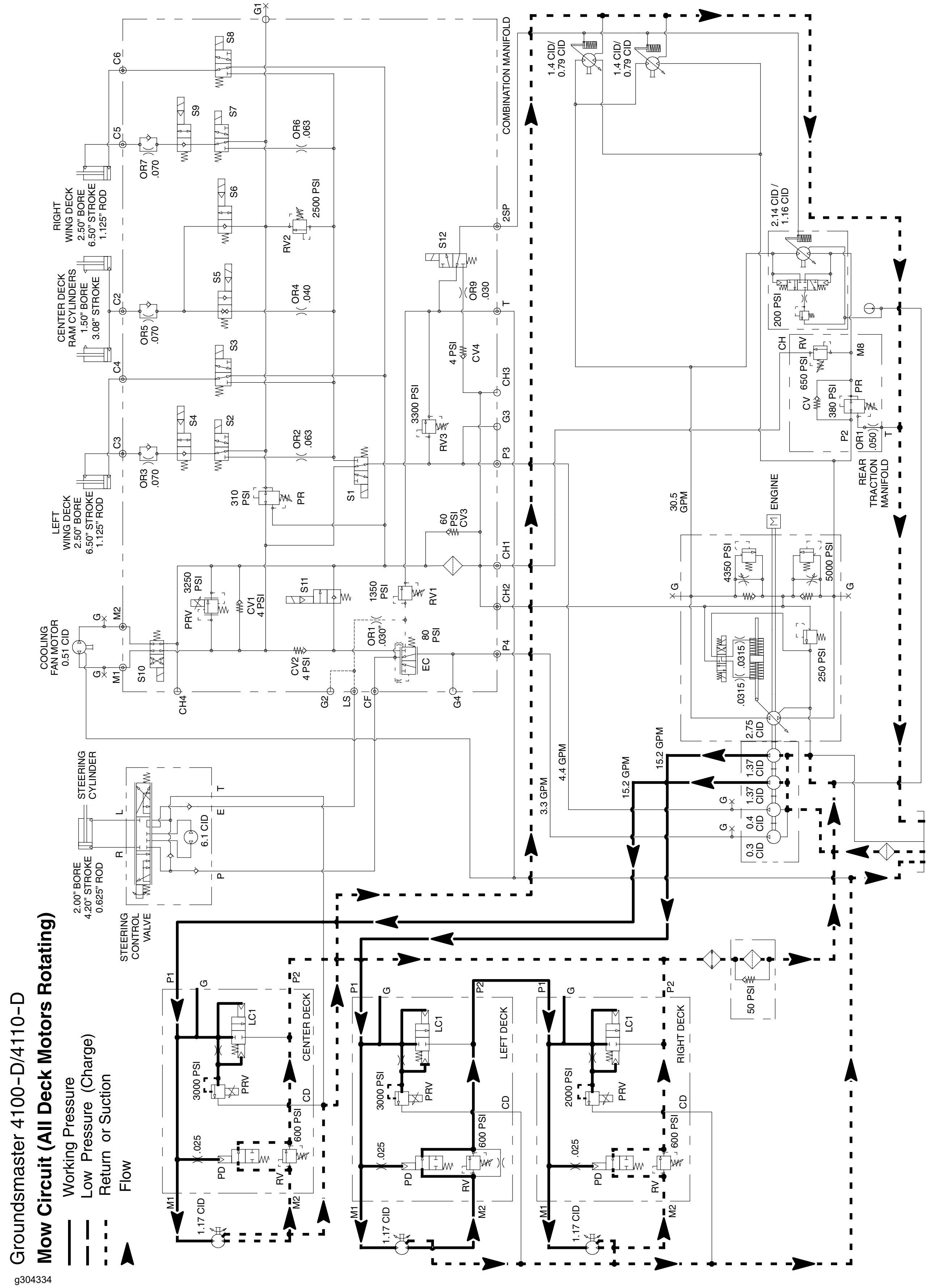

Figure 45

A four section gear pump is coupled to the piston (traction) pump. Hydraulic flow for the mow circuit is supplied by two sections of the gear pump. The gear pump section closest to the piston (traction) pump supplies hydraulic flow to the side cutting decks, while the next gear pump section supplies the front cutting deck.

Each cutting deck is controlled by a hydraulic manifold equipped with a proportional relief valve (PRV), a pilot directional valve (PD), a logic valve (LC1) and a relief valve (RV). The proportional relief valve is a solenoid operated valve that also functions as the circuit relief valve when energized. Circuit pressure can be measured at port (G) of the hydraulic manifold for each cutting deck.

Note: To engage the mow circuit, the operator must be in the operator seat, the traction speed must be in the LOW speed (mow) position, the PTO switch must be ON and the cutting deck(s) must be fully lowered and in float.

PTO Not Engaged

When the PTO switch is OFF or if the deck is raised with the PTO switch ON, the PTO manifold proportional relief valve (PRV) is not energized which allows a small amount of hydraulic flow through the valve. As this hydraulic flow returns to the hydraulic reservoir, a circuit pressure increase shifts logic valve LC1. The pump flow is routed through shifted LC1 and out manifold port P2 bypassing the cutting unit motor. Pilot direction valve PD and relief valve RV remain in the unshifted position to prevent any return flow from the deck motor which keeps the motor and cutting blades from rotating.

Return flow from the front and right PTO manifolds is routed through the oil cooler, oil filter and then to the gear pump input. Return flow from the left PTO manifold provides supply for the right deck.

PTO Engaged

When the PTO switch is turned ON and the decks are lowered, the PTO manifold proportional relief valve (PRV) is energized by the TEC controller. This shifted solenoid valve prevents any flow through the valve which allows the logic valve LC1 to be in its neutral position directing circuit flow toward the cutting deck motor. Gear pump flow entering the manifold is routed out manifold port M1 and to the cutting deck motor to cause the motor and cutting blades to rotate. As circuit pressure increases, pilot direction valve PD shifts to provide a return path for circuit flow. The return flow from the deck motor re−enters manifold port M2, is routed through shifted PD, out manifold port P2, through the oil cooler and filter and then is routed to the gear pump input. The deck motor continues to rotate as long as proportional relief valve (PRV) is energized.

Deck motor case drain leakage returns to the hydraulic reservoir.

PTO Circuit Relief

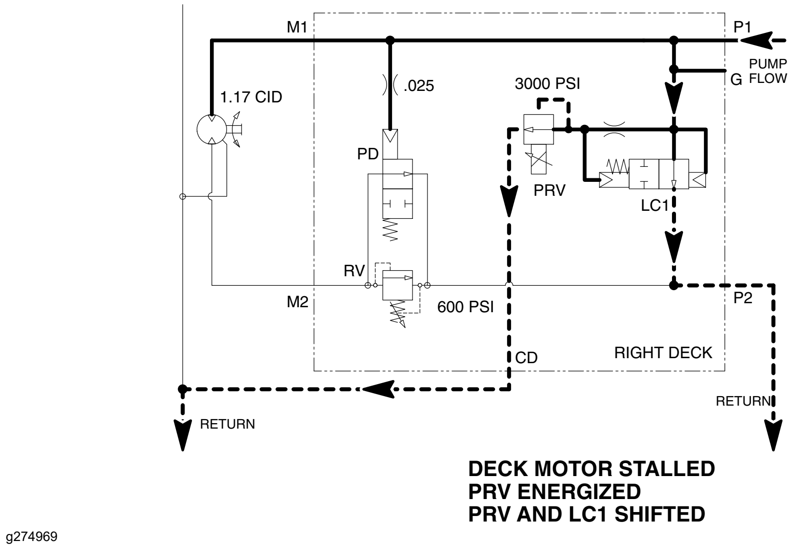

Figure 46

Maximum mow circuit pressure is limited for each deck by proportional relief valve (PRV) in the PTO manifold. The center and left deck relief valves are set at 207 bar (3000 PSI) and the right deck relief valve is set at 138 bar (2000 PSI).

Proportional relief valve (PRV) and logic valve (LC1) work together as a two stage circuit relief. When increased circuit resistance is met (e.g. a cutting blade strikes an object), the pressure increase is felt at the proportional relief valve. If the pressure should exceed the relief valve setting, the relief valve will open, allowing a small amount of hydraulic flow through the valve. This flow causes a pressure increase that shifts logic valve LC1 and diverts circuit flow away from the deck motor to manifold port P2 (Figure 46). When circuit pressure lowers, proportional relief valve (PRV) closes which returns logic valve LC1 back to its neutral position allowing flow to return to the deck motor.

Mow Circuit Cutting Deck Blade Braking

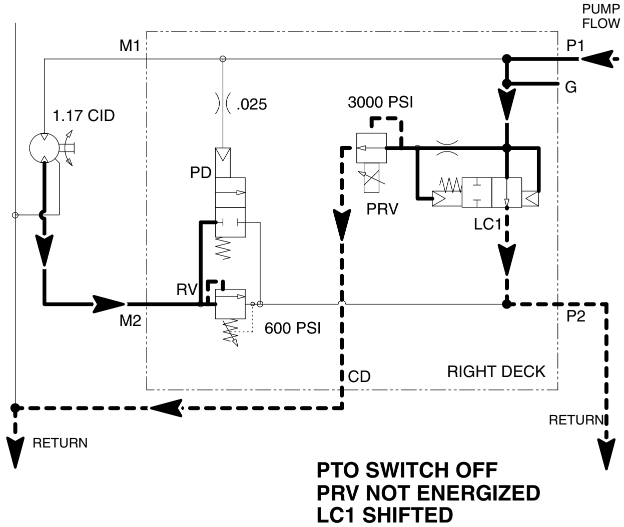

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Figure 47

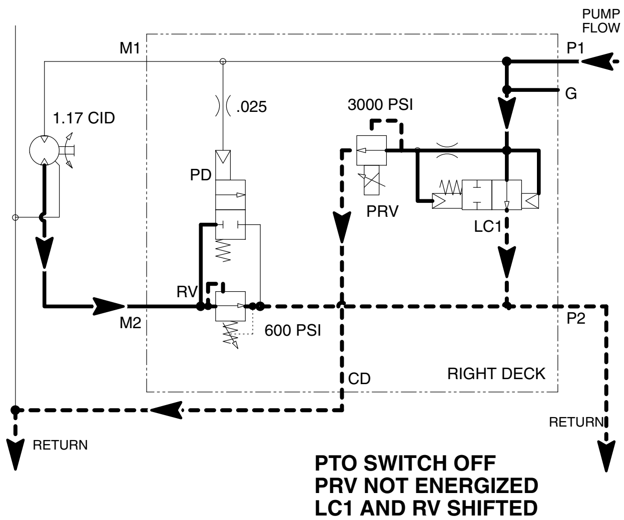

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Figure 48

When the operator turns the PTO switch OFF or if a deck is raised with the PTO switch ON, PTO manifold proportional relief valve (PRV) is de−energized causing logic valve (LC1) to shift (refer to information in Mow Circuit in this section). This shifted cartridge directs oil return out of manifold port P2. As circuit pressure decreases, pilot direction valve PD is shifted to it's neutral position, preventing return flow from the deck motor and slows the cutting blades (Figure 47).

The inertia of the rotating cutting blades, however, effectively turns the deck motor into a pump causing an increase in pressure as the flow from the motor comes up against the closed relief valve (RV). When this pressure builds to approximately 41 bar (600 PSI), relief valve (RV) opens which allows hydraulic flow to flow from the motor (Figure 48). When return pressure drops below 41 bar (600 PSI), relief valve (RV) reseats to once again block return flow from the deck motor to further slow the cutting blades. This action of the brake relief valve opening occurs several times in a very short time frame as the blades finally come to a stop. Once the blades have stopped, relief valve (RV) remains seated to keep the deck motor from rotating.

Steering Circuit

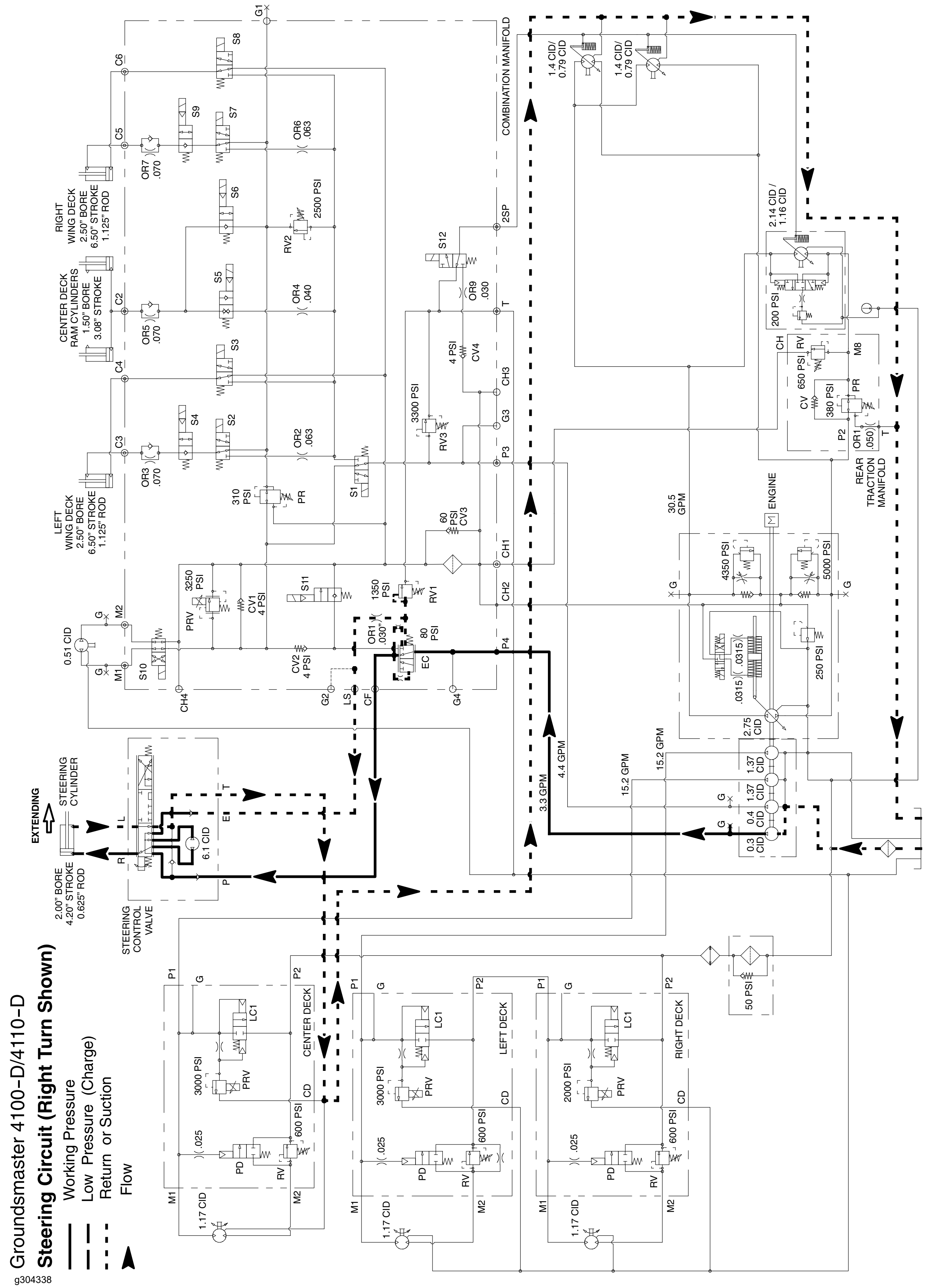


Figure 49

A four section gear pump is coupled to the piston (traction) pump. The fourth gear pump section (farthest from the piston pump) supplies hydraulic flow to the steering circuit, the engine cooling fan circuit and the traction charge circuit. Priority hydraulic flow from this gear pump section is provided to the steering circuit by the pressure compensator valve (EC) located in the combination manifold.

Note: The hydraulic schematic symbol for the pressure compensator valve (EC) appears to be a two (2) position valve. In operation, this valve will direct the gear pump section flow to the steering circuit as priority depending on steering input. The remainder of the gear pump section flow will be directed to the charge and engine cooling fan circuits. If there is no steering input, the compensator valve (EC) directs all gear pump section flow to the charge and engine cooling fan circuits.

The combination manifold controls the operation of the steering control valve, the engine cooling fan motor and the cutting deck lift cylinders. The pressure compensator valve (EC) in the manifold controls the oil flow to the steering control valve which is a closed center, load sensing valve. The steering control valve senses the oil flow that is needed for steering and the compensator valve (EC) will supply the correct amount. Oil flow not needed for the steering circuit is provided to the engine cooling fan motor and then to the traction charge circuit.

With the steering wheel in the neutral, at rest position and the engine running, hydraulic oil from the final gear pump section enters the combination manifold port P4, flows through the pressure compensator valve (EC) and to the steering control valve where it dead heads at the steering control spool. Oil is also sent to both ends of the compensator valve (EC) spool. On one end of the spool, oil is directed to the steering relief valve (RV1) and also is directed through the OR1 orifice and out the LS manifold port to the steering control valve. This flow provides steering load sense pressure and is directed through a small passage in the steering control valve spool and sleeve before returning to the hydraulic reservoir. While this load sense pressure is returning to the reservoir, the compensator valve (EC) spool shifts to direct pump flow to the engine cooling fan motor circuit and then to the traction charge circuit. Without steering input, no oil is flowing through the steering control valve to the steering cylinder.

Right Turn

When a right turn is made with the engine running, the turning of the steering wheel positions the steering control valve spool so that the load sense flow is blocked off. Without load sense flow, pressures on the ends of manifold compensator valve (EC) start to equalize causing (EC) to move toward its neutral position which allows the needed oil flow to the steering control valve. Oil is routed out manifold port CF, into steering valve port P, through the steering control spool, is drawn through the rotary meter section and out the R port to the steering cylinder. Pressure extends the steering cylinder for a right turn. The rotary meter ensures that the oil flow to the cylinder is proportional to the amount of the turning on the steering wheel. Fluid leaving the cylinder flows back through the steering valve L port, the spool valve, out the T port and then returns to the hydraulic reservoir.

The steering control valve returns to the neutral position when turning is completed.

Left Turn

When a left turn is made with the engine running, the turning of the steering wheel positions the steering control valve spool so that the load sense flow is blocked off. Without load sense flow, pressures on the ends of manifold compensator valve (EC) start to equalize causing (EC) to move toward its neutral position which allows the needed oil flow to the steering control valve. Oil is routed out manifold port CF, into steering valve port P, through the steering control spool, is drawn through the rotary meter section and out the L port to the steering cylinder. Pressure retracts the steering cylinder for a left turn. The rotary meter ensures that the oil flow to the cylinder is proportional to the amount of the turning on the steering wheel. Fluid leaving the cylinder flows back through the steering valve R port, the spool valve, out the T port and then returns to the hydraulic reservoir.

The steering control valve returns to the neutral position when turning is completed.

Steering Relief Operation

When the steering cylinder reaches the end of its stroke or if a rear wheel should encounter an obstruction (e.g. a curb) while steering, the pressure in the steering circuit will rise. Relief valve (RV1) in the combination manifold senses this pressure increase. When steering circuit pressure builds to approximately 93 bar (1350 PSI), relief valve (RV1) opens and allows hydraulic flow to return to the hydraulic reservoir. This action causes flow across the relief valve side orifice of compensator valve (EC) which shifts the spool in (EC) to send oil away from the steering circuit to the fan motor circuit. Relief valve (RV1) controls the action of compensator valve (EC) and allows the compensator valve to divert only enough oil flow to the steering circuit to maintain relief pressure.

Engine Cooling Fan Circuit

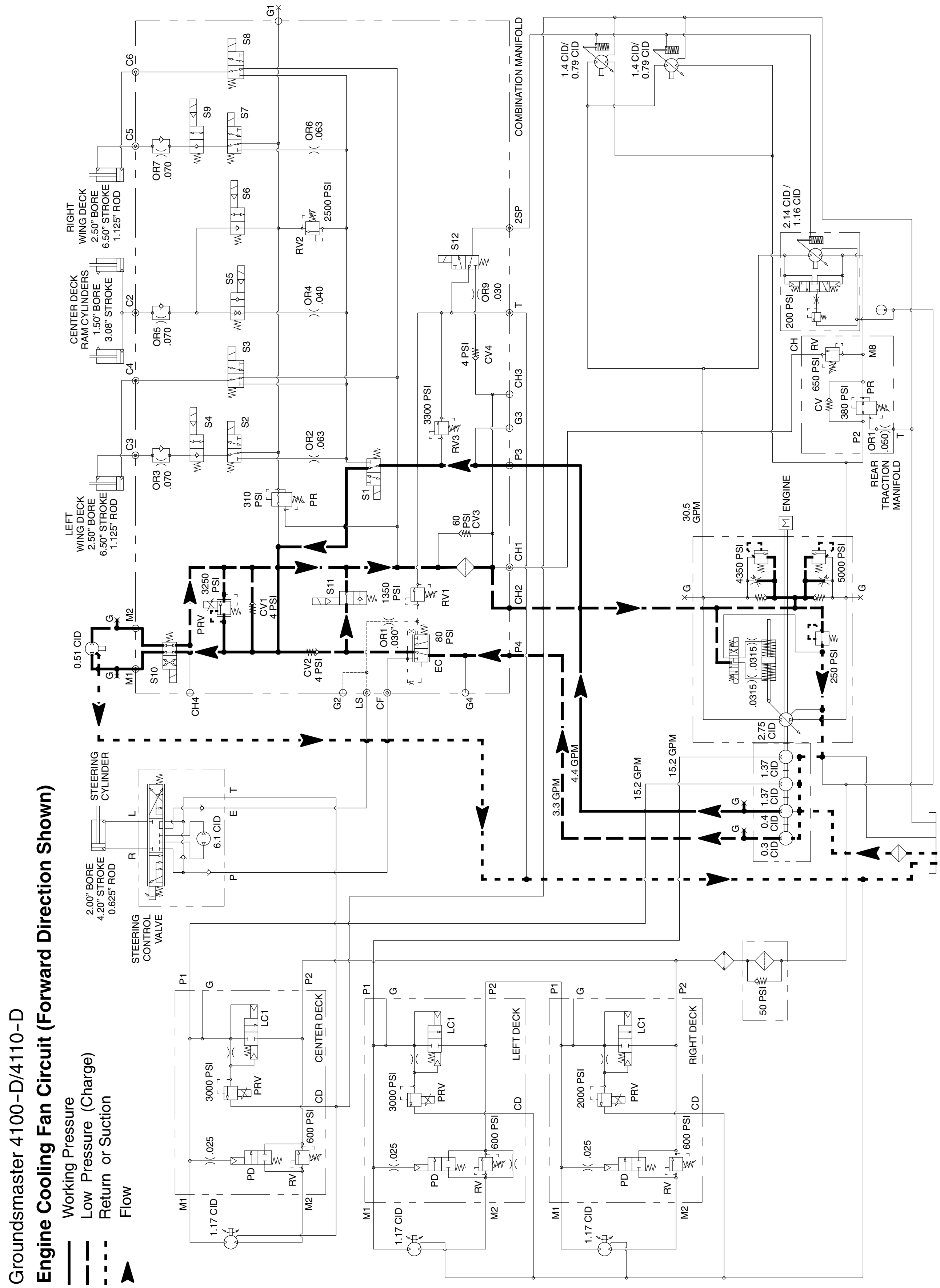


Figure 50

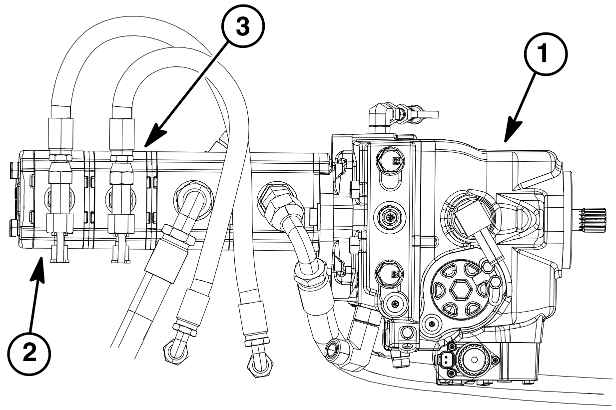


Figure 51

1. Piston (traction) pump
2. 4th gear pump section
3. 3rd gear pump section

A four section gear pump is coupled to the piston (traction) pump (Figure 51). The fourth gear pump section (farthest from the piston pump) supplies hydraulic flow to the steering circuit, the engine cooling fan circuit and the traction charge circuit. The third gear pump section supplies hydraulic flow to the engine cooling fan circuit, the lift/lower circuit and the traction charge circuit.

So that there is sufficient oil flow for the engine cooling fan circuit, oil flow from either or both of the third or fourth gear pump section is used to drive the hydraulic cooling fan motor depending on what other machine functions are being used (steering, lift/lower). If additional oil flow is needed for cooling fan operation in extreme conditions (e.g. high ambient temperatures, cutting very heavy grass), the TEC controller can allow flow from the two pump sections to be combined.

Oil flow from the third gear pump section is routed to the combination manifold (port P3) where it is available either for the lift/lower circuit or the engine cooling fan circuit. When the lift/lower circuit is not being used (all lift switches in the neutral position), solenoid valve (S1) in the combination manifold is not energized and gear pump section oil flow is directed toward the engine cooling fan motor.

Priority oil flow from the fourth gear pump section is provided to the steering circuit. All excess flow from this gear pump section is normally routed to the traction charge circuit by energized solenoid valve (S11). This valve is energized by the TEC controller as long as the lift/lower function is not being used and the hydraulic oil and engine coolant temperatures are within normal ranges. If inputs to the TEC controller suggest additional oil flow is necessary for the cooling fan (e.g. lift/lower circuit is engaged or engine coolant temperature is elevated), solenoid valve (S11) will be de−energized allowing excess pump section oil flow to be directed toward the engine cooling fan motor.

Oil flow from the gear pump section(s) to the cooling fan motor is controlled by the proportional relief valve (PRV) in the combination manifold. This valve adjusts fan circuit pressure and flow based on a PWM (Pulse Width Modulation) signal from the TEC controller. The controller uses engine coolant and hydraulic oil temperatures as inputs to determine the proper PWM signal for the (PRV) valve. The fan circuit flow determines the speed of the cooling fan motor and thus, the speed of the cooling fan.

If the fan motor is stalled for any reason during machine operation, the manifold proportional relief valve (PRV) has a secondary function as a circuit relief to limit fan motor pressure to 224 bar (3250 PSI).

When the engine is shut off, the over−running inertia load of the engine cooling fan blades keeps driving the fan motor and turns it into a pump. The check valve (CV1) in the combination manifold will open to keep the motor circuit full of oil so the fan motor will not cavitate.

Forward Direction Fan Operation

During normal, forward direction fan operation, circuit oil flow is sent through the de−energized solenoid valve (S10) in the combination manifold to rotate the cooling fan motor. Return flow from the motor re−enters the manifold (port M2), through the de−energized solenoid valve (S10), to the oil filter and then out of the manifold (port CH2). After exiting the manifold, circuit oil is routed to the traction charge circuit.

Reverse Direction Fan Operation

The TEC controller can reverse the cooling fan to clean debris from the rear intake screen. If hydraulic oil and/or engine coolant temperatures increase to an unsuitable level, a high PWM signal is sent to the (PRV) valve to slow the cooling fan and direct all pump oil flow to the traction charge circuit. The controller then energizes solenoid valve (S10) in the combination manifold to reverse cooling fan motor oil flow so that the motor runs in the reverse direction. A lower PWM signal is sent to the (PRV) valve allowing oil flow to return to the fan motor but in the reverse direction causing the motor and cooling fan to run in reverse. The controller determines the length of time that the fan should be run in reverse before fan rotation is returned to the forward direction.

Note: The operator can manually cause the cooling fan to reverse by simultaneously pressing the right and left buttons on the InfoCenter display.

Testing

The most effective method for isolating problems in the hydraulic system is by using hydraulic test equipment such as pressure gauges and flow meters in the circuits during various operational checks (see the Special Tools (page 2–17)).

IMPORTANT

All obvious areas such as hydraulic oil supply, oil filters, binding components, loose fasteners or improper adjustments must be checked before assuming that a hydraulic component is the source of the problem.

CAUTION

Failure to use gauges with recommended pressure (PSI/bar) rating as listed in test procedures could result in damage to the gauge and possible personal injury from leaking hot oil.

WARNING

Keep body and hands away from pin hole leaks or nozzles that eject hydraulic fluid under high pressure. Do not use hands to search for leaks; use paper or cardboard. Hydraulic fluid escaping under pressure can have sufficient force to penetrate the skin and cause serious injury. If fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type of injury. Gangrene may result from such an injury.

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure (page 5–3).

CAUTION

All testing should be performed by two (2) people. One person should be in the seat to operate the machine, and the second person should read test instruments and record test results.

Precautions for Hydraulic Testing

1. Clean machine thoroughly before disconnecting or disassembling any hydraulic components. Always keep in mind the need for cleanliness when working on hydraulic equipment. Contamination will cause excessive wear of components.
2. Before conducting a hydraulic test, make sure hydraulic oil is at normal operating temperature by operating the machine under load for approximately ten (10) minutes.
3. Put metal caps or plugs on any hydraulic lines left open or exposed during testing or removal of components.

Precautions for Hydraulic Testing (continued)

4. The engine must be in good operating condition. Use a phototac to determine engine speed when performing a hydraulic test. Engine speed will affect the accuracy of the tester readings. See Engine (Models 30602, 30604 and 30643) (page 2–4) and Engine (Models 30606, 30608 and 30644) (page 2–5).
5. When using the hydraulic tester with flow and pressure capabilities, the inlet and the outlet hoses must be properly connected and not reversed to prevent damage to the hydraulic tester or components.
6. When using the hydraulic tester with flow and pressure capabilities, completely open flow control valve on tester before starting the engine to minimize the possibility of damaging components.
7. Install fittings finger tight and far enough to make sure that they are not cross−threaded before tightening them with a wrench.
8. Position tester hoses to prevent rotating machine parts from contacting and damaging the hoses or tester.
9. Check oil level in the hydraulic reservoir. After connecting test equipment, make sure reservoir is full.
10. Check control linkages for improper adjustment, binding or broken parts.
11. After installing test gauges, run engine at low idle speed and check for any hydraulic oil leaks. Correct any leaks before proceeding with test procedure.
12. Before returning machine to use, make sure that hydraulic reservoir has correct fluid level.

Which Hydraulic Tests Are Necessary?

Before beginning any hydraulic test, identify if the problem is related to the traction circuit, cutting (mow) circuit, lift/lower circuit, steering circuit or engine cooling fan circuit. Once the faulty system has been identified, perform tests that relate to that circuit.

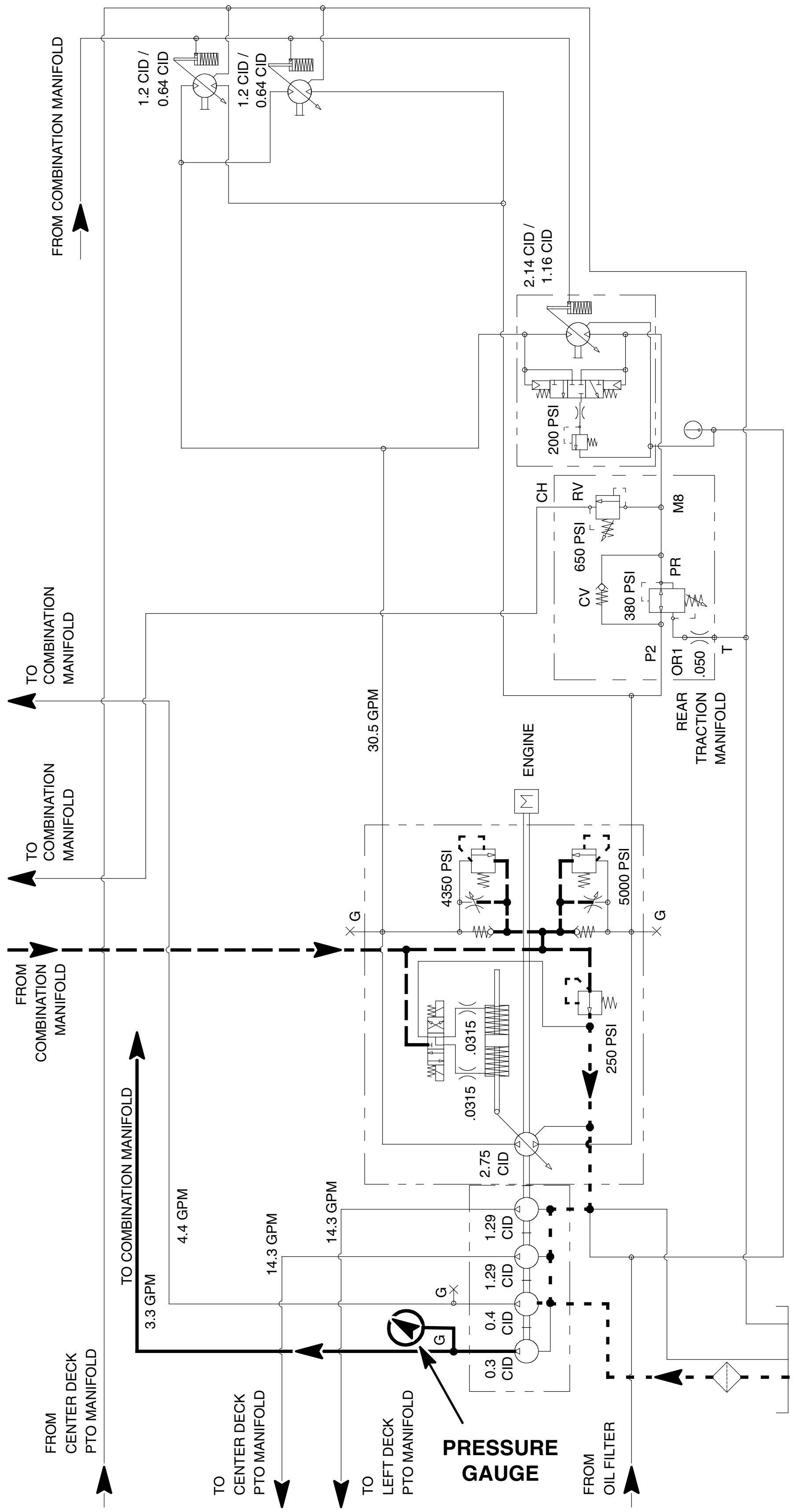
1. If a traction circuit problem exists, consider performing one or more of the following tests: Traction Circuit Charge Pressure, Traction Circuit Relief Pressure, Counterbalance Pressure, Reverse Traction Circuit Reducing Valve (PR) Pressure, Rear Traction Circuit Relief Valve (RV) Pressure, Piston (Traction) Pump Flow and/ or Gear Pump Flow Tests.

IMPORTANT

Refer to Traction Circuit Component Failure in the General Information section of this chapter for information regarding the importance of removing contamination from the traction circuit.

2. If a cutting (mow) circuit problem exists, consider performing one or more of the following tests: Cutting Deck Circuit Pressure, PTO Relief Pressure, Cutting Deck Motor Case Drain Leakage and/or Gear Pump Flow Tests.
3. If a lift/lower circuit problem exists, consider performing one or more of the following tests: Lift/Lower Circuit Relief Pressure and/or Gear Pump Flow Tests.
4. If a steering circuit problem exists, consider performing one or more of the following tests: Steering Circuit Relief Pressure, Steering Cylinder Internal Leakage and/or Gear Pump Flow Tests.
5. If a engine cooling fan circuit problem exists, consider performing one or more of the following tests: Engine Cooling Fan Circuit and/or Gear Pump Flow Tests.

Traction Circuit Charge Pressure (Using Pressure Gauge)



g304340

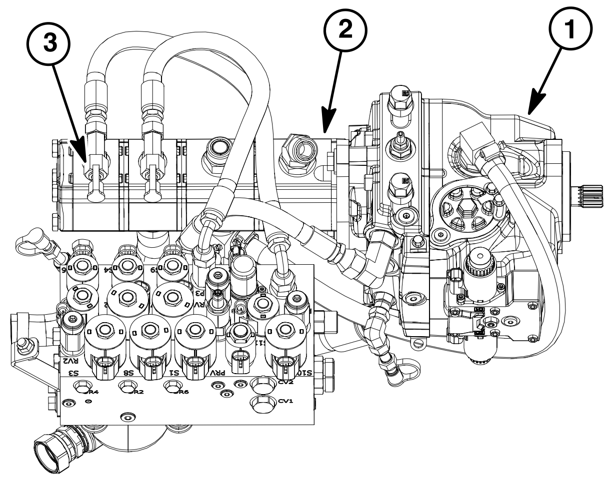
Figure 52

The traction charge circuit is designed to replace loss of hydraulic fluid from the closed loop traction circuit. This test is used to make sure that traction charge pressure is correct.

Procedure for Traction Circuit Charge Pressure Test

CAUTION

Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS and Precautions for Hydraulic Testing at the beginning of this section.

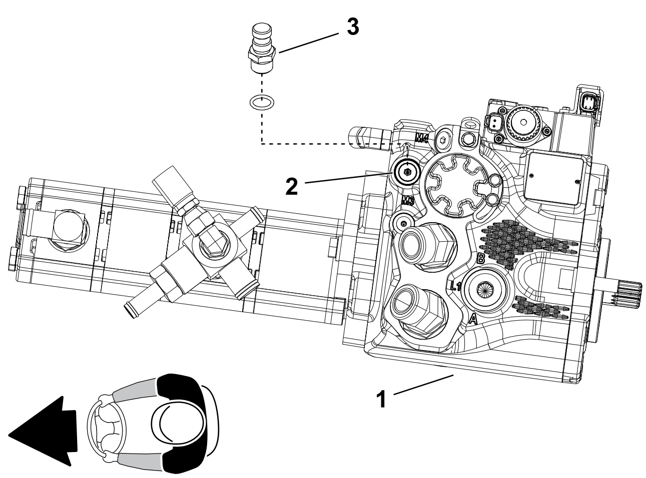


g275054

Figure 53

(For machines serial number below: 400000000)

1. Piston (traction) pump
2. Gear pump
3. Charge pressure port



g308252

Figure 54

(For machines serial number above: 400000000)

1. Traction pump
2. Traction charge port
3. Diagnostic test fitting

Procedure for Traction Circuit Charge Pressure Test (continued)

1. Park machine on a level surface with the cutting decks lowered and off. Make sure hydraulic oil is at normal operating temperature, engine is off and the parking brake is applied.
2. Raise and support operator seat.
3. Connect a 70 bar (1000 PSI) pressure gauge to test fitting attached to tee fitting in final section of gear pump (Figure 53 or Figure 54).

   Note: Make sure that steering wheel is not turned during charge pressure testing. Also, if engine coolant temperature is elevated, gear pump flow from the final pump section might be directed to the cooling fan motor which may affect charge pressure testing results.
4. Start engine and increase engine speed to high idle speed with no load on the hydraulic system.

   GAUGE READING TO BE 13.8 to 20.6 bar (200 to 300 PSI).
5. Stop engine and record test results.
6. If there is no pressure or pressure is low, check for restriction in gear pump intake line. Also, inspect charge relief valve located in piston (traction) pump (see Piston (Traction) Pump Service (For machines serial number below: 400000000) (page 5–111)). A worn or damaged gear pump section could also be considered (see Gear Pump Flow (Using Tester with Pressure Gauge and Flow Meter) (page 5–79)).

   Note: If the gear pump section that supplies the charge circuit is worn or damaged, charge, steering, lift/ lower and engine cooling fan circuits may all be affected.
7. Next, with the pressure gauge still connected to the charge pressure test port, take a gauge reading while operating the machine in forward and reverse. Start the engine and put throttle at high idle speed. Apply the brakes and push the traction pedal forward while monitoring the pressure gauge. Repeat for reverse direction. Stop engine and record test results.
8. If charge pressure meets specifications under no load conditions (step 5 above), but consistently drops more than 15% when under traction load, the piston (traction) pump and/or traction motor(s) should be suspected of wear and inefficiency. When the pump or motors are worn or damaged, the charge pump is not able to keep up with internal leakage in the traction system components.
9. When testing is completed, disconnect pressure gauge from test fitting. Secure dust cap to test fitting.
10. Lower and secure operator seat.

Traction Circuit Relief Pressure (Using Pressure Gauge)

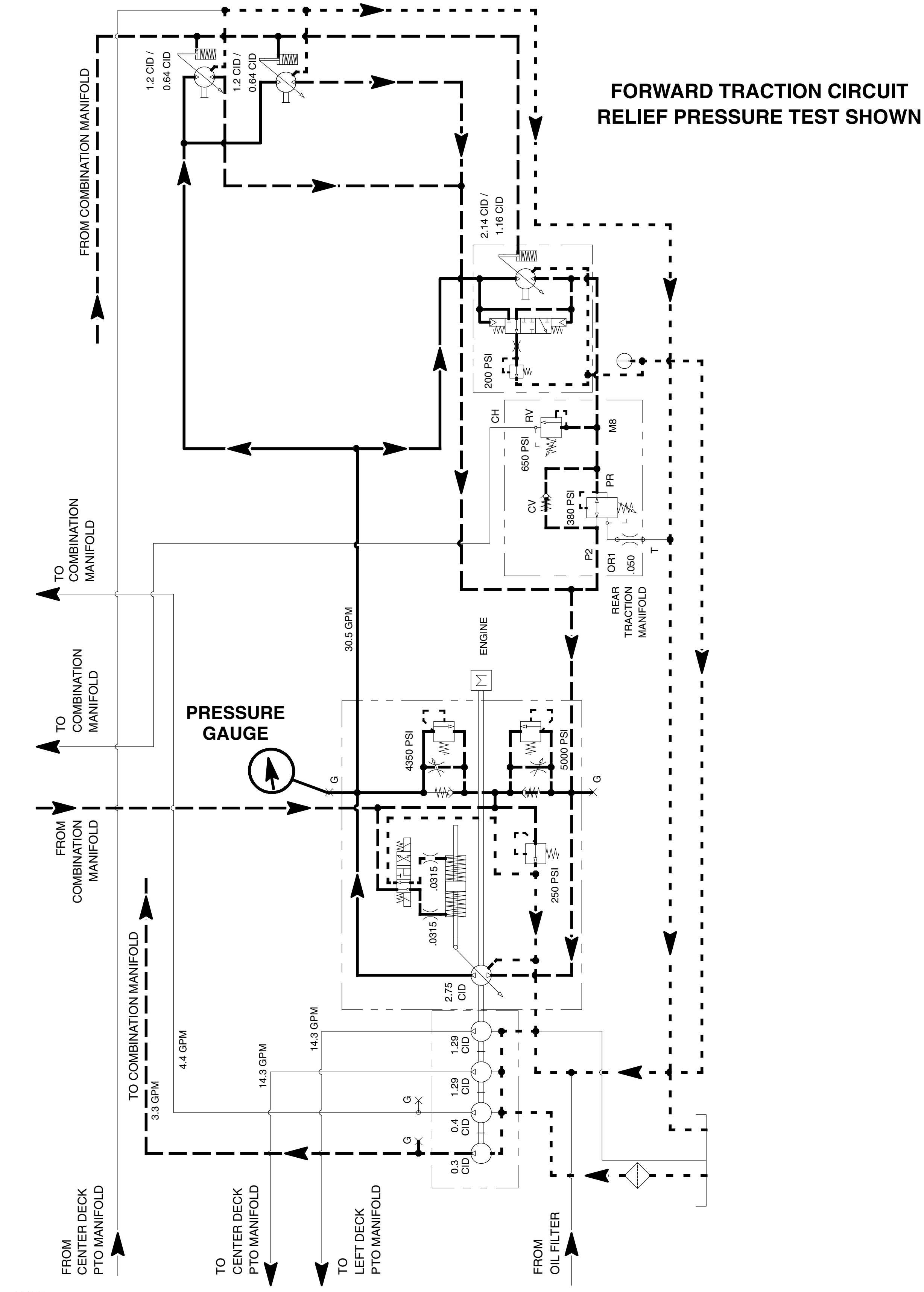


Figure 55

Procedure for Traction Circuit Relief Pressure Test

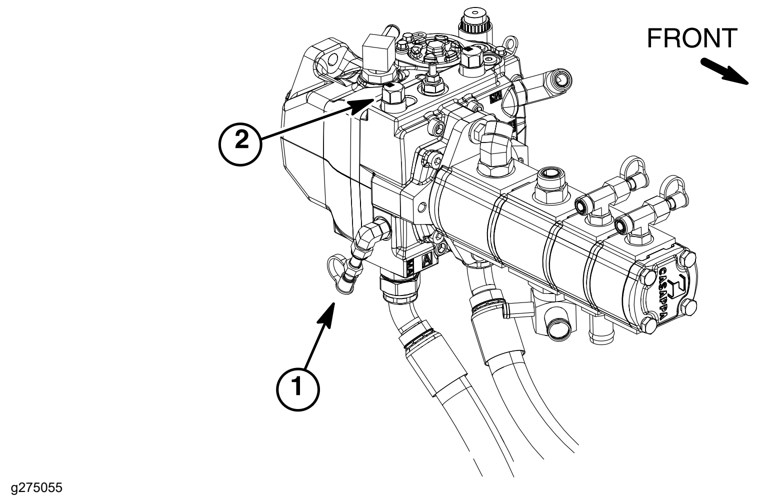


Figure 56
(For machines serial number below: 400000000)

1. Forward traction port
2. Forward relief valve

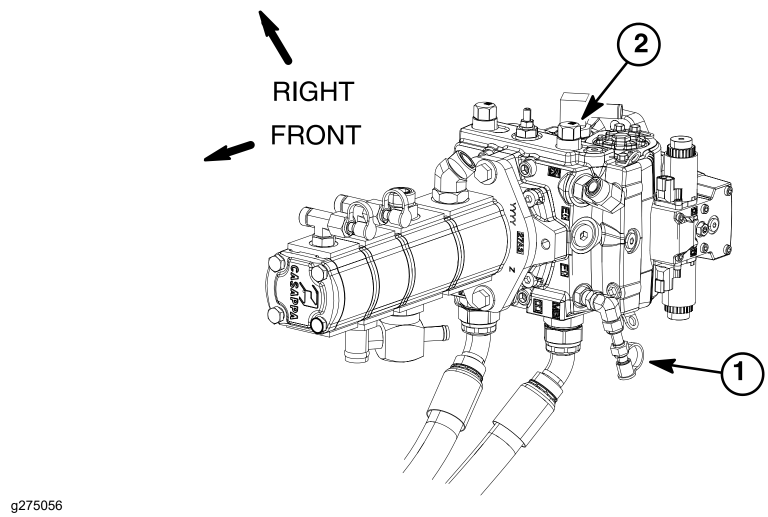


Figure 57
(For machines serial number below: 400000000)

1. Reverse traction port
2. Reverse relief valve

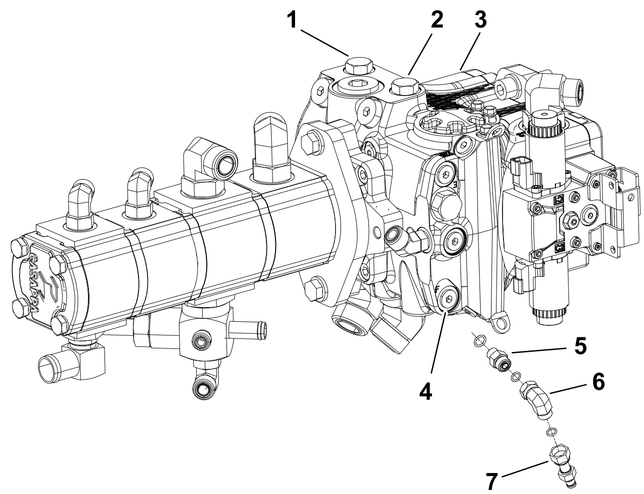
Note: The traction charge circuit is designed to replace loss of hydraulic fluid from the closed loop traction circuit.

CAUTION

Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS and Precautions for Hydraulic Testing at the beginning of this section.

1. Park machine on a level surface with the cutting decks lowered and off. Make sure hydraulic oil is at normal operating temperature, engine is off and the parking brake is applied.

Procedure for Traction Circuit Relief Pressure Test (continued)



g308279

Figure 58

(For machines serial number above: 400000000)

1. Forward relief valve
2. Reverse relief valve
3. Piston (traction) pump
4. Reverse traction port
5. Straight fitting
6. 90º fitting
7. Diagnostic test fitting

⚠ CAUTION ⚠

When performing the traction circuit relief pressure test, move machine to an open area, away from people and obstructions.

---

2. Drive machine to an open area, lower cutting decks, turn the engine off and apply the parking brake.
3. Connect a 700 bar (10,000 PSI) pressure gauge to traction circuit test port for function to be checked (Figure 56, Figure 57 or Figure 58).
4. Start engine and increase engine speed to high idle speed. Release parking brake. Make sure that HI/LOW speed switch is in the HI (transport) position.

   Note: If possible, turn off Smart Power™ by using the InfoCenter display protected menu. Machines with TEC software above revision level G will allow Smart Power™ to be disabled for testing. Check software revision level using the InfoCenter About screen.

5. Sit on seat, apply brakes fully and slowly depress the traction pedal in the appropriate direction (forward or reverse). While pushing traction pedal, look at pressure reading on gauge:

   GAUGE READING TO BE:

   Forward: 283 to 317 bar (4100 to 4600 PSI)

   Reverse: 328 to 362 bar (4750 to 5250 PSI)

6. Release traction pedal and stop engine. Record test results.

Procedure for Traction Circuit Relief Pressure Test (continued)

7. If traction pressure is too low, inspect traction pump relief valves (Figure 56, Figure 57 or Figure 58). Clean or replace relief valves as necessary. These cartridge type valves are factory set, and are not adjustable. If relief valves are in good condition, traction pump or wheel motors should be suspected of wear and inefficiency.
8. When testing is completed, disconnect pressure gauge from test port. Secure dust cap to test fitting.

Counterbalance Pressure (Using Pressure Gauge)

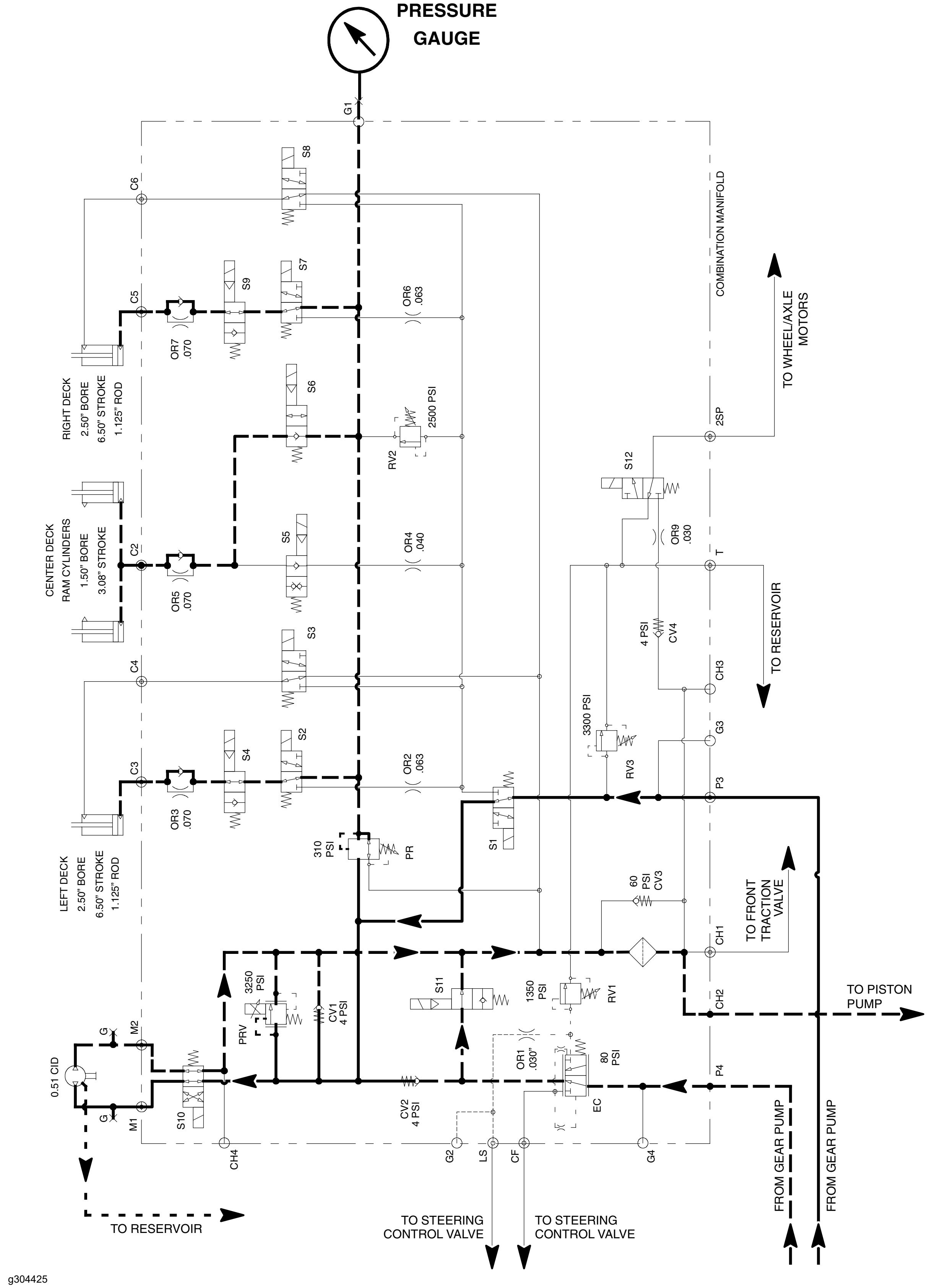
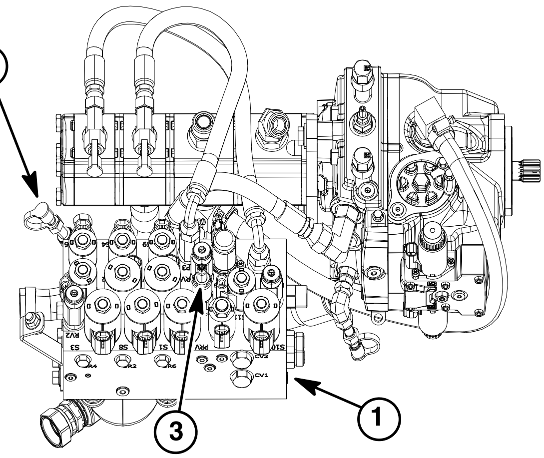


Figure 59

Procedure for Counterbalance Pressure Test



g275057

Figure 60

1. Combination manifold
2. Test port G1
3. Pressure reducing valve

⚠ CAUTION ⚠

Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS and Precautions for Hydraulic Testing at the beginning of this section.

---

1. Park machine on a level surface with the cutting decks lowered and off. Make sure hydraulic oil is at normal operating temperature, engine is off and the parking brake is applied.
2. Raise and support operator seat to gain access to combination manifold.
3. Connect a 70 bar (1000 PSI) pressure gauge to test port G1 on combination manifold (Figure 60).

   Note: The cutting decks need to be in the float position when checking counterbalance pressure. Also, make sure that all of the cutting deck castor wheels are on the ground when testing or adjusting counterbalance pressure.

IMPORTANT

While testing counterbalance pressure, DO NOT raise any of the cutting decks. If decks are raised, system pressure increase will damage pressure gauge.

4. Start engine and increase engine speed to high idle speed with no load on the hydraulic system. **Do not engage the cutting decks.**

   GAUGE READING TO BE approximately 22.4 bar (325 PSI).

   Note: The recommended counterbalance pressure for your Groundsmaster is 22.4 bar (325 PSI). It is recommended to 27.5 to 29.3 bar (400 to 425 PSI) as a starting point and increase or reduce the pressure as needed.

5. Stop engine and record test results.

Procedure for Counterbalance Pressure Test (continued)

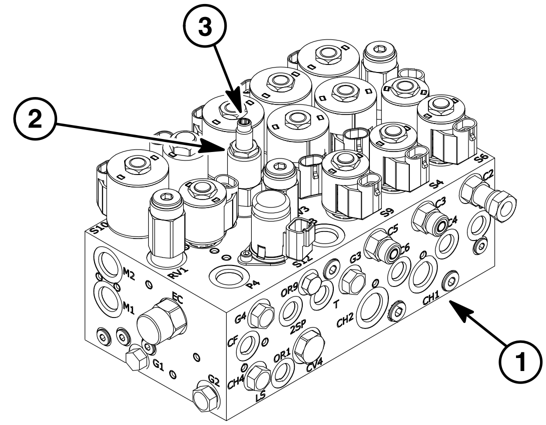


Figure 61

1. Combination manifold
2. Pressure reducing valve
3. Adjustment screw

6. The pressure reducing valve on the combination manifold is used to set the counterbalance pressure (Figure 61). If necessary, adjust pressure reducing valve:

   Note: Because of valve design, the pressure reducing valve can be adjusted with the engine running. Do not remove the pressure reducing valve from the hydraulic manifold for adjustment.

   A. Locate pressure reducing valve on combination manifold (Figure 61). Loosen lock nut on pressure reducing valve.

   B. Start engine and increase engine speed to high idle speed with no load on the hydraulic system. **Do not engage the cutting decks.**

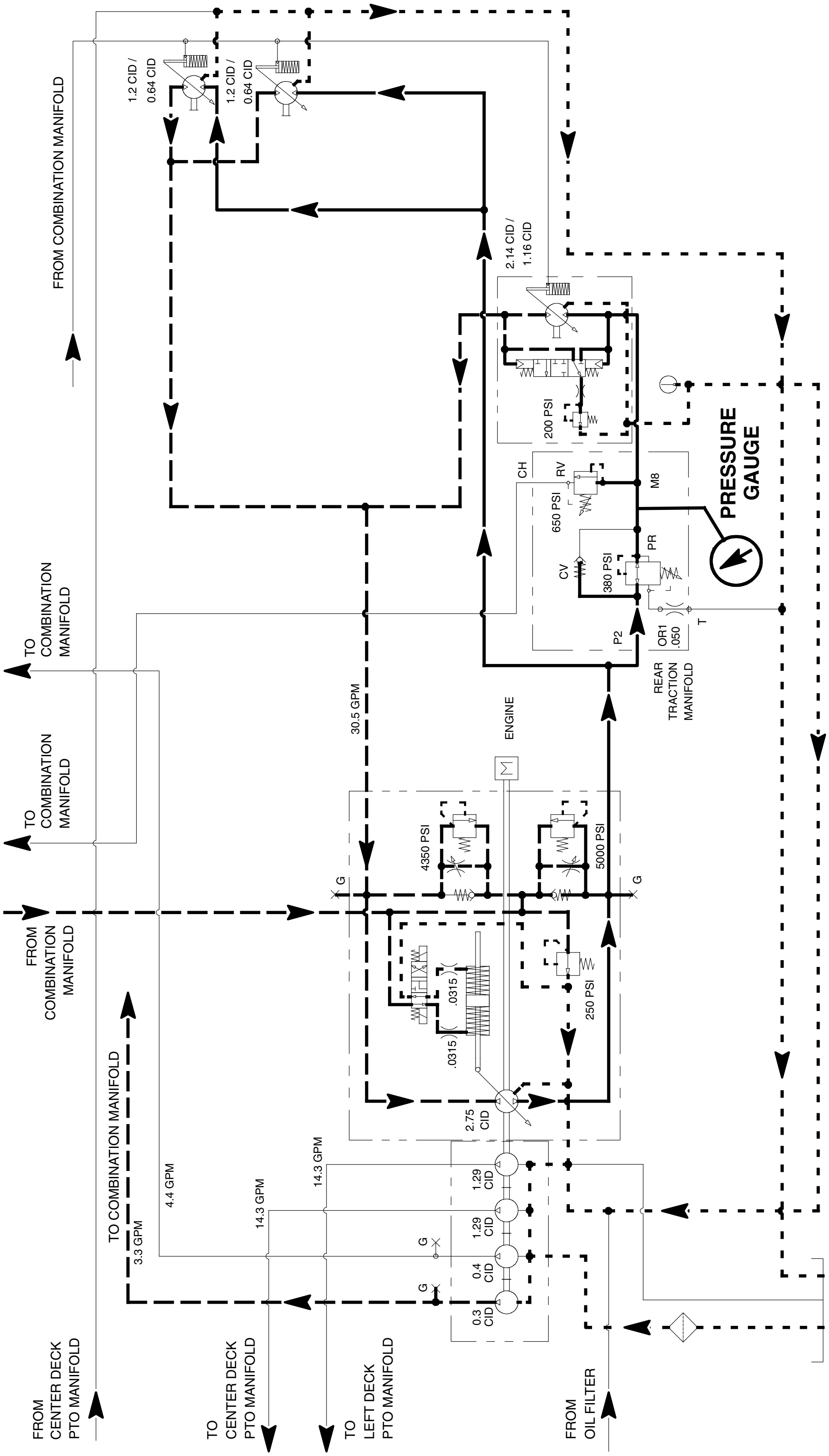
   C. To increase pressure setting, turn the adjustment screw on the valve in a clockwise direction. A 1/8 turn on the screw will make a measurable change in counterbalance pressure.

   D. To decrease pressure setting, turn the adjustment screw on the valve in a counterclockwise direction. A 1/8 turn on the screw will make a measurable change in counterbalance pressure.

   E. Tighten lock nut to secure adjustment. Check counterbalance pressure and readjust as needed.

7. When testing is completed, disconnect pressure gauge from manifold test port. Secure dust cap to test fitting. Lower operator seat.

Reverse Traction Circuit Reducing Valve (PR) Pressure (Using Pressure Gauge)



g304426

Figure 62

Procedure for Reverse Traction Circuit Reducing Valve (PR) Pressure Test

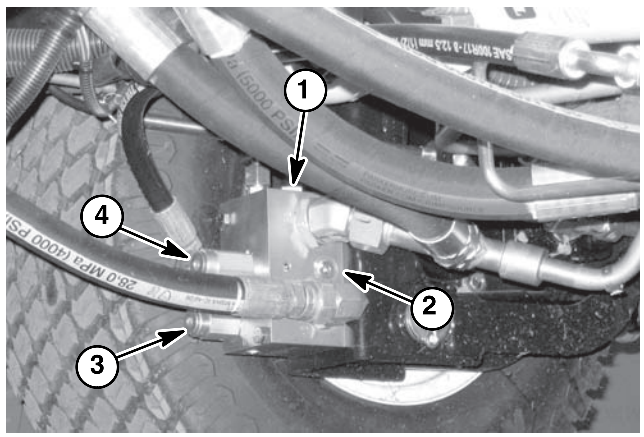
Note: When in reverse, pressure reducing valve (PR) limits the pressure to the rear axle motor to 26 bar (380 PSI) so the rear wheels will not scuff the turf.

CAUTION

Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS and Precautions for Hydraulic Testing at the beginning of this section.

1. Park machine on a level surface with the cutting decks lowered and off. Make sure hydraulic oil is at normal operating temperature, engine is off and the parking brake is applied.

   Note: The #6 zero leak plug on the inside of rear traction manifold is a zero leak plug that has a tapered sealing surface on the plug head. Lightly rap the plug head using a punch and hammer before using an allen wrench to remove the plug: the impact will allow plug removal with less chance of damage to the socket head of the plug.



g275059

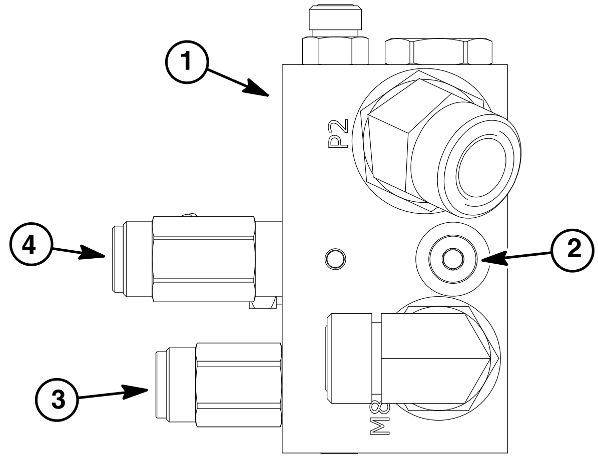
Figure 63

1. Rear traction manifold	3. Relief (RV) valve
2. #6 zero leak plug	4. Reducing (PR) valve

2. Locate rear traction manifold that is attached to the front frame next to the left side front wheel (Figure 63). Remove #6 zero leak plug on the inside of rear traction manifold and install diagnostic fitting (Toro part number 59−7410) into manifold port.
3. Connect a 70 bar (1000 PSI) pressure gauge with hydraulic hose attached to installed diagnostic fitting.
4. Start engine and increase engine speed to high idle speed. Make sure that HI/LOW speed switch is in the LOW speed (mow) position and release parking brake.
5. Sit on seat, apply brakes fully and slowly depress the traction pedal in the reverse direction. While pushing traction pedal, carefully monitor the pressure gauge to identify the opening pressure of the pressure reducing (PR) valve:

   GAUGE READING TO BE approximately 26 bar (380 PSI) when the pressure reducing (PR) valve opens.
6. Stop engine and record test results.

Procedure for Reverse Traction Circuit Reducing Valve (PR) Pressure Test (continued)



g275060

Figure 64

1. Rear traction manifold
2. #6 zero leak plug
3. Relief (RV) valve
4. Reducing (PR) valve

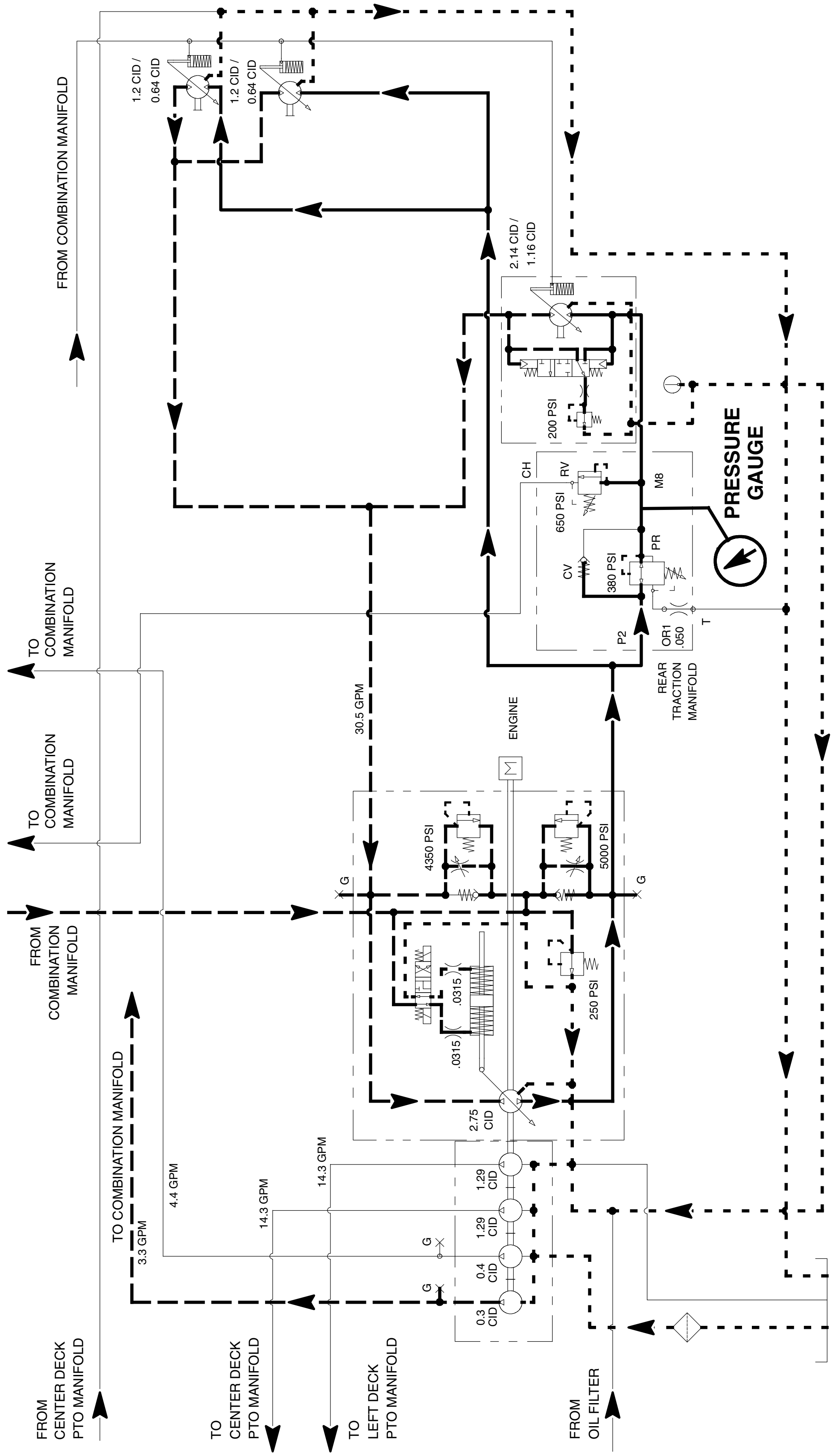
---

7. The pressure reducing (PR) valve is located on the rear side of the rear traction manifold (Figure 63 and Figure 64). If test pressure is incorrect, adjust pressure reducing (PR) valve (see Adjust Control Manifold Relief Valves (page 5–82)). Recheck pressure reducing valve pressure after any adjustment.

   Note: The rear traction circuit relief valve (RV) pressure test uses the same pressure gauge position as used to measure reverse traction circuit reducing valve (PR) pressure. Perform the rear traction circuit relief valve (RV) pressure test before removing pressure gauge from rear traction manifold.

8. When testing is completed, disconnect pressure gauge from the installed diagnostic fitting. Remove diagnostic fitting from manifold and install removed plug into manifold. Torque plug to **34 N·m (25 ft−lb)**.

Rear Traction Circuit Relief Valve (RV) Pressure (Using Pressure Gauge)



g304428

Figure 65

Procedure for Rear Traction Circuit Relief Valve (RV) Pressure Test

Note: Adjustable relief valve (RV) in the rear traction control manifold reduces rear axle motor pressure created in down hill, dynamic braking conditions to prevent rear wheel lock up.

CAUTION

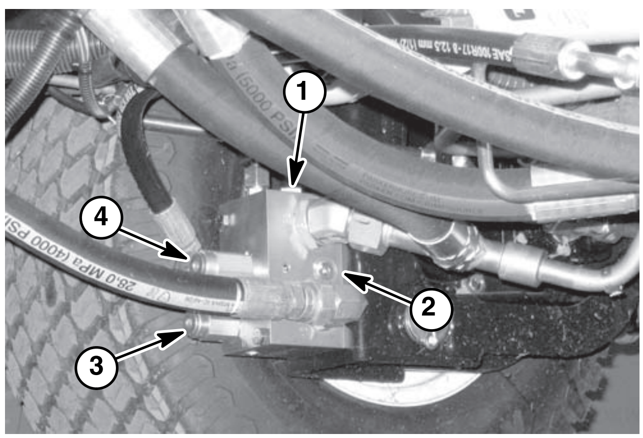
Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS and Precautions for Hydraulic Testing at the beginning of this section.

Note: If the rear traction circuit reducing valve (PR) pressure is excessive, operation of the rear traction relief valve (RV) may be affected. Before adjusting rear traction relief valve (RV), make sure that pressure reducing valve (PR) pressure is correct.

1. Park machine on a level surface with the cutting decks lowered and off. Make sure hydraulic oil is at normal operating temperature, engine is off and the parking brake is applied.

   Note: This test uses the same pressure gauge position as used to measure reverse traction circuit reducing valve (PR) pressure.

   Note: The #6 zero leak plug on the inside of rear traction manifold is a zero leak plug that has a tapered sealing surface on the plug head. Lightly rap the plug head using a punch and hammer before using an allen wrench to remove the plug: the impact will allow plug removal with less chance of damage to the socket head of the plug.



g275059

Figure 66

1. Rear traction manifold
2. #6 zero leak plug
3. Relief (RV) valve
4. Reducing (PR) valve

2. Locate rear traction manifold that is attached to the front frame next to the left side front wheel (Figure 66). Remove #6 zero leak plug on inside of rear traction manifold and install diagnostic fitting (Toro part number 59−7410) into manifold port.
3. Connect a 70 bar (1000 PSI) pressure gauge with hydraulic hose attached to installed diagnostic fitting.
4. Start engine and increase engine speed to high idle speed. Make sure that HI/LOW switch is in the LOW (mow) position and release the parking brake.
5. Operate the machine in LOW speed (mow) with the cutting decks lowered. Drive down a slope in a forward direction, decrease pressure on the traction

pedal and monitor the pressure gauge. Pressure should increase until the rear traction circuit relief valve lifts.

GAUGE READING TO BE approximately 45 bar (650 PSI) when the rear traction relief valve (RV) opens.

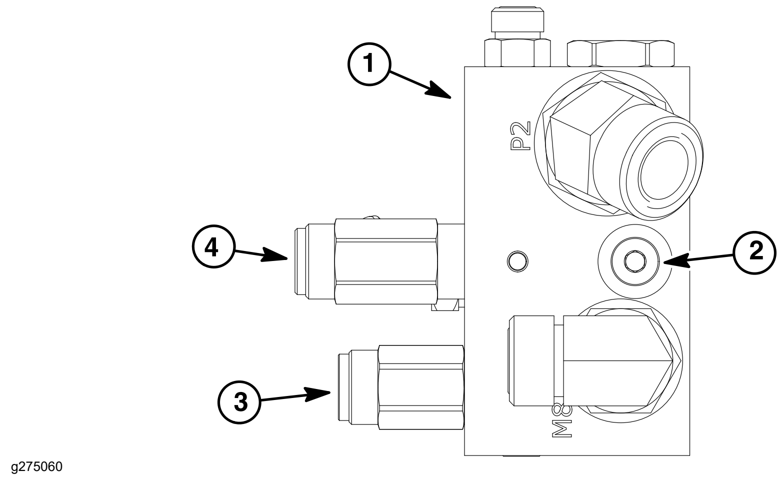
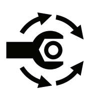


Figure 67

1. Rear traction manifold
2. #6 zero leak plug
3. Relief (RV) valve
4. Reducing (PR) valve

---

6. The rear traction circuit relief valve (RV) is located on the rear side of the rear traction manifold (Figure 66 and Figure 67). If test pressure is incorrect, adjust relief valve (RV) (see Adjust Control Manifold Relief Valves (page 5–82)).



7. When testing is completed, disconnect pressure gauge from the installed diagnostic fitting. Remove diagnostic fitting from manifold and install removed plug into manifold. Torque plug to **34 N·m (25 ft–lb)**.

Piston (Traction) Pump Flow Test (Using Tester with Pressure Gauge and Flow Meter)

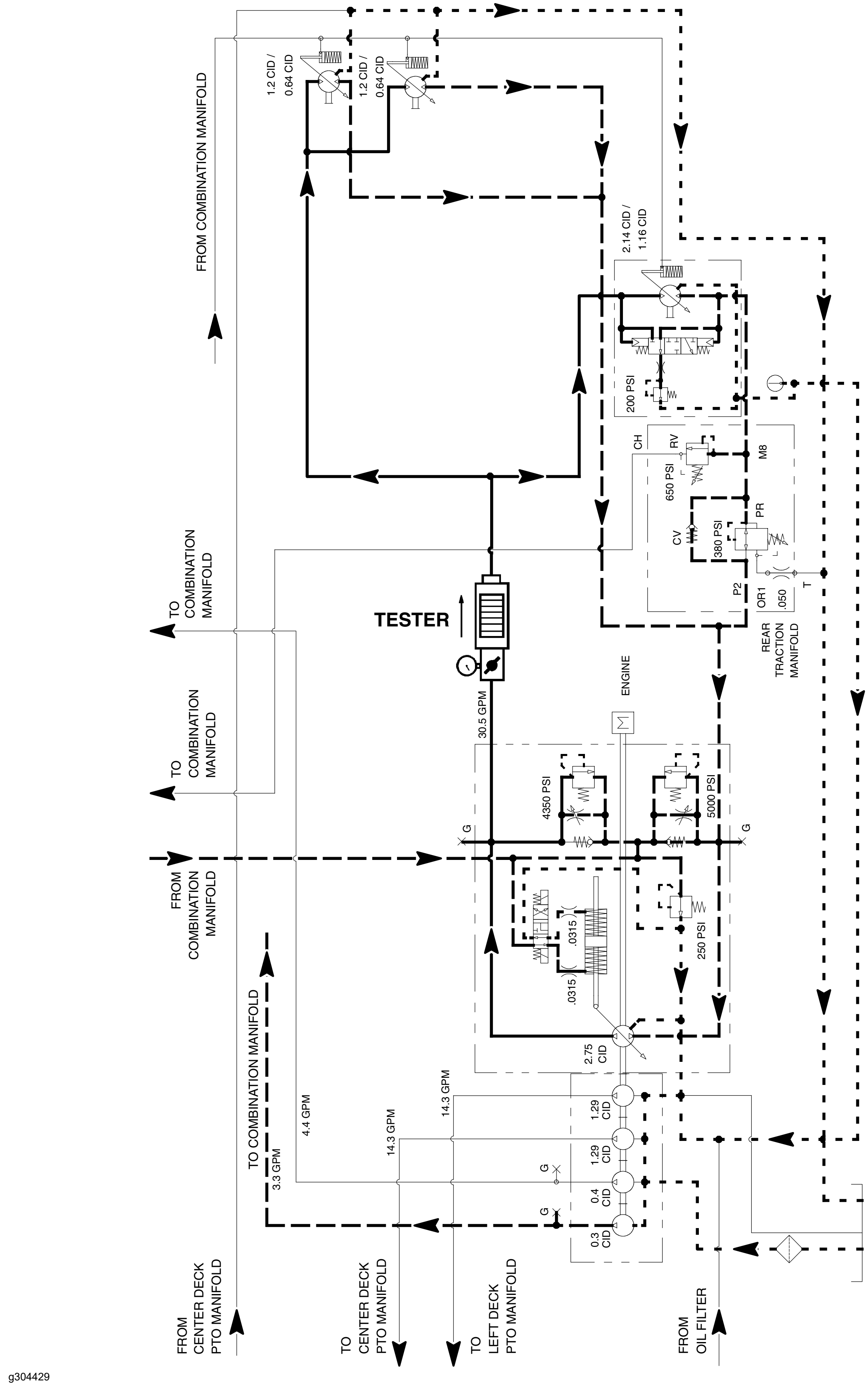


Figure 68

Procedure for Piston (Traction) Pump Flow Test

This test measures piston (traction) pump output (flow). During this test, pump load is created at the flow meter using the adjustable load valve on the tester.

Note: Before performing piston pump flow test, make sure that traction speed is set to 100% using the InfoCenter settings menu.

IMPORTANT

Traction circuit flow for the Groundsmaster 4100-D/4110-D is approximately 113.5 LPM (30 GPM). Use 151.4 LPM (40 GPM) Hydraulic Tester #AT40002 (pressure and flow) for this test (see Special Tools (page 2–17) in this chapter).

CAUTION

Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS and Precautions for Hydraulic Testing at the beginning of this section.

1. Park machine on a level surface with the cutting decks lowered and off. Make sure hydraulic oil is at normal operating temperature, engine is off and the parking brake is applied.

CAUTION

All wheels will be off the ground and rotating during this test. Make sure machine is supported so it will not move and accidentally fall to prevent injuring anyone near the machine.

2. Raise and support machine so all wheels are off the ground (see Jacking Instructions (page 1–7)).

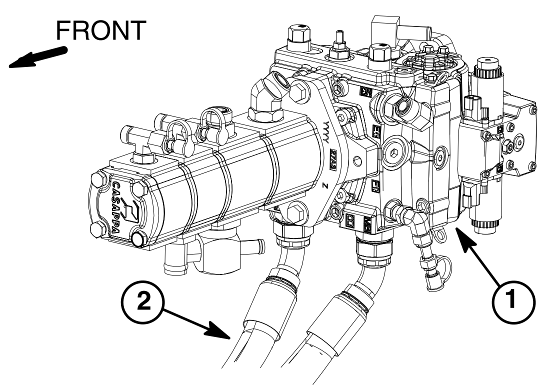


Figure 69

1. Piston (traction) pump
2. Forward direction hose

3. Thoroughly clean junction of hydraulic hose and right side fitting on bottom of piston pump (forward port) (Figure 69). Disconnect hose from right side pump fitting.

Procedure for Piston (Traction) Pump Flow Test (continued)

4. Install tester with pressure gauge and flow meter in series between piston pump fitting and disconnected hose to allow flow from traction pump to tester. Use hydraulic hose kit (see Special Tools (page 2–17)) to connect tester to machine. Make sure that fitting and hose connections are properly tightened. Also, make sure the flow control valve on tester is fully open.
5. Start engine and adjust engine speed to high idle speed.

   Note: If possible, turn off Smart Power™ by using the InfoCenter display protected menu. Machines with TEC software above revision level G will allow Smart Power™ to be disabled for testing. Check software revision level using the InfoCenter About screen.
6. Slowly push traction pedal to fully forward position. Keep pedal fully depressed in the fully forward position.
7. Have second person watch pressure gauge on tester carefully while slowly closing the flow control valve until 69 bar (1000 PSI) is obtained. Verify with the InfoCenter display that the engine speed is still at the correct high idle speed.

   Note: If engine speed drops during testing, pump flow will decrease and flow test results will be inaccurate.
8. Observe flow gauge. Flow indication should be approximately 113 LPM (30 GPM).
9. Release traction pedal to neutral, open flow control valve on tester and shut off engine. Record test results.
10. If flow is less than 91 LPM (24 GPM), consider the following:
    A. The traction pedal is not calibrated correctly (see Traction Pedal Position Sensor Calibration (page 6–23)).

    B. The piston pump swash plate is not being rotated fully (e.g. traction speed is not set to 100%).

    C. The forward traction relief valve is faulty.

    D. The piston pump needs to be repaired or replaced as necessary.
11. Make necessary repairs before performing any additional traction circuit tests.
12. When testing is complete, disconnect tester from pump fitting and machine hydraulic hose. Reconnect hose to pump fitting. Lower machine to ground.

Cutting Deck Circuit Pressure (Using Pressure Gauge)

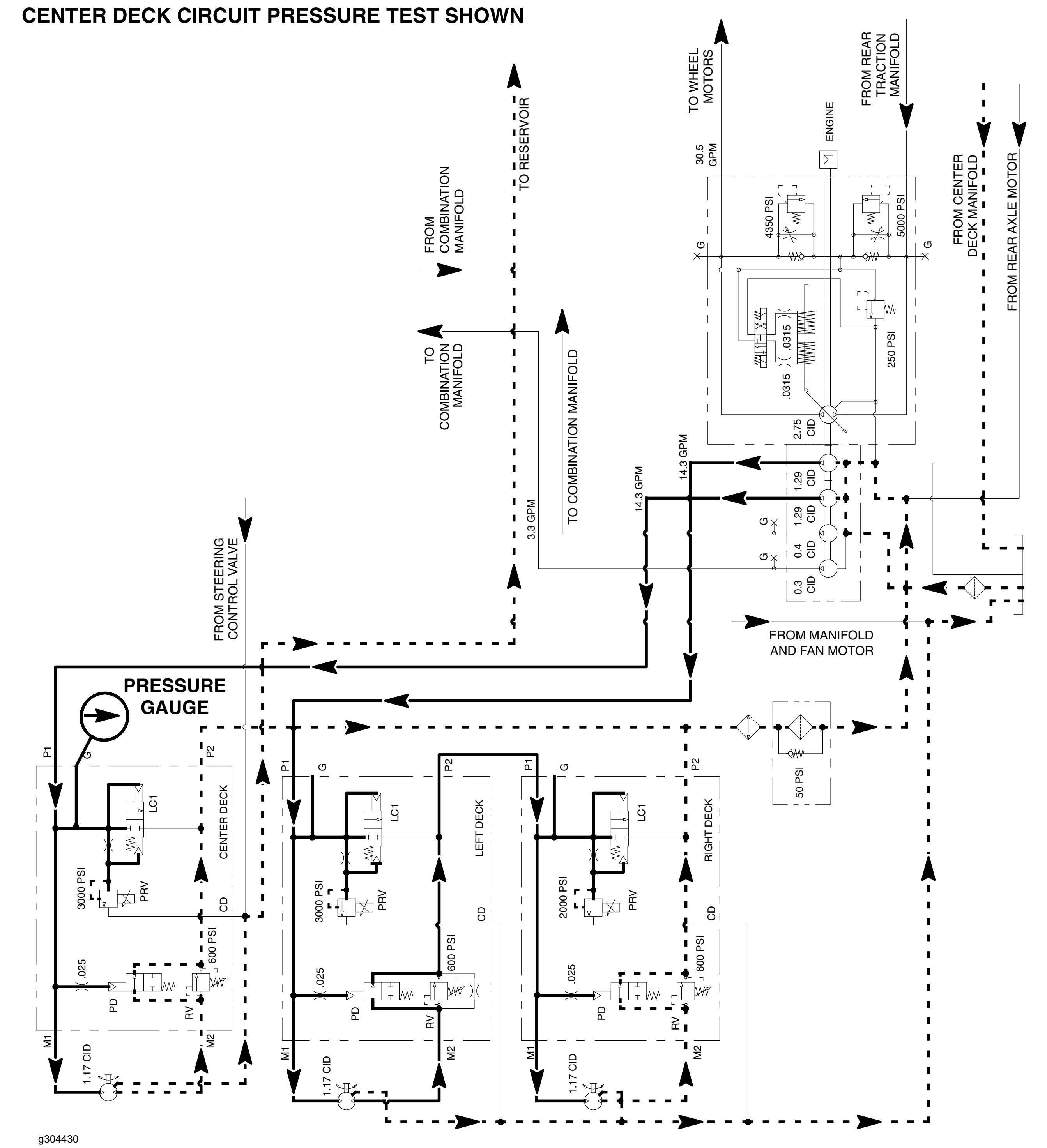
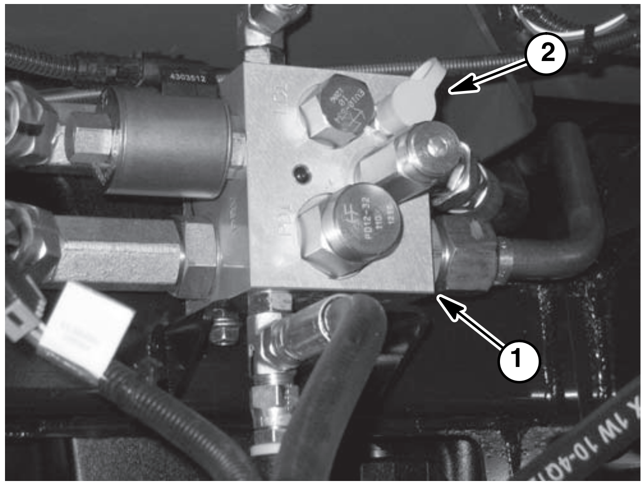


Figure 70

Procedure for Cutting Deck Circuit Pressure Test



g275064

Figure 71

1. PTO manifold (front)
2. Manifold test port

CAUTION

Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS and Precautions for Hydraulic Testing at the beginning of this section.

---

1. Park machine on a level surface with the cutting decks lowered and off. Make sure hydraulic oil is at normal operating temperature, engine is off and the parking brake is applied.
2. Install 350 bar (5000 PSI) pressure gauge with hydraulic hose attached to manifold test port (G) for the deck to be tested (Figure 71).

CAUTION

Cutting deck blades will rotate when cutting decks are lowered with PTO switch in ON position. Keep away from decks during test to prevent personal injury from rotating blades. Do not stand in front of the machine.

---

3. Start engine and increase engine speed to high idle speed. Release the parking brake.
4. Watch pressure gauge carefully while mowing with the machine.
5. Cutting deck circuit pressure should be as follows and will vary depending on mowing conditions:

   LH Deck: 69 to 207 bar (1000 to 3000 PSI)

   Center Deck: 69 to 207 bar (1000 to 3000 PSI)

   RH Deck: 69 to 137 bar (1000 to 2000 PSI)
6. Disengage cutting decks. Shut off engine and record test results.
7. When testing is completed, disconnect pressure gauge with hose from manifold test fitting. Secure dust cap to test fitting.

PTO Relief Pressure (Using Tester with Pressure Gauge and Flow Meter)

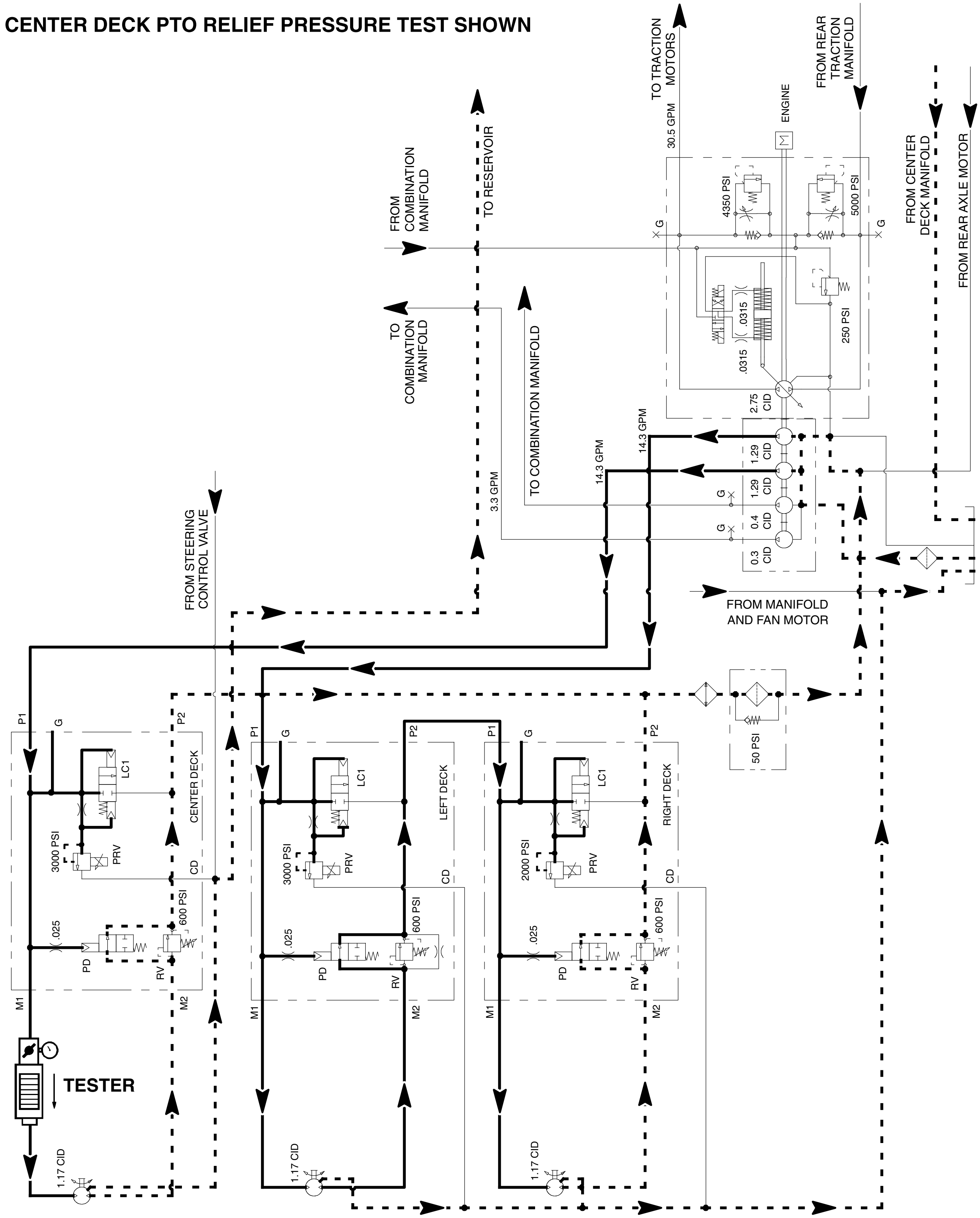


Figure 72

The PTO circuit relief pressure test should be performed to make sure that the PTO circuit relief pressures are correct.

Procedure for PTO Relief Pressure Test

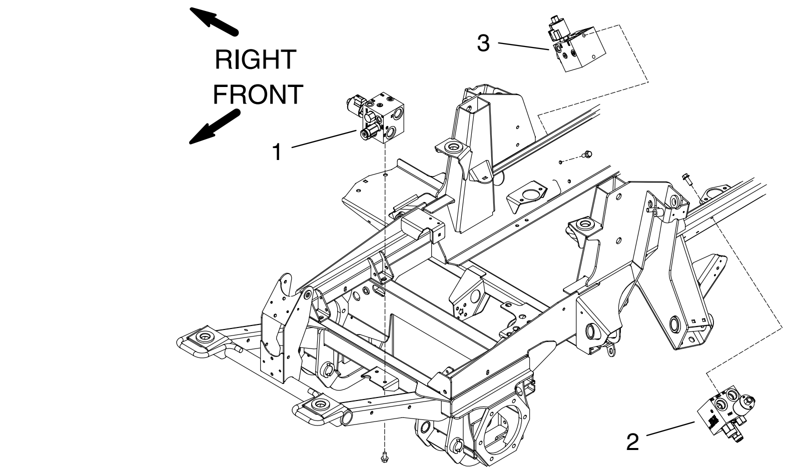


Figure 73

1. Center PTO manifold
2. LH PTO manifold
3. RH PTO manifold

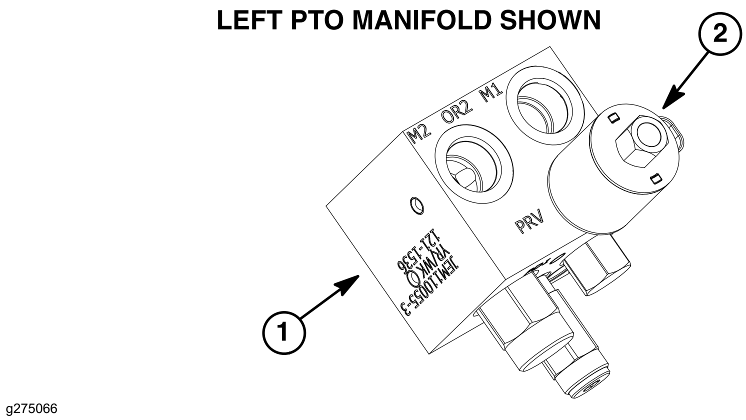


Figure 74

1. PTO manifold
2. PRV valve

CAUTION

Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS and Precautions for Hydraulic Testing at the beginning of this section.

1. Park machine on a level surface with the cutting decks lowered and off. Make sure hydraulic oil is at normal operating temperature, engine is off and the parking brake is applied.
2. Locate PTO (deck) manifold to be tested (Figure 73). Disconnect hydraulic hose at PTO manifold port (M1).

   Note: An alternative to using manifold port (M1) would be to disconnect the inlet hydraulic hose to the deck motor.
3. Install tester (flow and pressure) in series with the disconnected hose and PTO manifold port (M1) (or motor inlet if hose was disconnected at deck motor). Make sure the flow control valve on tester is fully open.

Procedure for PTO Relief Pressure Test (continued)

CAUTION

Cutting deck blades will rotate when cutting decks are lowered with PTO switch in ON position. Keep away from cutting decks during test to prevent personal injury from rotating blades. Do not stand in front of the machine.

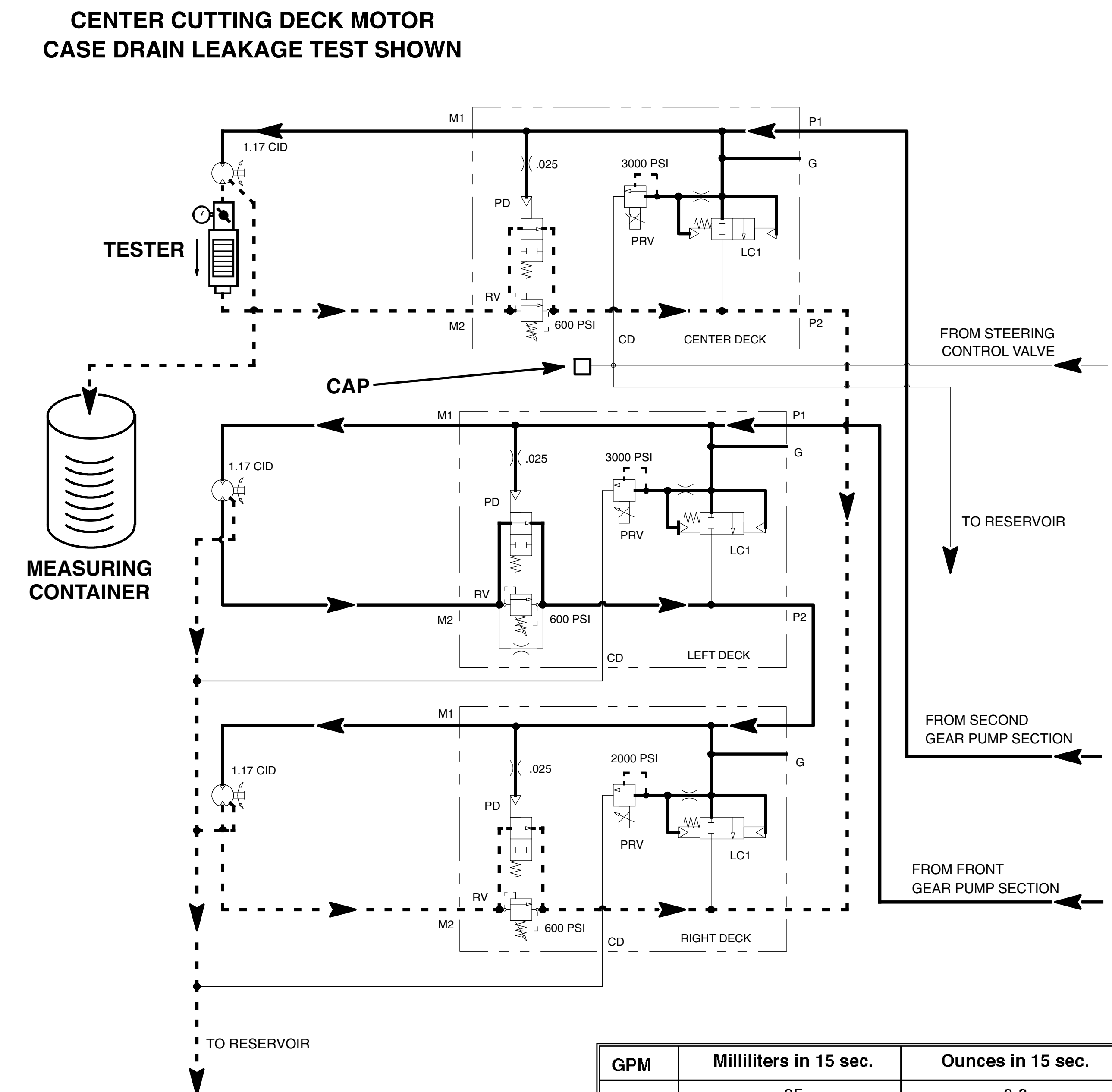
---

4. Start engine and increase engine speed to high idle speed. Release the parking brake.
5. Watch pressure gauge carefully while slowly closing the tester flow control valve to fully closed.
6. As the PTO relief valve lifts, system pressure should be approximately:

   200 to 213 bar (2900 to 3100 PSI) for the center and left decks

   131 to 144 bar (1900 to 2100 PSI) for the right deck
7. Fully open tester flow control valve and disengage cutting decks. Shut off engine and record test results.
8. If relief pressure is incorrect, remove PRV valve on mow manifold and clean or replace valve (see PTO Manifold Service (page 5–163)). Also, if pressure is still low after PRV valve service, check for restriction in pump intake line. The front gear pump section (center cutting deck circuit) and/ or the second gear pump section (side cutting deck circuits) could also be suspected of wear, damage or inefficiency (see Gear Pump Flow (Using Tester with Pressure Gauge and Flow Meter) (page 5–79)).
9. When relief pressure testing is complete, disconnect tester from PTO manifold and hydraulic hose. Reconnect hydraulic hose that was disconnected for test procedure.

Cutting Deck Motor Case Drain Leakage (Using Tester with Pressure Gauge and Flow Meter)



GPM	Milliliters in 15 sec.	Ounces in 15 sec.
.1	95	3.2
.2	189	6.4
.3	284	9.6
.4	378	12.8
.5	473	16.0
.6	568	19.2
.7	662	22.4
.8	756	25.6
.9	852	28.8
1.0	946	32.0

g304432

Figure 75

Procedure for Cutting Deck Motor Case Drain Leakage Test

Note: Over a period of time, a deck motor can wear internally. A worn motor may by−pass oil to its case drain causing the motor to be less efficient. Eventually, enough oil loss will cause the deck motor to stall under heavy cutting conditions. Continued operation with a worn, inefficient motor can generate excessive heat, cause damage to seals and other components in the hydraulic system and affect quality of cut.

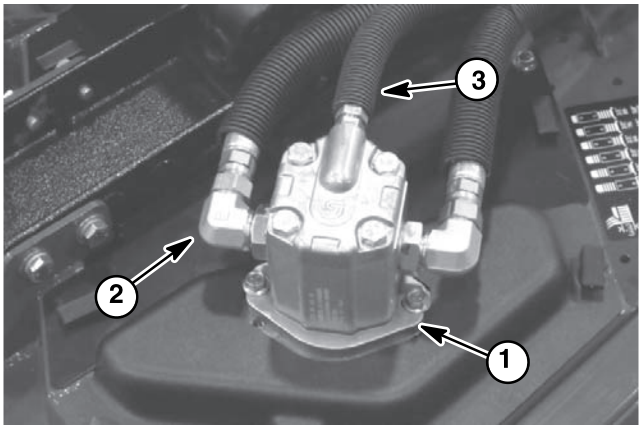
Note: One method to find a failing or malfunctioning deck motor is to have another person observe the machine while mowing in dense turf. A bad motor will run slower, produce fewer clippings and may cause a different appearance on the turf.

CAUTION

Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS and Precautions for Hydraulic Testing at the beginning of this section.

1. Park machine on a level surface with the cutting decks lowered and off. Make sure hydraulic oil is at normal operating temperature, engine is off and the parking brake is applied.

   Note: The side deck motors are connected in series. To isolate a faulty side deck motor, both motors in the circuit may have to be tested by starting with the left side motor first.



g275067

Figure 76

1. Deck motor (RH shown)
2. Return hose
3. Case drain hose

2. Disconnect hose from return of the motor to be tested (Figure 76). Install tester (flow and pressure) in series with the motor and disconnected return hose. Make sure the flow control valve on tester is fully open.
3. Disconnect the motor case drain hose (small diameter hose) where it connects to hydraulic manifold tee fitting (not at the motor). Put a steel cap on the fitting at the tee fitting; leave the case drain hose open.

CAUTION

Cutting deck blades will rotate when cutting decks are lowered with PTO switch in ON position. Keep away from cutting decks during test to prevent personal injury from rotating blades. Do not stand in front of the machine.

4. Sit on seat and start the engine. With engine running, increase engine speed to high idle speed and release the parking brake. Engage the cutting decks.

g031767

Figure 77

5. While watching pressure gauge, slowly close flow control valve on tester until a pressure of 83 bar (1200 PSI) is obtained.

   Note: Use a graduated container, special tool TOR4077, to measure case drain leakage (Figure 77).

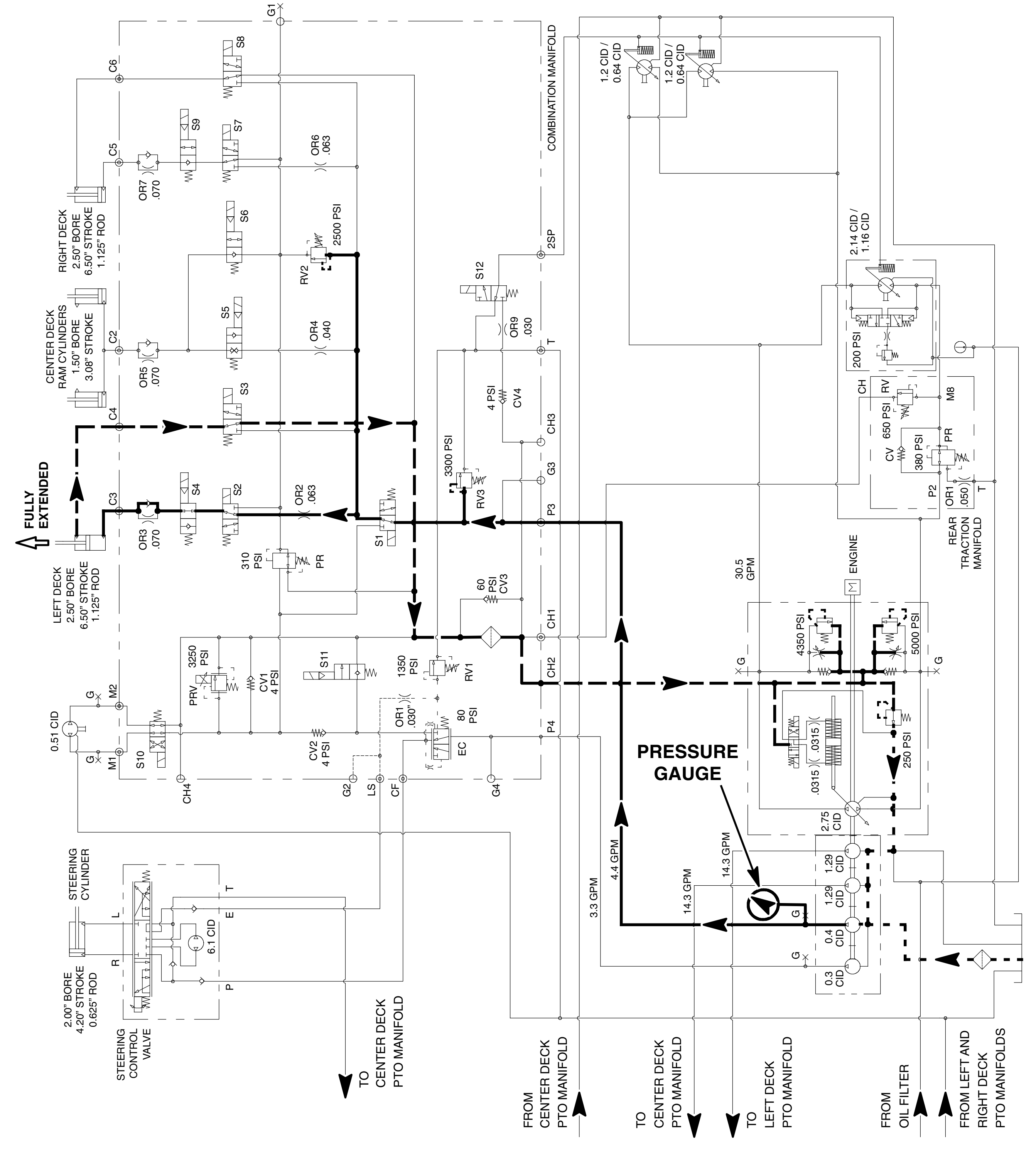
6. Have a second person collect the flow from the case drain line for 15 seconds, then move the PTO switch to OFF and stop the engine (Figure 77). Record test results.

   TEST RESULTS: Flow less than 662 ml (22.4 ounces) (0.7 GPM/2.6 LPM) of hydraulic fluid in 15 seconds.

7. If flow is more than 662 ml (22.4 ounces) (0.7 GPM/2.6 LPM) in 15 seconds, the motor is worn or damaged and should be repaired or replaced.

8. After testing is completed, disconnect tester from motor and hose. Reconnect hose to the deck motor. Remove cap from tee fitting and reconnect case drain hose to tee fitting.

Lift/Lower Circuit Relief Pressure (Using Pressure Gauge)



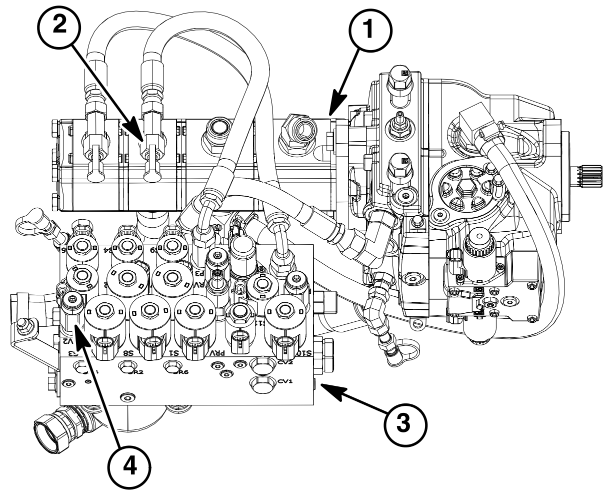
LEFT WING DECK LIFT SWITCH PRESSED IS SHOWN

g304433

Figure 78

The lift/lower circuit relief pressure test should be performed to make sure that the cutting unit lift and lower circuit relief pressure is correct.

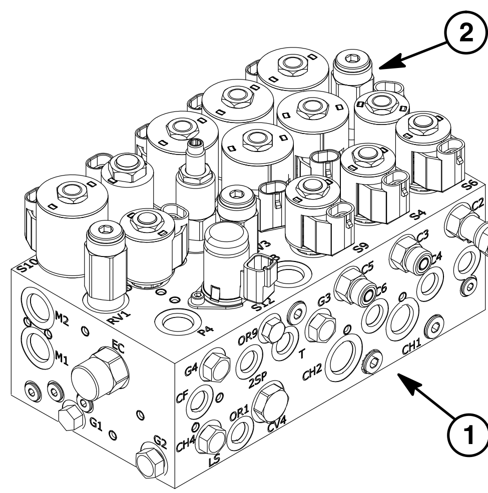
Procedure for Lift/Lower Circuit Relief Pressure Test



g275068

Figure 79

1. Gear pump
2. 3rd section test fitting
3. Combination manifold
4. Relief valve RV2



g275069

Figure 80

1. Combination manifold
2. Relief valve RV2

Note: Before attempting to check or adjust lift/lower circuit relief pressure, make sure that counterbalance pressure is correctly adjusted (see Counterbalance Pressure (Using Pressure Gauge) (page 5–45)).

CAUTION

Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS and Precautions for Hydraulic Testing at the beginning of this section.

1. Park machine on a level surface with the cutting decks lowered and off. Make sure hydraulic oil is at normal operating temperature, engine is off and the parking brake is applied.
2. Raise and support operator seat.

Procedure for Lift/Lower Circuit Relief Pressure Test (continued)

3. Connect a 345 bar (5,000 PSI) pressure gauge to test fitting attached to tee fitting in third section of gear pump (Figure 79).

4. Sit on the seat and start the engine. With engine running, increase engine speed to high idle speed.

5. While sitting on the seat, depress the rear of one of the lift switches to fully raise the cutting deck. Momentarily hold the switch with the deck fully raised while watching the pressure gauge.

   GAUGE READING TO BE approximately **170 to 175 bar (2450 to 2550 PSI)**.

6. Release the lift switch, stop the engine and record test results.

7. If specification is not met, clean or adjust relief valve RV2 located in the combination control manifold (see Combination Manifold Service (page 5–125)).

   A. If relief pressure is too high, adjust relief valve RV2 to reduce lift/lower circuit relief pressure (see Adjust Control Manifold Relief Valves (page 5–82)).

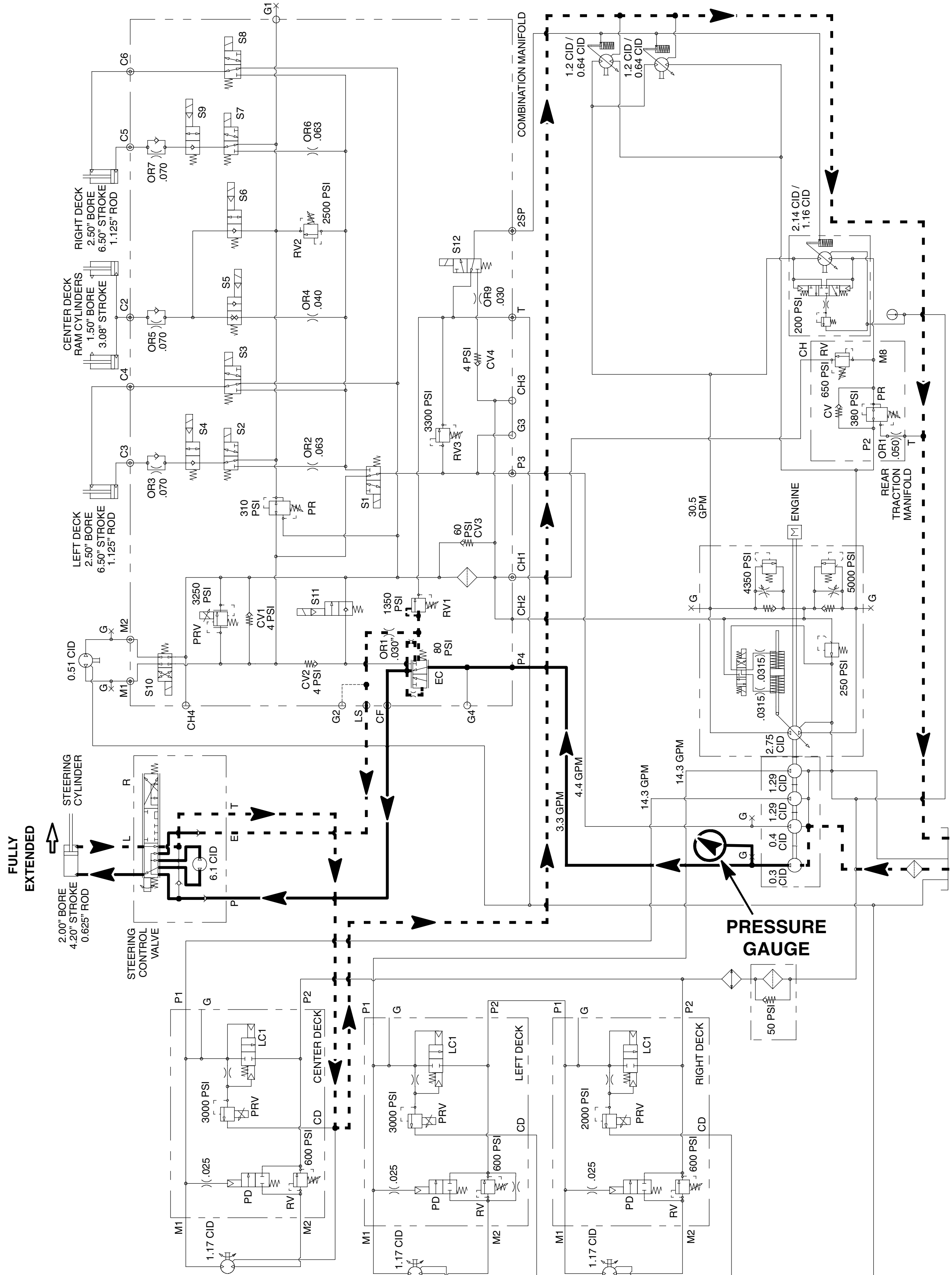
   B. If relief pressure is too low, check for restriction in gear pump intake line. Check the lift cylinders for internal leakage. If pump intake line is not restricted and lift cylinders are not leaking, adjust relief valve RV2 to increase lift/lower circuit relief pressure (see Adjust Control Manifold Relief Valves (page 5–82)).

   C. If pressure is still too low after relief valve adjustment, lift cylinder(s) or the third section of the gear pump should be suspected of wear or damage.

8. When relief pressure testing is completed, disconnect pressure gauge from test fitting. Secure dust cap to test fitting.

9. Lower and secure operator seat.

Steering Circuit Relief Pressure (Using Pressure Gauge)



g304434

Figure 81

The steering circuit relief pressure test should be performed to make sure that the steering circuit relief pressure is correct.

Procedure for Steering Circuit Relief Pressure Test

CAUTION

Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS and Precautions for Hydraulic Testing at the beginning of this section.

1. Park machine on a level surface with the cutting deck lowered and off. Make sure hydraulic oil is at normal operating temperature, engine is off and the parking brake is applied.
2. Raise and support operator seat.

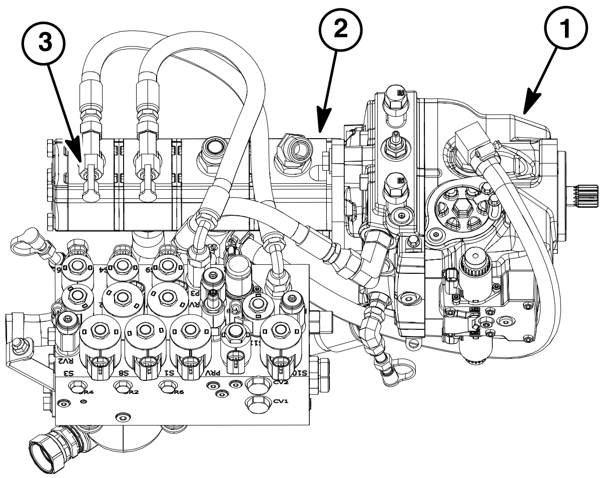


Figure 82

1. Piston (traction) pump
2. Gear pump
3. Test fitting

3. Connect a 350 bar (5000 PSI) pressure gauge to test fitting attached to tee fitting in final section of gear pump (Figure 82).
4. Start engine and increase engine speed to high idle speed.

IMPORTANT

Hold steering wheel at full lock only long enough to get a system relief pressure reading. Holding the steering wheel against the stop for an extended period can damage the steering control valve.

5. Turn steering all the way in one direction and momentarily hold the steering wheel against resistance.

   GAUGE READING TO BE 90 to 96 bar (1300 to 1400 PSI).

6. Stop the engine and record test results.

Procedure for Steering Circuit Relief Pressure Test (continued)

7. If pressure is incorrect, inspect steering relief valve in steering control valve (see Steering Control Valve Service (For machines serial number below: 400000000) (page 5–136)). If relief valve is operating properly and if lift/lower problems also exist, flow divider in fan manifold and/or gear pump (third section) should be suspected of wear and inefficiency. If steering wheel continues to turn at end of cylinder travel (with lower than normal effort), steering cylinder or steering control valve should be suspected of wear or damage.
8. When testing is completed, disconnect pressure gauge from test fitting. Secure dust cap to test fitting.
9. Lower and secure operator seat.

Steering Cylinder Internal Leakage

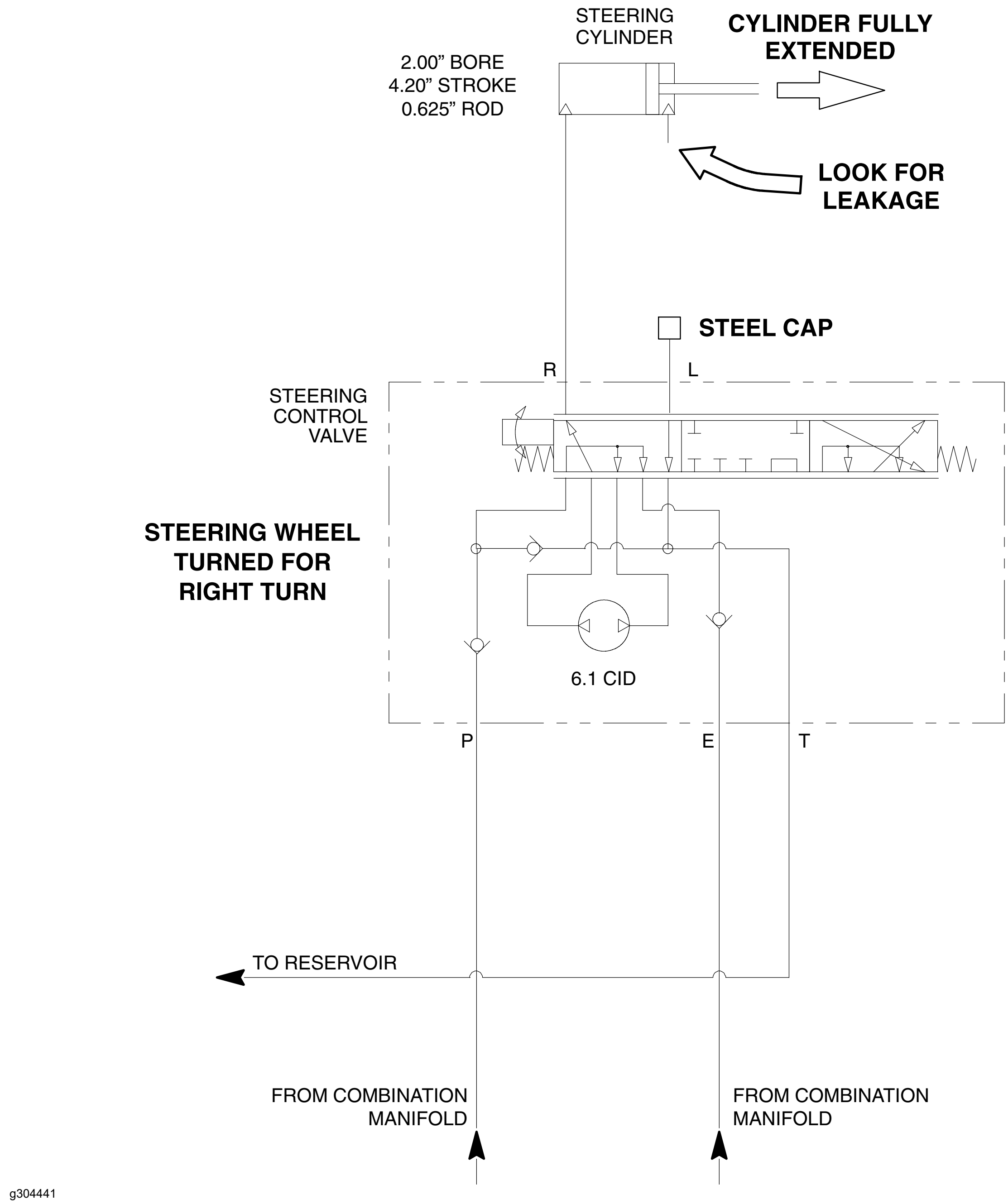


Figure 83

The steering cylinder internal leakage test should be performed if a steering problem is identified. This test will determine if the steering cylinder is faulty.

Procedure for Steering Cylinder Internal Leakage Test

Note: Steering circuit operation will be affected by rear tire pressure, binding of steering cylinder, extra weight on the vehicle and/or binding of rear axle steering components. Make sure that these items are checked before proceeding with steering cylinder internal leakage test.

Procedure for Steering Cylinder Internal Leakage Test (continued)

CAUTION

Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS and Precautions for Hydraulic Testing at the beginning of this section.

---

1. Park machine on a level surface with the cutting decks lowered and off. Make sure hydraulic oil is at normal operating temperature, engine is off and the parking brake is applied.
2. Turn the steering wheel for a right turn so that the steering cylinder rod is fully extended.
3. Thoroughly clean the area around the hydraulic hose at the rod end of the steering cylinder.
4. Place a drain pan under the steering cylinder. Remove hydraulic hose from the fitting on the rod end of the steering cylinder. Install a steel plug in the disconnected hose. Leave cylinder fitting open.
5. Remove all hydraulic oil from drain pan. Make sure that empty drain pan remains under the open fitting of the steering cylinder.
6. With the engine off, turn the steering wheel for a right turn. Observe the open fitting on the extended steering cylinder as the steering wheel is turned. If oil comes out of the fitting while turning the steering wheel, the steering cylinder has internal leakage and must be repaired (see Steering Cylinder (page 5–138) and Steering Cylinder Service (page 5–140)). Check drain pan for any evidence of oil that would indicate cylinder leakage.
7. If a steering problem exists and the steering cylinder tested acceptably, the steering control valve requires service (see Steering Cylinder (page 5–138) and Steering Cylinder Service (page 5–140)).
8. After testing is completed, remove plug from the hydraulic hose. Connect hose to the steering cylinder fitting.
9. Check oil level in hydraulic reservoir and adjust if needed.

Engine Cooling Fan Circuit (Using Pressure Gauge and Phototac)

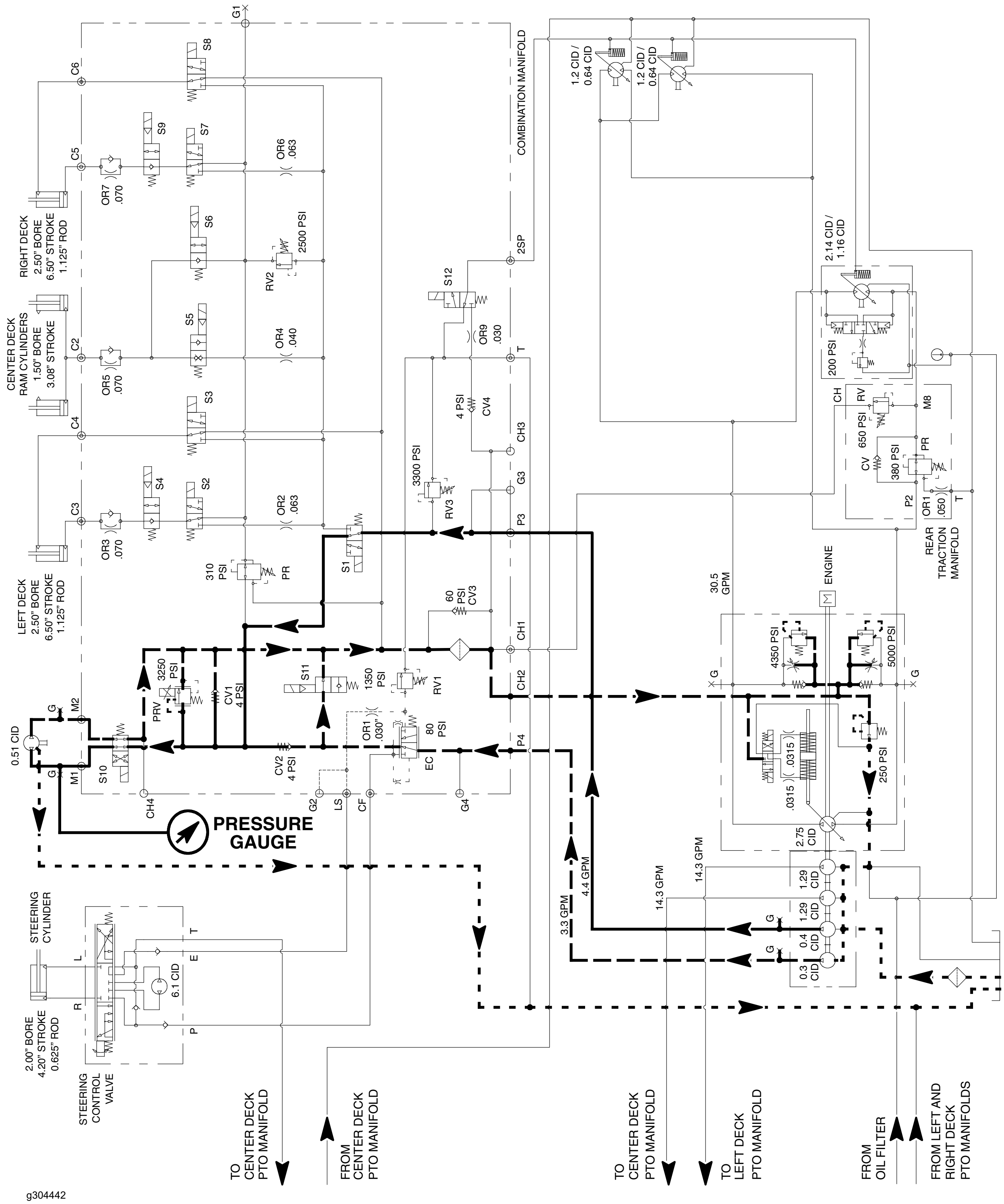
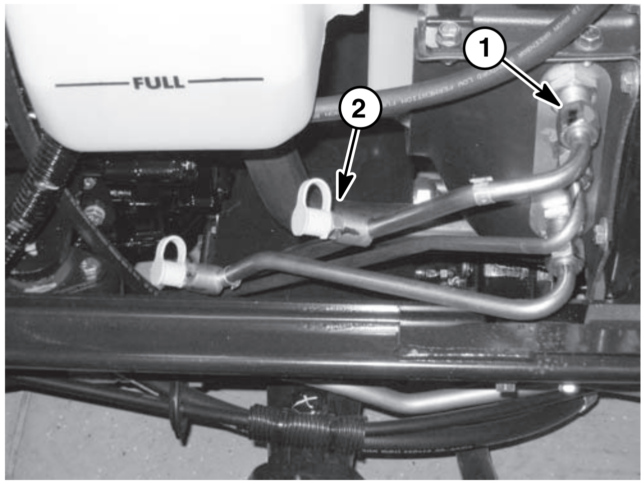


Figure 84

The cooling fan circuit test should be performed to make sure that the engine cooling fan circuit has the correct system pressure and fan speed.

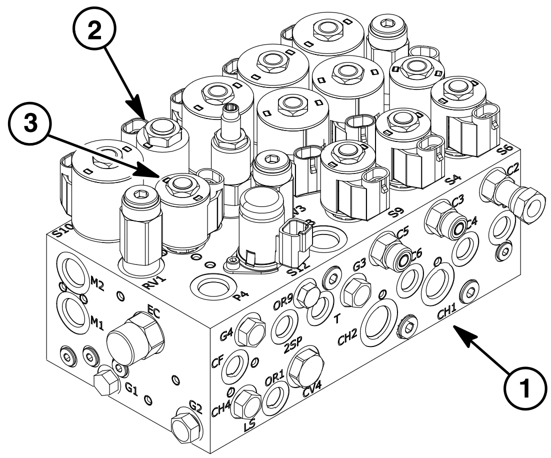
Procedure for Engine Cooling Fan Circuit Test



g275071

Figure 85

1. Upper hydraulic tube
2. Test port



g275072

Figure 86

1. Combination manifold
2. PRV solenoid
3. S11 solenoid

⚠ CAUTION ⚠

Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS and Precautions for Hydraulic Testing at the beginning of this section.

1. Park machine on a level surface with the cutting decks lowered and off. Make sure hydraulic oil is at normal operating temperature, engine is off and the parking brake is applied.
2. Raise and support hood to gain access to the hydraulic tubes that supply hydraulic flow to engine cooling fan motor (Figure 85). Connect a 345 bar (5,000 PSI) pressure gauge with hydraulic hose attached to test port on hydraulic tube connected in the upper location on radiator shroud.
3. Raise seat to gain access to the combination manifold (Figure 86). Locate PRV and S11 solenoid valves on manifold.

Procedure for Engine Cooling Fan Circuit Test (continued)

4. Have a phototac available to identify cooling fan speed once engine is running.
5. Start engine and increase engine speed to high idle speed. **Do not engage the cutting decks.**
6. While monitoring the pressure gauge and using the phototac to identify the cooling fan speed, disconnect the wire harness connectors from the PRV solenoid (white/green and black wires) and S11 solenoid (violet and black wires) on combination manifold (Figure 86). Both fan speed and pressure should increase and stabilize after the solenoids are disconnected.

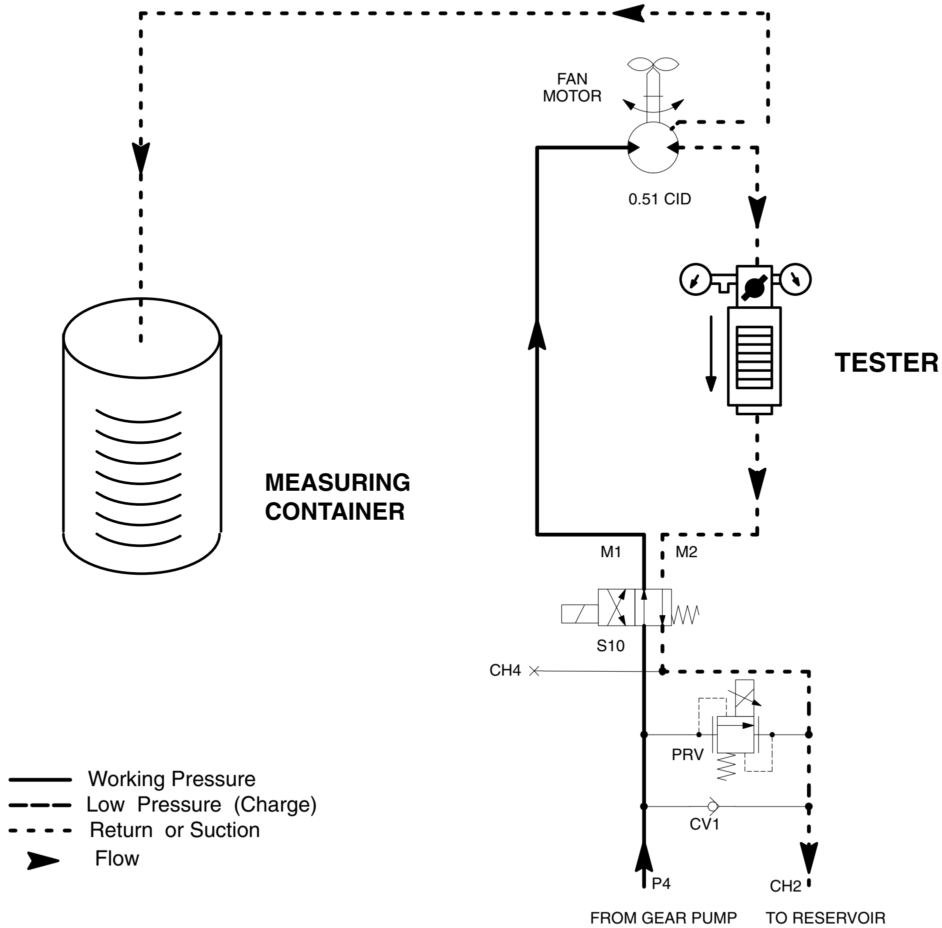
   PRESSURE GAUGE READING TO BE approximately 224 bar (3250 PSI).

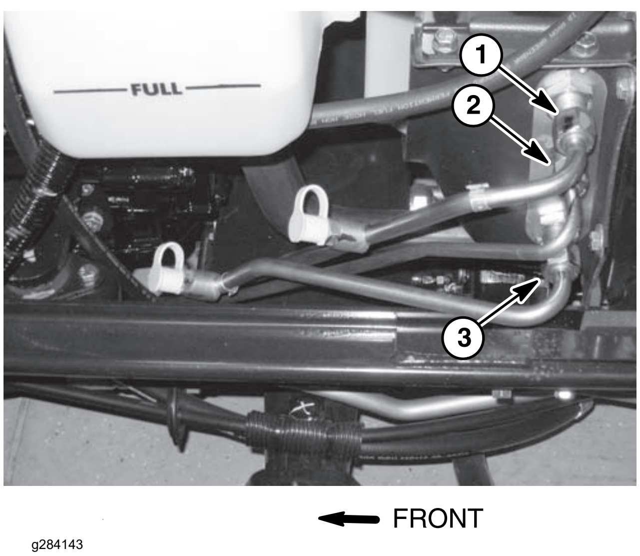
   PHOTOTAC READING (FAN SPEED) TO BE approximately 2800 to 3000 RPM.

   Note: The cooling fan speed will depend on hydraulic oil temperature. Higher oil temperatures will result in slower fan speed.
7. Stop engine and record test results.
8. If circuit pressure rises to approximately 224 bar (3250 PSI) but fan speed is low, consider that the fan motor is worn or damaged. If pressure and fan speed are both low, consider that the gear pump section is worn or damaged (see Gear Pump Flow (Using Tester with Pressure Gauge and Flow Meter) (page 5–79)).

   Note: If pressure and fan speed are both low and gear pump flow proves to be correct, suspect that engine cooling fan circuit cartridge valve seals in combination manifold (e.g. S10, S11, PRV) are leaking or faulty (see Combination Manifold Service (page 5–125)).
9. When testing is complete, remove pressure gauge from hydraulic tube test port and reconnect wire harness connectors to PRV and S11 solenoids. Lower and secure hood and operator seat.

Engine Cooling Fan Motor Case Drain Leakage Test





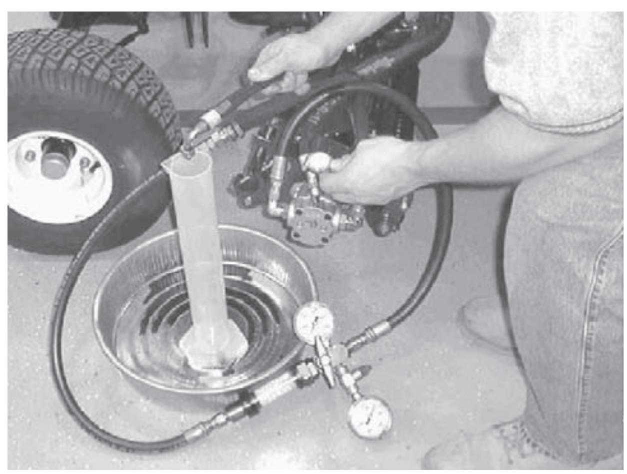


Figure 87

1. Pressure tube
2. Case drain tube
3. Return tube

Procedure for Engine Cooling Fan Motor Case Drain Leakage Test

Over a period of time, the motor can wear internally. This test measures case drain volume while restricting flow across the motor parts. Case drain volume under load of more than **12%** of total motor flow indicates the gears and wear plates in the motor have worn. A worn motor may by-pass hydraulic fluid to its case drain causing the motor to be less efficient. Eventually, enough fluid loss will cause the fan motor to slow, reducing its ability to cool the engine. Continued operation with a worn, inefficient motor can generate excessive heat, cause damage to seals and other components in the hydraulic system and affect engine performance.

Special Equipment Required:

- 56 LPM (15 GPM) Hydraulic Tester (Pressure and Flow) with hoses - 13/16 - 16
- Hydraulic Hose - 11/16 - 16 x 6 ft. (1.8 m)
- Phototach (non-contact tachometer)

1. Park the machine on a level surface with the cutting units lowered and the reel enable/disable switch in the DISABLE position. Make sure that the engine is off and the parking brake is applied.

⚠ CAUTION ⚠

Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS and Precautions for Hydraulic Testing at the beginning of this section.

---

2. Raise and support hood to gain access to fan shroud and fan motor plumbing.
3. Disconnect the return tube from the fan shroud (lower tube) and the fan control manifold M2 port. Remove the hydraulic tube and install the a hydraulic tester and hose between the fan shroud bulkhead fitting and the fan control manifold. Make sure that the tester flow control valve is fully open.
4. Start the engine and run at low idle speed. Check for hydraulic leaks at tester connections and make connections if necessary before proceeding with test.
5. Set the throttle to high speed.
   A. Use the InfoCenter display to verify the engine RPM is 2600 RPM for Models 30602, 30604 and 30643.
   B. Use the InfoCenter display to verify the engine RPM is 2700 RPM for Models 30606, 30608 and 30644.
6. Make sure that the hydraulic oil is at normal operating temperature by operating the machine for approximately ten minutes.
7. Stop the engine and disconnect the wire harness connector from the proportional relief valve solenoid at fan control manifold port.
8. Disconnect the case drain tube from the motor (small diameter center tube at fan shroud) and install a 1.8 m (6 ft.) hydraulic hose to the fan shroud bulkhead fitting. Put a steel plug on the disconnected tube to prevent system contamination.
9. Place open end of the case drain test hose into a drain pan.
10. Two people are required to complete the following steps. One person should sit in the operator’s seat and operate the machine while another person reads the tester and measures fan motor case drain volume.

CAUTION

Cooling fan blades will rotate during the test procedure. Keep away from cooling fan blades during test to prevent personal injury from rotating blades.

---

11. Sit in the operator's seat, start the engine and set the throttle to high idle speed.
12. While watching the tester pressure gauge, slowly close flow control valve on tester until a pressure of 138 bar (2000 PSI) is obtained.

    Note: Use a graduated container (special tool TOR4077) to measure case drain leakage.
13. Measure oil flow from the case drain test hose for 15 seconds, then open the tester flow control valve and stop the engine. Record the test results.

    TEST RESULTS: Case drain leakage should be less than 745 ml (25 oz) of hydraulic fluid in 15 seconds (3 LPM (0.8 GPM)).
14. If the case drain flow is more than 745 ml (25 oz) in 15 seconds, the fan motor is worn or damaged and should be repaired or replaced.
15. Remove the tester and hose fan control manifold and fan shroud bulkhead fitting. Install the removed hydraulic tube.
16. Remove the case drain hose. Remove the plug from the case drain tube and reconnect to fan shroud bulkhead fitting.
17. Reconnect the wire harness to proportional relief valve solenoid.
18. Start the engine and run at low idle speed. Check for hydraulic leaks and make corrections if necessary before returning machine to service.
19. Lower and secure hood when finished.

Gear Pump Flow (Using Tester with Pressure Gauge and Flow Meter)

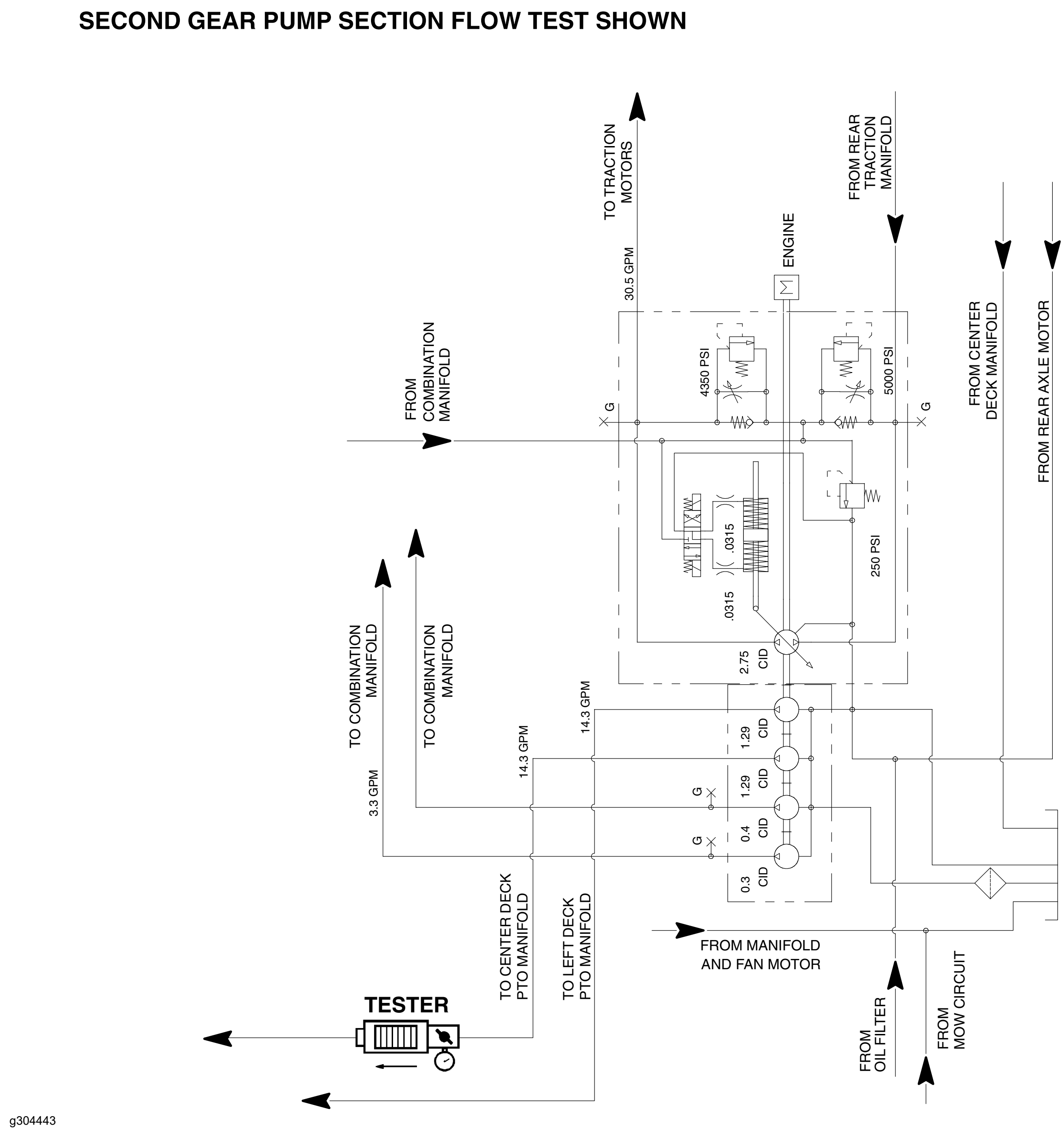


Figure 88

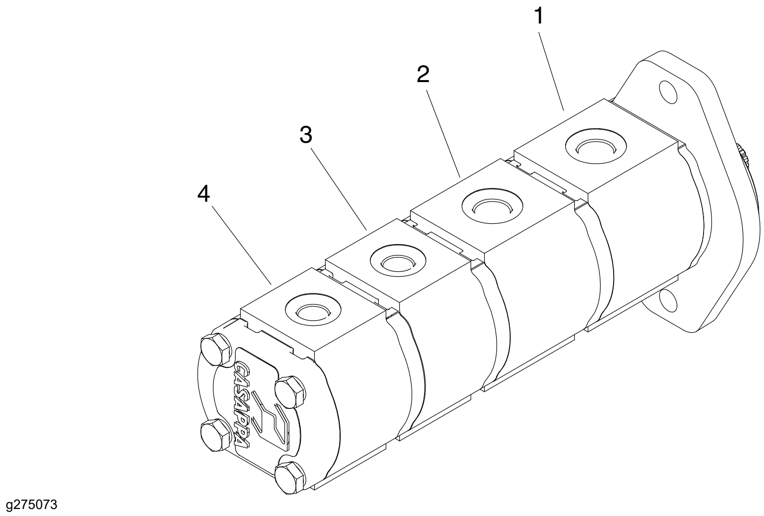


Figure 89

1. Front pump section (LH and RH PTO)
2. 2^{nd} pump section (front PTO)
3. 3^{rd} pump section (cooling fan, lift/lower and charge)
4. 4^{th} pump section (steering, charge and cooling fan)

The gear pump flow test should be performed to make sure that the mow, steering, lift/lower, cooling fan and traction charge circuits have adequate hydraulic flow. The front gear pump section provides hydraulic flow for the side cutting decks (Figure 89). The second gear pump section provides hydraulic flow for the center cutting deck. The third gear pump section provides hydraulic flow for the cooling fan, lift/lower and traction charge circuits. The fourth gear pump section provides hydraulic flow for the steering, traction charge and cooling fan circuits.

Note: Over a period of time, the gears and wear plates in the gear pump can wear. A worn pump will by pass oil and make the pump less efficient. Eventually, enough oil loss will occur to cause circuit problems (e.g. cutting deck motors stalling under heavy cutting conditions, lift or steering problems). Continued operation with a worn, inefficient gear pump can generate excessive heat and cause damage to the seals and other components in the hydraulic system.

Procedure for Gear Pump Flow Test

CAUTION

Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS and Precautions for Hydraulic Testing at the beginning of this section.

---

1. Park machine on a level surface with the cutting decks lowered and off. Make sure hydraulic oil is at normal operating temperature, engine is off and the parking brake is applied.
2. Raise and support operator seat to gain access to gear pump.
3. Determine which gear pump section is to be tested. Disconnect hydraulic hose from fitting in gear pump section that is to be tested (Figure 89).
4. Install tester (flow and pressure) in series with the disconnected hose and hydraulic fitting in gear pump section.
5. Make sure the flow control valve on tester is fully open.

Procedure for Gear Pump Flow Test (continued)

6. Start engine and increase engine speed to high idle speed. **Do not engage the cutting decks.**

IMPORTANT

Do not fully restrict oil flow through tester. In this test, the flow tester is positioned before the relief valve. Pump damage can occur if the oil flow is fully restricted.

7. Watch pressure gauge carefully while slowly closing the flow control valve until 69 bar (1000 PSI) is obtained. Verify with the InfoCenter display that the engine is still running at the correct high idle speed.

   Note: If engine speed drops during testing, pump flow will decrease and flow test results will be inaccurate.

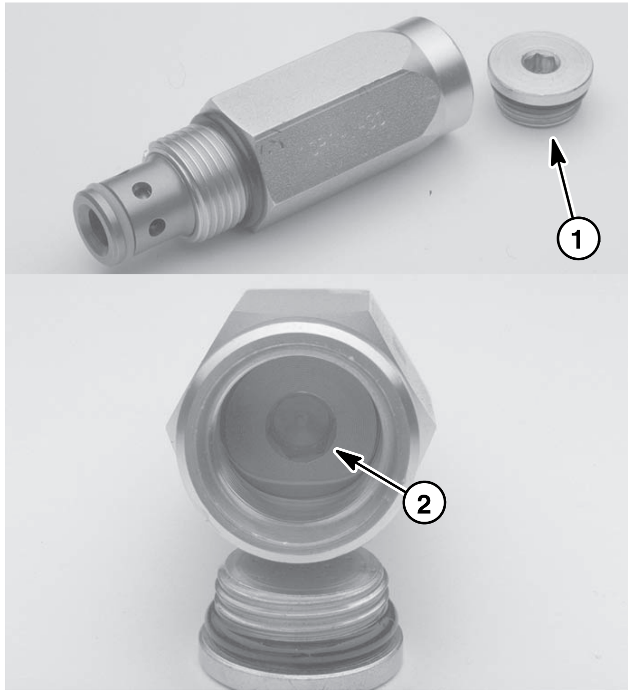
8. Normal flow indication for the four (4) gear pump sections is listed in below table:

PUMP SECTION	NORMAL FLOW	MINIMUM FLOW
FRONT SECTION	53 LPM (14 GPM)	41.6 LPM (11 GPM)
SECOND SECTION	53 LPM (14 GPM)	41.6 LPM (11 GPM)
THIRD SECTION	16.3 LPM (4.3 GPM)	12.8 LPM (3.4 GPM)
FOURTH SECTION	12.1 LPM (3.2 GPM)	9.5 LPM (2.5 GPM)

9. Shut off engine and record test results.
10. If a pressure of 69 bar (1000 PSI) cannot be obtained or flow was less than the minimum flow listed in above table, check for restriction in the pump intake line. If line is not restricted, consider that the tested gear pump section is worn or damaged.
11. After testing is completed, disconnect flow tester from hydraulic hose and fitting in gear pump section. Reconnect hose to the pump fitting.
12. Lower and secure operator seat.

Adjustments

Adjust Control Manifold Relief Valves



g275100

Figure 90

1. Relief valve cap
2. Adjustment socket

Several of the hydraulic control manifolds on your Groundsmaster include adjustable relief valves. The following procedure can be used to adjust these relief valves. Refer to the Testing (page 5–36) section of this chapter for information on testing relief pressure.

Note: Do not remove relief valve from the hydraulic manifold for adjustment.

1. Locate relief valve on control manifold.
2. Remove cap on relief valve with an allen wrench.
3. To increase pressure setting, turn the adjustment socket on the valve in a clockwise direction. A 1/8 turn on the socket will make a measurable change in relief pressure.
4. To decrease pressure setting, turn the adjustment socket on the valve in a counterclockwise direction. A 1/8 turn on the socket will make a measurable change in relief pressure.
5. Install and tighten cap on relief valve.
6. Recheck relief pressure and readjust as needed.

Service and Repairs

General Precautions for Removing and Installing Hydraulic System Components

Before Repair or Replacement of Components

1. Before removing any parts from the hydraulic system, park machine on a level surface, apply parking brake, lower cutting decks or attachments and stop engine. Remove key from the key switch.
2. Clean machine before disconnecting, removing or disassembling any hydraulic components. Make sure that all hydraulic components, hose connections and fittings are cleaned thoroughly. Always keep in mind the need for cleanliness when working on hydraulic equipment.

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure (page 5–3).

3. Put caps or plugs on any hydraulic lines, hydraulic fittings and components left open or exposed to prevent contamination.
4. Put labels on disconnected hydraulic lines and hoses for proper installation after repairs are completed.
5. Note the position of hydraulic fittings (especially elbow fittings) on hydraulic components before removal. Mark parts if necessary to make sure they will be aligned properly when installing hydraulic hoses and tubes.

After Repair or Replacement of Components

1. Check oil level in the hydraulic reservoir and add correct oil if necessary. Drain and refill hydraulic system reservoir and change oil filters if component failure was severe or system is contaminated (see Flush Hydraulic System (page 5–87)).

IMPORTANT

Follow all local codes and regulations when recycling or disposing hydraulic fluid and filters.

2. Lubricate O−rings and seals with clean hydraulic oil before installing hydraulic components.
3. Make sure caps or plugs are removed from the hydraulic lines, hydraulic fittings and components before reconnecting.
4. Use proper tightening methods when installing hydraulic lines and fittings (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–8)).
5. After repairs, check control linkages or cables for proper adjustment, binding or broken parts.
6. If piston (traction) pump, front wheel motors or rear axle motor was removed from machine for service, fill housing through case drain with new hydraulic oil before starting engine. This will ensure that internal components have adequate lubrication during initial operation.

After Repair or Replacement of Components (continued)

7. After disconnecting or replacing any hydraulic components, operate machine functions slowly until air is out of system (see Charge Hydraulic System (page 5–91)).
8. Check for hydraulic oil leaks. Shut off engine and correct leaks if necessary. Check oil level in hydraulic reservoir and add correct oil if necessary.

Check Hydraulic Lines and Hoses

WARNING

Keep body and hands away from pin hole leaks or nozzles that eject hydraulic fluid under high pressure. Use paper or cardboard, not hands, to search for leaks. Hydraulic fluid escaping under pressure can have sufficient force to penetrate the skin and cause serious injury. If fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type of injury. Gangrene may result from such an injury.

IMPORTANT

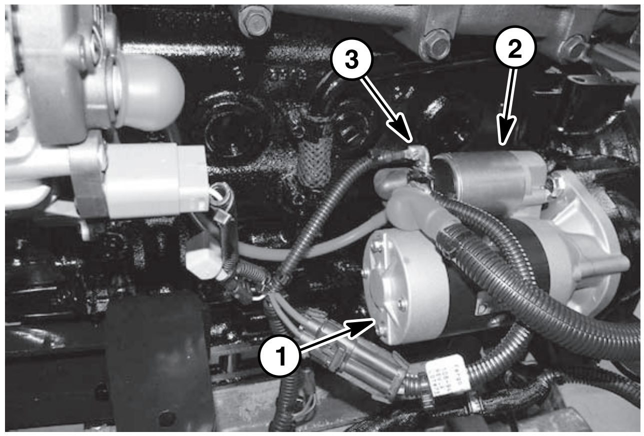
Check hydraulic lines and hoses daily for leaks, kinked lines, loose mounting supports, wear, loose fittings or any hose deterioration. Make all necessary repairs before operating.

Priming Hydraulic Pumps

Whenever the hydraulic system is flushed, the hydraulic system is charged or hydraulic components are installed, it is important to properly prime the hydraulic pumps. Hydraulic pump priming ensures that the gear pump and piston (traction) pump have adequate oil during initial start−up and running. The pumps can be primed by using a remote starter switch (see Special Tools (page 2–17)) to crank engine which allows the pumps to prime.

Use the following procedure to prime the hydraulic pumps:

1. Make sure that key switch is in the OFF position and key is removed from switch.



g275416

Figure 91

1. Starter motor
2. Starter solenoid
3. B+ terminal

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2. Check hydraulic reservoir oil level and adjust if necessary.

   Note: A blue wire connects to the starter motor solenoid B+ terminal (Figure 91). It is not necessary to remove this blue wire from the solenoid terminal for hydraulic pump priming.

3. Connect remote starter switch electrical leads to the starter motor solenoid B+ terminal and the positive post of the battery.
4. Engage remote starter switch and crank starter for thirty (30) seconds to prime hydraulic pumps. Wait thirty (30) seconds to allow the starter motor and starter solenoid to cool. Repeat cranking procedure a second time.
5. Disconnect remote starter switch leads from starter motor solenoid terminal and positive post of the battery.

Flush Hydraulic System

IMPORTANT

Flush the hydraulic system any time there is a severe component failure or the system is contaminated. Contaminated oil may appear milky or black or may contain metal particles.

IMPORTANT

If a component failure occurred in the closed loop traction circuit (e.g. piston pump or wheel motor), filtering the traction circuit is recommended. See Filtering Closed−Loop Traction Circuit (page 5–89).

1. Park machine on a level surface. Lower cutting decks to the ground, stop engine and apply parking brake. Remove key from the key switch.

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure (page 5–3).

IMPORTANT

Make sure to clean around any hydraulic connections that will be disconnected for draining.

2. Drain hydraulic reservoir. Remove suction screen from reservoir and clean thoroughly. Consider removing and cleaning reservoir if necessary.
3. Drain hydraulic system. Drain all hoses, tubes and components while the system is warm.
4. Change and replace both hydraulic oil filters.

IMPORTANT

Follow all local codes and regulations when recycling or disposing hydraulic fluid and filters.

5. Inspect and clean hydraulic reservoir (see Hydraulic Reservoir (page 5–93)).
6. Connect all hydraulic hoses, lines and components that were disconnected while draining system.

IMPORTANT

When filling hydraulic reservoir, use only hydraulic fluids specified in *Operator's Manual*. Other fluids could cause system damage.

7. Fill hydraulic reservoir with new hydraulic fluid.

Flush Hydraulic System (continued)

8. Prime hydraulic pumps (see Priming Hydraulic Pumps (page 5–86)).
9. Start engine and let it run at low idle speed for a minimum of two (2) minutes. Increase engine speed to high idle for minimum of one (1) minute under no load.
10. Raise and lower cutting decks several times. Turn steering wheel fully left and right several times.
11. Shut off engine and check for hydraulic oil leaks. Check oil level in hydraulic reservoir and add correct amount of oil if necessary.
12. Operate machine for two (2) hours under normal operating conditions.
13. Check condition of hydraulic oil. If the new fluid shows any signs of contamination, repeat steps 1 through 12 again until oil is clean.
14. Assume normal operation and follow recommended maintenance intervals.

Filtering Closed−Loop Traction Circuit

Filtering of a closed−loop hydraulic system after a major component failure (e.g. traction (piston) pump or front wheel motor) is a requirement to prevent debris from transmitting throughout the system. If a closed−loop hydraulic system filtering tool is not used to ensure system cleanliness, repeat failures, as well as subsequent damage to other hydraulic components in the affected system, will occur. To effectively remove contamination from closed−loop traction circuit, use of the Toro high flow hydraulic filter and hydraulic hose kits are recommended (see Special Tools (page 2–17)).

1. Park machine on a level surface with engine stopped and key removed from key switch.
2. Raise and support machine so all wheels are off the ground (see Jacking Instructions (page 1–7)).

   Note: If front wheel or rear axle motor was replaced, install high flow filter to the inlet of new motor instead of to the traction pump fitting. This will prevent system contamination from entering and damaging the new motor.

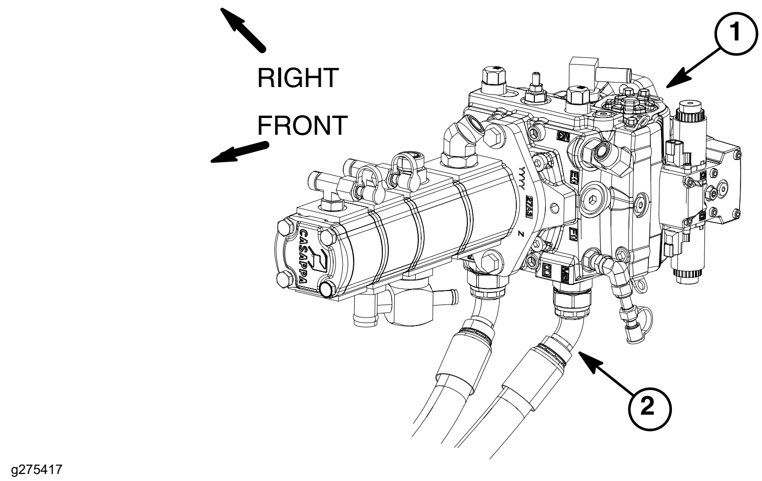

Figure 92

1. Piston (traction) pump
2. Left side fitting/hose

3. Thoroughly clean junction of hydraulic hose and left side fitting on bottom of piston (traction) pump (Figure 92). Disconnect hose from left side pump fitting.
4. Connect Toro high flow hydraulic filter in series between piston pump fitting and disconnected hose. Use hydraulic hose kit (see Special Tools (page 2–17)) to connect filter to machine. Make sure that fitting and hose connections are properly tightened.

IMPORTANT

When filling hydraulic reservoir, use only hydraulic fluids specified in *Operator's Manual*. Other fluids could cause system damage.

5. After installing high flow filter to machine, check and fill hydraulic reservoir with new hydraulic oil as required.
6. Start engine and run at idle speed. Check for any hydraulic leakage from filter and hose connections. Correct any leaks before proceeding.

Filtering Closed−Loop Traction Circuit (continued)

CAUTION

All wheels will be off the ground and rotating during this procedure. Make sure machine is well supported so it will not move and accidentally fall to prevent injuring anyone around machine.

IMPORTANT

While engaging the traction circuit, monitor the high flow hydraulic filter indicator. If the indicator should show red, either reduce traction pedal setting or reduce engine speed to decrease hydraulic flow through the filter.

7. With engine running at low idle speed, slowly move the traction pedal to the forward direction to allow flow through the traction circuit and high flow filter. Keep traction circuit engaged for five (5) minutes while gradually increasing both forward pressure on traction pedal and engine speed. Monitor filter indicator to make sure that green color is showing during operation.
8. With engine running at high idle speed and traction pedal moved to the forward direction, periodically apply brakes to increase pressure in traction circuit. While monitoring filter indicator, continue this process for an additional five (5) minutes.

IMPORTANT

If using a filter that is not the bi−directional Toro high flow filter, do not press the traction pedal in the reverse direction. If flow is reversed when using a filter that is not bi−directional, debris from the filter will re−enter the traction circuit.

9. With engine running at high idle speed, alternately move traction pedal from forward to reverse. While monitoring filter indicator, continue this process for an additional five (5) minutes.
10. Shut engine off and remove key from key switch.
11. Remove high flow hydraulic filter and hydraulic hose kit from machine. Connect hydraulic hose to right side piston (traction) pump fitting. Make sure to properly tighten hose (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–8)).
12. Lower machine to ground.
13. Check oil level in hydraulic reservoir and add correct oil if necessary.

Charge Hydraulic System

Note: When initially starting the hydraulic system with new or rebuilt components such as motors, pumps or lift cylinders, it is important that the hydraulic system be charged properly. Air must be purged from the system to reduce the chance of component damage.

IMPORTANT

Change hydraulic oil filters whenever hydraulic components are repaired or replaced.

1. Park machine on a level surface. Lower cutting decks, stop engine and apply parking brake. Remove key from the key switch.
2. Make sure all hydraulic connections, lines and components are secured tightly.
3. If hydraulic component failure was severe or the hydraulic system is contaminated, flush and refill hydraulic system and hydraulic reservoir (see Flush Hydraulic System (page 5–87)).

IMPORTANT

When filling hydraulic reservoir, use only hydraulic fluids specified in *Operator's Manual*. Other fluids could cause system damage.

4. Make sure hydraulic reservoir is full. Add correct hydraulic oil to reservoir if necessary.
5. Prime hydraulic pumps (see Priming Hydraulic Pumps (page 5–86)).

WARNING

Before jacking up the machine, review and follow Jacking Instructions (page 1–7).

6. Raise machine so that all wheels are off the ground and place appropriate jack stands under the frame to support the machine.

IMPORTANT

During initial operation, check hydraulic reservoir oil level frequently and add oil as necessary.

7. Make sure traction pedal and lift switches are in neutral. Start engine and run at low idle speed. The gear pump should pick up oil and fill the hydraulic system. If there is no indication of fill in thirty (30) seconds, stop the engine and determine the cause.
8. After the hydraulic system starts to show signs of fill, actuate a lift switch until the lift cylinder rod moves in and out several times. If the lift cylinder does not move after ten (10) to fifteen (15) seconds, or if the pump emits abnormal sounds, shut the engine off immediately and determine cause or problem. Inspect for the following:
    A. Loose filter or suction lines.
    B. Blocked suction line.

Charge Hydraulic System (continued)

C. Faulty charge relief valve.

D. Faulty gear pump.

9. Once the lift cylinder does move in ten (10) to fifteen (15) seconds, proceed to step 10.

10. Operate the traction pedal in the forward and reverse directions. The wheels should rotate in the proper direction.

    A. If the wheels rotate in the wrong direction, stop engine and check for proper hydraulic hose and electrical connections at traction pump and motors. Correct as needed.

    B. If the wheels rotate in the proper direction, stop engine.

11. Check operation of the traction interlock switch (see Check Operation of Interlock Switches (page 6–26)).

12. With engine not running and key switch in the OFF position, remove jack stands that are supporting the machine and lower the machine to the ground.

13. If the piston (traction) pump or a traction motor was replaced or rebuilt, run the machine so all wheels turn slowly for ten (10) minutes.

14. Operate machine by gradually increasing its work load to full over a ten (10) minute period.

15. Stop the machine. Check hydraulic reservoir and fill if necessary. Check hydraulic components for leaks and tighten any loose connections.

Hydraulic Reservoir

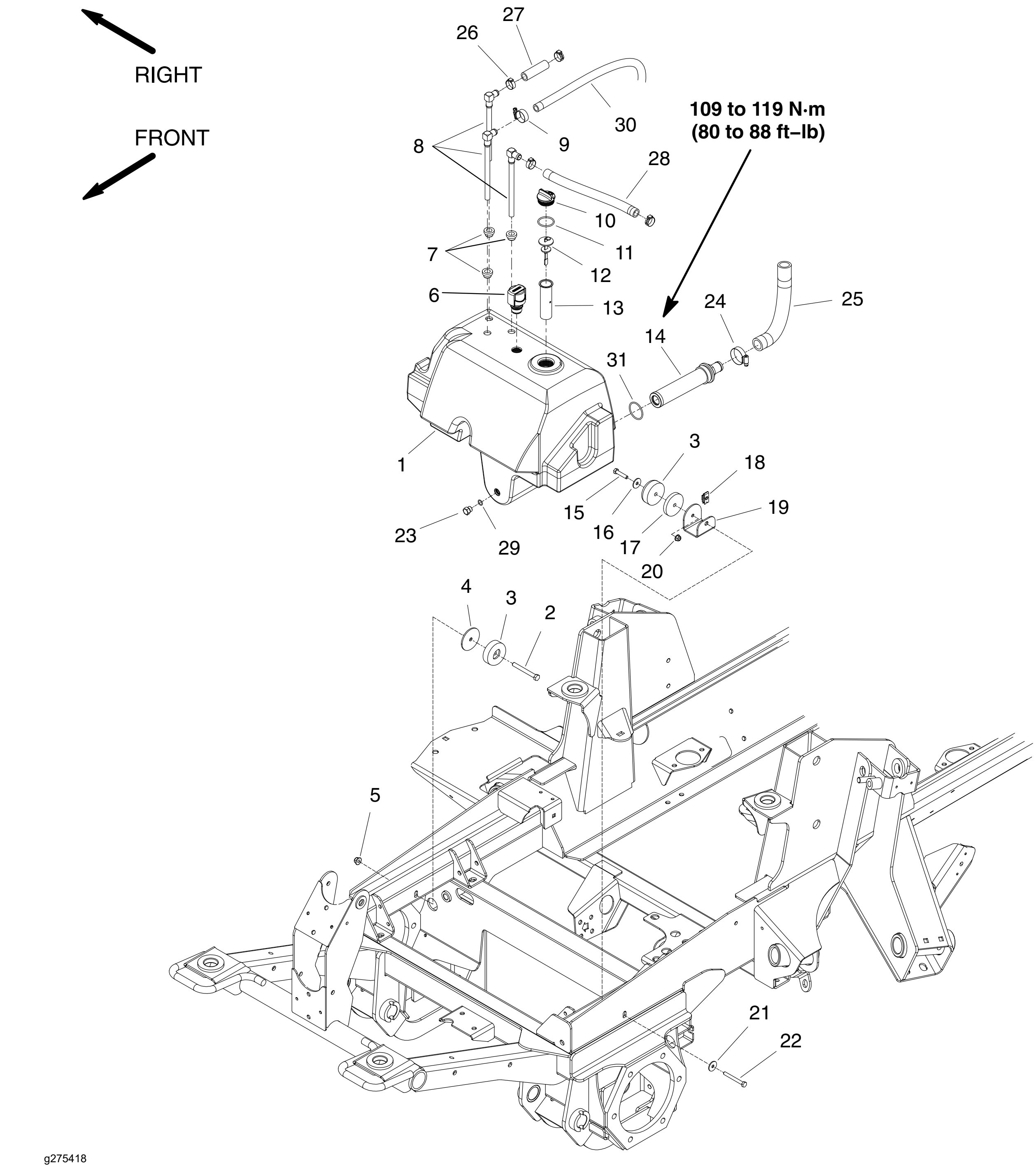

Figure 93

1. Hydraulic reservoir
2. Cap screw
3. Recess bumper (2 used)
4. Thin spacer
5. Flange nut
6. Breather
7. Bushing (3 used)
8. Stand pipe (3 used)
9. Hose clamp
10. Reservoir cap
11. O−ring
12. Dipstick
13. Screen filter
14. Tank strainer
15. Cap screw
16. Flat washer
17. Thick spacer
18. Retainer nut
19. Tank mount
20. Flange nut
21. Flat washer
22. Cap screw
23. Plug
24. Hose clamp
25. Suction hose
26. Hose clamp (4 used)
27. Hydraulic hose
28. Hydraulic hose
29. O−ring
30. Hydraulic hose
31. O−ring

Note: The operator platform needs to be raised from the main frame so that the hydraulic reservoir can be removed from the machine (see Operator Platform (page 8–18)).

Removal (Figure 93)

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the key switch.
2. Read the General Precautions for Removing and Installing Hydraulic System Components (page 5–83).
3. Drain reservoir into a suitable container.

IMPORTANT

Follow all local codes and regulations when recycling or disposing hydraulic fluid.

IMPORTANT

Make sure to not damage the electrical wire harness, hydraulic hoses or other components while raising the operator platform.

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4. Raise and support operator platform from the main frame to allow clearance to remove the hydraulic reservoir from the machine (see Operator Platform (page 8–18)).
5. Disconnect hydraulic hoses from reservoir. Label disconnected hydraulic hoses for proper installation. Put plugs on open hydraulic hoses and reservoir fittings to prevent contamination.
6. Loosen hose clamp (item 24) that secures suction hose to tank strainer. Remove suction hose (item 25) from strainer.
7. Remove tank strainer (item 14) from reservoir.
8. Remove cap screw (item 22) and flat washer (item 21) that secure tank mount (item 19) to left side of frame.
9. Carefully remove hydraulic reservoir and tank mount assembly (items 3, 15, 16, 17, 18 and 19) from machine.

Inspection

1. Clean hydraulic reservoir and tank strainer with solvent.
2. Inspect reservoir for leaks, cracks or other damage.

Installation (Figure 93)

Note: Make sure that recess bumper (item 3) and thin spacer (item 4) are secured to right side of frame before hydraulic reservoir is installed to machine.

1. Position hydraulic reservoir to machine. Make sure that recess bumper (item 3) on right side of frame is inserted into tank slot.

Installation (Figure 93) (continued)

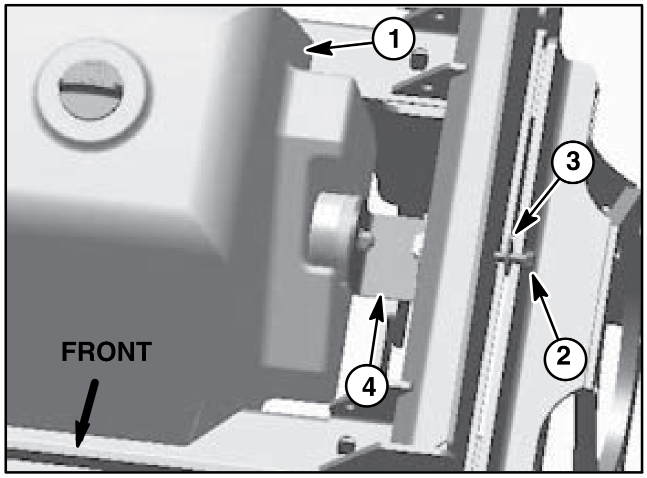

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Figure 94

1. Hydraulic reservoir
2. Cap screw
3. Flat washer
4. Tank mount

2. Slide tank mount assembly (items 15, 16, 3, 17, 18 and 19) between frame and hydraulic reservoir and position bumper into slot on left side of reservoir. Align tank mount with hole in frame. Secure mount with cap screw and flat washer (Figure 94).

3. Install tank strainer into reservoir port and torque from **109 to 119 N·m (80 to 88 ft−lb)**.

4. Remove plugs from hydraulic hoses and reservoir fittings that were placed during the removal process. Using labels placed during reservoir removal, connect hydraulic hoses to fittings on reservoir. Secure hoses with hose clamps.

IMPORTANT

Make sure to not damage the electrical wire harness, hydraulic hoses or other components while lowering the operator platform.

5. Carefully lower operator platform to the main frame (see Operator Platform (page 8–18)). Make sure that fasteners are properly torqued during assembly.

IMPORTANT

Use only hydraulic fluids specified in *Operator's Manual*. Other fluids could cause system damage.

6. Fill reservoir with new hydraulic oil to proper level.
7. Properly fill hydraulic system (see Charge Hydraulic System (page 5–91)).
8. Stop engine and check for hydraulic oil leaks. Check hydraulic reservoir oil level.

Radiator and Oil Cooler Assembly

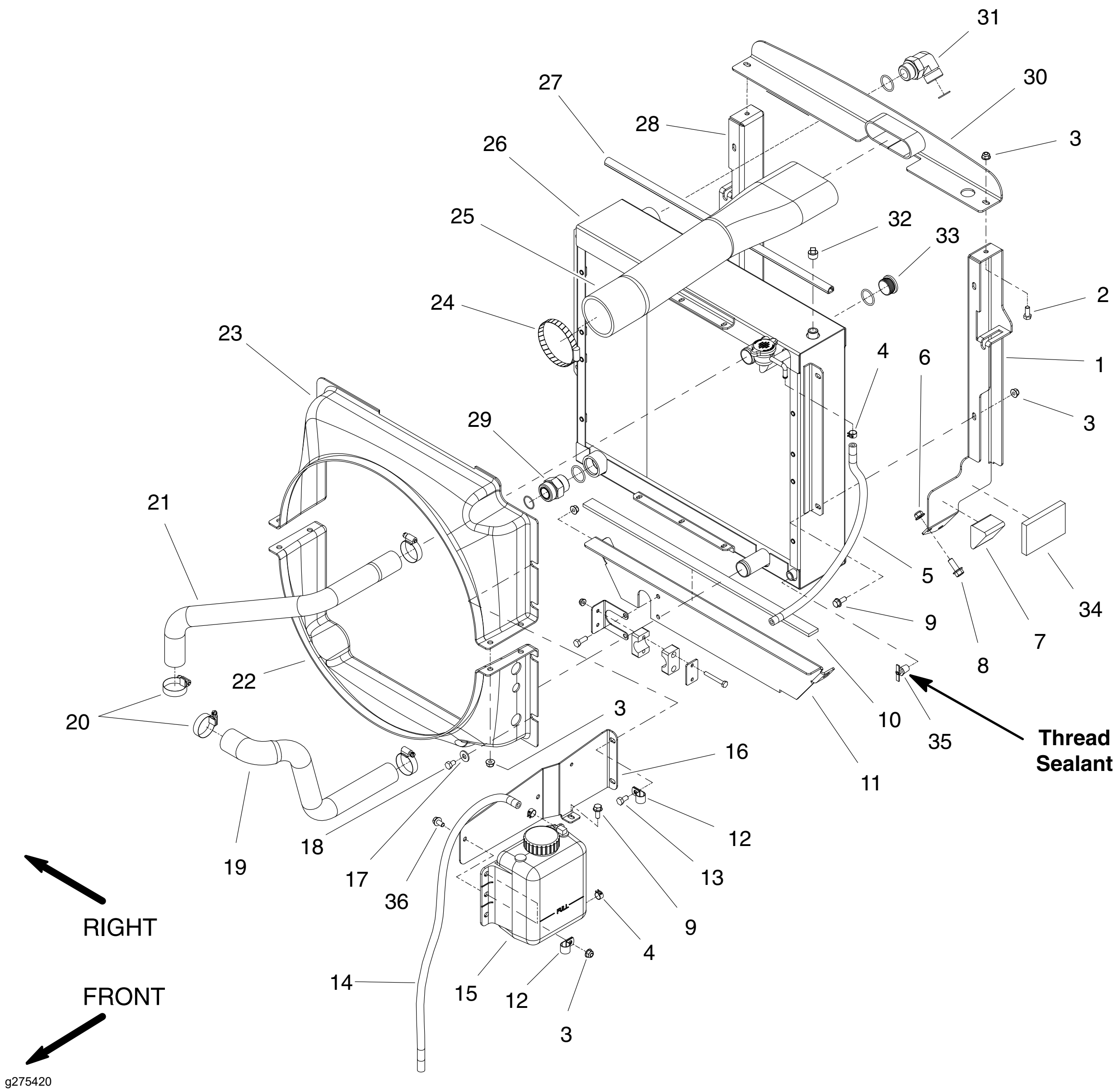

Figure 95

1.	LH radiator support	13.	Cap screw (2 used)	25.	Air cleaner inlet hose
2.	Cap screw (2 used)	14.	Hose	26.	Radiator/hydraulic oil cooler
3.	Flange nut (12 used)	15.	Coolant reservoir	27.	Bulb seal
4.	Hose clamp (3 used)	16.	Tank mount	28.	RH radiator support
5.	Hose	17.	Flat washer (7 used)	29.	Straight hydraulic fitting
6.	Flange nut (6 used)	18.	Cap screw (6 used)	30.	Intake bracket
7.	Foam plug (2 used)	19.	Lower radiator hose	31.	90º hydraulic fitting
8.	Flange head screw (6 used)	20.	Hose clamp (4 used)	32.	Pipe plug
9.	Flange head screw (9 used)	21.	Upper radiator hose	33.	Hex plug with O−ring
10.	Foam strip	22.	Lower radiator shroud	34.	Foam pad (2 used)
11.	Hose bracket	23.	Upper radiator shroud	35.	Draincock
12.	R−clamp (2 used)	24.	Hose clamp	36.	Cap screw (2 used)

Note: The hydraulic oil cooler on your Groundsmaster is combined with the radiator. See Radiator and Oil Cooler Assembly (page 4–17).

Gear Pump

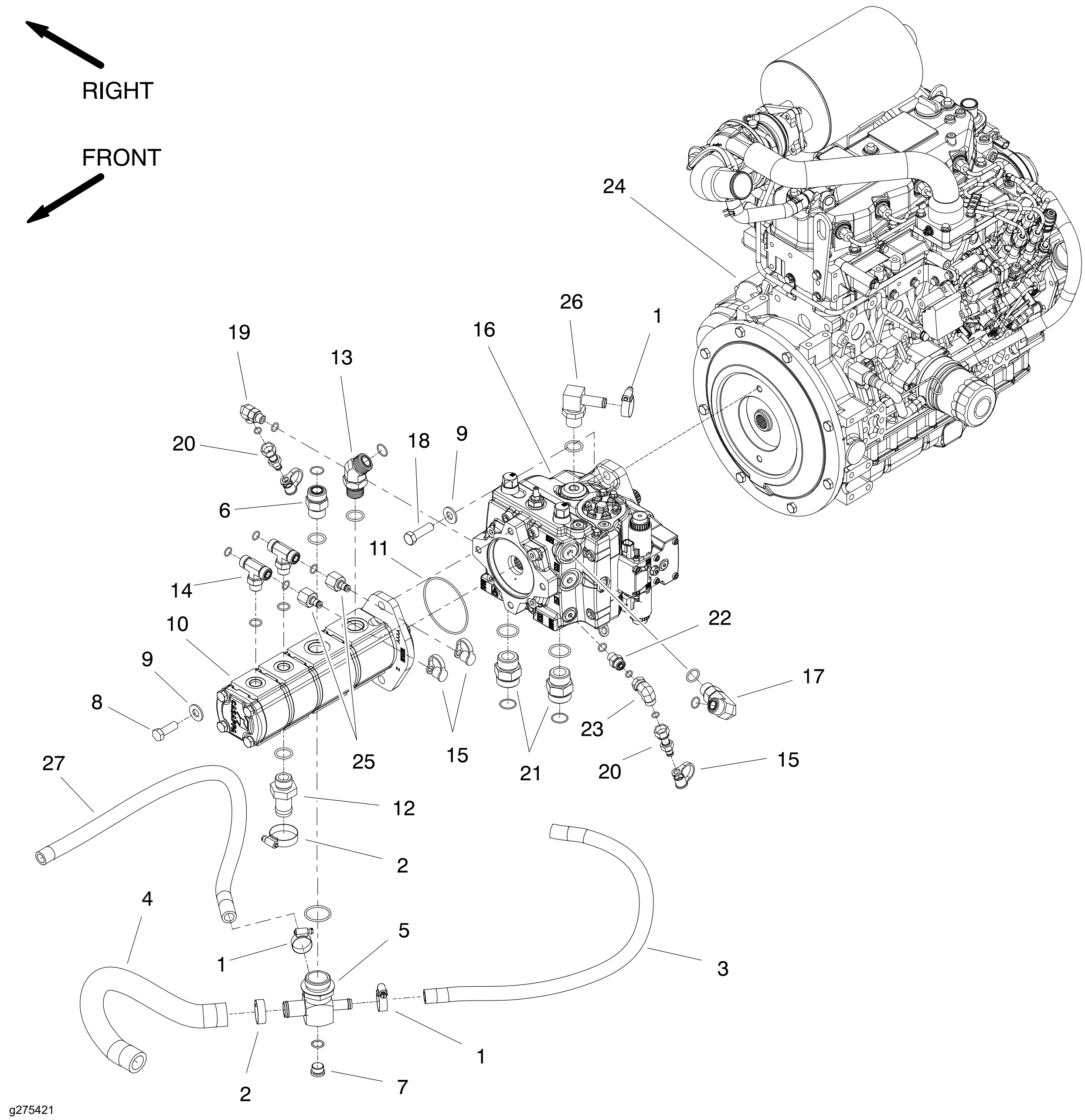

Figure 96

(For machines serial number below: 400000000)

1. Hose clamp (3 used)
2. Hose clamp (2 used)
3. Hydraulic hose
4. Suction hose
5. Tee fitting
6. Straight hydraulic fitting
7. Plug
8. Cap screw (2 used)
9. Flat washer (4 used)
10. Gear pump
11. O−ring
12. Hydraulic fitting
13. 45º hydraulic fitting
14. Hydraulic tee fitting (2 used)
15. Dust cap (4 used)
16. Piston pump
17. 90º hydraulic fitting
18. Cap screw (2 used)
19. 90º hydraulic fitting
20. Test nipple (2 used)
21. Straight hydraulic fitting (2 used)
22. Straight hydraulic fitting
23. 90º hydraulic fitting
24. Engine (model 30602/30604 shown)
25. Test fitting (2 used)
26. 90º barbed hydraulic fitting
27. Hydraulic hose

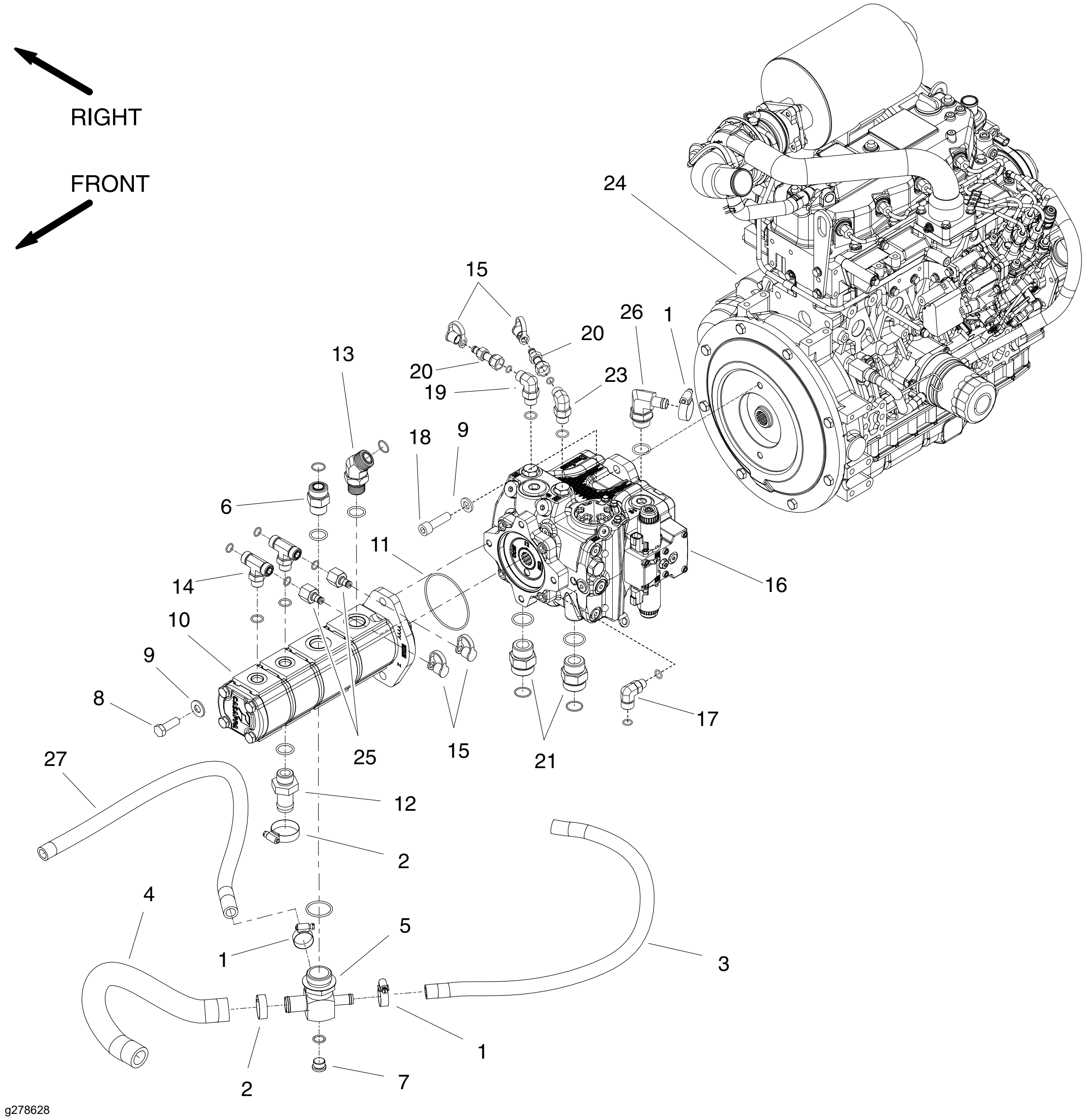

Figure 97

(For machines serial number above: 400000000)

1. Hose clamp (3 used)
2. Hose clamp (2 used)
3. Hydraulic hose
4. Suction hose
5. Tee fitting
6. Straight hydraulic fitting
7. Plug
8. Cap screw (2 used)
9. Flat washer (4 used)
10. Gear pump
11. O−ring
12. Hydraulic fitting
13. 45º hydraulic fitting
14. Hydraulic tee fitting (2 used)
15. Dust cap (4 used)
16. Piston pump
17. 90º hydraulic fitting
18. Cap screw (2 used)
19. 90º hydraulic fitting
20. Test nipple (2 used)
21. Straight hydraulic fitting (2 used)
22. Straight hydraulic fitting
23. 90º hydraulic fitting
24. Engine (model 30602/30604 shown)
25. Test fitting (2 used)
26. 90º barbed hydraulic fitting
27. Hydraulic hose

Removal (Figure 96 and Figure 97)

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the key switch.

Removal (Figure 96 and Figure 97) (continued)

2. Raise and support machine to gain access to gear pump from the underside of the machine.
3. Drain the hydraulic reservoir.

IMPORTANT

Follow all local codes and regulations when recycling or disposing hydraulic fluid.

4. To prevent contamination of hydraulic system during removal, thoroughly clean exterior of pump and fittings.
5. Read the General Precautions for Removing and Installing Hydraulic System Components (page 5–83).
6. Disconnect hydraulic lines from gear pump and put caps or plugs on open hydraulic lines and fittings. Label disconnected hydraulic lines for proper installation.

IMPORTANT

Dry weight of gear pump is 10.2 kg (23 lbs).

7. Support gear pump assembly to prevent it from falling.

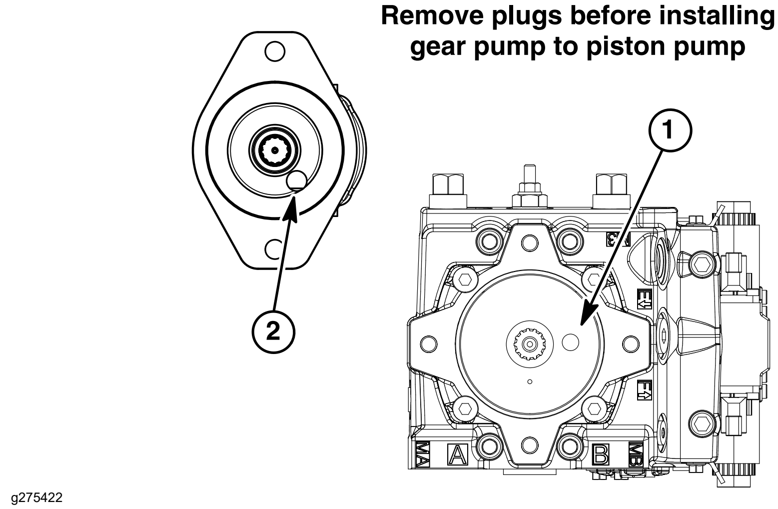

Figure 98

1. Piston pump case drain
2. Gear pump suction port

8. Remove two (2) cap screws and washers securing gear pump to piston pump. Lower and remove gear pump from machine.

   Note: A case drain exists in the piston (traction) pump and a suction port is near the input shaft of the gear pump (Figure 98). When the gear pump is removed from the piston pump, plug piston pump case drain hole to prevent draining the piston pump.

9. Remove O−ring (item 11) from between the gear pump and piston pump. Discard O−ring.
10. If hydraulic fittings are to be removed from gear pump, mark fitting orientation to allow correct assembly. Remove fittings from pump and discard O−rings.

Installation (Figure 96 and Figure 97)

1. If fittings were removed from gear pump, lubricate and place new O−rings onto fittings. Install fittings into pump openings using marks made during the removal process to properly orientate fittings. Tighten fittings (see Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings) (page 5–10)).
2. Make sure mounting and O−ring sealing surfaces on the gear pump and piston pump are clean.
3. Apply clean hydraulic oil to gear pump flange O−ring (item 11). Place O−ring on the gear pump.

IMPORTANT

Position gear pump to the piston (traction) pump so that the gear pump inlet (suction) ports are facing down.

IMPORTANT

A case drain exists in the piston (traction) pump and a suction port is near the input shaft of the gear pump (Figure 98). Before the gear pump is installed to the piston pump, make sure that plugs placed in either of these ports are removed. Failure to remove plugs will cause excessive pressure in the piston pump and damage seals. Also, before securing gear pump to piston pump, fill piston pump housing with clean hydraulic oil through case drain hole.

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4. Remove plugs that were placed in piston pump case drain and gear pump suction port. Fill piston pump housing with clean hydraulic oil through case drain hole.
5. Position gear pump to the piston (traction) pump so that the pump inlet ports are facing down.
6. Align gear teeth and slide gear pump input shaft into piston pump shaft. Secure gear pump to piston pump with two (2) cap screws and flat washers.
7. Remove caps and plugs from hydraulic lines and fittings. Using labels placed during gear pump removal, properly install lines to gear pump (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–8)).

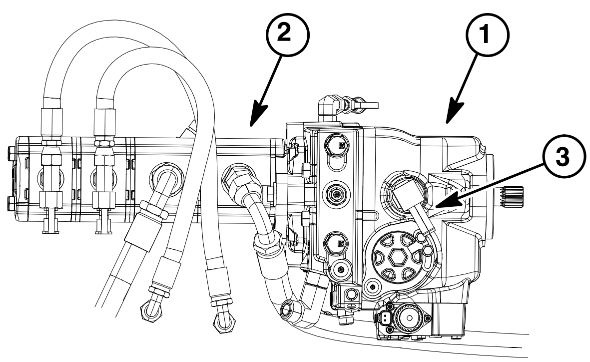

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Figure 99

1. Piston (traction) pump
2. Gear pump
3. Piston pump case drain

Installation (Figure 96 and Figure 97) (continued)

8. Fill piston pump housing through case drain (90º barbed fitting) with new hydraulic oil (Figure 99). This will ensure that internal pump components have adequate lubrication during initial operation.
9. Lower machine to ground.
10. Replace hydraulic filters and fill hydraulic reservoir with new hydraulic oil.
11. Prime hydraulic pumps (see Priming Hydraulic Pumps (page 5–86)).
12. Properly fill hydraulic system (see Charge Hydraulic System (page 5–91)).
13. Stop engine and check for hydraulic oil leaks. Check hydraulic reservoir oil level.

Gear Pump Service

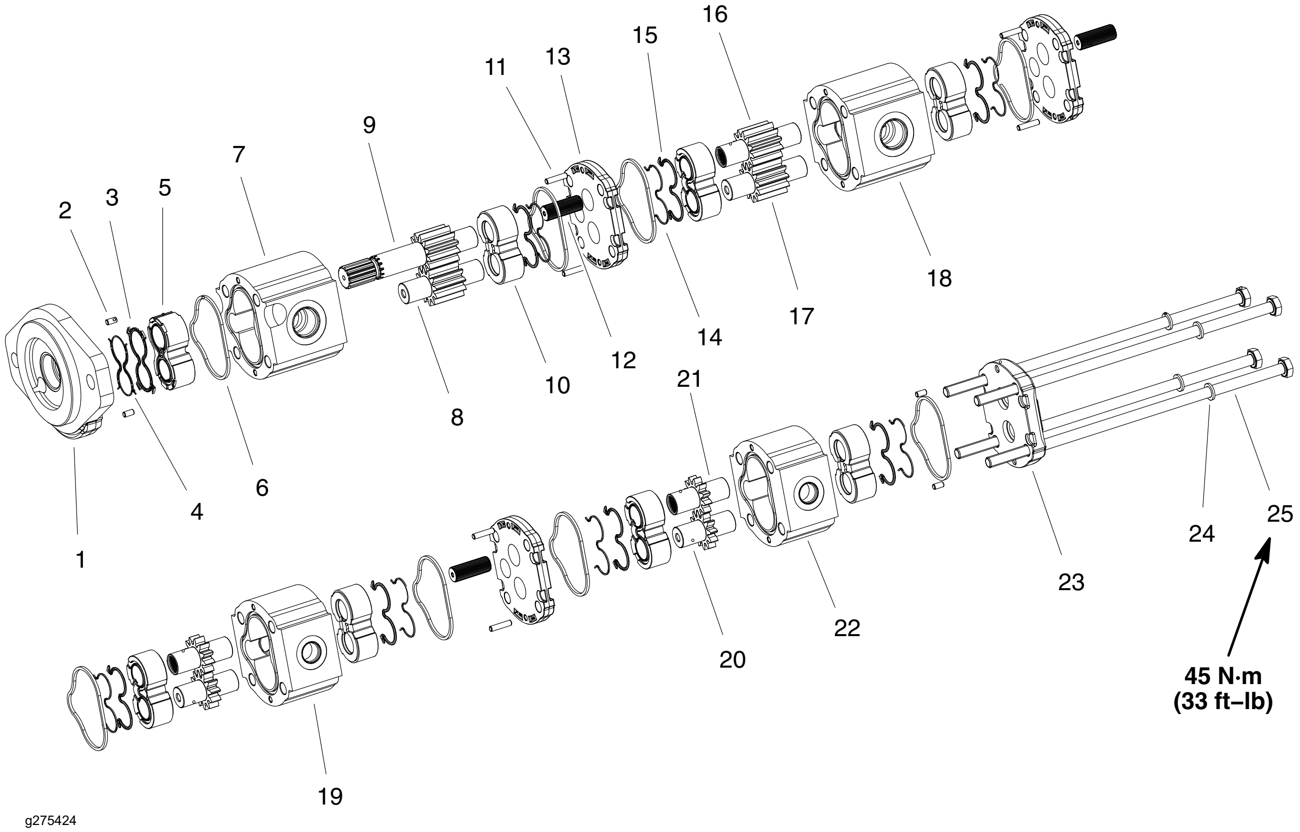

Figure 100

1. Front cover
2. Dowel pin (4 used)
3. Pressure seal
4. Back−up gasket
5. Front thrust plate
6. Seal (8 used)
7. Front body
8. Idler gear
9. Drive shaft
10. Thrust plate (7 used)
11. Dowel pin (6 used)
12. Splined connecting shaft (3 used)
13. Flange (3 used)
14. Back−up gasket
15. Pressure seal
16. Drive gear
17. Idler gear
18. Body
19. Body
20. Idler gear
21. Drive gear
22. Rear body
23. Rear cover
24. Washer (4 used)
25. Cap screw (4 used)

Disassembly (Figure 100)

Note: The gear pump must be replaced as a complete assembly. Individual gears, housings and thrust plates are not available separately. Disassemble gear pump for cleaning, inspection and seal replacement only.

IMPORTANT

Keep bodies, gears, flanges and thrust plates for each pump section together; do not mix parts between pump sections.

1. Plug pump ports and thoroughly clean exterior of pump with cleaning solvent. Make sure work area is clean.

Disassembly (Figure 100) (continued)

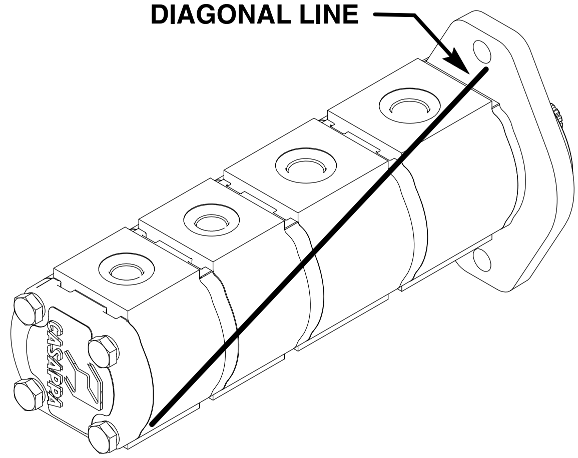

Figure 101

2. Use a marker to make a diagonal line across the gear pump for assembly purposes (Figure 101).

IMPORTANT

Use caution when clamping gear pump in a vise to avoid distorting any pump components.

3. Secure the front cover of the pump in a vise with the drive shaft pointing down.
4. Loosen the four (4) cap screws that secure pump assembly.
5. Remove pump from vise and remove fasteners.
6. Support the pump assembly and gently tap the pump case with a soft face hammer to loosen the pump sections. Be careful to not drop parts or disengage gear mesh.

IMPORTANT

Mark the relative positions of the gear teeth and the thrust plates so they can be reassembled in the same position. Do not touch the gear surfaces as residue on hands may be corrosive to gear finish.

7. Remove the thrust plates and seals from each pump section. Before removing each gear set, apply marking dye to mating teeth to retain ”timing”. Pump efficiency may be affected if the teeth are not installed in the same position during assembly. Keep the parts for each pump section together; do not mix parts between sections.
8. Clean all parts. Check all components for burrs, scoring, nicks and other damage.
9. Replace the entire pump assembly if parts are excessively worn or scored.

Assembly (Figure 100)

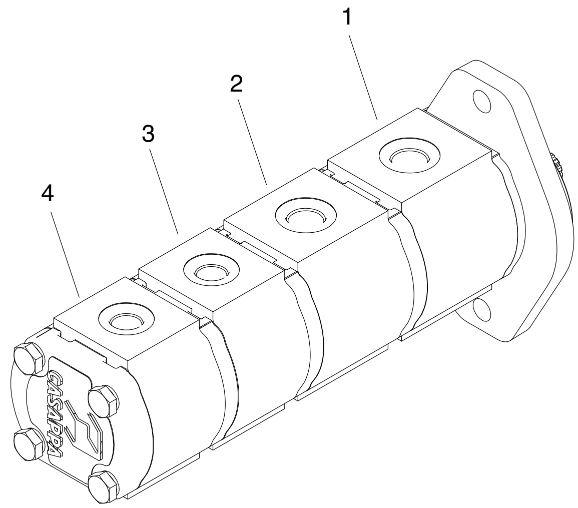

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Figure 102

1. LH and RH PTO pump section
2. Front PTO pump section
3. Cooling fan, lift/lower and charge pump section
4. Steering, charge and cooling fan pump section

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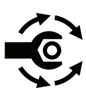
1. Apply clean hydraulic oil to all parts before assembling.

   Note: Pressure seals and back−up gaskets fit in grooves machined into thrust plates. Body seals fit in grooves machined in body faces.

2. Assemble pump sections starting at front cover end. Apply grease or petroleum jelly to new section seals to hold them in position during gear pump assembly.
3. After pump has been assembled, tighten cap screws by hand. Rotate the drive shaft to check for binding. Protect the shaft if using a pliers.



4. Tighten the four (4) cap screws evenly in a crossing pattern to a torque of **45 N·m (33 ft−lb)**.

Piston (Traction) Pump

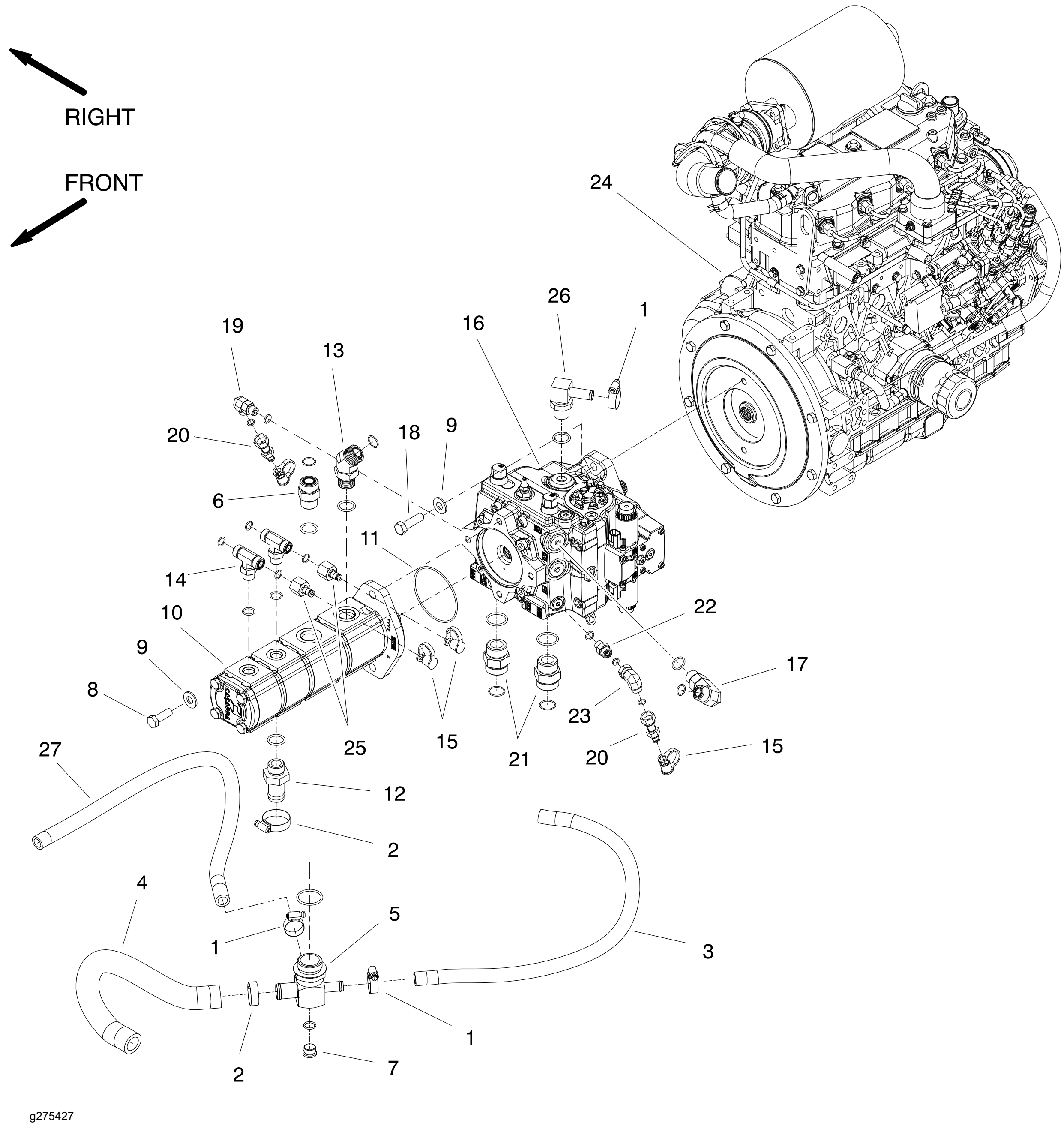


Figure 103

(For machines serial number below: 400000000)

1. Hose clamp (3 used)
2. Hose clamp (2 used)
3. Hydraulic hose
4. Suction hose
5. Tee fitting
6. Straight hydraulic fitting
7. Plug
8. Cap screw (2 used)
9. Flat washer (4 used)
10. Gear pump
11. O−ring
12. Hydraulic fitting
13. 45º hydraulic fitting
14. Hydraulic tee fitting (2 used)
15. Dust cap (4 used)
16. Piston pump
17. 90º hydraulic fitting
18. Cap screw (2 used)
19. 90º hydraulic fitting
20. Test nipple (2 used)
21. Straight hydraulic fitting (2 used)
22. Straight hydraulic fitting
23. 90º hydraulic fitting
24. Engine (model 30602/30604 shown)
25. Test fitting (2 used)
26. 90º barbed hydraulic fitting
27. Hydraulic hose

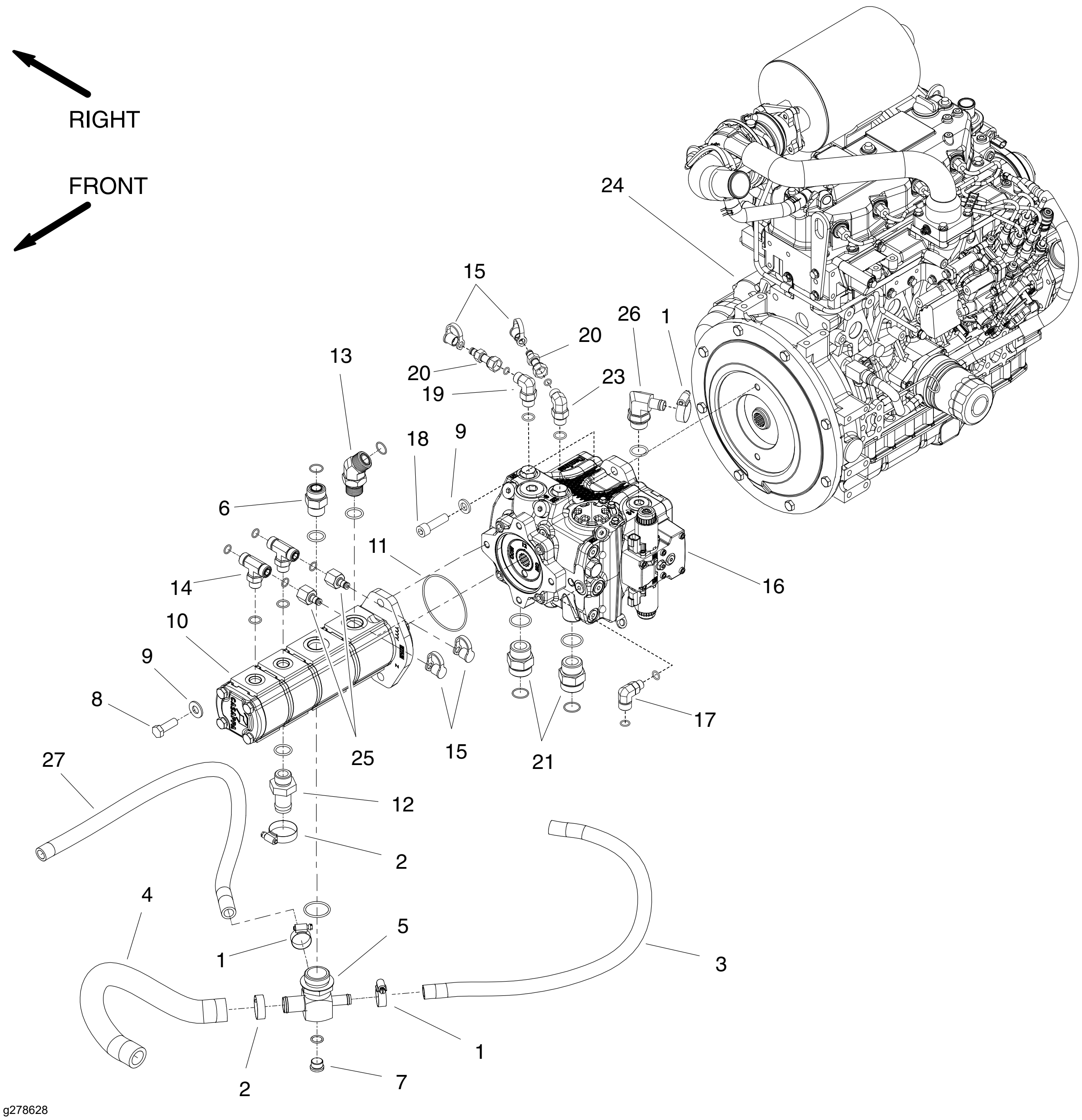


Figure 104

(For machines serial number above: 400000000)

1. Hose clamp (3 used)
2. Hose clamp (2 used)
3. Hydraulic hose
4. Suction hose
5. Tee fitting
6. Straight hydraulic fitting
7. Plug
8. Cap screw (2 used)
9. Flat washer (4 used)
10. Gear pump
11. O−ring
12. Hydraulic fitting
13. 45º hydraulic fitting
14. Hydraulic tee fitting (2 used)
15. Dust cap (4 used)
16. Piston pump
17. 90º hydraulic fitting
18. Cap screw (2 used)
19. 90º hydraulic fitting
20. Test nipple (2 used)
21. Straight hydraulic fitting (2 used)
22. Straight hydraulic fitting
23. 90º hydraulic fitting
24. Engine (model 30602/30604 shown)
25. Test fitting (2 used)
26. 90º barbed hydraulic fitting
27. Hydraulic hose

Removal (Figure 103 and Figure 104)

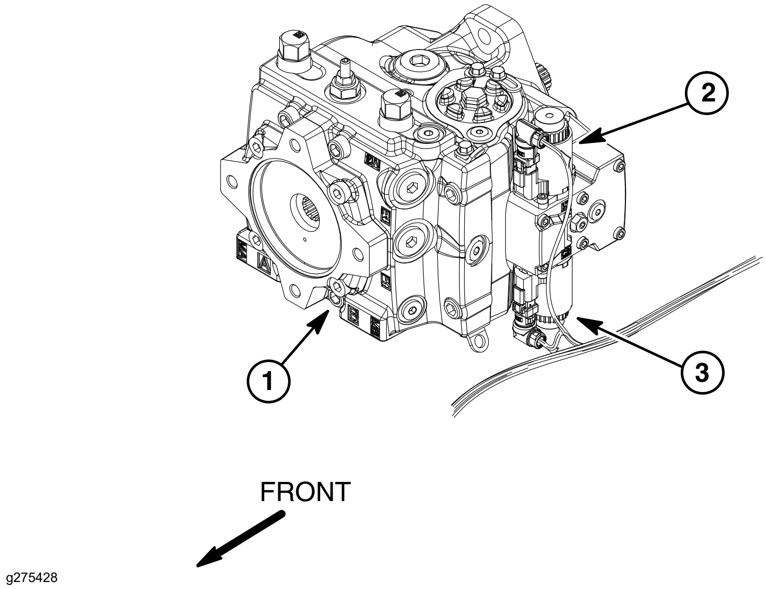


Figure 105

1. Piston pump
2. Solenoid coil (forward)
3. Solenoid coil (reverse)

---

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the key switch.
2. To prevent contamination of hydraulic system during removal, thoroughly clean exterior of pump assembly.
3. Raise and support machine to gain access to pump assembly from the underside of machine.
4. Label wire harness connectors that attach to the two (2) solenoid coils on left side of piston pump (Figure 105). Disconnect harness connectors from solenoid coils on piston pump.
5. Read the General Precautions for Removing and Installing Hydraulic System Components (page 5–83).
6. For installation purposes, label all hydraulic lines that connect to gear pump and piston pump.
7. Put a drain pan below the pump assembly. Remove hydraulic lines connected to piston and gear pump fittings. Put plugs or caps on disconnected hydraulic lines and fittings to prevent contamination of the system.

   Note: If fuel tank is removed from the machine, the gear pump and piston pump can be removed as a complete assembly.

Removal (Figure 103 and Figure 104) (continued)

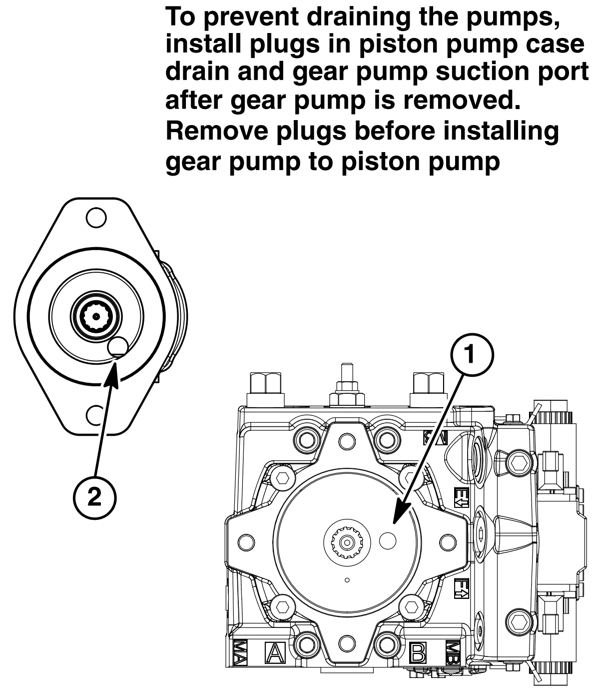


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Figure 106

1. Piston pump case drain
2. Gear pump suction port

8. Remove gear pump from machine (see Gear Pump (page 5–97)).

IMPORTANT

Dry weight of piston (traction) pump is 90 pounds (41 kg).

Note: A case drain exists in the piston (traction) pump and a suction port is near the input shaft of the gear pump (Figure 106). When the gear pump is removed from the piston pump, plug piston pump case drain hole to prevent draining the piston pump.

9. Support the piston pump to prevent it from falling. Remove two (2) cap screws and washers retaining pump assembly to engine flywheel plate. Carefully pull pump assembly from flywheel plate and lower it out of the machine.
10. If hydraulic fittings are to be removed from piston pump, mark fitting orientation to allow correct assembly. Remove fittings from pump and discard O−rings.

Installation (Figure 103 and Figure 104)

1. If fittings were removed from piston pump, lubricate and place new O−rings onto fittings. Install fittings into pump openings using marks made during the removal process to properly orientate fittings. Tighten fittings (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–8)).

IMPORTANT

To prevent spring coupler damage, make sure that piston pump is properly supported and does not put side load into coupler during pump installation.

Installation (Figure 103 and Figure 104) (continued)

2. Carefully raise piston pump into the machine, align pump input shaft to spring coupler on engine and position it to the engine flywheel plate. Support pump to prevent it from producing any side load into coupler and also to align pilot diameter of pump to flywheel plate bore.
3. While maintaining pump alignment with spring coupler and flywheel plate, install two (2) cap screws and washers to secure piston pump to engine.

IMPORTANT

A case drain exists in the piston (traction) pump and a suction port is near the input shaft of the gear pump (Figure 106). Before the gear pump is installed to the piston pump, make sure that plugs placed in either of these ports are removed. Failure to remove plugs will cause excessive pressure in the piston pump and damage seals. Also, before securing gear pump to piston pump, fill piston pump housing with clean hydraulic oil through case drain hole.

4. Remove plugs that were placed in piston pump case drain and gear pump suction port. Fill piston pump housing with new hydraulic oil through case drain hole.
5. Install gear pump to piston pump (see Gear Pump (page 5–97)).
6. Using labels placed during pump removal, connect wire harness connectors to the two (2) solenoid coils on left side of piston pump.

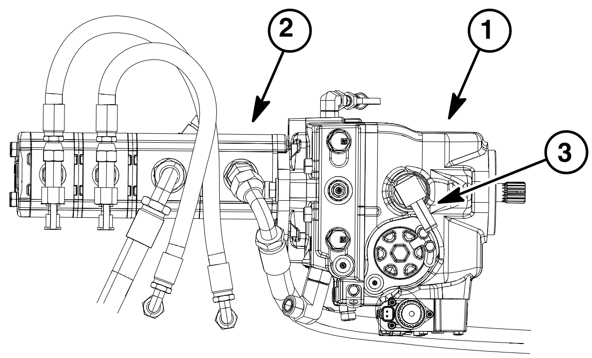

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Figure 107

1. Piston (traction) pump
2. Gear pump
3. Piston pump case drain

7. Fill piston (traction) pump housing with new hydraulic oil through the case drain (90º barbed fitting) at the top of the pump (Figure 107). This will ensure that internal pump components have adequate lubrication during initial operation.
8. Remove plugs and caps from disconnected hydraulic lines and fittings of the pump assembly. Install hydraulic lines to correct location on gear and piston pumps (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–8)).
9. Lower machine to ground.
10. Install new hydraulic filter and fill hydraulic reservoir with correct oil.

Installation (Figure 103 and Figure 104) (continued)

IMPORTANT

Refer to Traction Circuit Component Failure in the General Information section of this chapter for information regarding the importance of removing contamination from the traction circuit.

11. Prime hydraulic pumps (see Priming Hydraulic Pumps (page 5–86)).
12. Properly fill hydraulic system (see Charge Hydraulic System (page 5–91)).
13. Stop engine and check for hydraulic oil leaks. Check hydraulic reservoir oil level.

Piston (Traction) Pump Service (For machines serial number below: 400000000)

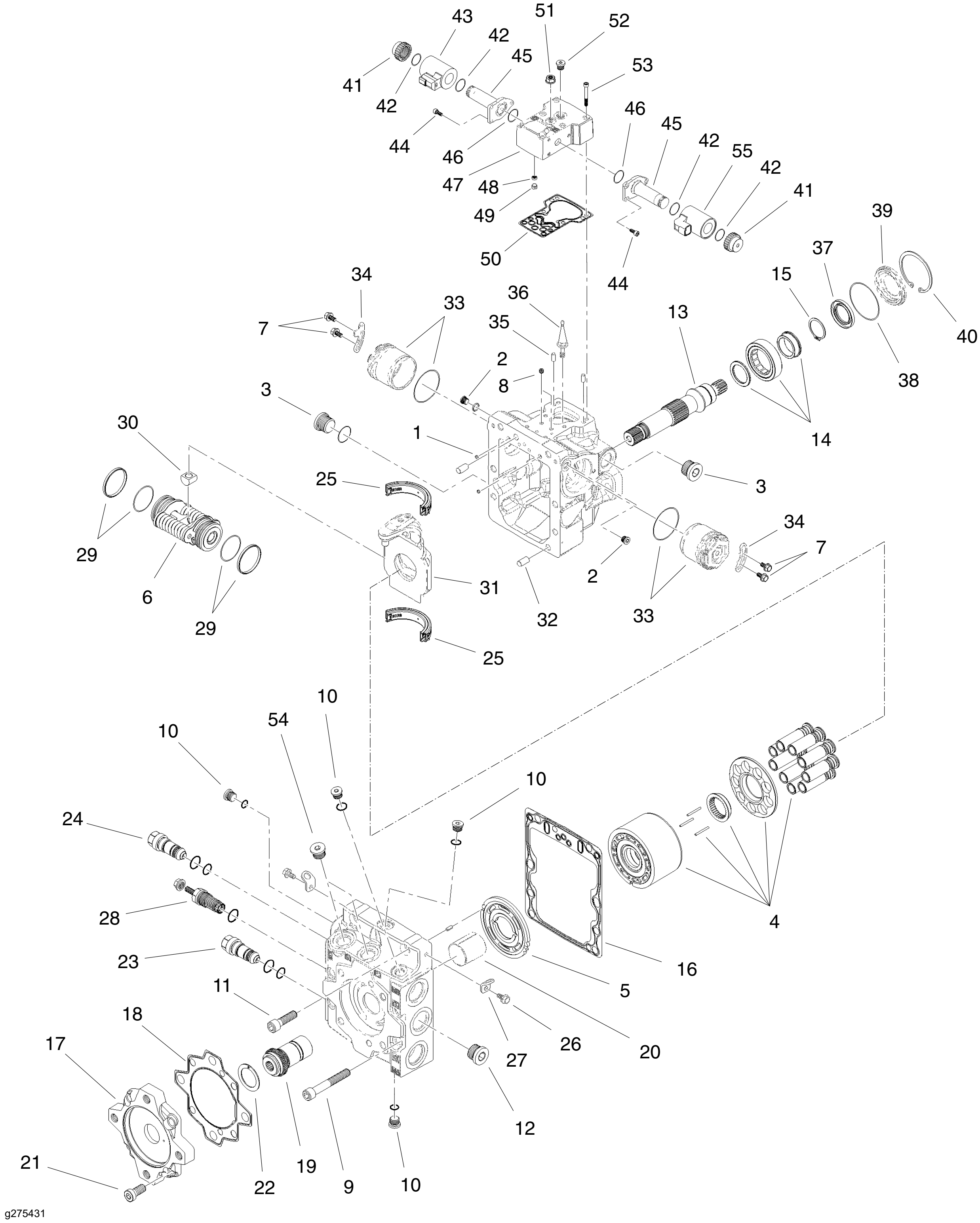

Figure 108

Piston (Traction) Pump Service (For machines serial number below: 400000000) (continued)

Figure 108 (continued)

1. Screen (2 used)
2. Plug with O−ring (2 used)
3. Plug with O−ring (2 used)
4. Cylinder block assembly
5. Valve plate
6. Servo piston
7. Screw (4 used)
8. Orifice (2 used)
9. Screw (4 used)
10. Plug with O−ring (4 used)
11. Screw (2 used)
12. Plug
13. Shaft
14. Bearing assembly
15. Retaining ring
16. Gasket
17. Adapter
18. Adapter seal
19. Coupling
20. Bearing
21. Screw (4 used)
22. Thrust plate
23. Forward relief valve assembly
24. Reverse relief valve assembly
25. Swash plate bearing assembly
26. Screw (2 used)
27. Bracket (2 used)
28. Charge relief valve assembly
29. Servo piston seal assembly
30. Piston follower
31. Swash plate
32. Dowel pin (2 used)
33. Servo cylinder assembly (2 used)
34. Locking plate (2 used)
35. Dowel pin (2 used)
36. Feedback pin
37. Seal
38. O−ring
39. Seal carrier
40. Retaining ring
41. Coil nut (2 used)
42. O−ring
43. Forward solenoid coil
44. Screw (3 used per solenoid)
45. Solenoid (2 used)
46. O−ring
47. Control housing
48. Screen (2 used)
49. Retaining ring (2 used)
50. Gasket
51. Lock nut
52. Plug
53. Screw (6 used)
54. Plug (2 used)
55. Reverse solenoid coil

For service of the piston (traction) pump, see the **Sauer− Danfoss H1 Closed Circuit Axial Piston Pumps Service Manual**.

Note: The forward (item 43) and reverse (item 55) solenoid coils are identical.

Piston (Traction) Pump Service (For machines serial number above: 400000000)

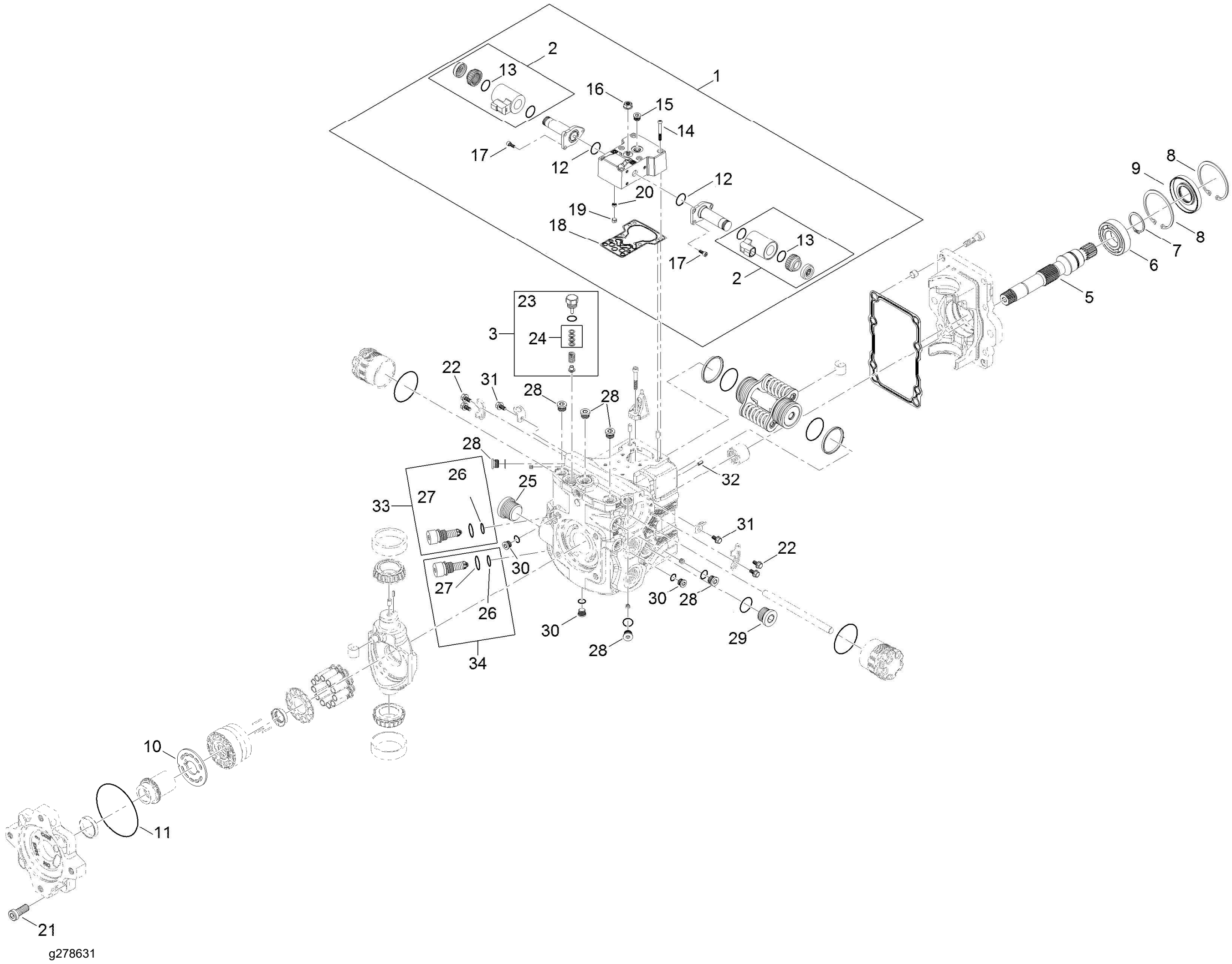

Figure 109

1. Control kit (12 volt)
2. Coil kit
3. Charge relief kit
4.
5. Shaft
6. Bearing-ball
7. Ring-retaining
8. Ring-retaining
9. Seal-lip
10. Valve plate
11. O-ring
12. O-ring
13. O-ring
14. Screw
15. Plug asm
16. Nut-seal
17. Screw
18. Gasket-control
19. Ring-locking
20. Screen
21. Screw
22. Screw
23. O-ring
24. Shim kit
25. Plug asm
26. O-ring
27. O-ring
28. Plug
29. Plug
30. Plug-thread, straight
31. Screw
32. Pin-slotted
33. Valve-relief, high pressure (345 bar)
34. Valve-relief, high pressure (300 bar)
35. Overhaul seal kit

For service of the piston (traction) pump, see the **Danfoss MP1 Closed Circuit Axial Piston Pumps Service Manual**.

Rear Axle Motor

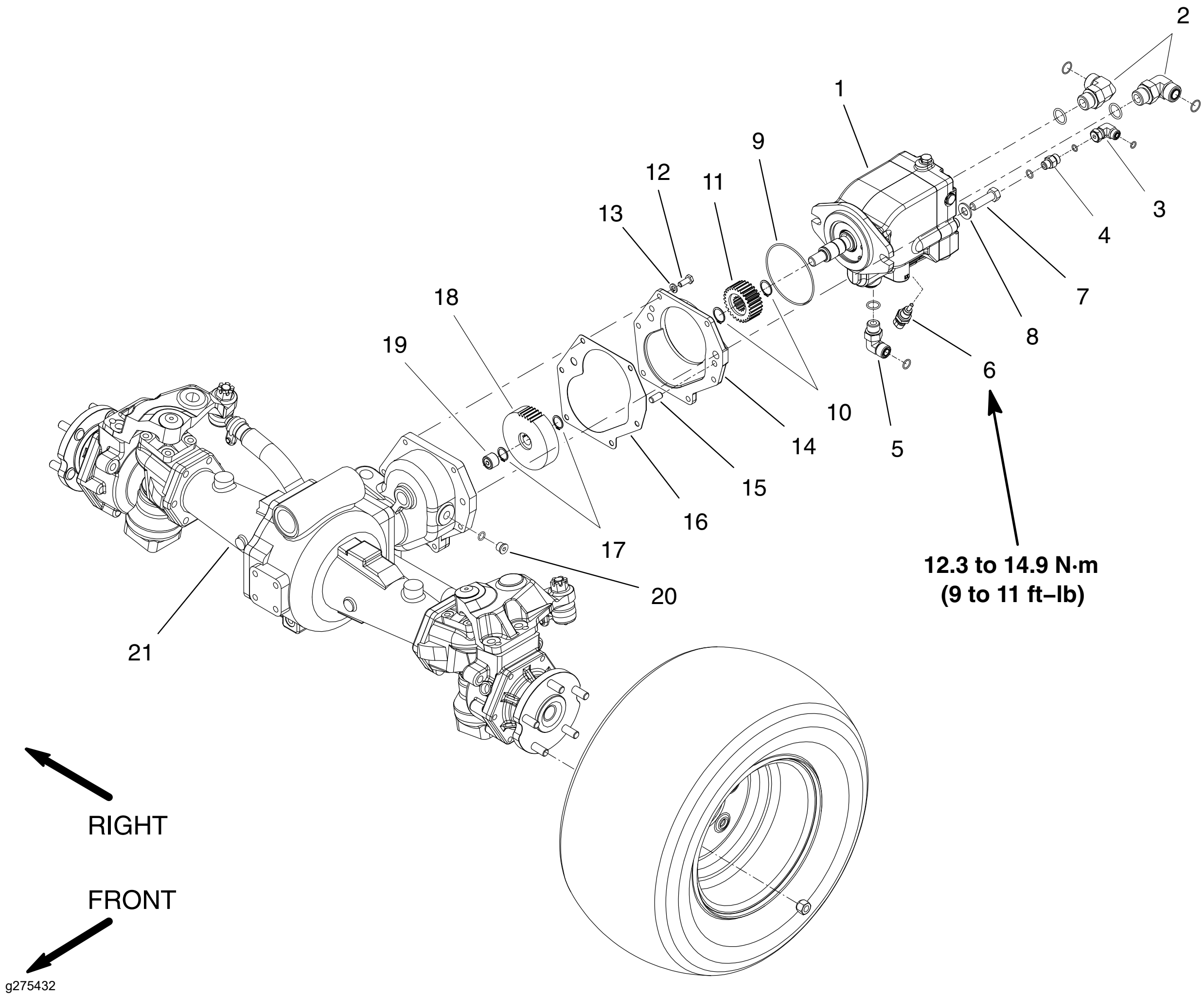

Figure 110

1.	Rear axle motor	8.	Flat washer (2 used)	15.	Dowel pin (2 used)
2.	90º hydraulic fitting (2 used)	9.	O−ring	16.	Gasket
3.	90º hydraulic fitting	10.	External snap ring (2 used)	17.	External snap ring (2 used)
4.	Straight hydraulic fitting	11.	Pinion gear (27T)	18.	Gear (45T)
5.	90º hydraulic fitting	12.	Cap screw (6 used)	19.	Needle bearing
6.	Temperature sender	13.	Lock washer (6 used)	20.	Plug with O−ring
7.	Cap screw (2 used)	14.	Cover plate	21.	Drive axle assembly

Removal (Figure 110)

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the key switch.
2. Drain lubricant from rear axle gearbox.
3. Read the General Precautions for Removing and Installing Hydraulic System Components (page 5–83).
4. To prevent contamination of hydraulic system during axle motor removal, thoroughly clean exterior of motor and fittings.
5. Disconnect wire harness connector from temperature sender (item 6) on rear axle motor.

Removal (Figure 110) (continued)

Note: To ease installation, label the hydraulic lines to show their correct position on the axle motor.

6. Disconnect hydraulic lines from motor. Put caps or plugs on motor fittings and hydraulic line openings to prevent contamination.

IMPORTANT

Before loosening fasteners that secure rear axle motor, support motor to prevent it from falling during removal.

7. Remove motor from rear axle using Figure 110 as a guide.
8. If hydraulic fittings are to be removed from motor, mark fitting orientation to allow correct assembly. Remove fittings from motor and discard O−rings.
9. If necessary, remove temperature sender (item 6) from rear axle motor.
10. If necessary, remove pinion gear (item 11) from rear axle motor shaft.

Installation (Figure 110)

IMPORTANT

Refer to Traction Circuit Component Failure in the General Information section of this chapter for information regarding the importance of removing contamination from the traction circuit.

1. If fittings were removed from axle motor, lubricate and place new O−rings onto fittings. Install fittings into port openings using marks made during the removal process to properly orientate fittings. Tighten fittings (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–8)).
2. If temperature sender (item 6) was removed from rear axle motor, thread sender into motor port. Torque sender from **12.3 to 14.9 N·m (9 to 11 ft−lb)**.
3. If removed, install pinion gear (item 11) to axle motor. Make sure that retaining rings are fully seated into the grooves of the motor shaft.
4. Install O−ring (item 9) onto motor. Position motor to rear axle assembly and align gear teeth. Slide motor into place.
5. Secure motor to axle with cap screws and flat washers.
6. Remove plugs from motor fittings and hydraulic line openings. Using labels placed during motor removal, correctly attach hydraulic lines to axle motor fittings (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–8)).
7. Secure wire harness connector to temperature sender (item 6) on rear axle motor.
8. Fill rear axle gearbox with SAE 85W−140 weight gear lube. Gearbox capacity is approximately 0.47 liters (16 fl. oz.).
9. Fill reservoir with hydraulic fluid as required.
10. Properly fill hydraulic system (see Charge Hydraulic System (page 5–91)).
11. After assembly is completed, verify that hydraulic lines and fittings do not contact anything.

Front Wheel Motors

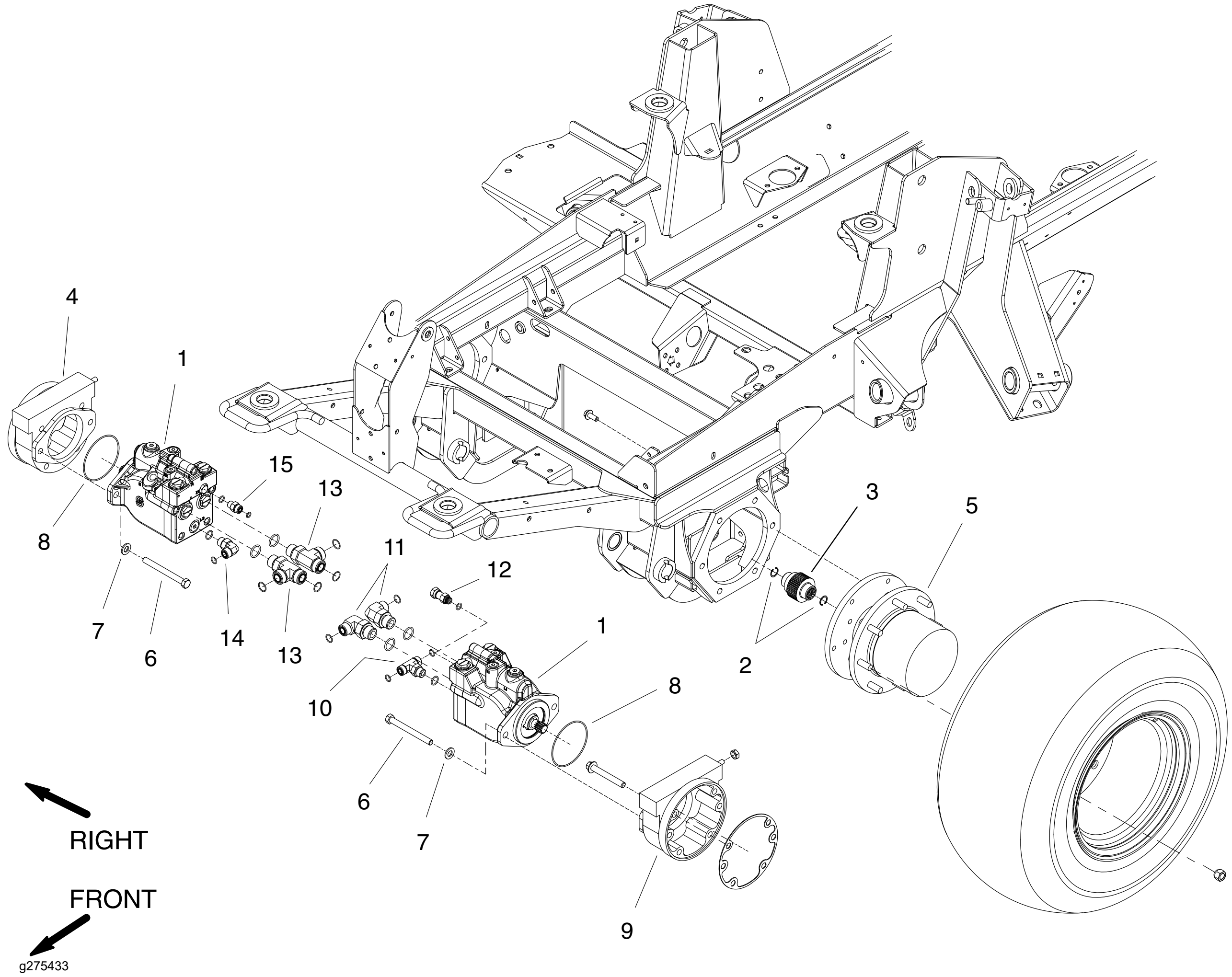

Figure 111

1. Front wheel motor
2. Internal retaining ring
3. Splined brake shaft
4. RH brake assembly
5. Planetary assembly (2 used)
6. Cap screw (2 used per motor)
7. Flat washer (2 used per motor)
8. O−ring
9. LH brake assembly
10. Hydraulic tee fitting
11. 90º hydraulic fitting (2 used)
12. Hydraulic connector
13. Hydraulic tee fitting (2 used)
14. 90º hydraulic fitting
15. Straight hydraulic fitting

Removal (Figure 111)

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the key switch.
2. Read the General Precautions for Removing and Installing Hydraulic System Components (page 5–83).
3. To prevent contamination of hydraulic system during wheel motor removal, thoroughly clean exterior of motor and fittings.

   Note: To ease installation, label the hydraulic lines to show their correct position on the wheel motor.
4. Disconnect hydraulic hoses and tubes from wheel motor. Put caps or plugs on motor ports and hose openings to prevent contamination.

Removal (Figure 111) (continued)

IMPORTANT

Before loosening fasteners that secure wheel motor, support motor to prevent it from falling during removal.

5. Remove wheel motor using Figure 111 as a guide.
6. If hydraulic fittings are to be removed from wheel motor, mark fitting orientation to allow correct assembly. Remove fittings from motor and discard O−rings.

Installation (Figure 111)

IMPORTANT

Refer to Traction Circuit Component Failure in the General Information section of this chapter for information regarding the importance of removing contamination from the traction circuit.

1. If fittings were removed from motor, lubricate and place new O−rings onto fittings. Install fittings into port openings using marks made during the removal process to properly orientate fittings. Tighten fittings (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–8)).
2. Install new O−ring (item 8) onto motor.
3. Align splines on motor shaft and splined brake shaft. Slide motor into brake assembly.
4. Secure motor to brake assembly with cap screws and flat washers.
5. Remove plugs from wheel motor fittings and hydraulic line openings. Using labels placed during motor removal, correctly attach hydraulic hoses and tubes to wheel motor fittings (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–8)).
6. Fill reservoir with hydraulic fluid as required.
7. Properly fill hydraulic system (see Charge Hydraulic System (page 5–91)).

Rear Axle and Front Wheel Motor Service

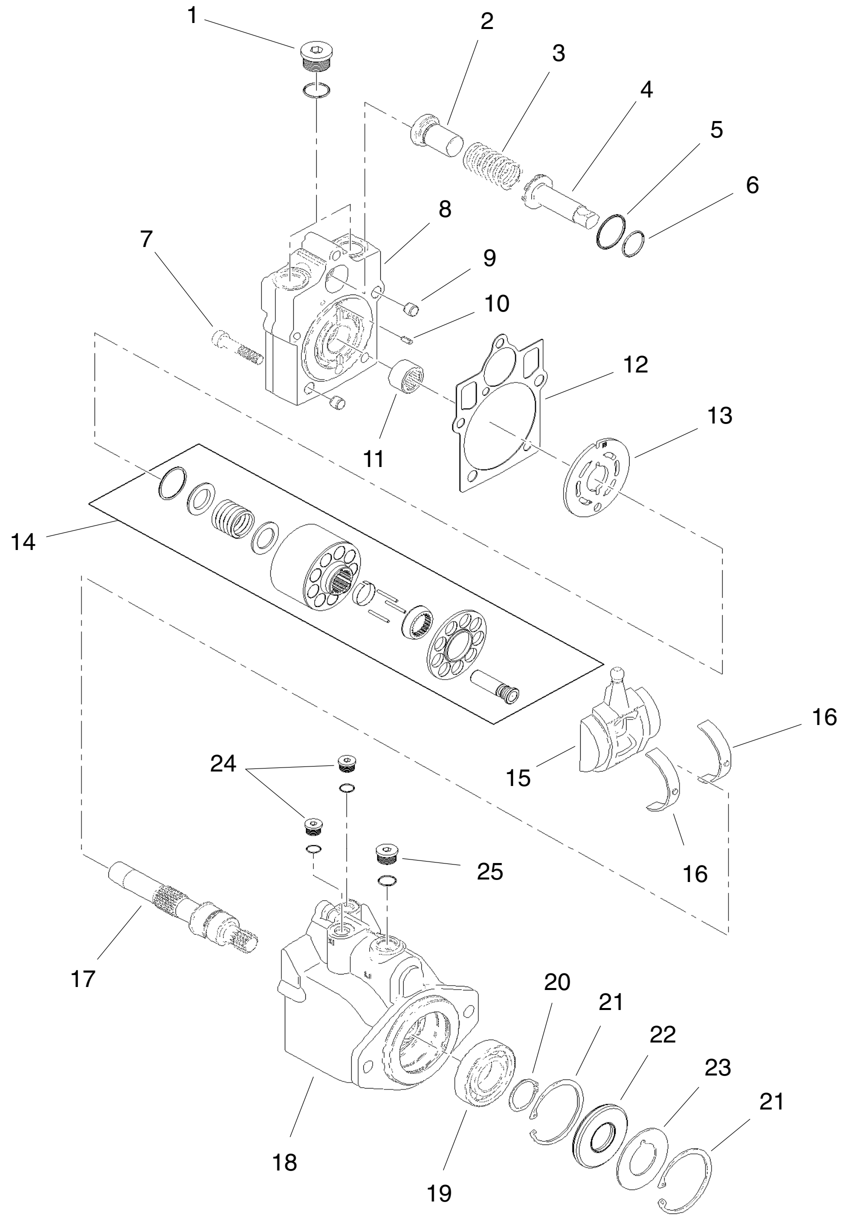

Figure 112

1. Plug with O−ring
2. Minimum angle stop
3. Bias spring
4. Servo piston
5. O−ring
6. O−ring
7. Socket head screw (5 used)
8. Endcap
9. Dowel
10. Dowel pin
11. Bearing
12. Gasket
13. Valve plate
14. Cylinder block kit
15. Swash plate
16. Swash plate bearing assembly
17. Output shaft
18. Housing
19. Bearing
20. Retaining ring
21. Retaining ring (2 used)
22. Seal
23. Support washer
24. Plug with O−ring (2 used)
25. Plug with O−ring

REAR AXLE MOTOR FLUSHING VALVE

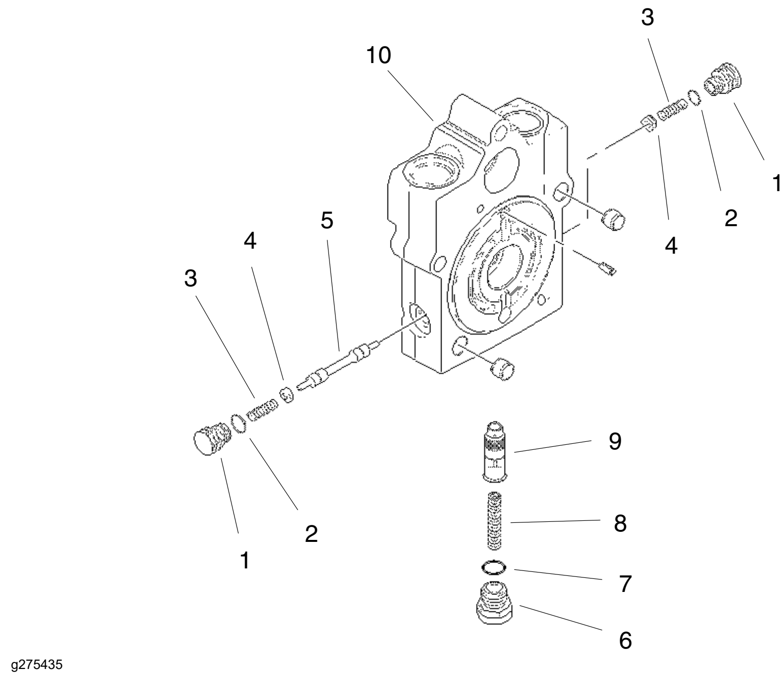

Figure 113

1.	Plug	6.	Plug
2.	O−ring	7.	O−ring
3.	Centering spring	8.	Centering spring
4.	Spring retaining washer	9.	Orifice poppet
5.	Shift spool	10.	Endcap

Note: The front wheel motors on your Groundsmaster are identical (Figure 112). The rear axle motor includes a flushing valve for cooling of the closed loop traction circuit and therefore has some differences from the front motors (Figure 113). Service of the wheel and axle motors uses the same procedure.

Note: For service of the front wheel and rear axle motors, see the Sauer−Danfoss K and L Frame Variable Motors Service Manual.

Rear Traction Manifold

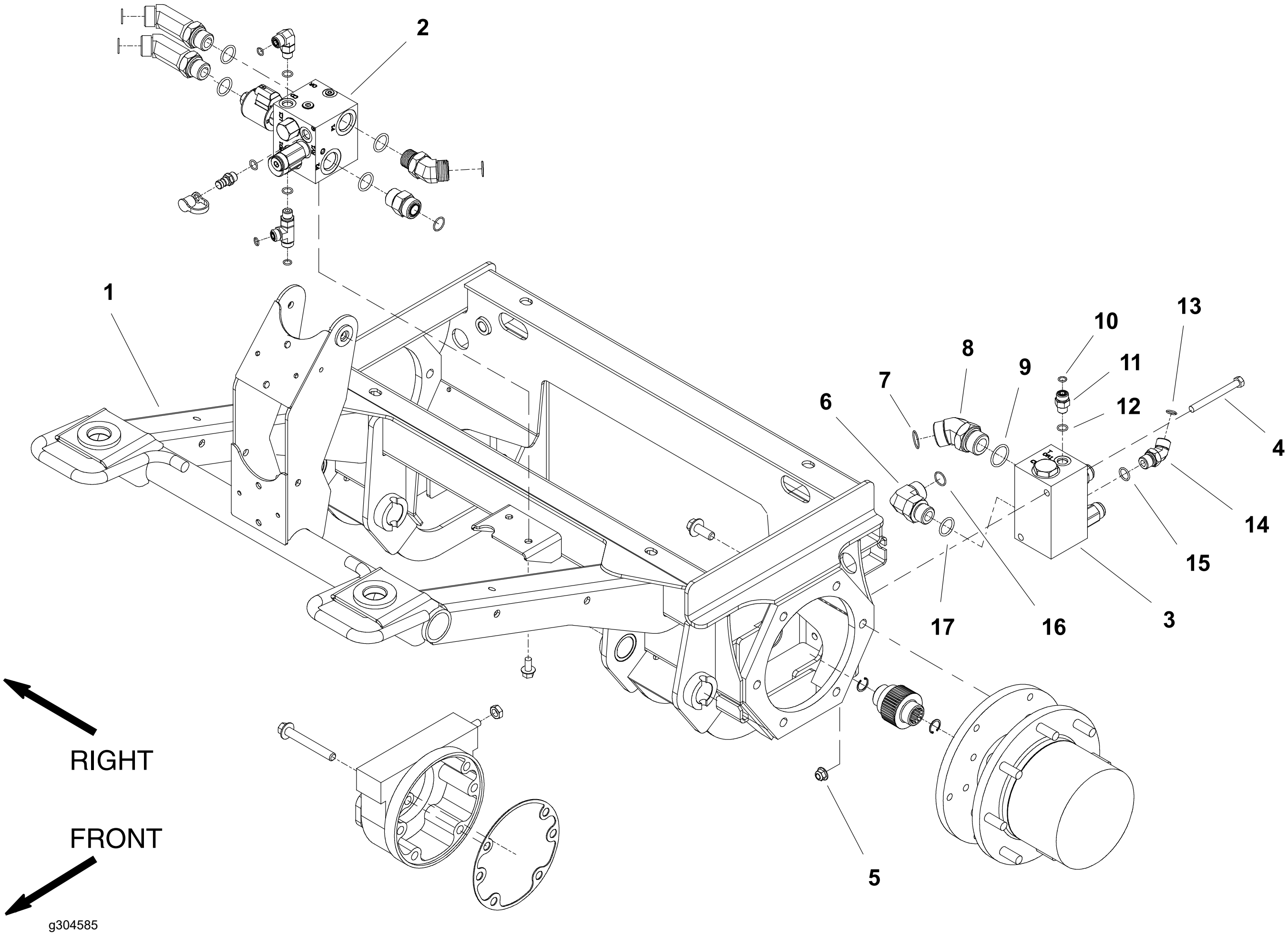

Figure 114

1.	Front frame	7.	O−ring	13.	O−ring
2.	PTO manifold (center deck)	8.	45º hydraulic fitting	14.	45º hydraulic fitting
3.	Rear traction manifold	9.	O−ring	15.	O−ring
4.	Cap screw (2 used)	10.	O−ring	16.	O−ring
5.	Flange nut (2 used)	11.	Straight fitting	17.	O−ring
6.	90º hydraulic fitting	12.	O−ring		

Note: The ports on the rear traction manifold are marked for easy identification of components. Example: P2 is a piston pump connection port and RV is the location for the relief valve (see A Hydraulic Schematic (page A–5) to identify the function of the hydraulic lines and cartridge valves at each port).

Removal (Figure 114)

1. Read the General Precautions for Removing and Installing Hydraulic System Components (page 5–83).
2. To prevent contamination of hydraulic system during manifold removal, thoroughly clean exterior of manifold and fittings.
3. Disconnect hydraulic lines from manifold and put caps or plugs on open hydraulic lines and fittings. Label disconnected hydraulic lines for proper installation.

Removal (Figure 114) (continued)

4. Remove hydraulic manifold from the frame using Figure 114 as a guide.
5. If hydraulic fittings are to be removed from manifold, mark fitting orientation to allow correct assembly. Remove fittings from manifold and discard O−rings.

Installation (Figure 114)

1. If fittings were removed from manifold, lubricate and place new O−rings onto fittings. Install fittings into manifold openings using marks made during the removal process to properly orientate fittings. Tighten fittings (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–8)).
2. Install hydraulic manifold to the frame using Figure 114 as a guide.
3. Remove caps and plugs from fittings and hydraulic lines. Using labels placed during manifold removal, properly connect hydraulic lines to manifold (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–8)).
4. Make sure hydraulic tank is full. Add correct oil if necessary before returning machine to service.

Rear Traction Manifold Service

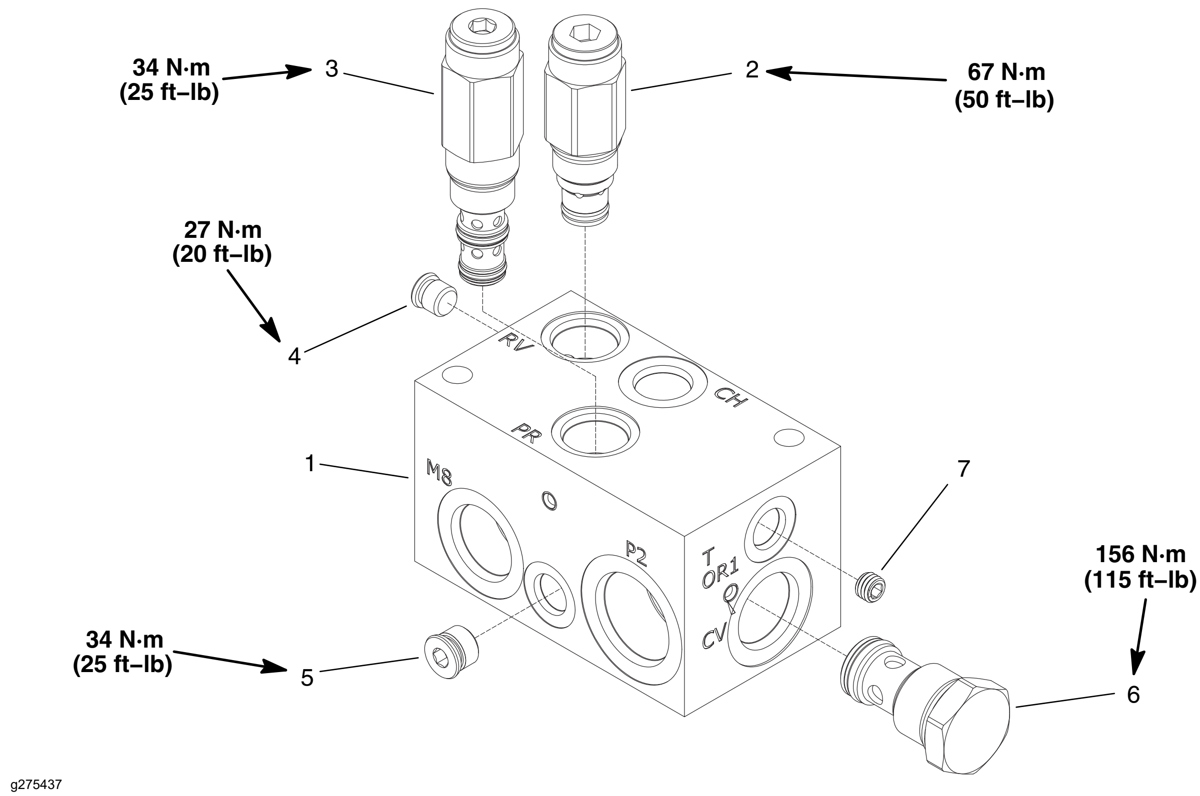

Figure 115

1. Rear traction manifold body
2. Relief valve (port RV)
3. Pressure reducing valve (port PR)
4. #4 zero leak plug with O−ring
5. #6 zero leak plug with O−ring
6. Check valve (port CV)
7. Orifice (0.050) (port OR1)

Note: The ports on the rear traction manifold are marked for easy identification of components. Example: P2 is a piston pump connection port and RV is the location for the relief valve (see A Hydraulic Schematic (page A–5) to identify the function of the hydraulic lines and cartridge valves at each port).

Note: The rear traction manifold uses several zero leak plugs. These plugs have a tapered sealing surface on the plug head that is designed to resist vibration induced plug loosening. The zero leak plugs also have an O−ring as a secondary seal. If zero leak plug removal is necessary, lightly rap the plug head using a punch and hammer before using an allen wrench to remove the plug: the impact will allow plug removal with less chance of damage to the socket head of the plug.

For rear traction manifold cartridge valve service procedures, see Control Manifold Cartridge Valve Service (page 5–128). Refer to Figure 115 for rear traction manifold cartridge valve and plug installation torque.

IMPORTANT

A flow control orifice (item 7) is located beneath the hydraulic fitting in rear traction manifold port T/OR1. If the orifice is removed from this manifold port, make sure to label its position for assembly purposes. When installing the orifice in the manifold, make sure that the orifice is properly tightened in the port.

Combination Manifold

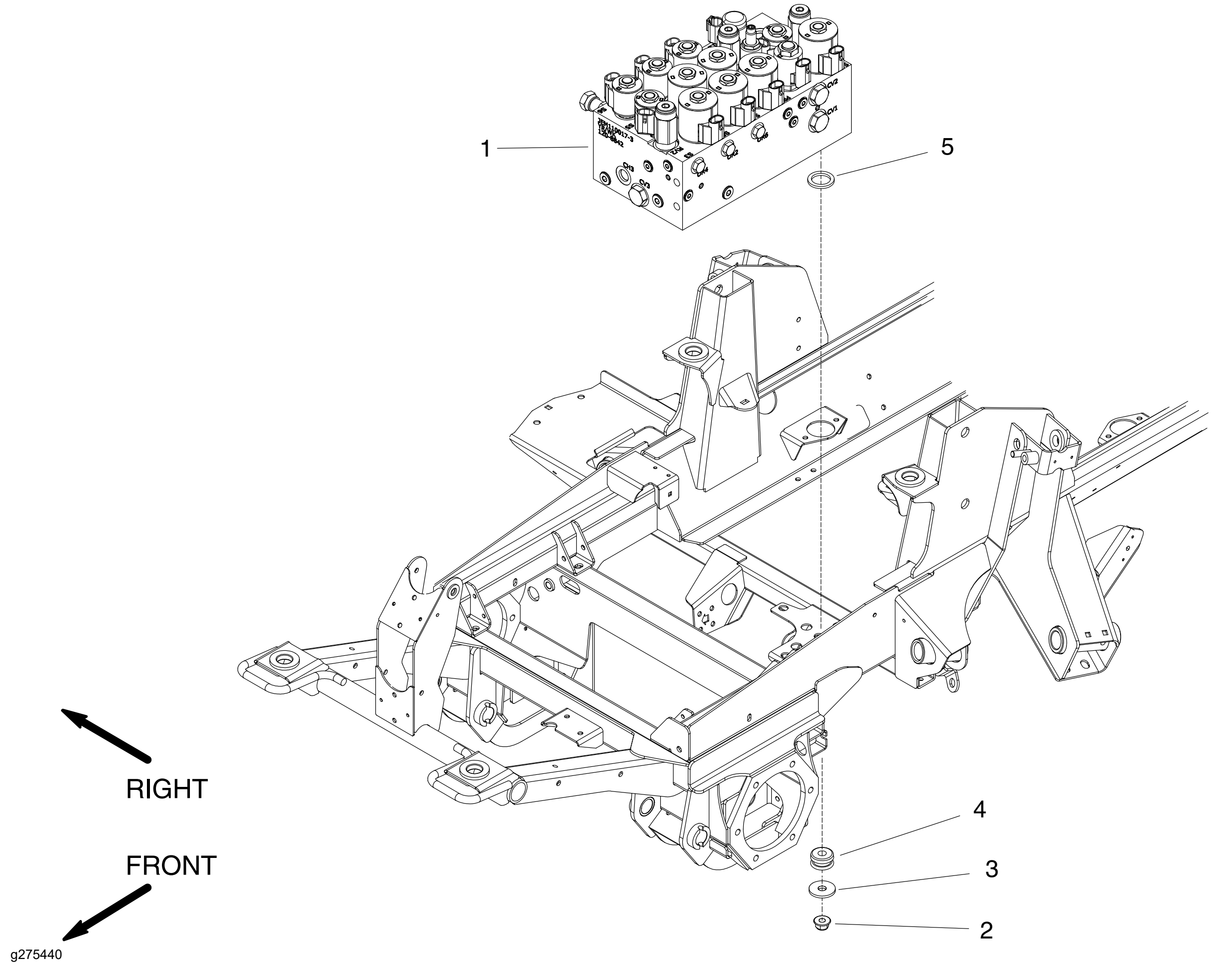

Figure 116

1. Combination manifold
2. Flange nut (3 used)
3. Flat washer (3 used)
4. Mount (3 used)
5. Spacer (3 used)

Note: The ports on the combination manifold are marked for easy identification of components. Example: P3 and P4 are the gear pump connection ports, S1 is the location for solenoid valve S1 and OR6 is the location for orifice OR6 (see A Hydraulic Schematic (page A–5) to identify the function of the hydraulic lines and cartridge valves at each port).

Removal (Figure 116)

1. Read the General Precautions for Removing and Installing Hydraulic System Components (page 5–83).
2. To prevent contamination of hydraulic system during manifold removal, thoroughly clean exterior of combination manifold and fittings.
3. Label all wire harness connectors that attach to solenoid coils on combination manifold. Disconnect wire harness connectors from solenoid coils on the combination manifold.
4. Disconnect hydraulic lines from combination manifold and put caps or plugs on open hydraulic lines and fittings. Label disconnected hydraulic lines for proper reassembly.

   Note: The combination manifold has three (3) studs on the bottom surface of the manifold used for securing the manifold to the machine.
5. Remove combination manifold from the frame using Figure 116 as a guide.

Removal (Figure 116) (continued)

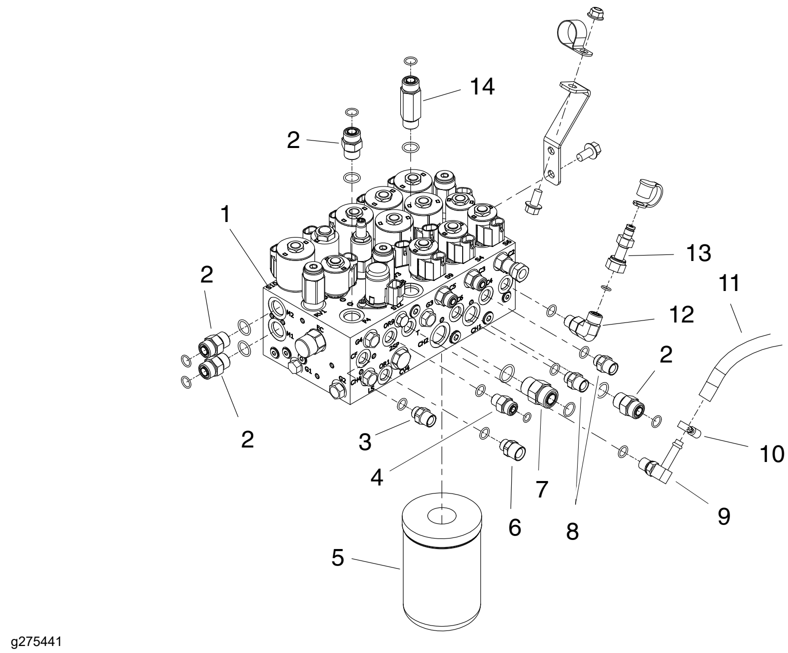

Figure 117

1.	Manifold	8.	Straight fitting
2.	Straight fitting	9.	Barbed 90º fitting
3.	Straight fitting	10.	Hose clamp
4.	Straight fitting	11.	Hose
5.	Oil filter	12.	90º fitting
6.	Straight fitting	13.	Test nipple
7.	Straight fitting	14.	Straight fitting

6. If hydraulic fittings are to be removed from manifold, mark fitting orientation to allow correct assembly (Figure 117). Remove fittings from manifold and discard O−rings.

Installation (Figure 116)

1. If fittings were removed from manifold, lubricate and place new O−rings onto fittings. Install fittings into manifold openings using marks made during the removal process to properly orientate fittings. Tighten fittings (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–8)).
2. Install combination manifold to the frame using Figure 116 as a guide.
3. Remove caps and plugs from fittings and hydraulic lines. Using labels placed during manifold removal, properly connect hydraulic lines to manifold (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–8)).
4. Using labels made during manifold removal, connect wire harness connectors to the solenoid coils on the combination manifold.
5. Make sure hydraulic tank is full. Add correct oil if necessary before returning machine to service.

Combination Manifold Service

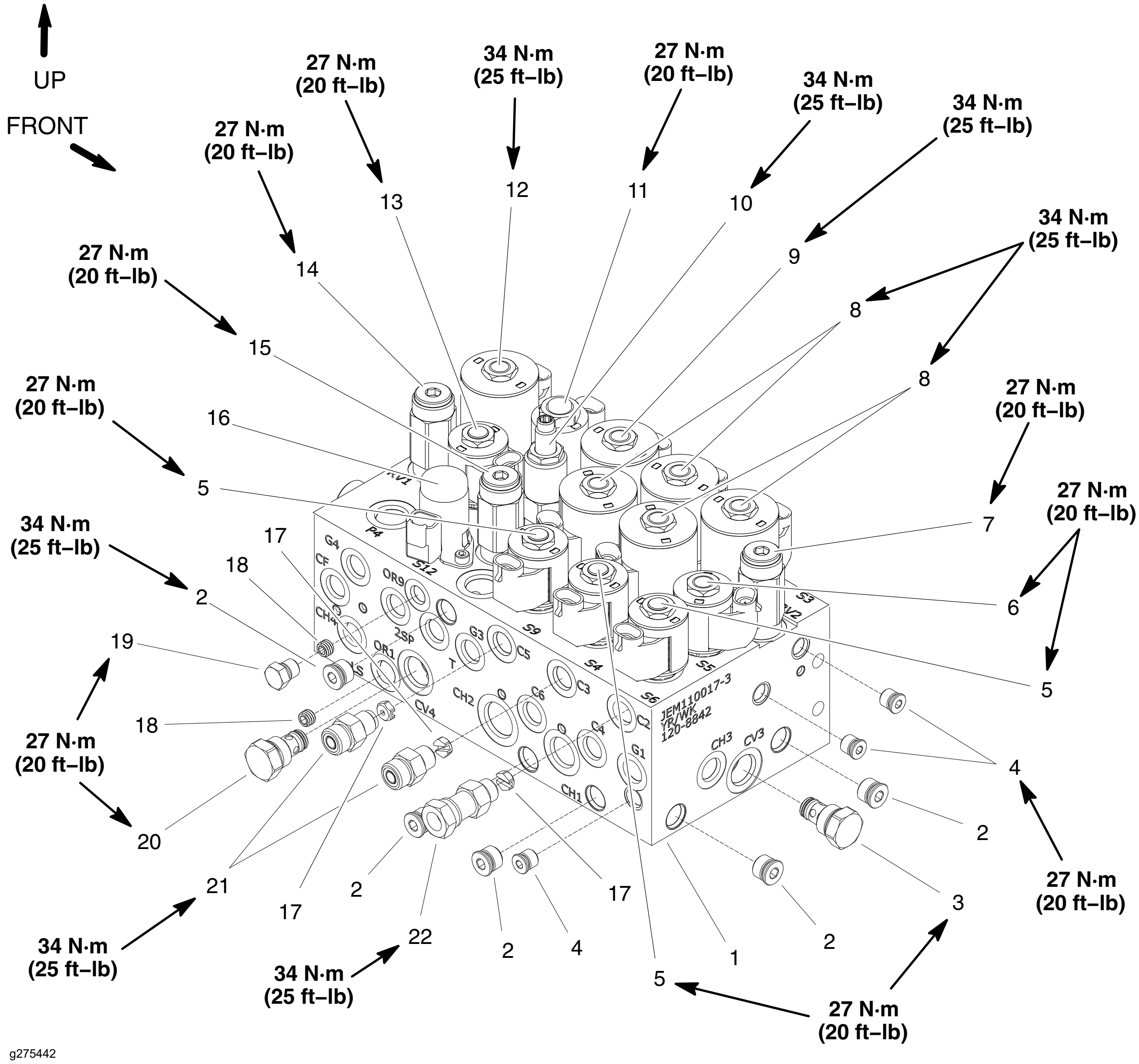

Figure 118

1. Combination manifold
2. #6 zero leak plug with O–ring
3. Check valve (CV3)
4. #4 zero leak plug with O–ring
5. Solenoid valve (S4, S6 and S9)
6. Solenoid valve (S5)
7. Relief valve (RV2)
8. Solenoid valve (S2, S3, S7 and S8)
9. Solenoid valve (S1)
10. Pressure reducing valve (PR)
11. Proportional relief valve (PRV)
12. Solenoid valve (S10)
13. Solenoid valve (S11)
14. Relief valve (RV1)
15. Relief valve (RV3)
16. Solenoid valve (S12)
17. Orifice (0.070) (C2, C3 and C5)
18. Orifice (0.030) (OR1 and OR9)
19. #4 zero leak plug with O–ring
20. Check valve (CV4)
21. Straight fitting
22. Fitting adapter

Note: The ports on the combination manifold are marked for easy identification of components. Example: P4 is the gear pump connection port, S1 is the lift/lower solenoid valve and SV10 is the engine cooling fan solenoid valve (see A Hydraulic Schematic (page A–5) to identify the function of the hydraulic lines and cartridge valves at each port).

WARNING

If combination manifold is attached to machine, make sure that cutting units are fully lowered before loosening hydraulic lines or cartridge valves from combination manifold. If cutting units are raised as components are loosened in manifold, cutting units may drop unexpectedly.

Note: The combination manifold uses several zero leak plugs. These plugs have a tapered sealing surface on the plug head that is designed to resist vibration induced plug loosening. The zero leak plugs also have an O−ring as a secondary seal. If zero leak plug removal is necessary, lightly rap the plug head using a punch and hammer before using an allen wrench to remove the plug: the impact will allow plug removal with less chance of damage to the socket head of the plug.

Combination Manifold Service

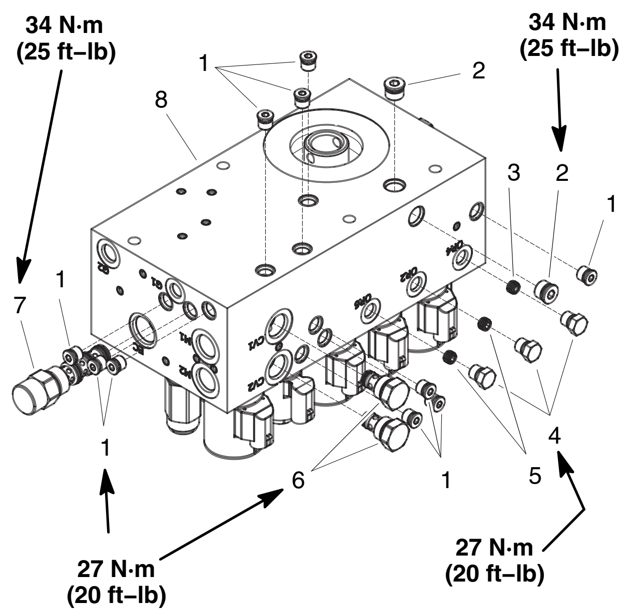

Figure 119

1. #4 zero leak plug
2. #6 zero leak plug
3. Orifice (0.040)
4. #4 zero leak plug
5. Orifice (0.063)
6. Check valve
7. Compensator valve

Combination Manifold Service (continued)

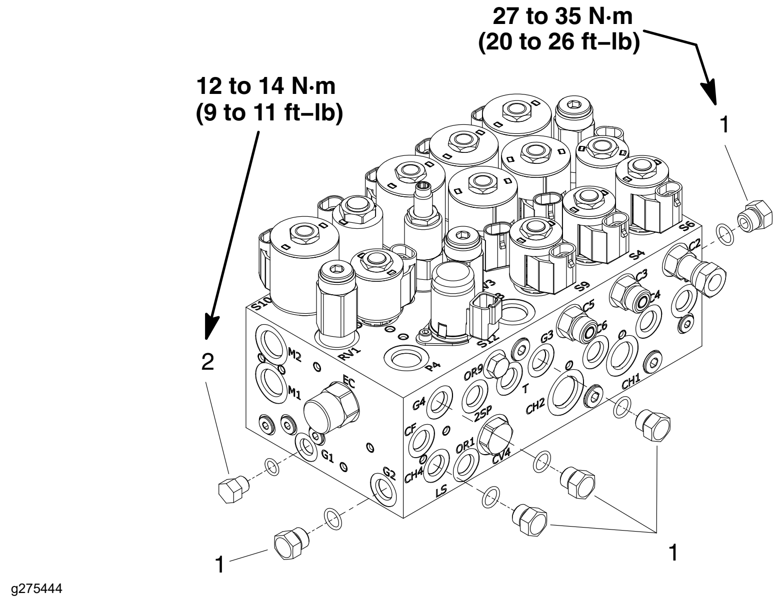

Figure 120

1. #6 hex head plug
2. #4 hex head plug

For combination manifold cartridge valve service procedures, see Control Manifold Cartridge Valve Service (page 5–128). Refer to Figure 118, Figure 119 and Figure 120 for combination manifold cartridge valve and plug installation torque.

IMPORTANT

A flow control orifice is located beneath several plugs in the combination control manifold. If an orifice is removed from a manifold port, make sure to label its position for assembly purposes. When installing the orifice in the manifold, make sure that the orifice is properly tightened in the port.

IMPORTANT

A flow control orifice is placed beneath hydraulic fittings in combination manifold ports C2, C3 and C5. If any of these fittings is removed from the manifold, make sure to remove orifice and label its position for assembly purposes. Also note location of groove in orifice for assembly purposes. When installing the orifice in the manifold, make sure that the orifice is flat in the base of the port.

Control Manifold Cartridge Valve Service

1. Make sure the control manifold is clean before removing the cartridge valve from the control manifold.
2. If cartridge valve is solenoid operated, remove nut securing solenoid coil to the cartridge valve. Carefully slide coil off the valve.

IMPORTANT

Use care when handling the cartridge valve. Slight bending or distortion of the stem tube can cause binding and malfunction. When removing cartridge valve from manifold, make sure that deep well socket fully engages the valve base.

3. Remove cartridge valve from manifold using a deep socket wrench. Note correct location for O−rings, sealing rings and backup rings. Remove seal kit from cartridge valve and discard removed seals.
4. Visually inspect the port in the manifold for damage to the sealing surfaces, damaged threads and contamination.
5. Visually inspect cartridge valve for damaged sealing surfaces and contamination.
   A. Contamination may cause valves to stick or hang up. Contamination can become lodged in small valve orifices or seal areas causing malfunction.
   B. If valve sealing surfaces appear pitted or damaged, the hydraulic system may be overheating or there may be water in the system.

⚠ CAUTION ⚠

Use eye protection such as goggles when using compressed air.

6. Clean cartridge valve using clean mineral spirits. Submerge valve in clean mineral spirits to flush out contamination. Particles as fine as talcum powder can affect the operation of high pressure hydraulic valves. If cartridge design allows, use a wood or plastic probe to push the internal spool in and out 20 to 30 times to flush out contamination. Be extremely careful not to damage cartridge. Use compressed air for cleaning.
7. Install the cartridge valve into the manifold:
   A. Lubricate new seal kit components with clean hydraulic oil and install on valve. The O−rings, sealing rings and backup rings must be arranged properly on the cartridge valve for proper operation and sealing.
   B. Dip assembled cartridge into clean hydraulic oil.

IMPORTANT

Use care when handling the valve cartridge. Slight bending or distortion of the stem tube can cause binding and malfunction. When installing cartridge valve into manifold, make sure that deep well socket fully engages the valve base.

   C. Thread cartridge valve carefully into manifold port by hand until the top O−ring is met. The valve should go into manifold port easily without binding.

Control Manifold Cartridge Valve Service (continued)

D. Torque cartridge valve using a deep socket wrench to value identified in control manifold illustration.

8. If cartridge valve is solenoid operated, carefully install solenoid coil to the cartridge valve. Secure coil to valve with nut and torque nut to **6.8 N·m (60 in−lb)**.

9. If problems still exist after assembly, remove valve and clean again or replace valve.

Steering Control Valve (For machines serial number below: 400000000)

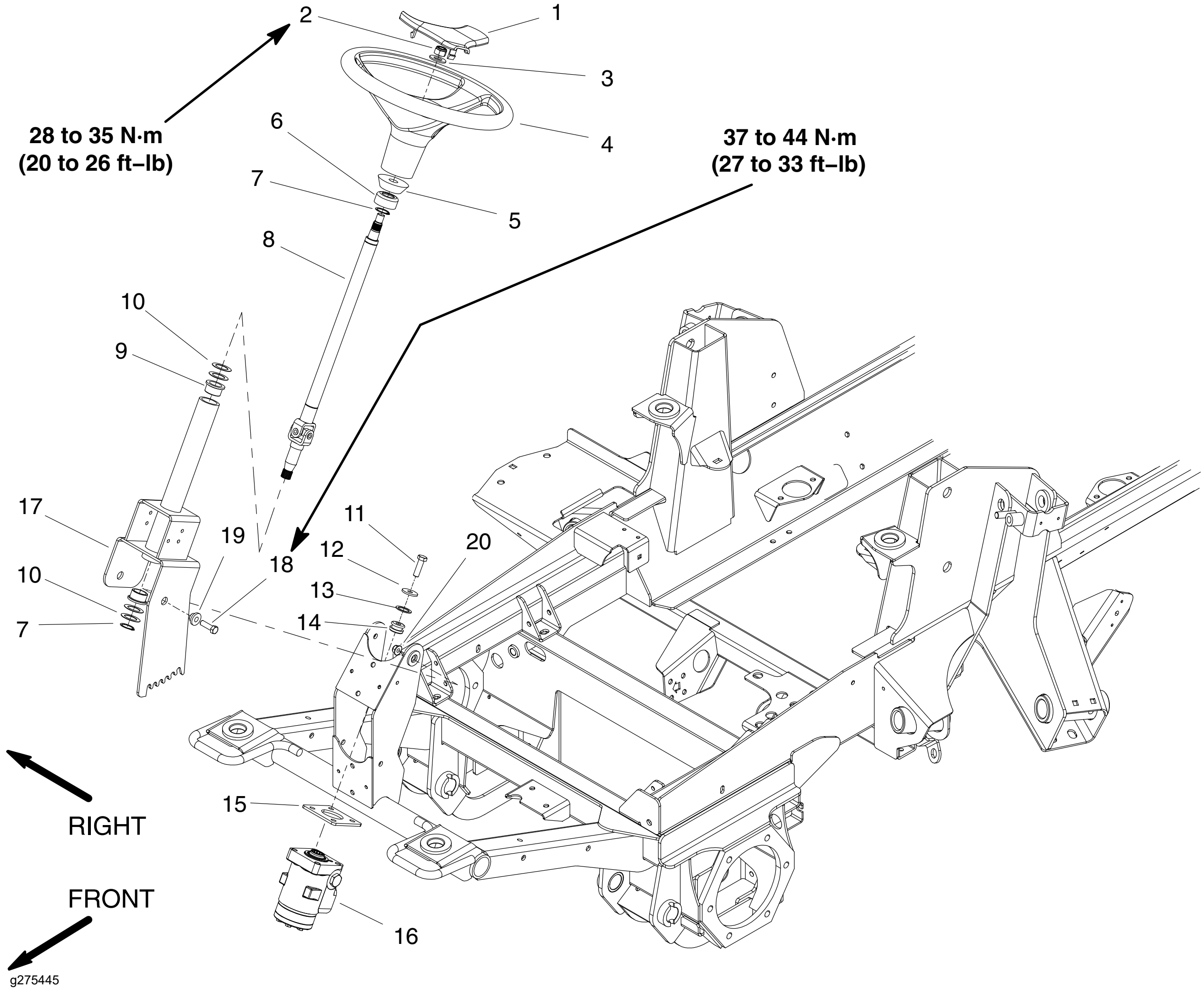

Figure 121

1. Steering wheel cover
2. Hex nut
3. Flat washer
4. Steering wheel
5. Foam collar
6. Steering seal
7. External snap ring (2 used)
8. Steering shaft
9. Flange bushing
10. Thrust washer (as needed)
11. Cap screw (4 used)
12. Washer (4 used)
13. Washer (4 used)
14. Mount (4 used)
15. Valve mount plate
16. Steering control valve
17. Steering tower
18. Cap screw (2 used)
19. Pivot hub (2 used)
20. Flange nut (2 used)

Removal (Figure 121)

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the key switch.
2. Remove steering tower cover to allow access to steering control valve.
3. Read the General Precautions for Removing and Installing Hydraulic System Components (page 5–83).
4. To prevent contamination of hydraulic system during steering control valve removal, thoroughly clean exterior of control valve and fittings.

Removal (Figure 121) (continued)

Note: To ease installation, label the hydraulic lines to show their correct position on the steering control valve.

5. Remove hydraulic lines from steering control valve.
6. Remove steering control valve from machine using Figure 121 as a guide.

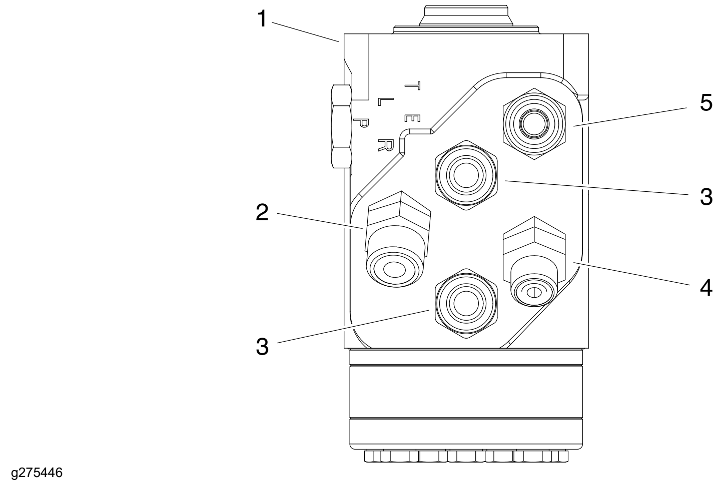

Figure 122

1. Steering control valve
2. 45º hydraulic fitting
3. Straight fitting (2 used)
4. 45º hydraulic fitting
5. Straight fitting

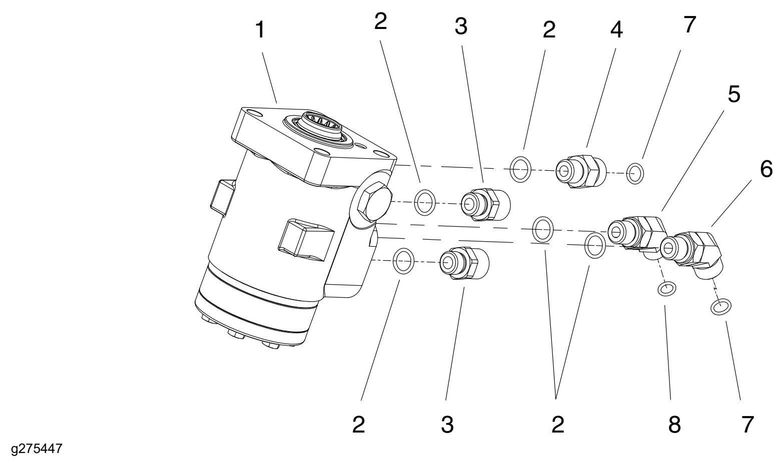

Figure 123

1. Steering control valve
2. O−ring
3. Straight fitting
4. Straight fitting
5. 45º fitting
6. 45º fitting
7. O−ring
8. O−ring

7. If hydraulic fittings are to be removed from steering control valve, mark fitting orientation to allow correct assembly. Remove fittings from valve and discard O−rings (Figure 122 and Figure 123).

Installation (Figure 121)

1. If fittings were removed from steering control valve, lubricate and place new O−rings onto fittings. Install fittings into port openings using marks made during the removal process to properly orientate fittings (Figure 122 and Figure 123). Tighten fittings (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–8)).
2. Install steering control valve using Figure 121 as a guide.
3. Using labels placed during steering control valve removal, properly install hydraulic lines to control valve (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–8)).
4. Make sure hydraulic tank is full.
5. Properly fill hydraulic system (see Charge Hydraulic System (page 5–91)).
6. Install steering tower cover to machine.

Steering Control Valve (For machines serial number above: 400000000)

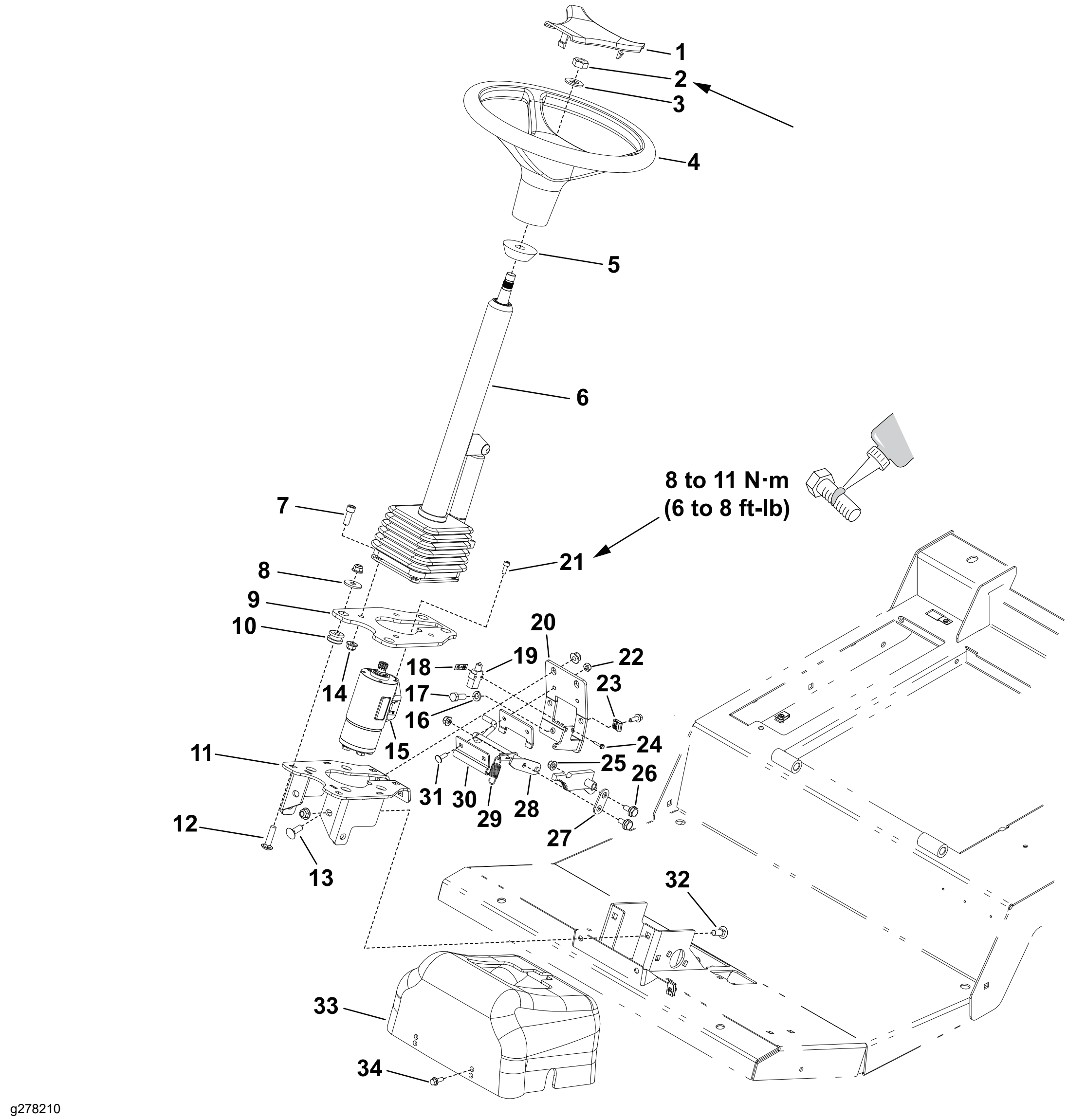

Figure 124

1. Steering wheel cover
2. Hex nut
3. Flat washer
4. Steering wheel
5. Foam collar
6. Steering shaft
7. Bolt (4 each)
8. Washer (4 each)
9. Steering mount plate
10. Mount (4 each)
11. Mount assembly
12. Carriage bolt (4 each)
13. Carriage bolt (6 each)
14. Nut (4 each)
15. Steering control valve
16. Lock washer (2 each)
17. Bolt (2 each)
18. Switch nut
19. Switch
20. Rear support
21. Bolt (4 each)
22. Lock nut (2 each)
23. Speed nut
24. Bolt (2 each)
25. Nut (2 each)
26. Shoulder bolt (2 each)
27. Brake link
28. Brake rod
29. Extension spring
30. Brake plate
31. Carriage bolt (2 each)
32. Carriage bolt (6 each)
33. Steering cover
34. Bolt (6 each)

Removal (Figure 124)

1. Park the machine on the level surface, lower cutting decks, stop engine, apply parking brake and remove the key from the key switch.
2. Remove the steering cover to allow access to the steering control valve.
3. Support the steering tower to prevent it from falling.
4. Read the General Precautions for Removing and Installing Hydraulic System Components (page 5–83).
5. To prevent contamination of hydraulic system during steering control valve removal, thoroughly clean exterior of control valve and fittings.
6. For assembly purpose, label all the hydraulic connections. Note the port designations on the steering control valve.

CAUTION

Before opening hydraulic system, operate all hydraulic controls to release system pressure and avoid injury from the pressurized hydraulic fluid; refer to Relieving Hydraulic System Pressure (page 5–3).

7. Disconnect the hydraulic lines from the steering control valve. Allow the lines to drain into a suitable container.
8. Install clean cap or plugs on the hydraulic lines and fitting to prevent contamination.
9. Remove the steering control valve from machine using Figure 124 as a guide.
10. If hydraulic fittings are to be removed from steering control valve, mark fitting orientation to allow correct assembly. Remove fittings from valve and discard O-rings; refer to Figure 125 and Figure 126.

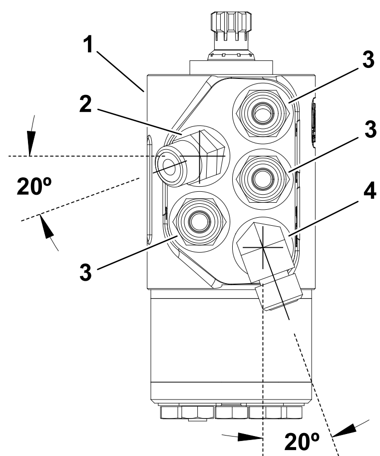

Figure 125

1. Steering control valve
2. 45º hydraulic fitting
3. Straight fitting (3 used)
4. 90º hydraulic fitting

Removal (Figure 124) (continued)

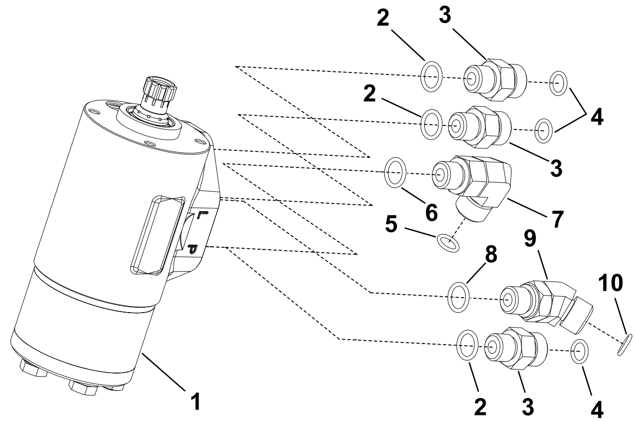

Figure 126

1. Steering control valve
2. O-ring
3. Straight fitting
4. O-ring
5. O-ring
6. O-ring
7. 90º hydraulic fitting
8. O-ring
9. 45º hydraulic fitting
10. O-ring

Installation (Figure 124)

1. If the hydraulic fitting were removed from the steering valve, lubricate new O-ring with clean hydraulic fluid, position the O-rings to the fittings. Install the fittings to the steering control valve using the marks made during the removal process to properly orientate fittings (refer to Figure 125 and Figure 126). Tighten the fittings; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings) (page 5–10).
2. Install the steering control valve using Figure 124 as a guide.
3. Apply loctite to four (4) bolts and secure the steering control valve to the steering column with four (4) bolts. Torque bolts in a criss-cross pattern from **8 to 11 N-m (6 to 8 ft-lb)**.
4. Remove the caps and plugs that were installed to the hydraulic lines and fittings during the removal process.
5. Using the labels placed during steering control valve removal, properly install the hydraulic lines to control valve; refer Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–8).
6. Check the hydraulic fluid level in the hydraulic tank and add correct quantity of fluid if necessary; refer to the *Operator's Manual*.
7. Operate the machine functions slowly until air is out of system; refer to Charge Hydraulic System (page 5–91).
8. Install the steering tower cover to the machine.

Steering Control Valve Service (For machines serial number below: 400000000)

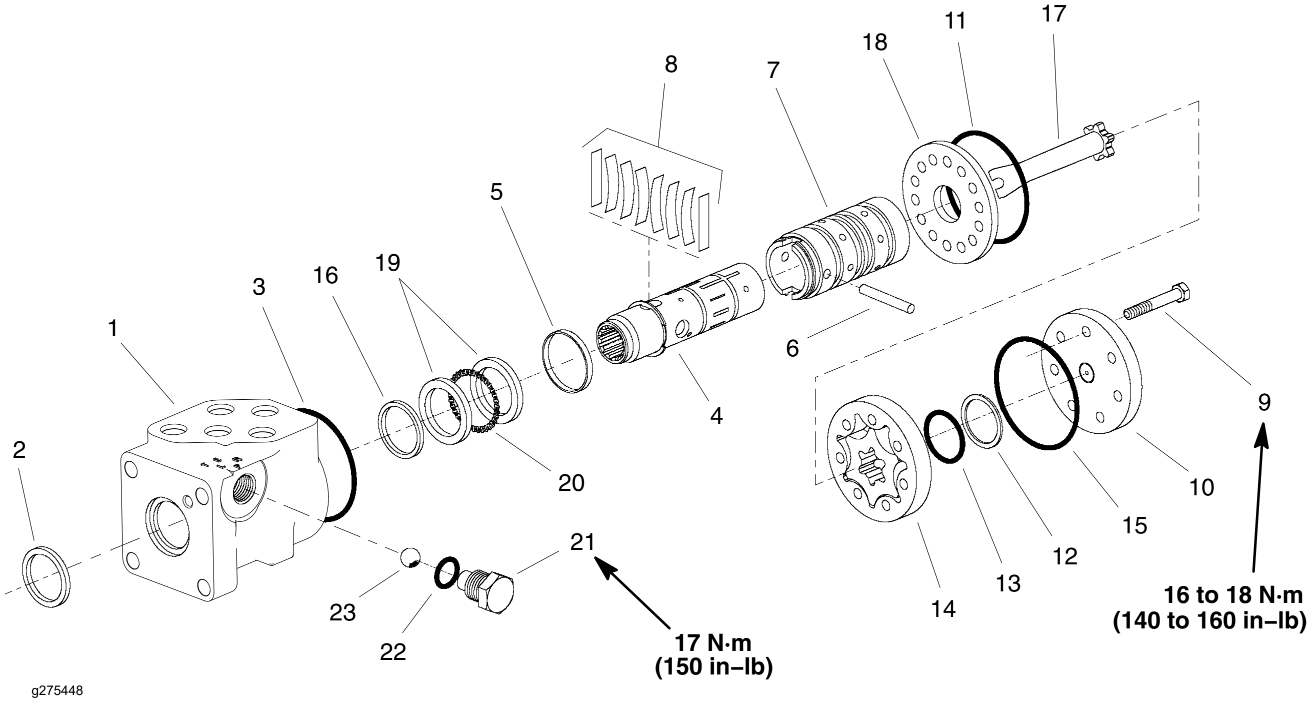

Figure 127

1. Steering valve housing
2. Dust seal
3. O–ring
4. Spool
5. Spring retaining ring
6. Pin
7. Sleeve
8. Centering springs/spacers
9. Cap screw (7 used)
10. End cap
11. O–ring
12. Seal ring
13. O–ring
14. Geroter
15. O–ring
16. Quad seal
17. Geroter drive
18. Wear plate
19. Bearing race
20. Thrust bearing
21. Plug
22. O–ring
23. Check ball

Note: For steering control valve repair procedures, see the Eaton Parts And Repair Information: 5 Series Steering Control Units.

Steering Control Valve Service (For machines serial number above: 400000000)

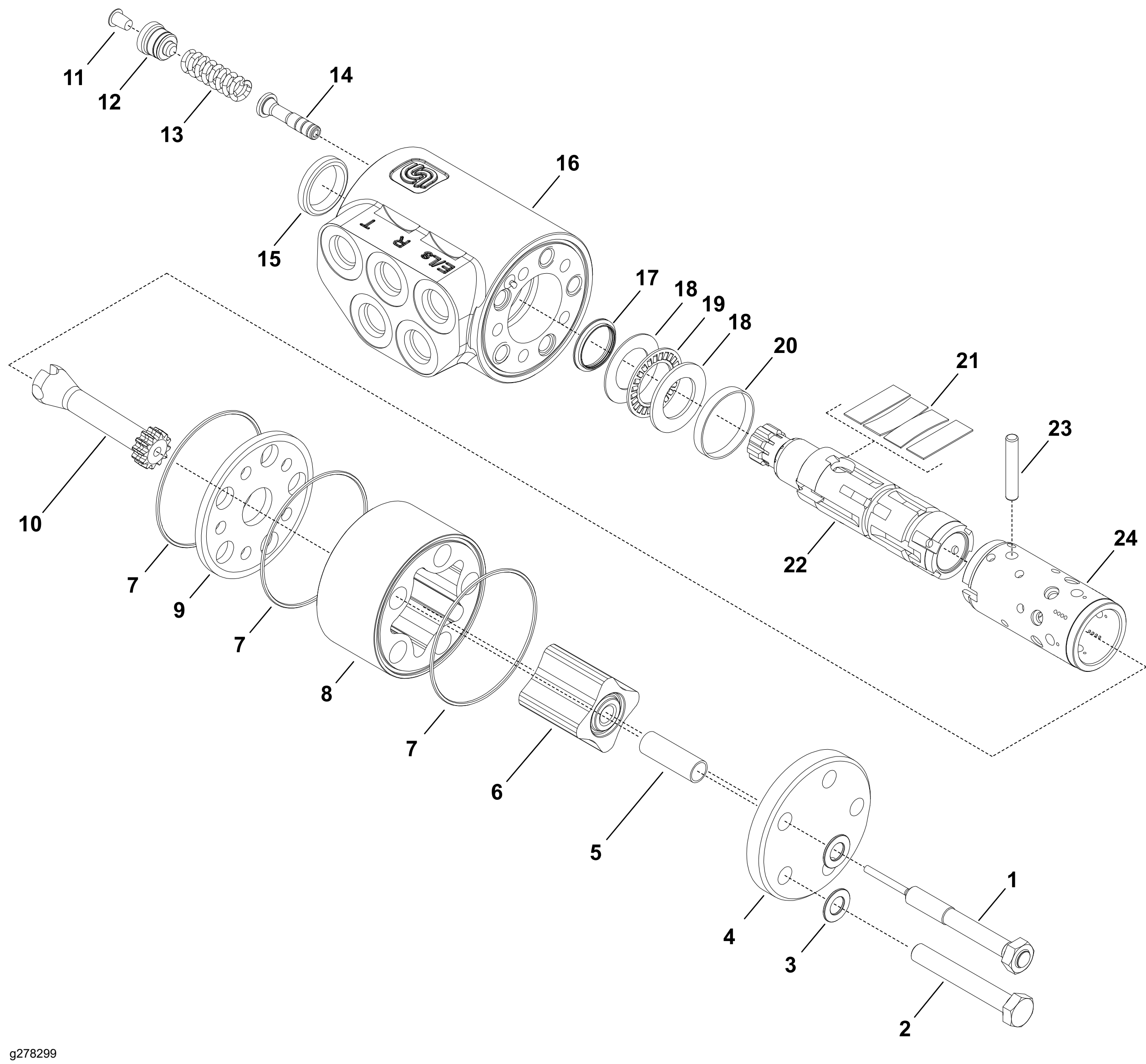

Figure 128

1.	Pin bolt	9.	Distributor plate	17.	Shaft seal
2.	Bolt (4 each)	10.	Cardan shaft	18.	Thrust washer (2 each)
3.	Washer (5 each)	11.	Plug	19.	Bearing
4.	End cover	12.	Plug	20.	Ring
5.	Tube (2 each)	13.	Spring	21.	Spring set
6.	Inner gearwheel	14.	Relief valve	22.	Spool
7.	O-ring (3 each)	15.	Dust sealing ring	23.	Cross pin
8.	Outer gearwheel	16.	Housing	24.	Sleeve

Note: For the steering control valve repair procedures, refer to the Danfoss Steering Unit Type OSPM Service Manual.

Steering Cylinder

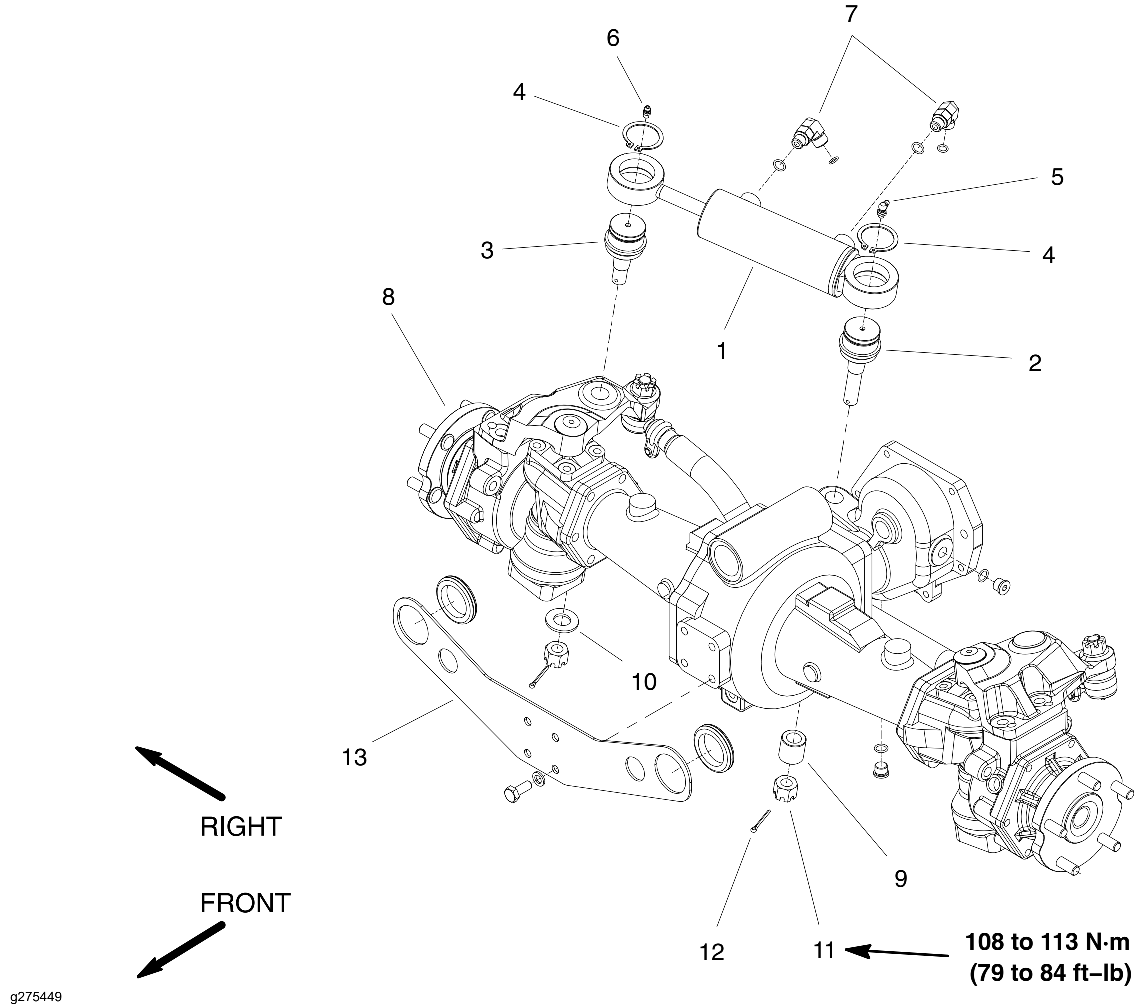

Figure 129

1. Steering cylinder
2. Ball joint
3. Ball joint
4. Retaining ring (2 used)
5. Grease fitting
6. Grease fitting
7. 90º hydraulic fitting (2 used)
8. Drive axle assembly
9. Ball joint spacer
10. Axle washer
11. Slotted hex nut (2 used)
12. Cotter pin (2 used)
13. Bulkhead mount plate

Removal (Figure 129)

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the key switch.
2. Read the General Precautions for Removing and Installing Hydraulic System Components (page 5–83).
3. To prevent contamination of hydraulic system during cylinder removal, thoroughly clean exterior of cylinder and fittings.

   Note: To ease installation, label the hydraulic hoses to show their correct position on the steering cylinder.

Removal (Figure 129) (continued)

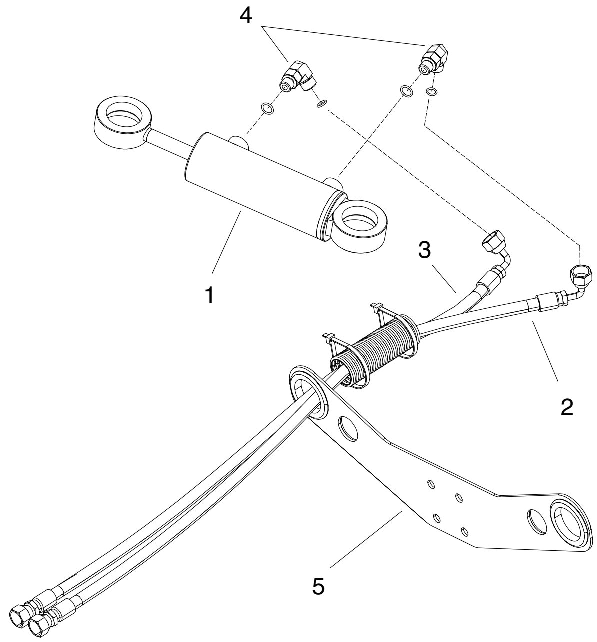

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Figure 130

1. Steering cylinder
2. Hydraulic hose
3. Hydraulic hose
4. 90º hydraulic fitting
5. Bulkhead mount plate

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4. Remove hydraulic hoses from steering cylinder (Figure 130).
5. Remove cotter pins, slotted hex nuts, axle washer and ball joint spacer from the threaded ends of ball joints. Remove steering cylinder with ball joints from machine.
6. If hydraulic fittings are to be removed from steering cylinder, mark fitting orientation to allow correct assembly. Remove fittings from cylinder and discard O−rings.
7. If needed, remove ball joints from steering cylinder.

Installation (Figure 129)

1. If removed, install ball joints into steering cylinder.
2. If fittings were removed from steering cylinder, lubricate and place new O−rings onto fittings. Install fittings into port openings using marks made during the removal process to properly orientate fittings. Tighten fittings (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–8)).
3. Slide ram end ball joint through hole on steering arm. Secure with axle washer and hex slotted nut. Slide fixed end of cylinder through hole on axle. Secure with slotted hex nut. Torque slotted hex nuts from **108 to 113 N·m (79 to 84 ft−lbs)** and then continue tightening the nut until hex nut groove aligns with cotter pin hole in ball joint. Install cotter pin to nut and ball joint.
4. Install hydraulic hoses to steering cylinder (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–8)).
5. Fill reservoir with new hydraulic fluid as required.
6. Properly fill hydraulic system (see Charge Hydraulic System (page 5–91)).
7. After assembly is completed, operate steering cylinder to verify that hydraulic hoses and fittings are not contacted by anything.

Steering Cylinder Service

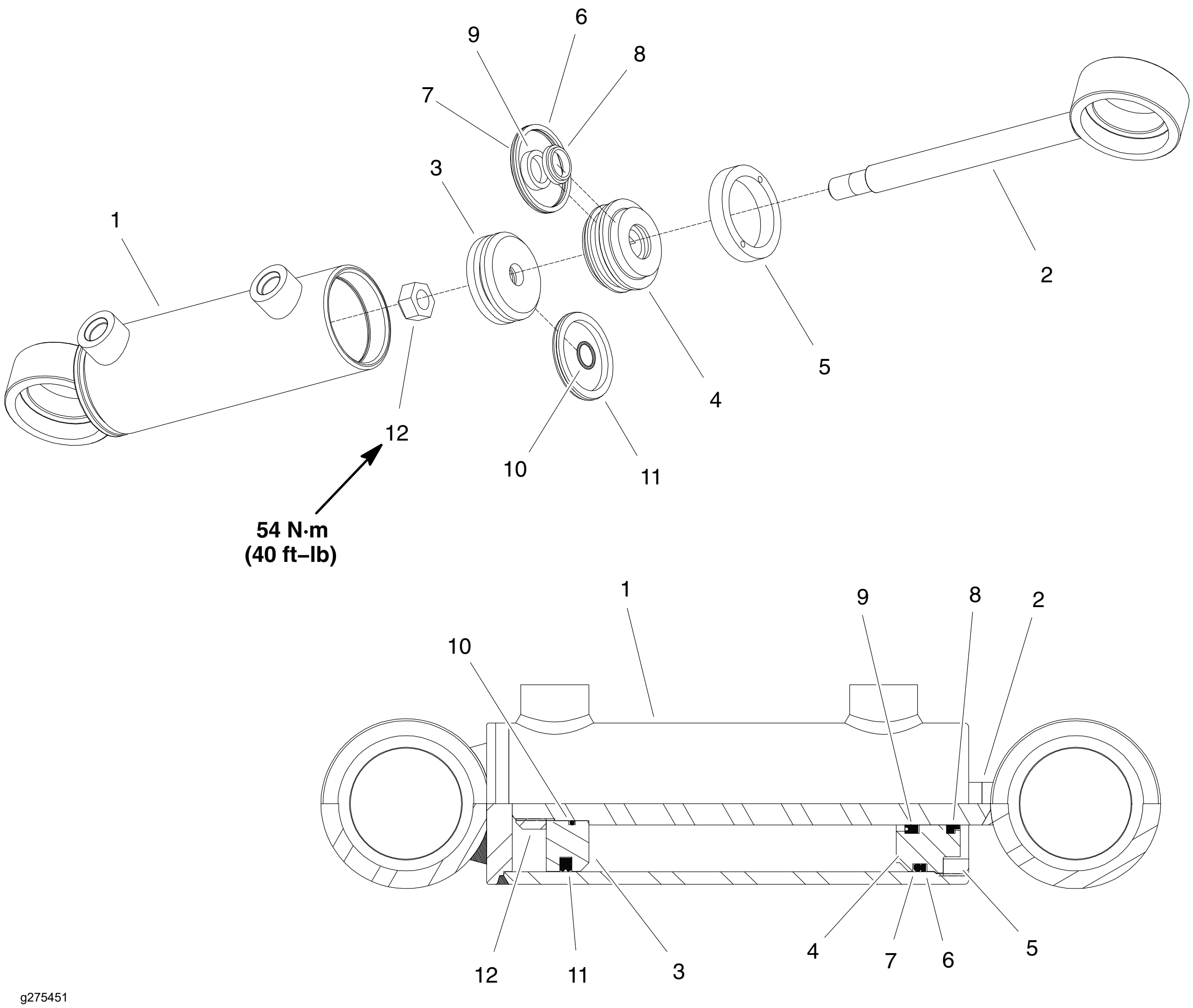


Figure 131

1.	Barrel	5.	Internal collar	9.	Rod seal
2.	Rod	6.	Backup ring	10.	O−ring
3.	Piston	7.	O−ring	11.	Piston seal
4.	Head	8.	Dust seal	12.	Lock nut

Disassembly (Figure 131)

1. Pump oil out of steering cylinder into a drain pan by slowly moving rod in and out of cylinder bore. After oil has been removed from cylinder, plug ports and clean outside of cylinder.

IMPORTANT

Prevent damage when clamping the cylinder in a vise, clamp on the clevis only. Use of a vise with soft jaws is recommended.

2. Mount steering cylinder securely in a vise by clamping on the clevis end of the barrel. Use of a vise with soft jaws is recommended.
3. Use a spanner wrench to loosen and remove internal collar (item 5) from barrel.

Disassembly (Figure 131) (continued)

4. Grasp end of rod and use a twisting and pulling motion to carefully extract rod, piston and head assembly from cylinder barrel.

IMPORTANT

Do not clamp vise jaws against rod surface; the rod will be damaged.

5. Securely mount rod, piston and head assembly into vise with soft jaws.
6. Remove lock nut and then piston from the rod. Slide head and then internal collar off the rod.
7. Remove and discard all seals and O−rings from the piston and the head.

CAUTION

Use eye protection such as goggles when using compressed air to dry cylinder components.

8. Wash cylinder parts in clean solvent. Dry parts with compressed air. Do not wipe parts dry with paper towels or cloth. Lint in a hydraulic system will cause damage.
9. Carefully inspect internal surface of barrel for damage (deep scratches, out−of−round, etc.). Inspect rod and piston for evidence of excessive scoring, pitting or wear. Replace steering cylinder if internal components are worn or damaged.

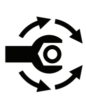
Assembly (Figure 131)

1. Use a complete repair kit when rebuilding the steering cylinder. Put a coating of clean hydraulic oil on all new seals and O−rings.
2. Install new lubricated O−rings and seals to the piston and head.

IMPORTANT

Do not clamp vise jaws against the rod surface.

3. Mount rod securely in a vise by clamping on the clevis of the rod.
4. Lubricate rod with clean hydraulic oil. Carefully slide internal collar, head and then piston onto the rod.



5. Install and tighten lock nut onto rod. Torque lock nut **54 N·m (40 ft−lb)**.
6. Remove rod assembly from vise.
7. Put a coating of clean hydraulic oil on all cylinder parts to ease assembly.
8. Carefully slide rod assembly into cylinder barrel.

IMPORTANT

Prevent damage when clamping the cylinder in a vise, clamp on the clevis only. Use of a vise with soft jaws is recommended.

Assembly (Figure 131) (continued)

9. Mount steering cylinder securely in a vise by clamping on the clevis end of the barrel. Use of a vise with soft jaws is recommended.
10. Secure head in barrel by using a spanner wrench to install and tighten internal collar (item 5) into barrel.

Engine Cooling Fan Motor

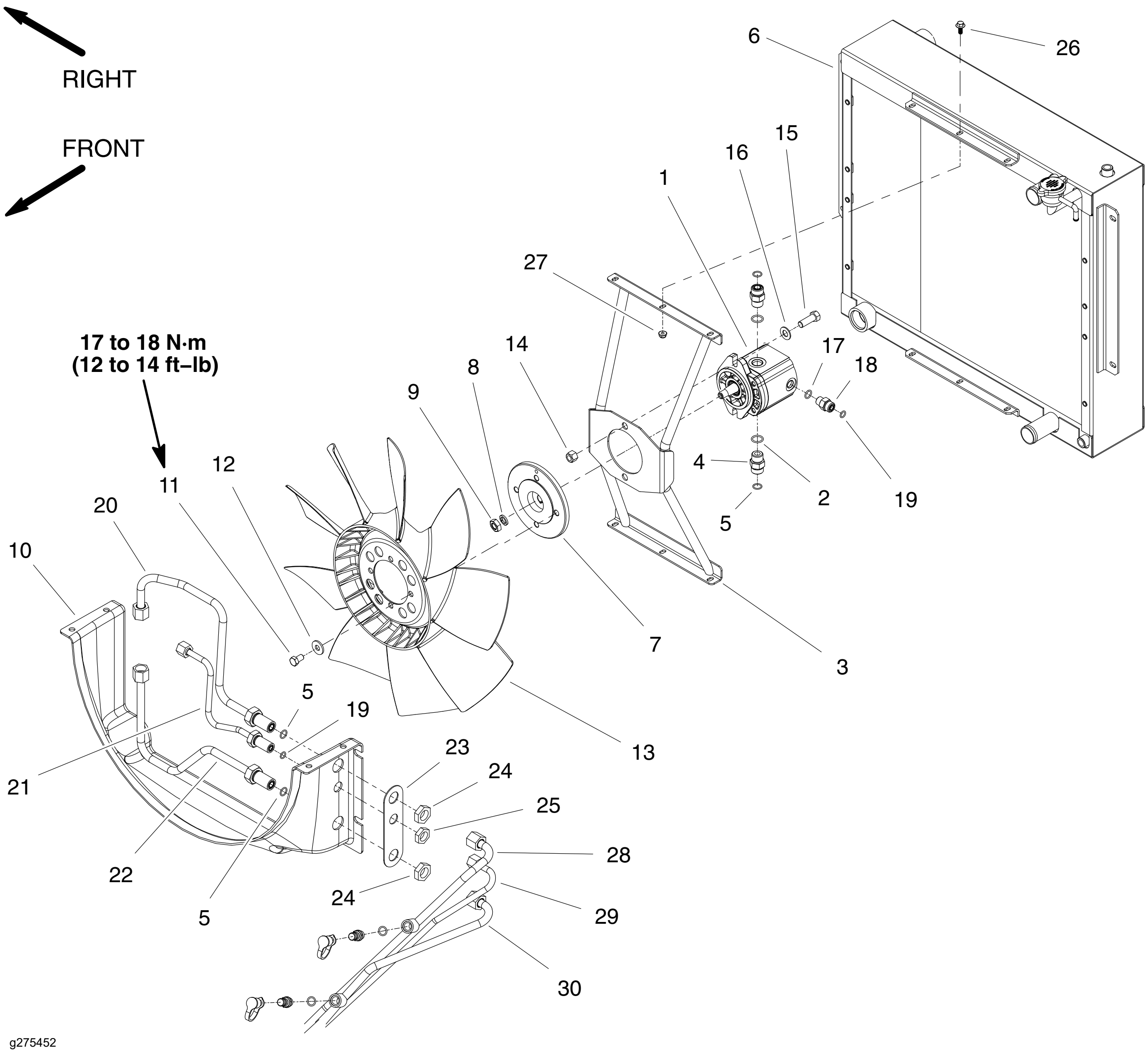


Figure 132

1. Hydraulic fan motor	11. Cap screw (4 used)	21. Hydraulic tube
2. O–ring	12. Washer (4 used)	22. Hydraulic tube
3. Fan bracket	13. Fan	23. Support shim
4. Hydraulic fitting (2 used)	14. Lock nut (2 used)	24. Bulkhead nut (2 used)
5. O–ring	15. Cap screw (2 used)	25. Bulkhead nut
6. Radiator/oil cooler assembly	16. Flat washer (2 used)	26. Cap used (6 used)
7. Fan hub	17. O–ring	27. Flange nut (6 used)
8. Washer	18. Hydraulic fitting	28. Hydraulic tube
9. Hex nut	19. O–ring	29. Hydraulic tube
10. Lower radiator shroud	20. Hydraulic tube	30. Hydraulic tube

Removal (Figure 132)

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the key switch.
2. Unlatch and raise hood.

Removal (Figure 132) (continued)

CAUTION

The radiator and oil cooler may be hot. To avoid possible burns, allow the engine and cooling systems to cool before removing fan motor.

3. Read the General Precautions for Removing and Installing Hydraulic System Components (page 5–83).
4. Thoroughly clean three (3) hydraulic tubes at lower radiator shroud. Disconnect hydraulic tubes and put caps or plugs on tubes to prevent contamination. Label disconnected hydraulic tubes for proper installation.

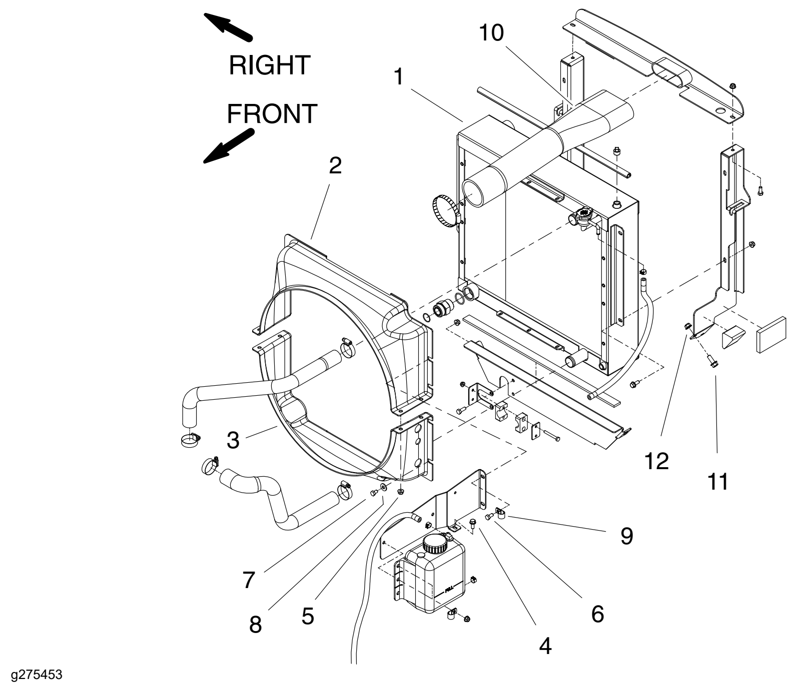


Figure 133

1.	Radiator	7.	Cap screw (6 used)
2.	Upper radiator shroud	8.	Flat washer (7 used)
3.	Lower radiator shroud	9.	R−clamp
4.	Screw (4 used)	10.	Air cleaner inlet hose
5.	Flange nut (4 used)	11.	Screw (4 used)
6.	Cap screw (2 used)	12.	Flange nut (4 used)

5. Remove air cleaner inlet hose and radiator shrouds (upper and lower) to allow easier access to hydraulic fan motor (Figure 133).
6. Remove flange head screws and flange nuts that secure radiator supports to frame (items 11 and 12 in Figure 133). This will allow radiator assembly to be moved slightly to ease removal of cooling fan motor and bracket assembly.
7. Remove four (4) cap screws (item 11) and washers used to secure fan to fan hub. Remove fan.

Removal (Figure 132) (continued)

IMPORTANT

Make sure to not damage the radiator or other machine components while loosening and removing the fan motor and bracket assembly.

8. Remove cooling fan motor and bracket assembly.
   A. To prevent contamination of hydraulic system, thoroughly clean exterior of fan motor and fittings.
   B. Disconnect three (3) hydraulic tubes from fan motor. Put caps or plugs on fittings and tubes to prevent contamination. Label hydraulic lines for proper assembly.
   C. Remove six (6) cap screws and flange nuts that secure fan motor bracket to radiator.
   D. Carefully remove fan motor and bracket assembly from machine and place on suitable work surface.
9. Remove hex nut (item 9) and washer (item 8) that secure fan hub to fan motor. Use suitable puller to carefully remove fan hub from fan motor shaft. Locate and retrieve woodruff key from motor shaft.
10. Remove two (2) cap screws (item 15), flat washers (item 16) and lock nuts (item 14) that secure fan motor to fan motor bracket. Remove fan motor from bracket.
11. If necessary, remove fittings from motor and discard O−rings.

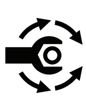
Installation (Figure 132)

1. If fittings were removed from fan motor, lubricate and place new O−rings onto fittings. Install and tighten fittings in port openings (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–8)).
2. Position fan motor to fan motor bracket and secure with cap screws (item 15), flat washers (item 16) and lock nuts (item 14).
3. Thoroughly clean tapered surfaces of fan motor shaft and fan hub. Place woodruff key in slot in motor shaft.
4. Position fan hub onto motor shaft and secure with washer (item 8) and hex nut (item 9).

IMPORTANT

Make sure to not damage the radiator or other machine components while installing the fan motor and bracket assembly.

5. Carefully position fan motor and bracket assembly to radiator and secure with six (6) cap screws and flange nuts.
6. Secure radiator assembly to frame with removed fasteners (Figure 133).
7. Connect three (3) hydraulic tubes to cooling fan motor (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–8)).



8. Position fan to fan hub and secure with four (4) cap screws and washers. Torque screws from **17 to 18 N·m (12 to 14 ft−lb)**.

Installation (Figure 132) (continued)

9. Install radiator shrouds (lower and upper) and air cleaner hose (Figure 133). Make sure that clearance between shrouds and cooling fan is at least **4.6 mm (0.180 in)** at all points.
10. Connect three (3) hydraulic tubes at lower radiator shroud (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–8)).
11. Lower and secure hood.
12. Make sure hydraulic tank is full.
13. Properly fill hydraulic system (see Charge Hydraulic System (page 5–91)).

Engine Cooling Fan Motor Service

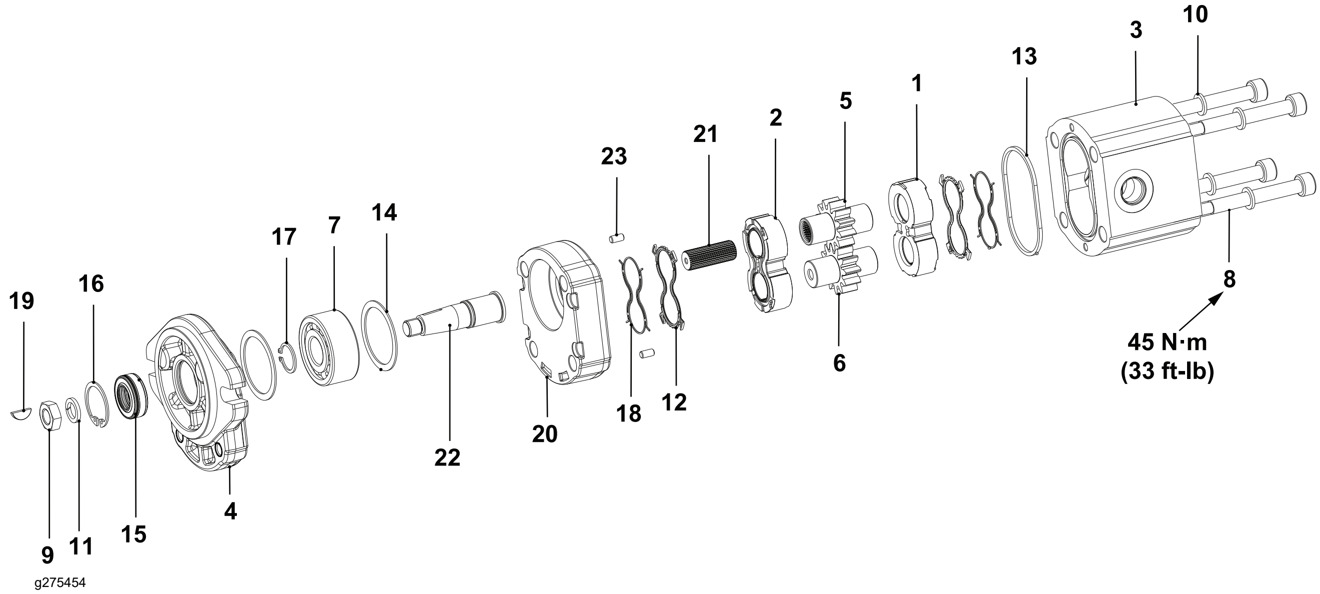


Figure 134

1. Flange washer
2. O−ring
3. Front flange
4. Dust seal
5. Retaining ring
6. Front wear plate
7. Shaft seal
8. Backup gasket
9. Pressure seal
10. Rear wear plate
11. Body
12. Idler gear
13. Cap screw (4 used)
14. Dowel (2 used)
15. Drive gear
16. Washer (4 used)

Note: Internal components for a cooling fan motor are not available separately. Disassemble motor for cleaning, inspection and seal replacement only.

Disassembly (Figure 134)

1. Plug motor ports and clean the outside of the motor thoroughly. After cleaning, remove plugs and drain any oil out of the motor.

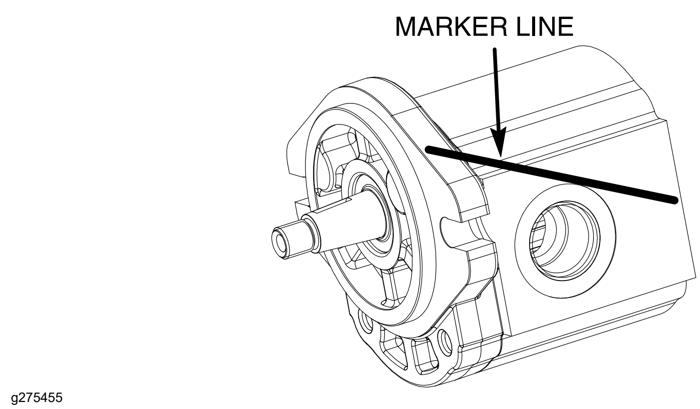


Figure 135

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2. Use a marker to make a diagonal line across the front flange and body for assembly purposes (Figure 135).

Disassembly (Figure 134) (continued)

IMPORTANT

Prevent damage when clamping the fan motor in a vise; clamp on the front flange only. Also, use a vise with soft jaws.

3. Clamp front flange of motor in a vise with soft jaws with the shaft end down.
4. Loosen cap screws from the rear of the body.
5. Remove motor from the vise. Turn motor so that the shaft end is facing down. Remove cap screws.
6. Carefully remove body. Lift body straight up to remove. Make sure the rear wear plate remains on the drive and idler gear shafts. Remove and discard O− rings from the body. Locate and retrieve dowel pins.

IMPORTANT

Note position of the open and closed side of the wear plates before removing. Also, identify wear plates (front and rear) with a marker for proper assembly.

7. Carefully remove rear wear plate, idler gear, drive gear and front wear plate from the front flange.
8. Remove and discard back−up gaskets and pressure seals from wear plates.
9. Turn front flange over, with seal side up.

IMPORTANT

Make sure not to damage the front flange counter bore when removing the seals from the front flange.

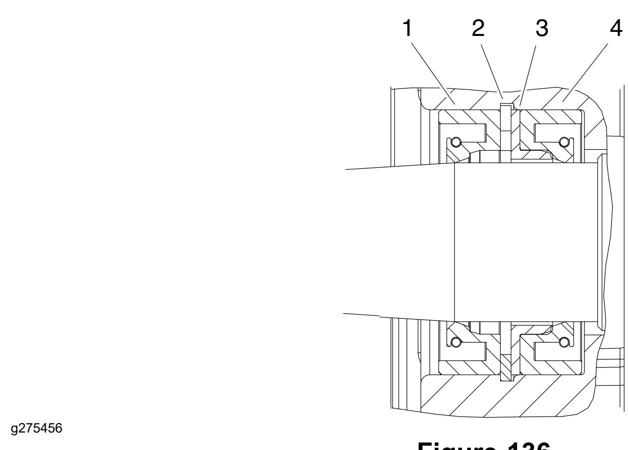


Figure 136

1. Dust seal
2. Retaining ring
3. Flange washer
4. Shaft seal

10. Carefully remove dust seal, retaining ring, flange washer and shaft seal from the front flange (Figure 136). Note orientation of seal lips during removal. Discard removed seals.

Inspection

1. Remove any nicks and burrs from all parts with emery cloth.

⚠ CAUTION ⚠

Use eye protection such as goggles when using compressed air.

2. Clean all parts with solvent. Dry all parts with compressed air.

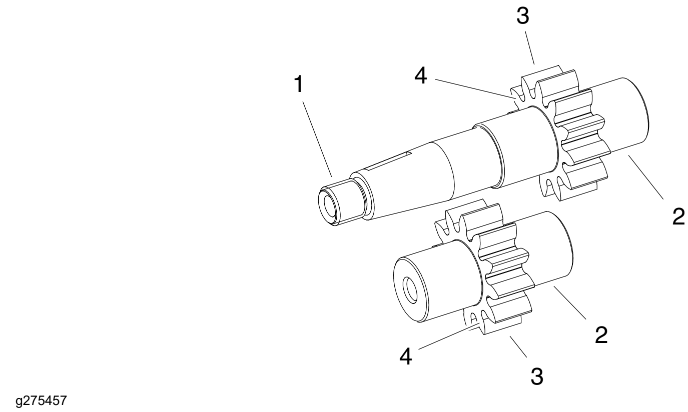


Figure 137

1. Gear shaft spline
2. Gear shaft
3. Gear teeth
4. Gear face edge

3. Inspect drive gears and idler gears for the following (Figure 137):
   A. Gear shafts should be free of rough surfaces and excessive wear at bushing points and sealing areas. Scoring, rough surfaces or wear on gear shafts indicates need for replacement.
   B. Gear teeth should be free of excessive scoring and wear. Any broken or nicked gear teeth must be replaced.
   C. Inspect gear face edge for sharpness. Sharp edges of gears will mill into wear plates and, thus, must be replaced.
4. Inspect wear plates for the following:
   A. Bearing areas should not have excessive wear or scoring.
   B. Face of wear plates that are in contact with gears should be free of wear, roughness or scoring.
   C. Thickness of wear plates should be equal.
5. Inspect front flange and body for damage or wear.

Assembly (Figure 134)

Note: When assembling motor, check the marker line on each part to make sure parts are properly aligned during assembly.

1. Lubricate O−rings, pressure seals, back−up gaskets and wear plate grooves with a thin coat of petroleum jelly. Lubricate all other internal parts freely with clean hydraulic oil.
2. Install new seals into front flange (Figure 136). Note orientation of seal lips during installation:
   A. Press shaft seal into front flange until it reaches the bottom of the bore.
   B. Install flange washer into front flange and then install retaining ring into the groove of the front flange.

Assembly (Figure 134) (continued)

C. Install new dust seal into front flange.

3. Place front flange, seal side down, on a flat surface.
4. Install the pressure seals, flat side outward, into the grooves in the wear plates. Follow by carefully placing the backup gaskets, flat side outward, between the pressure seals and the grooves in the wear plate.
5. Apply a light coating of petroleum jelly to the exposed side of the front flange.
6. Lubricate the drive gear shaft with clean hydraulic oil. Insert the drive end of the drive shaft through the wear plate with the pressure seal side down and the open side of the pressure seal pointing to the inlet side of the motor. Carefully install shaft into front flange.
7. Lubricate the idler gear shaft with clean hydraulic oil. Install idler gear shaft into the remaining position in the front wear plate. Apply a light coating of clean hydraulic oil to gear faces.
8. Install rear wear plate with pressure seal side up and open side of the pressure seal pointing to the inlet side of the motor.
9. Apply a light coating of petroleum jelly to new O− rings and O−ring grooves in the body. Install new O− rings to the body.
10. Install locating dowels in body. Align marker line on the body and front flange.

IMPORTANT

Do not dislodge seals during installation.

11. Gently slide the body onto the assembly. Firm hand pressure should be sufficient to engage the dowels.
12. Install the four (4) cap screws with washers and hand tighten.

IMPORTANT

Prevent damage when clamping the fan motor into a vise; clamp on the front flange only. Also, use a vise with soft jaws.

13. Place front flange of the motor into a vise with soft jaws and alternately torque the cap screws **45 N·m (33 ft−lb)**.
14. Remove motor from vise.
15. Place a small amount of clean hydraulic oil in the inlet of the motor and rotate the drive shaft away from the inlet one revolution. If any binding is noted, disassemble the motor and check for assembly problems.

Cutting Deck Motors

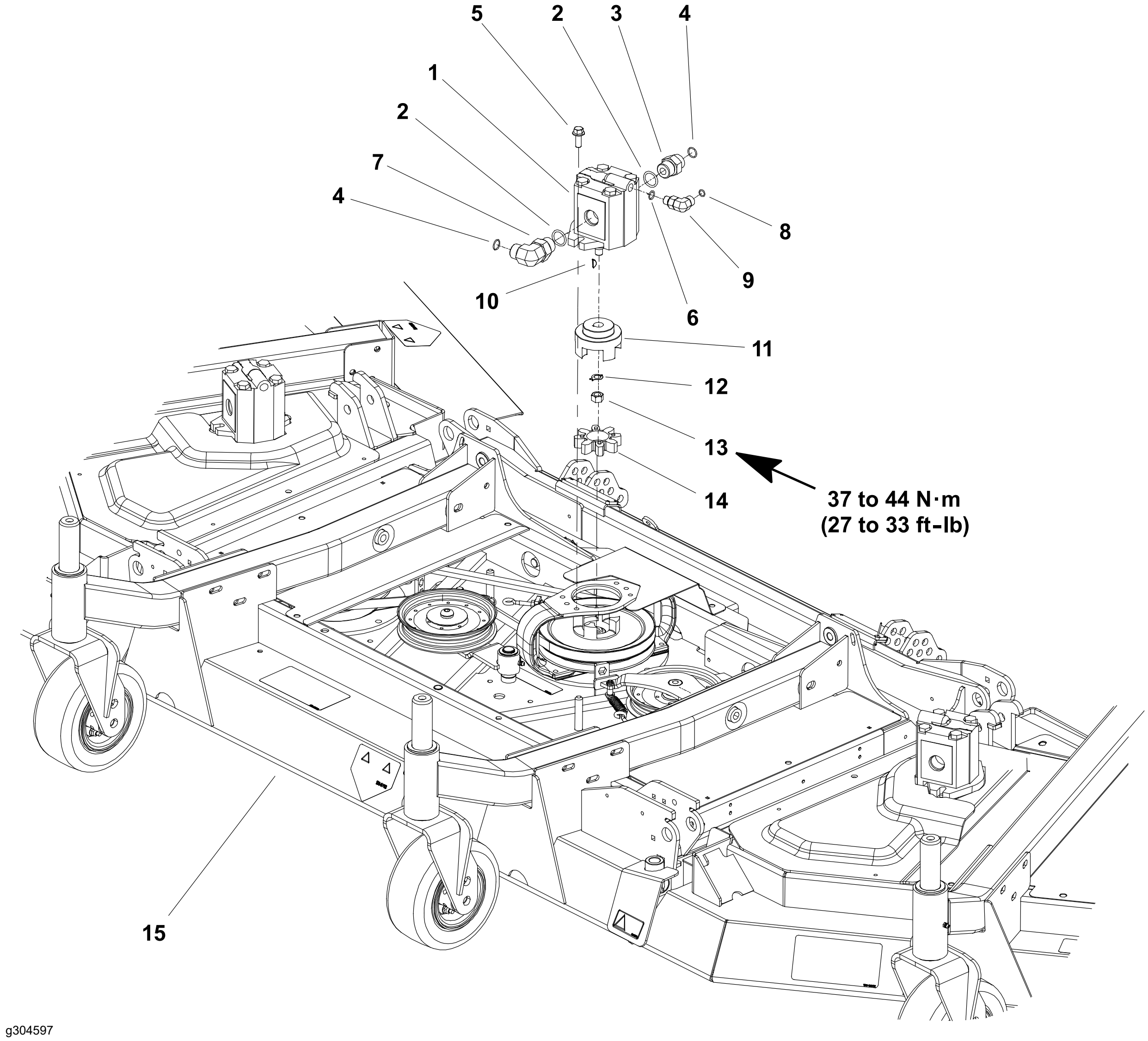


Figure 138

1. Cutting deck motor	6. O-ring	11. Spider hub
2. O-ring	7. 90º hydraulic fitting	12. Tab washer
3. Hydraulic adapter	8. O-ring	13. Nut
4. O-ring	9. 90º hydraulic fitting	14. Spider
5. Flange head screw (2)	10. Woodruff key	15. Cutting deck

Removal

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the key switch.
2. Read the General Precautions for Removing and Installing Hydraulic System Components (page 5–83).
3. To prevent contamination of hydraulic system during motor removal, thoroughly clean exterior of motor and fittings.
4. Disconnect hydraulic lines from deck motor. Put caps or plugs on fittings and hoses to prevent contamination. Label hydraulic lines for proper installation.
5. Remove two (2) flange head screws that secure hydraulic motor to motor mount (Figure 138).

Removal (continued)

6. Carefully remove hydraulic motor from cutting deck taking care not to damage spider hub attached to motor. Locate and remove spider from the deck.
7. If required, remove spider hub from motor shaft. Straighten tab washer and remove nut, spider and woodruff key.

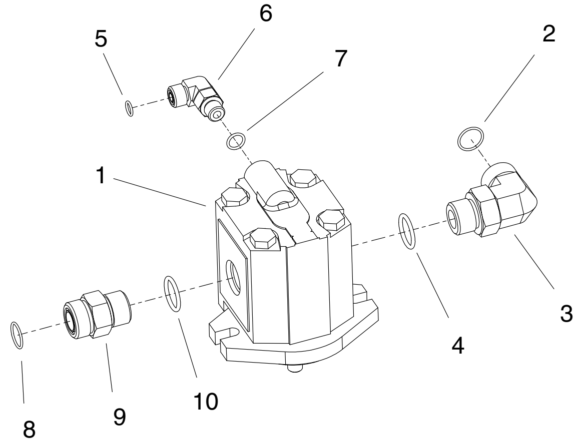


Figure 139

1.	Motor (center deck)	6.	Hydraulic fitting
2.	O−ring	7.	O−ring
3.	Hydraulic fitting	8.	O−ring
4.	O−ring	9.	Hydraulic fitting
5.	O−ring	10.	O−ring

8. If hydraulic fittings are to be removed from motor, mark fitting orientation to allow correct assembly. Remove fittings from motor and discard O−rings (Figure 139).

Installation

1. If fittings were removed from motor, lubricate and place new O−rings onto fittings. Install fittings into port openings using marks made during the removal process to properly orientate fittings. Tighten fittings (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–8)).
2. If removed, install spider hub on motor shaft. Secure with tab washer and nut. Torque nut from **37 to 44 N·m (27 to 33 ft−lb)**. Bend small tab of washer into keyway and large tab against nut.
3. Position spider in spindle pulley. Carefully install hydraulic motor to the cutting deck taking care not to damage spider hub attached to motor.
4. Secure motor to cutting deck with two (2) flange head screws (Figure 138).

IMPORTANT

For proper hydraulic hose routing, make sure cutting deck is fully lowered before installing hoses to deck motor.

5. Remove caps or plugs from fittings and hoses. Connect hydraulic hoses to deck motor (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–8)).
6. After assembly is completed, verify that hydraulic hoses and fittings are not contacted by moving components through full range of deck movement.

Cutting Deck Motor Service (Sauer−Danfoss)

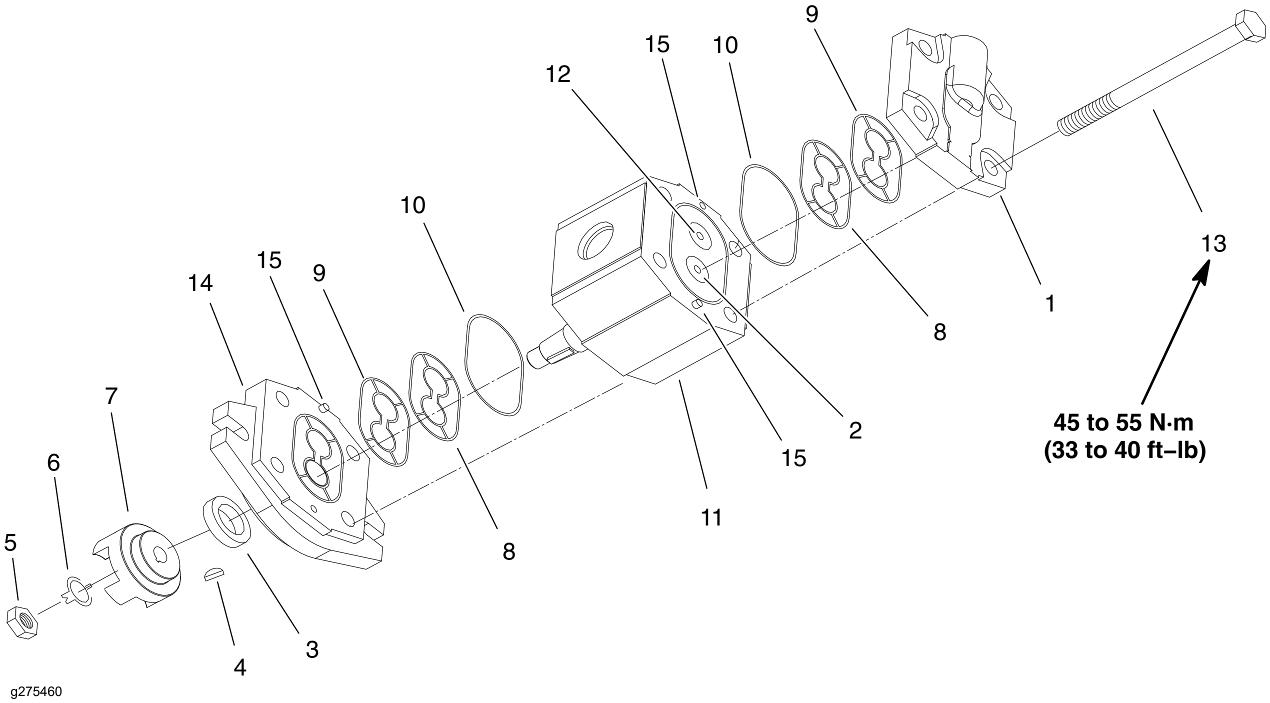


Figure 140

1. Rear cover	6. Tab washer	11. Body
2. Drive gear	7. Spider hub	12. Idler gear
3. Seal	8. Pressure seal	13. Cap screw (4 used)
4. Woodruff key	9. Back−up ring	14. Front flange
5. Nut	10. O−ring	15. Dowel pin

Note: Internal components for a cutting deck motor are not available separately. Disassemble motor for cleaning, inspection and seal replacement only.

Disassembly (Figure 140)

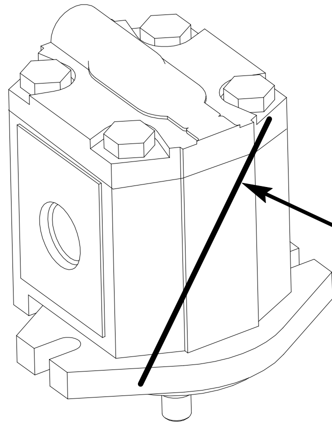
1. Plug motor ports and clean the outside of the motor thoroughly. After cleaning, remove plugs and drain any oil out of the motor.
2. Straighten tabs on tab washer to allow removal of nut from motor shaft. Remove tab washer, spider hub and woodruff key from motor.
3. Use a marker or scribe to make a diagonal mark across the front flange, body and rear cover for reassembly purposes (Figure 141).

IMPORTANT

Prevent damage when clamping the deck motor into a vise; clamp on the front flange only. Also, use a vise with soft jaws.

4. Clamp mounting flange of motor in a vise with the shaft end down.
5. Loosen cap screws on the rear cover.

Disassembly (Figure 140) (continued)



g275461

Figure 141

6. Take motor from the vise and remove cap screws.
7. Remove front flange from the body, then remove rear cover. Locate and remove dowel pins from body.

IMPORTANT

Mark the relative positions of the gear teeth and the bearing blocks so they can be reassembled in the same position. Do not touch the gear surfaces as residue on hands may be corrosive to gear finish.

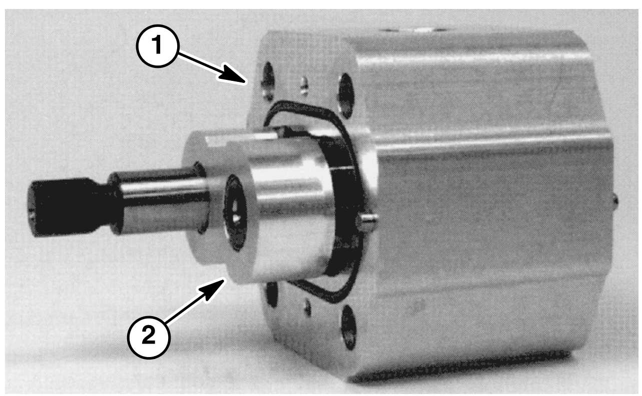


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Figure 142

1. Motor body
2. Bearing block & gear set

Disassembly (Figure 140) (continued)

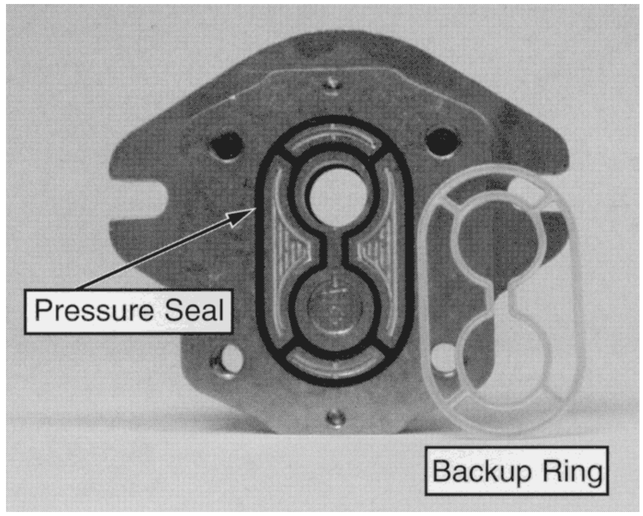

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Figure 143

8. Place the motor on its side and push on the rear bearing block to remove the bearing block and gear set (Figure 142).
9. Carefully remove and discard O−rings, pressure seals and back−up rings (Figure 143) from motor. Do not cause any damage to the machined grooves during the removal process.

IMPORTANT

Make sure not to damage the counter bore when removing the shaft seal from the front plate.

10. Position front flange with seal side up. Carefully remove shaft seal taking care to not damage seal bore.

Inspection

1. Remove any nicks and burrs from all motor components with emery cloth.

CAUTION

Use eye protection such as goggles when using compressed air.

2. Clean all motor components with solvent. Dry all parts with compressed air.

Inspection (continued)

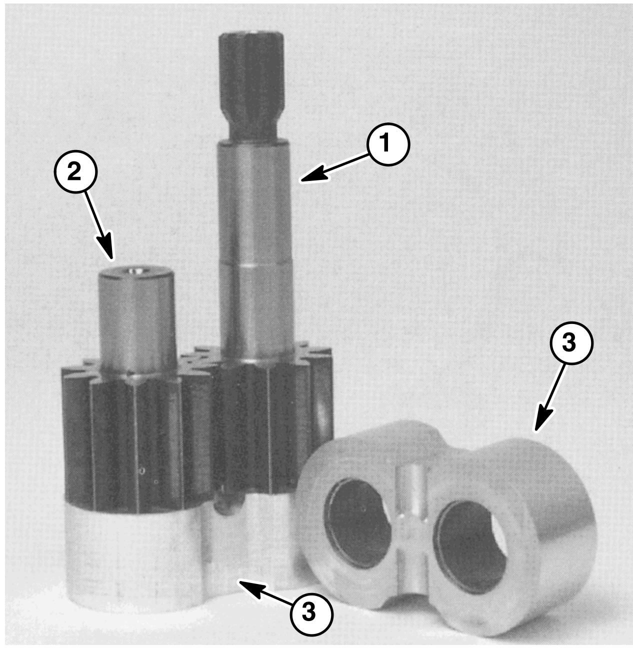

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Figure 144

1. Drive gear
2. Idler gear
3. Bearing block

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3. Inspect drive gear, idler gear and bearing blocks (Figure 144) for the following:
   A. Gear shafts should be free of rough surfaces and excessive wear at bushing points and sealing areas. Scoring, rough surfaces or wear on gear shafts indicates need for replacement.
   B. Gear teeth should be free of excessive scoring and wear. Any broken or nicked gear teeth must be replaced.
   C. Inspect gear face edge for sharpness. Sharp edges of gears will mill into bearing blocks and, thus, must be replaced.
   D. Bearing areas of bearing blocks should not have excessive wear or scoring.
   E. Face of bearing blocks that are in contact with gears should be free of wear, roughness or scoring.
4. Inspect front flange, body and rear cover for damage or wear.

Assembly (Figure 140)

Note: When assembling the motor, check the identification marks made during disassembly to make sure the parts are properly aligned during assembly.

1. Lubricate O−rings, pressure seals, back−up gaskets and seal grooves with a thin coat of petroleum jelly. Lubricate all other internal parts freely with clean hydraulic oil.
2. Install new shaft seal into front flange.
3. Install lubricated pressure seals into the grooves in the front flange and rear cover. Follow by carefully placing the back−up rings into the grooves.
4. Install new O−rings to the body.
5. Lubricate gear faces and bearing surfaces of drive gear, idler gear and bearing blocks. Carefully assemble bearing blocks and gears noting identification marks made during disassembly.

Assembly (Figure 140) (continued)

6. Position the motor body on its side. Carefully slide bearing block and gear assembly into the body cavity using identification marks made during disassembly.
7. Remove any excess lubrication from mating surfaces of body, rear cover and front flange. Make sure that these surfaces are clean and dry.
8. Install dowel pins in body.

IMPORTANT

Do not dislodge O−rings, pressure seals or back−up rings during final assembly.

9. Gently slide the rear cover onto the assembly using marker or scribe mark for proper location. Firm hand pressure should be sufficient to engage the dowel pins.
10. Position the motor with rear cover downwards. Carefully slide the front flange onto the assembly using marker or scribe mark for proper location.
11. Install the four (4) cap screws and hand tighten.

IMPORTANT

Prevent damage when clamping the deck motor into a vise; clamp on the front flange only. Also, use a vise with soft jaws.

12. Place motor front flange in a vise and alternately torque the screws from **45 to 55 N·m (33 to 40 ft−lb)**.
13. Put a small amount of hydraulic oil in port on motor and rotate driveshaft one revolution. Protect the shaft if using a pliers. If drive shaft binds, disassemble motor and repeat assembly process.
14. Make sure that tapered surface of motor shaft and spider hub are thoroughly clean.
15. Place woodruff key in motor shaft slot. Install spider hub and tab washer on shaft. Secure spider hub to shaft with nut. Torque nut from 27 to 33 ft–lb (37 to 45 N–m).
16. Secure nut to motor shaft by bending small tab of tab washer into keyway and large tab against nut.
17. Remove motor from vise.

Cutting Deck Motor Service (Casappa)

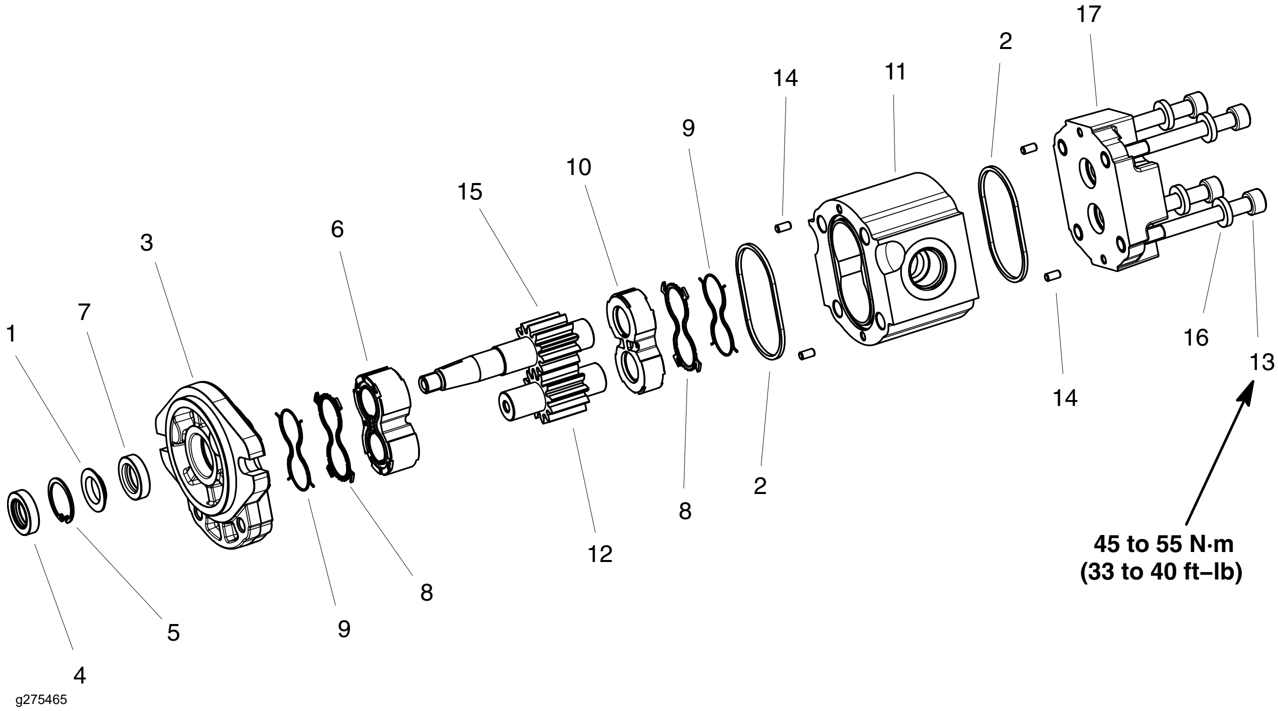

Figure 145

1. Flange washer
2. O−ring
3. Front flange
4. Dust seal
5. Retaining ring
6. Front wear plate
7. Shaft seal
8. Backup gasket
9. Pressure seal
10. Rear wear plate
11. Body
12. Idler gear
13. Cap screw (4 used)
14. Dowel (4 used)
15. Drive gear
16. Washer (4 used)
17. Rear cover

The Casappa cutting deck motors have similar construction as the cooling fan motor (also a Casappa brand) used on the Groundsmaster 4100−D and 4110−D. The deck motors have a separate rear cover (item 17 in Figure 145) which is a difference from the cooling fan motor which includes the rear cover with the motor body. Orientation of the dust seal (item 4 in Figure 145) is different in the deck motors than in the cooling fan motor.

For disassembly, inspection and assembly procedures of the Casappa cutting deck motors, refer to Engine Cooling Fan Motor Service (page 5–147). When installing the seals into the front flange in a cutting deck motor, use the orientation shown in Figure 146.

Cutting Deck Motor Service (Casappa) (continued)

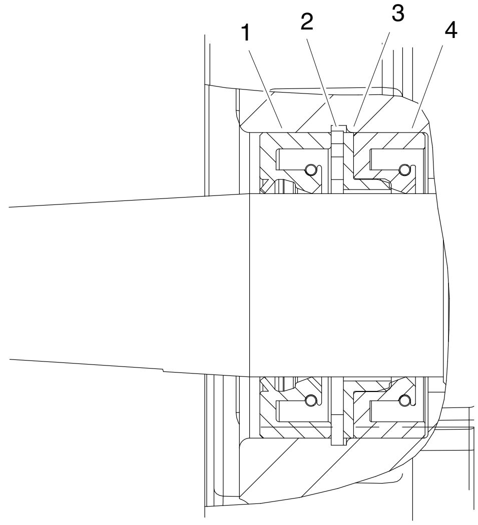

Figure 146

1. Dust seal
2. Retaining ring
3. Flange washer
4. Shaft seal

Note: Internal components for a cutting deck motor are not available separately. Disassemble motor for cleaning, inspection and seal replacement only.

PTO Manifold

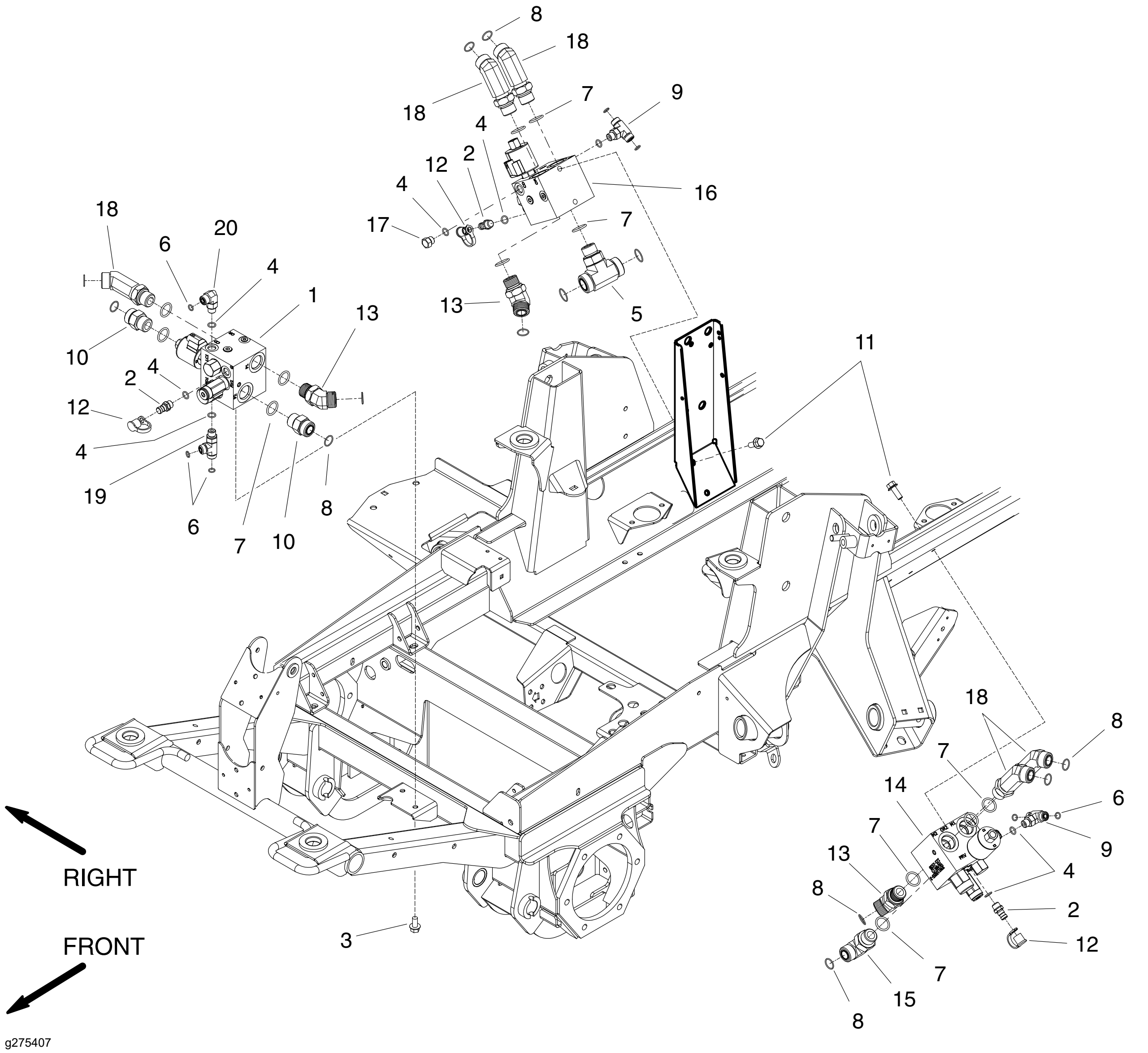

Figure 147

1. Hydraulic PTO manifold (center deck)
2. Quick fitting (1 used per manifold)
3. Flange screw (2 used per manifold)
4. O−ring
5. Hydraulic tee fitting
6. O−ring
7. O−ring
8. O−ring
9. Hydraulic adapter
10. Straight fitting
11. Flange screw (2 used per manifold)
12. Dust cap
13. 45º hydraulic fitting
14. Hydraulic PTO manifold (LH deck)
15. 90º hydraulic fitting
16. Hydraulic PTO manifold (RH deck)
17. Hex head plug
18. 45º hydraulic fitting
19. Hydraulic tee fitting
20. 90º hydraulic fitting

Note: The ports on the manifold are marked for easy identification of components. Example: PRV is the proportional relief valve and P1 is a gear pump connection port (see A Hydraulic Schematic (page A–5) to identify the function of the hydraulic lines and cartridge valves at each port).

Removal (Figure 147)

1. Read the General Precautions for Removing and Installing Hydraulic System Components (page 5–83).
2. To prevent contamination of hydraulic system during manifold removal, thoroughly clean exterior of PTO manifold and fittings.
3. Disconnect wire harness connector from the proportional relief valve coil on the PTO manifold.
4. Disconnect hydraulic lines from manifold and put caps or plugs on open hydraulic lines and fittings. Label disconnected hydraulic lines for proper installation.

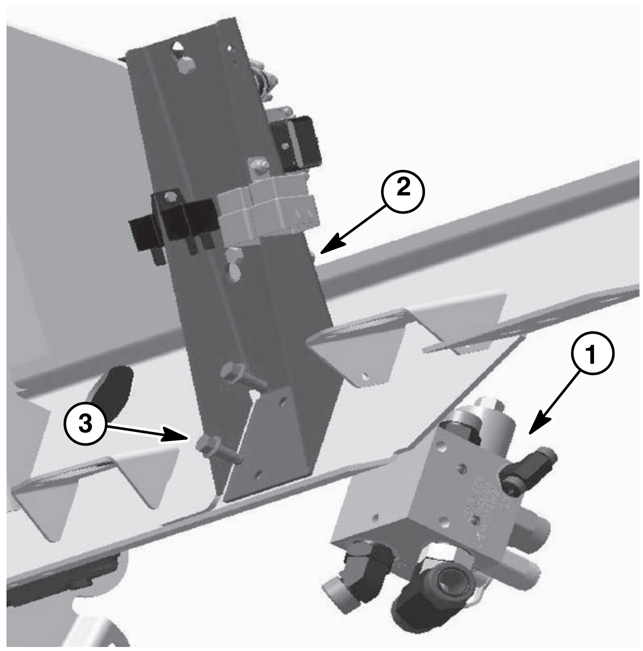

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Figure 148

1. RH PTO manifold
2. Controller mount
3. Flange screw (2 used)

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5. Remove PTO manifold from the frame using Figure 147 as a guide.

   Note: The flange head screws that secure the right side PTO manifold also secures the controller mount to the frame (Figure 148). Support controller mount before removing the right side PTO manifold.

6. If hydraulic fittings are to be removed from manifold, mark fitting orientation to allow correct assembly. Remove fittings from manifold and discard O−rings.

Installation (Figure 147)

1. If fittings were removed from manifold, lubricate and place new O−rings onto fittings. Install fittings into manifold openings using marks made during the removal process to properly orientate fittings. Tighten fittings (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–8)).
2. Install PTO manifold to the frame using Figure 147 as a guide.

   Note: Make sure that the controller mount is secured when installing the right side PTO manifold (Figure 148).
3. Remove caps and plugs from fittings and hoses. Using labels placed during manifold removal, properly connect hydraulic lines to manifold (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–8)).
4. Connect wire harness connector to the proportional relief valve coil on the PTO manifold.
5. Make sure hydraulic tank is full. Add correct oil if necessary before returning machine to service.

PTO Manifold Service

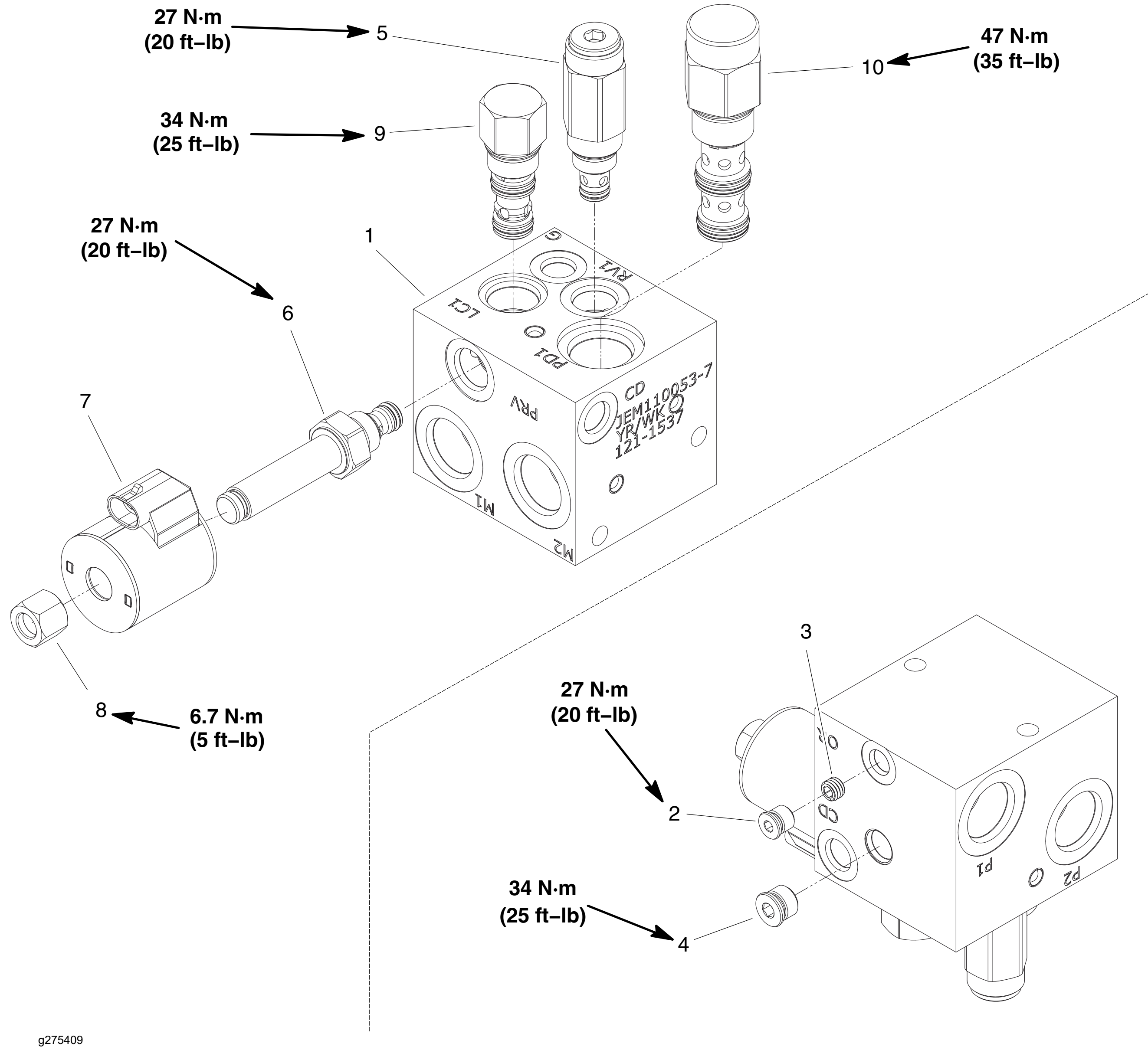


Figure 149

1.	PTO manifold body	5.	Relief valve (port RV1)	9.	Logic cartridge valve (port LC1)
2.	NWD SAE #4 plug with O−ring	6.	Proportional relief valve (port PRV)	10.	Pilot directional valve (port PD1)
3.	Orifice (0.025) (port OR)	7.	Solenoid coil		
4.	6 zero leak plug with O−ring	8.	Nut		

Note: The ports on the manifold are marked for easy identification of components. Example: RV is the relief valve port and P1 is the gear pump connection port (see A Hydraulic Schematic (page A–5) to identify the function of the hydraulic lines and cartridge valves at each port location).

The manifolds for the three (3) cutting decks are very similar. The front and right side PTO manifolds are identical. The left side PTO manifold uses the same cartridges and plugs as the front and right side manifolds but also includes an additional orifice that threads into the manifold OR2 port (Figure 150). NOTE: When servicing the PTO manifolds, DO NOT interchange parts from one manifold to another.

Note: The PTO manifold assembly includes zero leak plugs. These plugs have a tapered sealing surface on the plug head that is designed to resist vibration induced plug loosening. The zero leak plugs also have an O−ring as a secondary seal. If zero leak plug removal is necessary, lightly rap the plug head using a punch and hammer before using an allen wrench to remove the plug: the impact will allow plug removal with less chance of damage to the socket head of the plug.

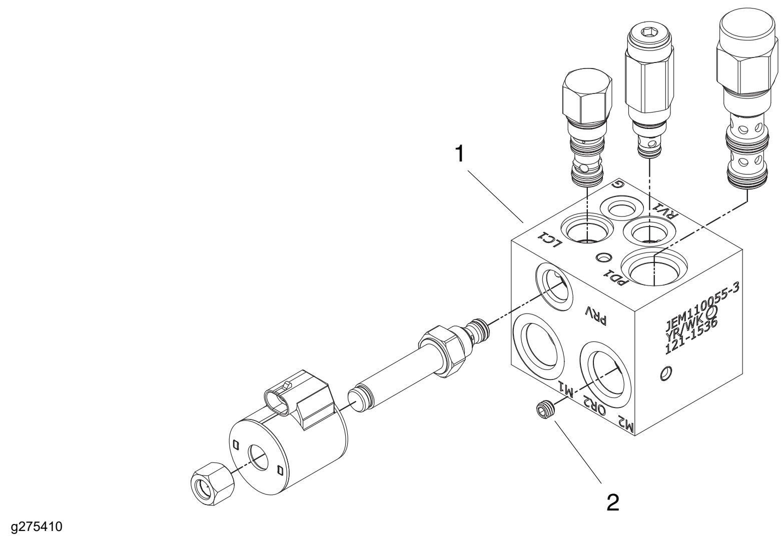


Figure 150

1. LH PTO manifold
2. Orifice (OR2 port)

PTO Manifold Service (Figure 149)

For PTO manifold solenoid and control valve service procedures, see Control Manifold Cartridge Valve Service (page 5–128). Refer to Figure 149 for PTO manifold cartridge valve and plug installation torque.

Center Deck Lift Cylinders

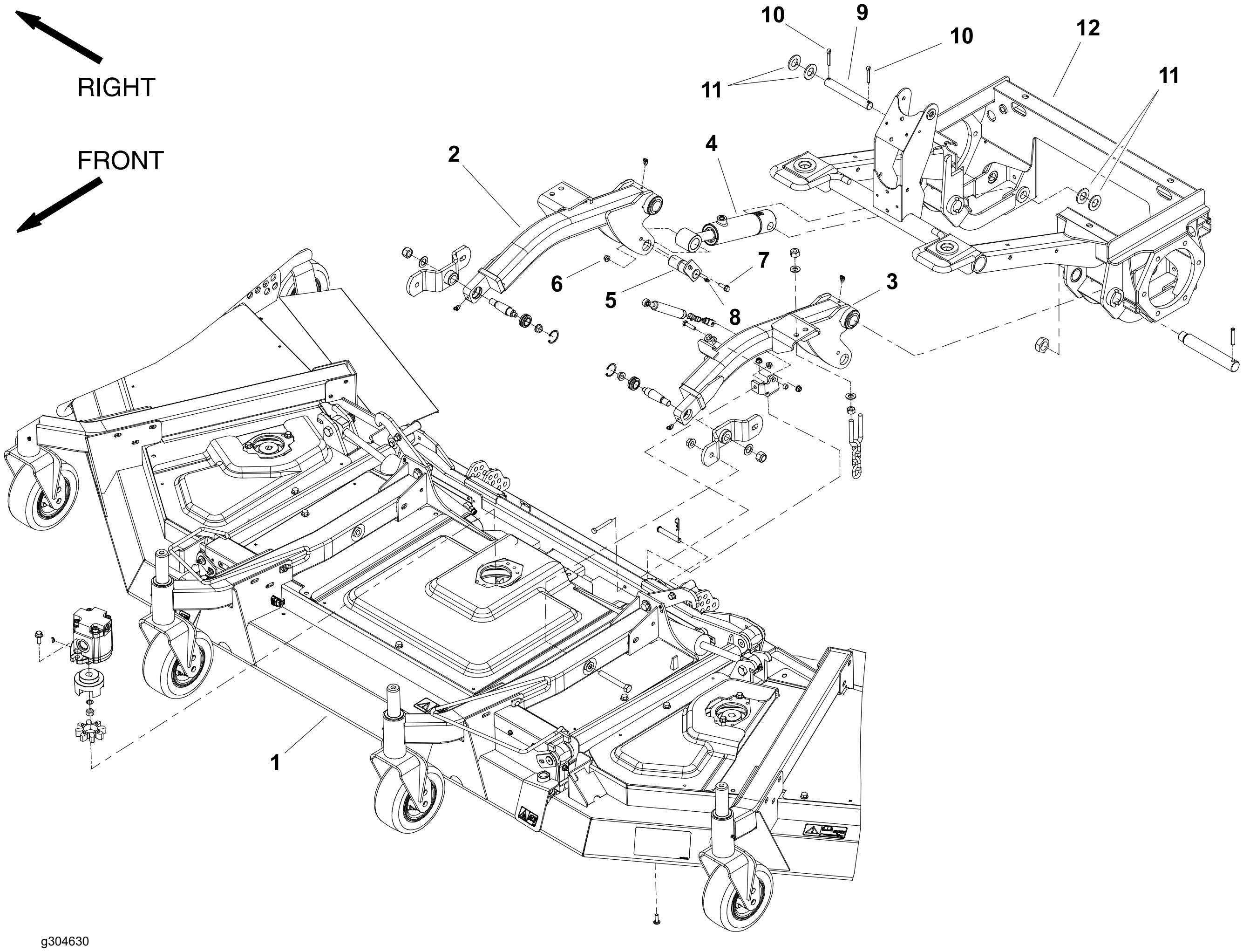


Figure 151

1. Cutting deck
2. RH lift arm
3. LH lift arm
4. Lift cylinder (2 used)
5. Pin (1 used per cylinder)
6. Flange nut (1 used per pin)
7. Cap screw (1 used per pin)
8. Grease fitting (1 used per pin)
9. Clevis pin (1 used per cylinder)
10. Cotter pin (2 used per clevis pin)
11. Flat washer (4 used per clevis pin)
12. Front frame

Removal (Figure 151)

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the key switch.
2. Read the General Precautions for Removing and Installing Hydraulic System Components (page 5–83).
3. To prevent contamination of hydraulic system during lift cylinder removal, thoroughly clean exterior of cylinder and fitting.

WARNING

Make sure that front cutting deck is fully lowered before loosening hydraulic lines from center deck lift cylinders. If deck is not fully lowered as hydraulic lines are loosened, deck may drop unexpectedly.

Removal (Figure 151) (continued)

Note: To ease installation, label the hydraulic hoses to show their correct position on the lift cylinder.

4. Disconnect hydraulic lines from lift cylinder and put caps or plugs on open hydraulic lines and fittings. Label disconnected hydraulic lines for proper installation.
5. Support lift cylinder to prevent it from falling.
6. Remove cap screw and flange nut that secure the pin (item 5) to the lift arm. Remove pin from lift arm and cylinder shaft clevis which will free lift cylinder from lift arm.
7. Remove one (1) cotter pin and two (2) flat washers from clevis pin (item 9) that secures lift cylinder to front frame. Pull clevis pin from frame and cylinder barrel clevis.
8. Remove lift cylinder from machine.
9. If hydraulic fittings are to be removed from lift cylinder, mark fitting orientation to allow correct assembly. Remove fittings from cylinder and discard O-rings (Figure 152).

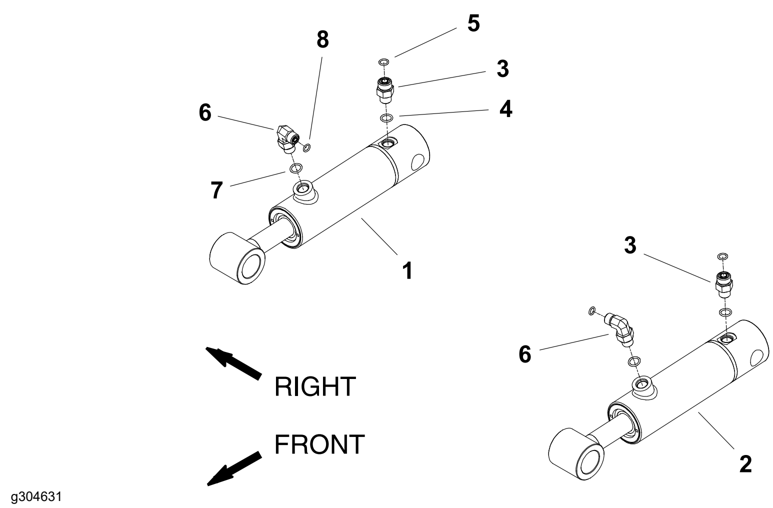


Figure 152

1. RH lift cylinder	5. O-ring
2. LH lift cylinder	6. 90º fitting
3. Straight fitting	7. O-ring
4. O-ring	8. O-ring

Installation (Figure 151)

1. If fittings were removed from lift cylinder, lubricate and place new O-rings onto fittings. Install fittings into cylinder port openings using marks made during the removal process to properly orientate fittings (Figure 152). Tighten fitting (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–8)).
2. Make sure that cotter pin and two (2) flat washers are installed on one end of clevis pin (item 9).
3. Position lift cylinder barrel clevis to front frame and insert clevis pin into frame and clevis. Secure clevis pin with two (2) flat washers and one (1) cotter pin.
4. Insert pin (item 5) through lift arm and cylinder shaft clevis. Secure pin to lift arm with cap screw and flange nut.

Installation (Figure 151) (continued)

5. Remove caps and plugs from fittings and hydraulic lines. Using labels placed during cylinder removal, properly attach hydraulic hose to lift cylinder (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–8)).
6. Lubricate lift cylinder grease fittings.
7. Fill reservoir with hydraulic fluid as required.
8. After assembly is completed, operate lift cylinders to verify that hydraulic hoses and fittings are not contacted by anything.

Wing Deck Lift Cylinders

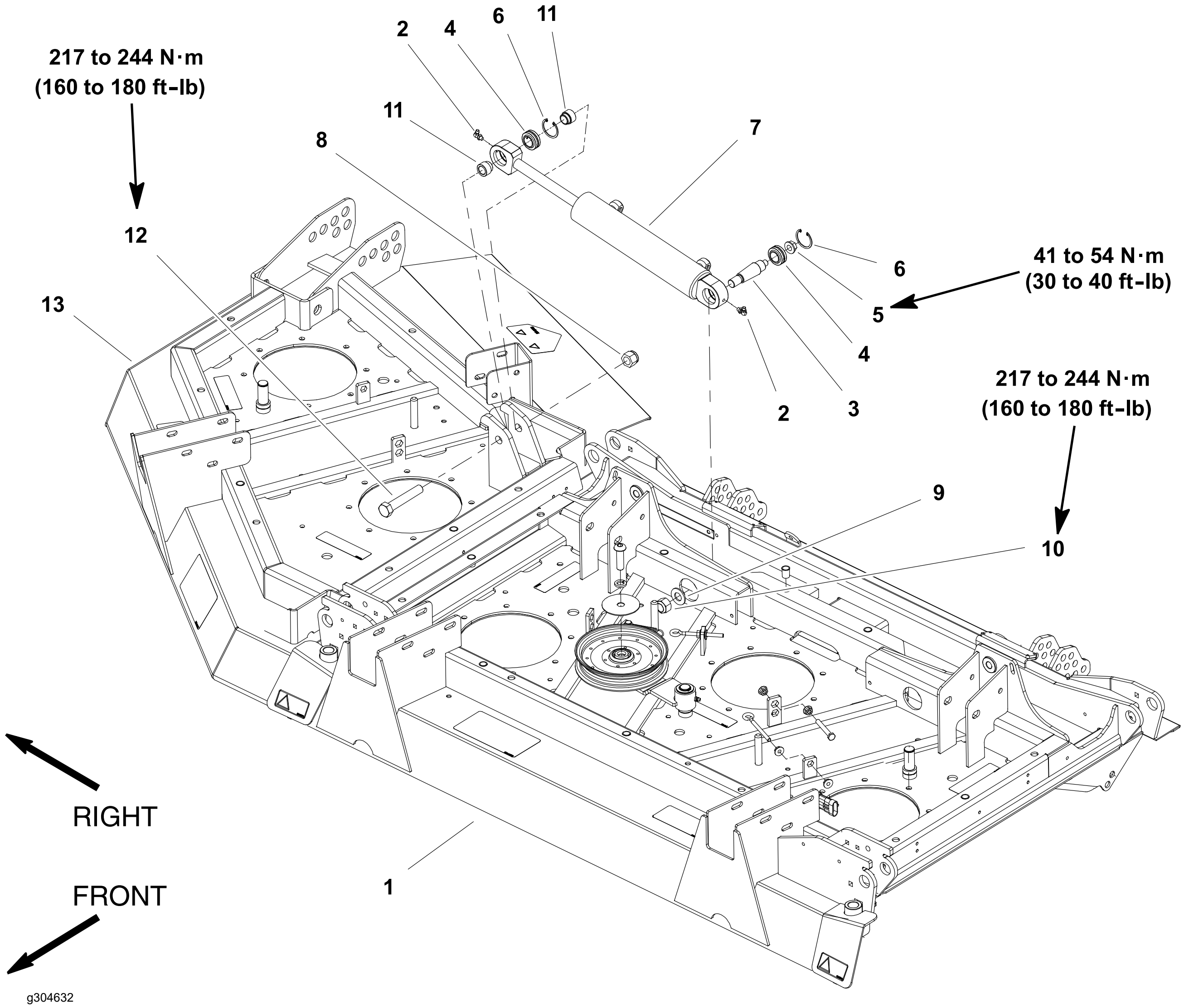


Figure 153

1. Center deck
2. Grease fitting
3. Tapered stud
4. Spherical bearing
5. Flange nut
6. Retaining ring
7. Wing deck lift cylinder
8. Lock nut
9. Flat washer
10. Lock nut
11. Pilot spacer
12. Cap screw
13. Wing deck (RH shown)

Removal (Figure 153)

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the key switch.
2. Read the General Precautions for Removing and Installing Hydraulic System Components (page 5–83).

Removal (Figure 153) (continued)

WARNING

Make sure that side cutting deck is fully lowered before loosening hydraulic lines from side deck lift cylinder. If deck is not fully lowered as hydraulic lines are loosened, deck may drop unexpectedly.

3. Remove deck covers as needed to allow access to lift cylinder hoses and fasteners.
4. To prevent contamination of hydraulic system during lift cylinder removal, thoroughly clean exterior of cylinder and hose fittings.

   Note: To ease installation, label the hydraulic hoses to show their correct position on the lift cylinder.
5. Disconnect hydraulic hoses from lift cylinder and put caps or plugs on open hydraulic hoses and fittings. Label disconnected hydraulic hoses for proper installation.
6. Remove cap screw and lock nut that secure the lift cylinder clevis to the wing deck.
7. Remove lock nut and flat washer from the tapered stud on the barrel end of the lift cylinder.
8. Remove lift cylinder from deck assembly.
9. Remove spherical bearings from lift cylinder clevis ends, if required.
   A. On shaft clevis, remove retaining ring and then press spherical bearing from clevis.
   B. On barrel clevis, remove retaining ring and then press tapered stud with spherical bearing and flange nut from clevis. Remove flange nut and then spherical bearing from stud.

Installation (Figure 153)

1. If removed, install spherical bearings into lift cylinder clevis ends.
   A. On shaft clevis, press spherical bearing into clevis and secure with retaining ring.
   B. On barrel clevis, install spherical bearing on tapered stud and secure with flange nut. Torque flange nut from **41 to 54 N·m (30 to 40 ft-lb)**. Install stud with spherical bearing into clevis and secure with retaining ring.
2. Thoroughly clean tapered surfaces of lift cylinder stud and mounting boss on deck.
3. Position lift cylinder to cutting deck. Insert tapered stud into deck mounting boss. Secure stud with flat washer and lock nut. Torque flange nut from **217 to 244 N·m (160 to 180 ft-lb)**.
4. Insert cap screw from the front of the deck through the deck brackets and cylinder shaft clevis. Secure cap screw with lock nut. Torque lock nut from **217 to 244 N·m (160 to 180 ft-lb)**.
5. Remove caps and plugs from fittings and hydraulic hoses. Using labels placed during cylinder removal, properly attach hydraulic hoses to lift cylinder (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–8)).
6. Install all removed deck covers.

Installation (Figure 153) (continued)

7. Fill reservoir with hydraulic fluid as required.
8. After installation is completed, operate lift cylinder to verify that lift cylinder, hydraulic hoses and fittings are not contacted by anything.

Lift Cylinder Service

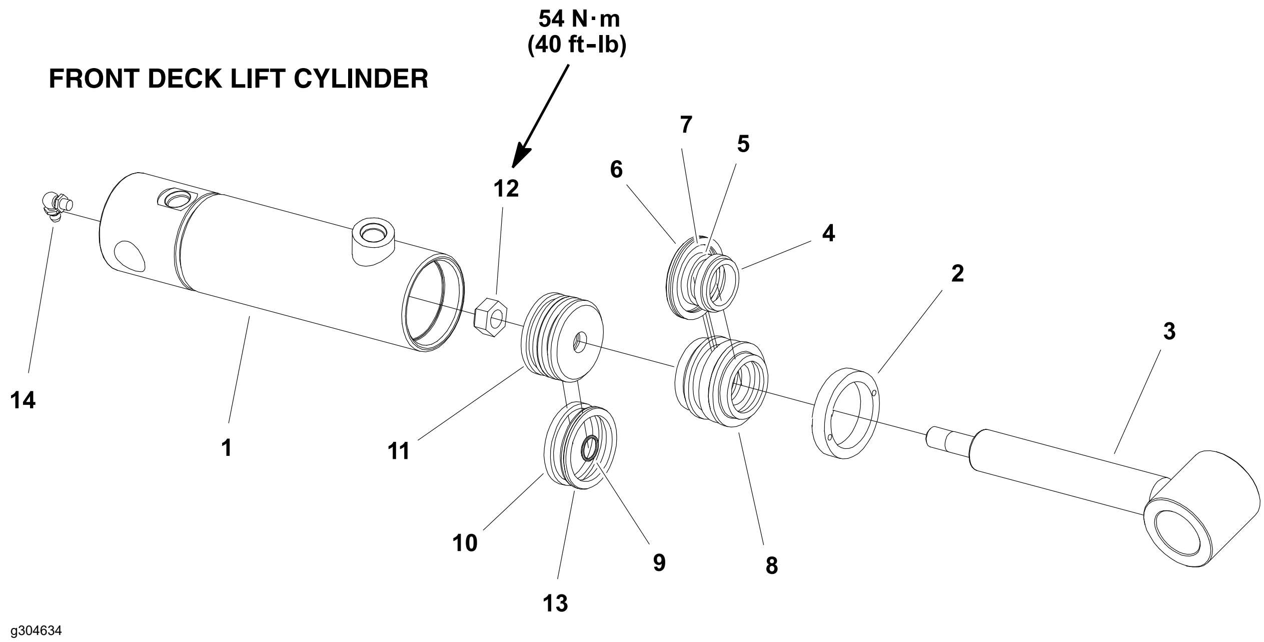


Figure 154

1. Barrel with clevis
2. Internal collar
3. Shaft with clevis
4. Dust seal
5. Rod seal
6. O-ring
7. Back-up ring
8. Head
9. O-ring
10. Wear ring
11. Piston
12. Lock nut
13. Piston seal
14. Grease fitting

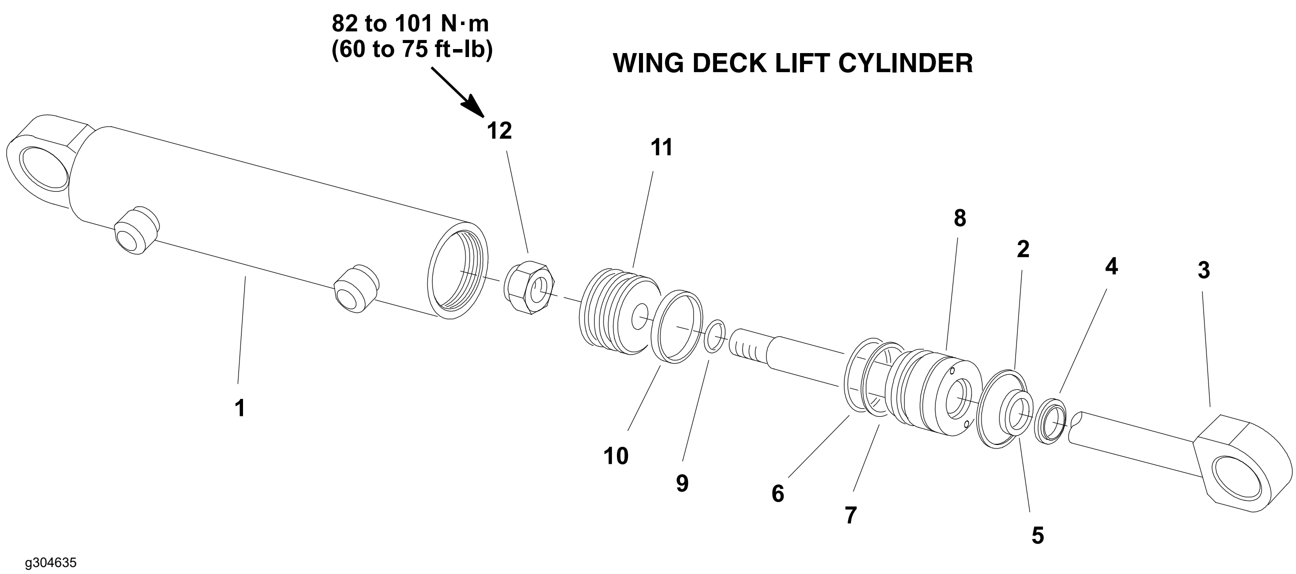


Figure 155

1. Barrel with clevis
2. Retaining ring
3. Shaft with clevis
4. Dust seal
5. Rod seal
6. O-ring
7. Back-up ring
8. Head
9. O-ring
10. Seal with O-ring
11. Piston
12. Lock nut

Disassembly (Figure 154 and Figure 155)

1. Remove oil from lift cylinder into a drain pan by slowly pumping the cylinder shaft. Plug both ports and clean the outside of the cylinder.

IMPORTANT

Prevent damage when clamping the cylinder in a vise; clamp on the clevis only.

2. Mount lift cylinder securely in a vise by clamping on the clevis end of the barrel. Use of a vise with soft jaws is recommended.
3. For front deck lift cylinder, use a spanner wrench to loosen and remove internal collar (item 2 in Figure 154) from barrel.
4. For wing deck lift cylinder, loosen head from barrel as follows:
   A. Use a spanner wrench to rotate head clockwise until the edge of the retaining ring appears in the barrel opening.
   B. Insert a screwdriver under the beveled edge of the retaining ring to start the retaining ring through the opening.
   C. Rotate the head counter-clockwise to remove retaining ring from barrel and head.
5. Extract shaft with head and piston by carefully twisting and pulling on the shaft.

IMPORTANT

Do not clamp vise jaws against the shaft surface.

6. Mount shaft securely in a vise by clamping on the clevis of the shaft. Remove lock nut and then slide piston and head off the shaft. For front deck lift cylinder, remove internal collar from shaft.
7. Remove and discard all seals and O−rings from the piston and the head.

CAUTION

Use eye protection such as goggles when using compressed air to dry cylinder components.

8. Wash cylinder parts in clean solvent. Dry parts with compressed air. Do not wipe parts dry with paper towels or cloth. Lint in a hydraulic system will cause damage.
9. Carefully inspect internal surface of barrel for damage (deep scratches, out-of-round, etc.). Inspect shaft and piston for evidence of excessive scoring, pitting or wear. Replace lift cylinder if internal components are found to be worn or damaged.

Assembly (Figure 154 and Figure 155)

1. Make sure all cylinder components are clean before assembly.
2. Coat new seal kit components with clean hydraulic oil.
   A. Install new seals and O-rings to the piston.
   B. Install new seals, O-ring and back-up ring to the head.

Assembly (Figure 154 and Figure 155) (continued)

IMPORTANT

Do not clamp vise jaws against the shaft surface.

3. Mount shaft securely in a vise by clamping on the clevis of the shaft.
   A. Coat shaft with clean hydraulic oil.
   B. For front deck lift cylinder, slide internal collar onto shaft.
   C. Carefully slide head and then piston onto the shaft. Secure piston to shaft with lock nut.
   D. Torque lock nut to specification in Figure 154 (front deck lift cylinder) or Figure 155 (wing deck lift cylinder).
4. Lubricate head and piston with clean hydraulic oil. Carefully slide shaft assembly into cylinder barrel.

IMPORTANT

Prevent damage when clamping the hydraulic cylinder into a vise; clamp on the clevis end of the barrel ONLY

5. Mount lift cylinder in a vise with soft jaws by clamping on the clevis end of the barrel.
6. For front deck lift cylinder, use a spanner wrench to install and tighten internal collar (item 2 in Figure 154) into barrel.
7. For wing deck lift cylinder, secure head in barrel as follows:
   A. Align retaining ring hole in the head with the access slot in the barrel.
   B. Insert the retaining ring hook into the hole and rotate head clockwise until the retaining ring is completely pulled into the barrel and the ring ends are covered.
   C. Apply silicone sealer to barrel access slot.

Chapter 6

Electrical System

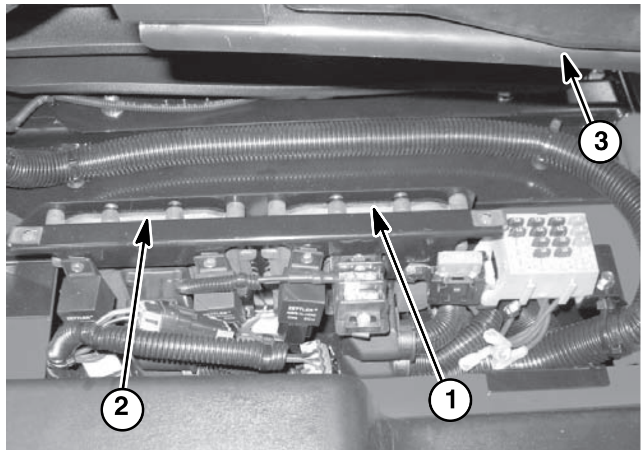
Table of Contents

General Information

Operator's Manual

The *Operator's Manual* provides information regarding the operation, general maintenance, and maintenance intervals for your Greensmaster machine. Refer to the *Operator's Manual* for additional information when servicing the machine.

Toro Electronic Controllers (TEC)



g275690

Figure 156

1. Front TEC controller
2. Rear TEC controller
3. Operator seat

Toro Electronic Controllers (TEC) (continued)

Groundsmaster 4100−D and 4110−D machines use two (2) Toro Electronic Controllers (TEC) to manage machine electrical functions. The controllers are microprocessor controlled that sense the condition of various switches and sensors (inputs). The controllers then direct electrical power to control appropriate machine functions (outputs) based on the input state. Communication between the two (2) TEC controllers, the Yanmar engine electronic control unit (ECU) and the machine InfoCenter Display is provided with a CAN−bus system. The status of inputs to the controllers as well as outputs from the controllers can be monitored with the InfoCenter Display.

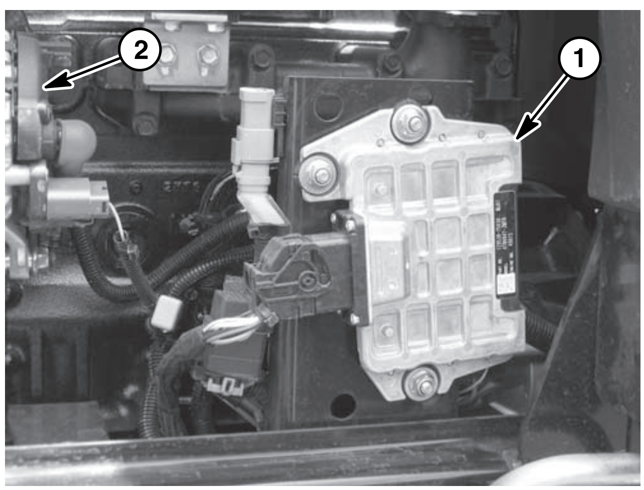
The TEC controllers are attached to the machine under the power center cover next to the operator seat. The TEC controllers are visually identical but they have different software and therefore cannot be interchanged.

IMPORTANT

To prevent machine electrical system damage while welding on the machine, disconnect the battery cables from the batteries, disconnect the wire harness connectors from both Toro Electronic Controllers, disconnect the wire harness connectors from the engine electronic control unit and disconnect the terminal connector from the alternator. Also, disconnect and remove the engine ECU from the machine before welding.

If the wire harness connector is removed from the TEC controller for any reason, tighten the harness connector screw from **2.8 to 3.2 N·m (25 to 28 in-lb)**.

Yanmar Engine Electronic Control Unit (ECU)

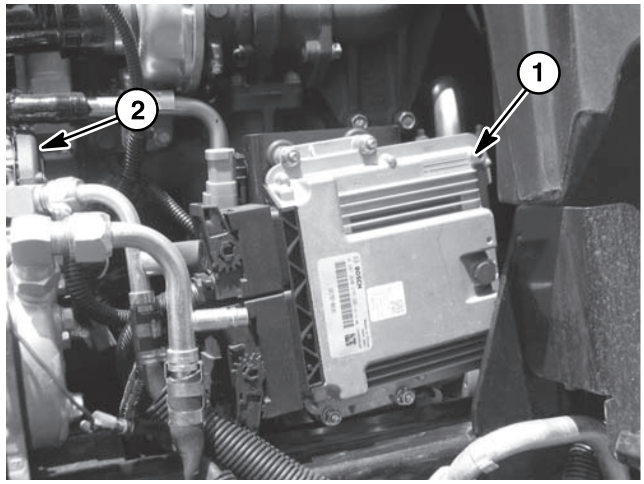


g275700

Figure 157

1. Electronic control unit (model 30602 / 30604 / 30643)
2. Alternator

Yanmar Engine Electronic Control Unit (ECU) (continued)



g275701

Figure 158

1. Electronic control unit (model 30606 / 30608 / 30644)
2. Alternator

The Yanmar engine that powers the Groundsmaster 4100−D and 4110−D uses an electronic control unit (ECU) for engine management and also to communicate with the TEC controllers and the InfoCenter Display on the machine. All engine ECU electrical connectors should be plugged into the controller before the machine key switch is moved from the OFF position to either the RUN or START position. If the engine ECU is to be disconnected for any reason, make sure that the key switch is in the OFF position with the key removed for a minimum of thirty (30) seconds before disconnecting the engine ECU. See Engine Electronic Control Unit (ECU) (page 4–3) for additional engine ECU information.

Yanmar Engine Electrical Components

When servicing or troubleshooting the engine electrical components, use the correct engine service manual and troubleshooting manual. Also, the Yanmar SMARTASSIST− Direct electronic control diagnostics service system is available to support the error diagnosis and maintenance services of engine electrical control devices.

CAN−bus Communications

The two (2) TEC controllers, the Yanmar engine electronic control unit and the InfoCenter Display used on the Groundsmaster 4100−D and 4110−D communicate with each other on a CAN−bus system. Using this system allows the traction unit to fully integrate all the different electrical components of the tractor. The CAN−bus system reduces the number of electrical components and connections used on the machine and allows the number of wires in the wire harness to be significantly reduced. The integration of electrical functions also allows the InfoCenter Display to assist with electrical system diagnostics.

CAN identifies the Controller Area Network that is used between the controllers on the Groundsmaster. Two (2) specially designed, twisted wires form the bus. These wires provide the data pathways between the controllers (the TEC controllers and the Yanmar electronic control unit) and the InfoCenter Display used on the machine. The engineering term for these wires are CAN High and CAN Low. At the ends of the twisted pair of bus wires are 120 ohm termination resistors. One of these resistors is included in the wire harness and the second is inside the engine ECU.

Each of the components that is controlled by the CAN− bus link needs only four (4) wires to operate and communicate to the system: CAN High, CAN Low, B+ (power) and ground. The CAN−bus needs the key switch ON input for both the TEC and engine ECU to be activated.

Electrical Drawings

The electrical schematics and wire harness drawings for Groundsmaster 4100−D and 4110−D machines are located in Appendix A (page A–1).

InfoCenter Display

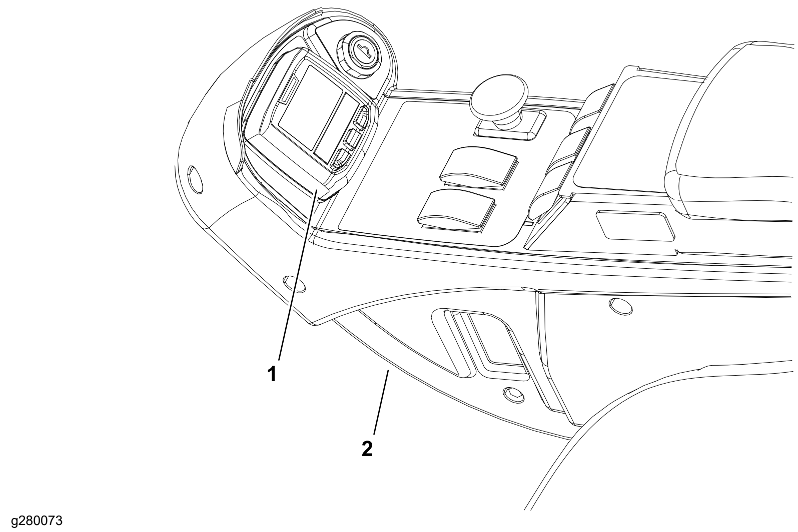


Figure 159

1. InfoCenter display
2. Control arm

The InfoCenter Display used on your Groundsmaster is a LCD device that is located on the console. The InfoCenter provides information for the machine operator during machine operation, provides electrical system diagnostic assistance for technicians and allows inputs for adjustable machine settings.

Power for the InfoCenter is available when energized by the main power relay (key switch in the RUN or START position). A CAN−bus system involving the machine TEC controllers, the Yanmar engine electronic control unit and the InfoCenter is used to provide necessary machine communication for InfoCenter operation.

Note: Icons that are used on the InfoCenter display are identified in the Traction Unit *Operator's Manual*.

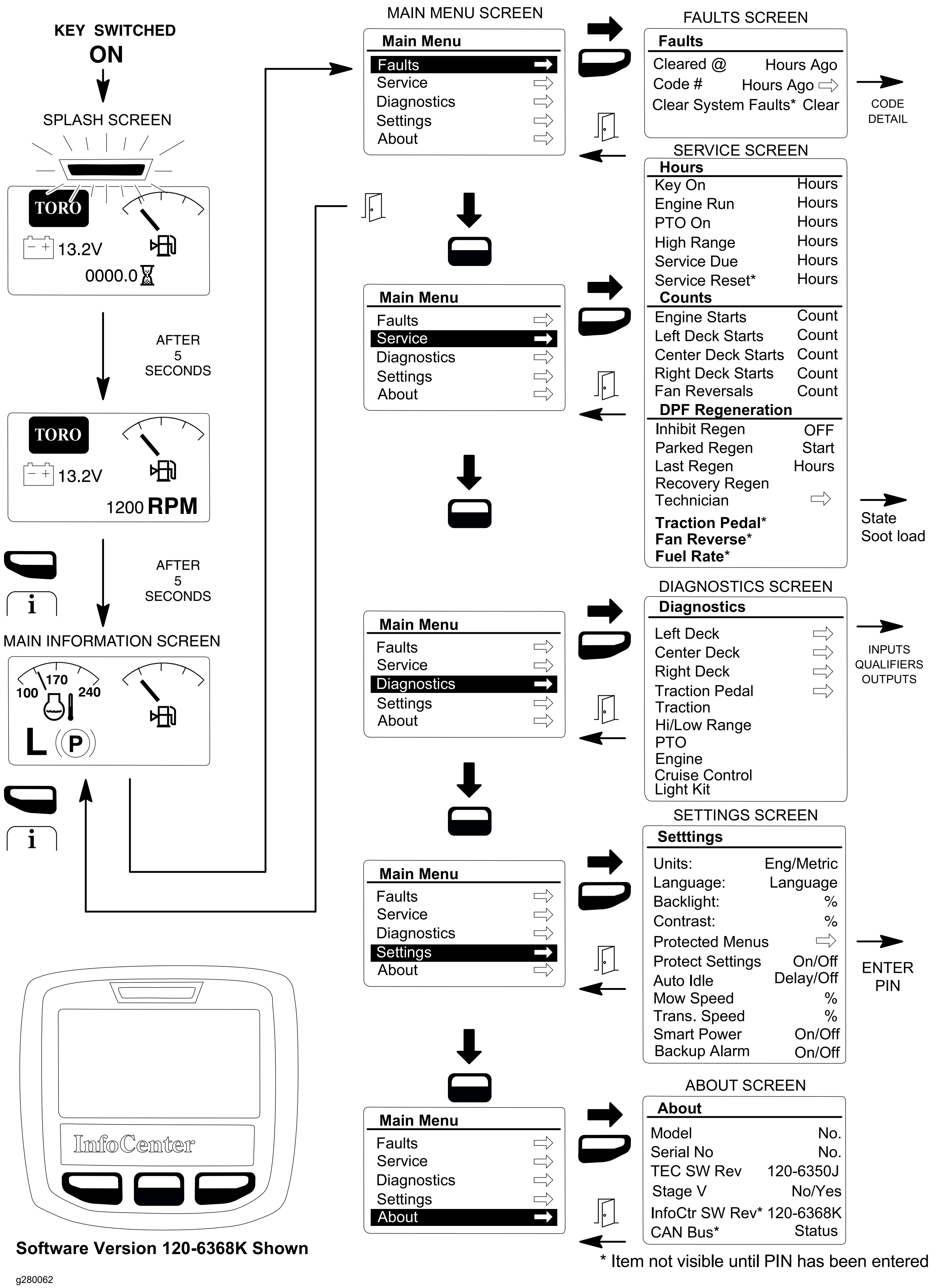
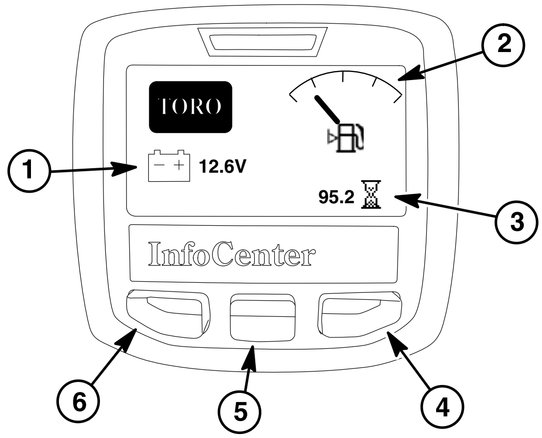

KEY SWITCHED
ON
SPLASH SCREEN
TORO
13.2V
0000.0
AFTER 5 SECONDS
TORO
13.2V
1200 RPM
AFTER 5 SECONDS
MAIN INFORMATION SCREEN
100
170
240
L
P
InfoCenter
MAIN MENU SCREEN
Main Menu
Faults
Service
Diagnostics
Settings
About
FAULTS SCREEN
Faults
Cleared @ Hours Ago
Code # Hours Ago
Clear System Faults* Clear
CODE DETAIL
SERVICE SCREEN
Hours
Key On Hours
Engine Run Hours
PTO On Hours
High Range Hours
Service Due Hours
Service Reset* Hours
Counts
Engine Starts Count
Left Deck Starts Count
Center Deck Starts Count
Right Deck Starts Count
Fan Reversals Count
DPF Regeneration
Inhibit Regen OFF
Parked Regen Start
Last Regen Hours
Recovery Regen
Technician
State
Soot load
Traction Pedal*
Fan Reverse*
Fuel Rate*
DIAGNOSTICS SCREEN
Diagnostics
Left Deck
Center Deck
Right Deck
Traction Pedal
Traction
Hi/Low Range
PTO
Engine
Cruise Control
Light Kit
INPUTS
QUALIFIERS
OUTPUTS
SETTINGS SCREEN
Setttings
Units: Eng/Metric
Language: Language
Backlight: %
Contrast: %
Protected Menus
Protect Settings On/Off
Auto Idle Delay/Off
Mow Speed %
Trans. Speed %
Smart Power On/Off
Backup Alarm On/Off
ENTER PIN
ABOUT SCREEN
About
Model No.
Serial No No.
TEC SW Rev 120-6350J
Stage V No/Yes
InfoCtr SW Rev* 120-6368K
CAN Bus* Status
* Item not visible until PIN has been entered
Software Version 120-6368K Shown
g280062

Figure 160

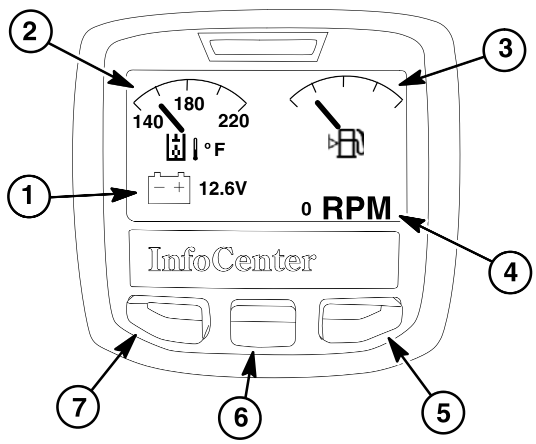
Splash Screen



g275702

Figure 161

1. Battery voltage
2. Fuel gauge
3. Hour meter
4. Right button
5. Down button
6. Menu/back button



g275703

Figure 162

1. Battery voltage
2. Hydraulic oil temperature
3. Fuel gauge
4. Engine RPM
5. Right button
6. Down button
7. Menu/back button

The two (2) InfoCenter splash screens (Figure 161 and Figure 162) are displayed when the key switch is initially turned to the RUN or START position. The splash screens allow basic machine information to be reviewed by the operator. After each of the splash screens has been on the InfoCenter for several seconds, the main information screen will be displayed on the InfoCenter.

The splash screens can be used to identify machine battery voltage, fuel level, hour meter reading, hydraulic oil temperature and engine status.

Main Information Screen

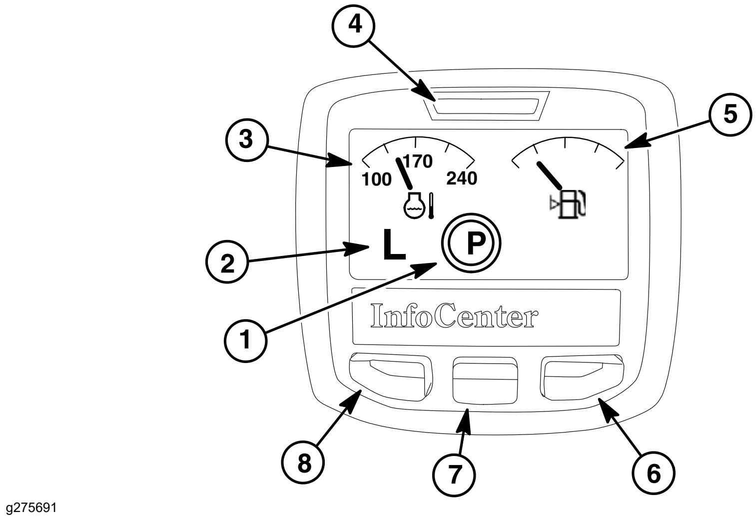


Figure 163

1. Parking brake applied
2. Traction speed
3. Coolant temperature
4. Fault indicator
5. Fuel gauge
6. Right button
7. Down button
8. Menu/back button

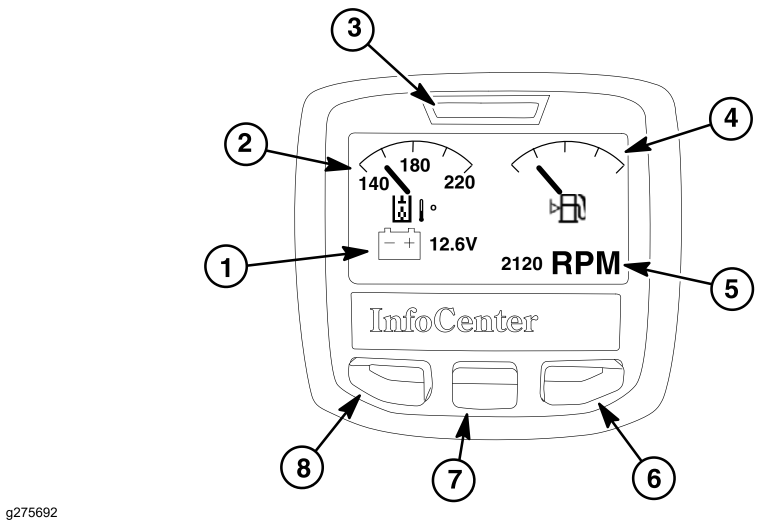


Figure 164

1. Battery voltage
2. Hydraulic oil temperature
3. Fault indicator
4. Fuel gauge
5. Engine RPM
6. Right button
7. Down button
8. Menu/back button

The two (2) InfoCenter main information screens (Figure 163 and Figure 164) are displayed after the initial splash screen has been displayed for several seconds. During normal machine operation, the main information screens provide machine information for the operator. Toggling between the main information screens is done by pressing the right button on the InfoCenter.

The main information screens can be used to monitor engine coolant temperature, fuel level, hydraulic oil temperature, battery voltage, engine RPM and traction speed range. The screens will also identify if the parking brake is applied, if the PTO is engaged or if the cruise control is activated.

Main Information Screen (continued)

The main information screens will also display arrows whenever the cutting decks are either raising (up arrows) or lowering (down arrows).

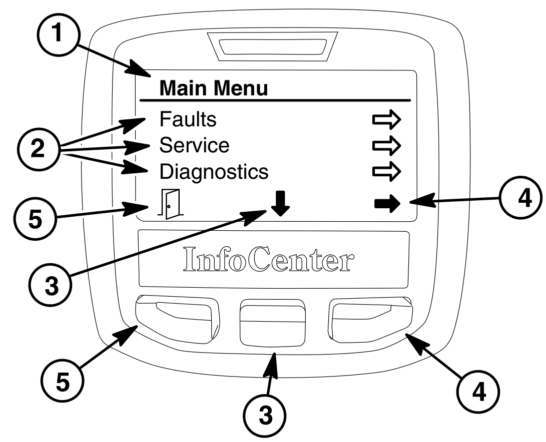
If controls are not selected properly to allow certain machine operations, an advisory will be displayed on the InfoCenter Display. Typically, an advisory can be eliminated with a change in controls by the operator.

If a machine fault occurs during machine operation, the InfoCenter fault indicator will blink to notify the operator. Accessing the fault log is described below in Faults Screen.

If an electrical engine fault occurs during machine operation, the fault will be displayed on the InfoCenter to notify the operator. The engine fault will be retained in the engine ECU and can be viewed using the engine diagnostic tool. Engine faults are not stored in the TEC controller so they cannot be viewed using the InfoCenter Faults Screen.

The main menu and additional information screens can be accessed from the InfoCenter main information screen by pressing and releasing the menu/back button (left button) on the display. Information on the main menu and menu item screens is included below.

Main Menu Screen



g275693

Figure 165

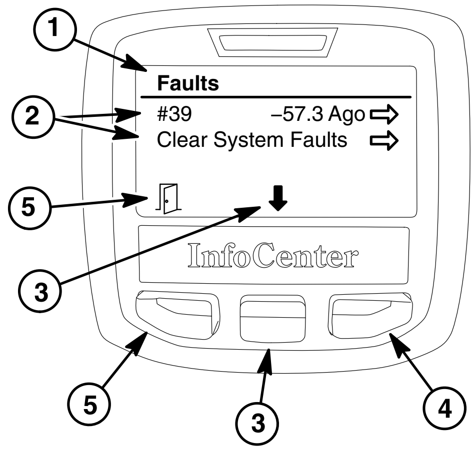
1. Main menu
2. Menu items
3. Move to menu items
4. Choose menu item
5. Back button

The main menu screen can be accessed from the Info- Center main information by pressing and releasing the menu/back button (left button) on the display. Once to the main menu screen (Figure 165), navigation to the five (5) different menu items can occur. Pressing the move to menu item button (center button) allows a different menu item to be highlighted. Selection of the highlighted item is completed by pressing the choose item button (right button).

The main menu items include faults, service, diagnostics, settings and about. These menu items are described below.

To return to the main information screen from the main menu screen, press the back button (left button).

Faults Screen



g275694

Figure 166

1. Fault menu
2. Fault items
3. Move to menu items
4. Choose menu item
5. Back button

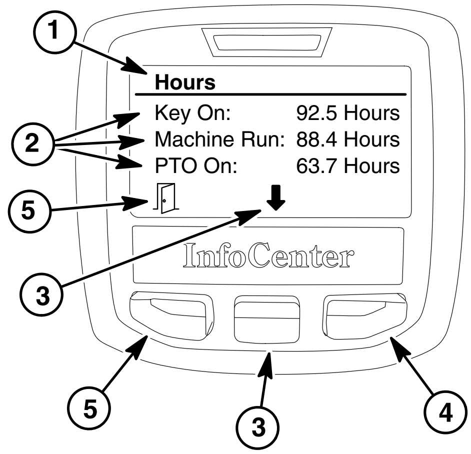
The faults screen (Figure 166) will list all machine electrical faults that have occurred since the faults were last cleared from the InfoCenter. The faults will be identified by a fault number and when the fault occurred. Faults that might occur on the machine are listed in Fault Codes in the Troubleshooting section of this chapter.

After entry of the PIN code, the InfoCenter fault log can be cleared by selecting the clear system faults menu item. The cleared faults will be removed from the Info- Center list but will be retained in the TEC controller memory.

If a fault occurs during machine use, there may be a change in machine functionality due to the fault. Should there be machine operation issues due to a fault, a first step to remedy the issue would be to disengage the cutting decks, release the traction pedal, turn the key switch OFF and allow all machine functions to stop. Then, attempt to restart the machine to see if operation has returned to normal. Some faults will be reset during the restart and will then allow normal function. If a fault continues to occur, further system evaluation and possible component repair or replacement will be necessary.

To return to the main menu screen from the faults screen, press the back button (left button).

Service Screen



g275695

Figure 167

1. Service menu
2. Service items
3. Move to menu items
4. Choose menu item
5. Back button

The service screen (Figure 167) contains machine operational information including hours and counts. Values listed for these service menu items cannot be changed. If the machine PIN has been entered to allow access to protected menu items in the settings screen, the protected service menu items will be listed and available in the service screen.

Note: If the protected menu items are available, PIN will be shown in the upper right corner of the InfoCenter display.

The options listed for hours include the following:

- **Key On** identifies the number of hours that the key switch has been in the RUN position.
- **Machine Run** identifies the number of hours that the engine has been running.
- **PTO On** identifies the number of hours that the machine has been operated with the cutting decks engaged.
- **High Range** identifies the number of hours that the machine has been operated in HI range speed (transport).
- **Service Due** identifies the number of hours before the next scheduled maintenance is due.

The options listed for counts include the following:

- **Starts** identifies the number of times that the engine has been started.
- **Left Deck** identifies the number of times that the left side cutting deck has been energized.
- **Center Deck** identifies the number of times that the center cutting deck has been energized.
- **Right Deck** identifies the number of times that the right side cutting deck has been energized.
- **Fan Reversals** identifies the number of times that the engine cooling fan has been operated in the reverse direction.
- **Fan − Coolant** identifies the number of times that engine coolant temperature caused the engine cooling fan speed to change.

Service Screen (continued)

- **Fan − Oil** identifies the number of times that hydraulic oil temperature caused the engine cooling fan speed to change.
- **Inlet** identifies the temperature of the inlet air into the engine intake system.

The protected menu items include the following:

- **DPF Regeneration** provides the necessary procedure for stationary regeneration for the exhaust system DPF (diesel particulate filter) on machines with a Tier 4 engine (models 30606, 30608 and 30644). If the engine ECU identifies that a stationary DPF regeneration is necessary, an advisory will occur on the InfoCenter and the necessary steps will be listed in the service screen menu.
- **Traction Pedal** allows the traction pedal sensor to be calibrated (see Traction Pedal Position Sensor Calibration (page 6–23)).
- **Fan Reverse** provides the necessary inputs to cause the cooling fan to reverse direction. This protected menu item allows the demonstration of the fan reversal and would never be necessary to use on a normally functioning machine.

To return to the main menu screen from the service screen, press the back button (left button).

Diagnostics Screen

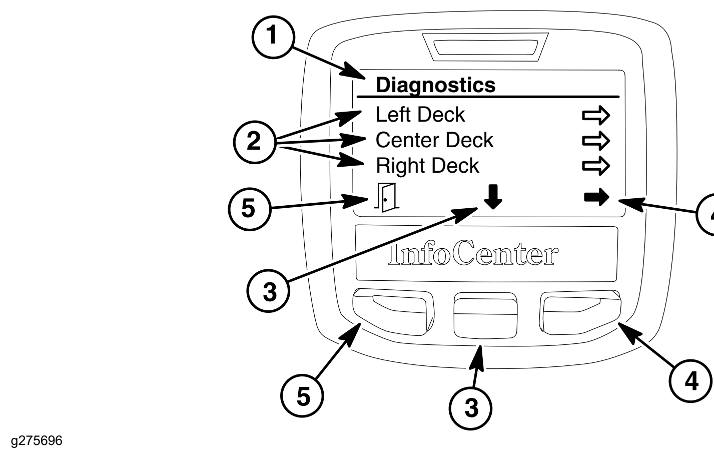


Figure 168

1. Diagnostics menu
2. Diagnostics items
3. Move to menu items
4. Choose menu item
5. Back button

The diagnostics screen (Figure 168) lists the various states of machine electrical components. The diagnostics screen should be used to check operation of machine controls and to verify that switches and circuit wiring are functioning correctly.

For each of the diagnostics screen items, inputs, qualifiers and outputs are identified. The diagnostics screen includes the following:

- **Left Deck** identifies machine requirements to allow the left deck to raise and lower. Inputs indicate the state of the left deck lift/lower switch and whether the machine is in LOW range speed. Qualifiers include the LOW range speed, seat switch and parking brake position. Identified outputs consist of master, lower, raise and float solenoids.

Diagnostics Screen (continued)

- **Center Deck** identifies machine requirements to allow the center deck to raise and lower. Inputs indicate the state of the center deck lift/lower switch. Qualifiers include the LOW range speed, seat switch and parking brake position. Identified outputs consist of master, raise and float solenoids.
- **Right Deck** identifies machine requirements to allow the right deck to raise and lower. Inputs indicate the state of the right deck lift/lower switch. Qualifiers include the LOW range speed, seat switch and parking brake position. Identified outputs consist of master, lower, raise and float solenoids.
- **Traction Pedal** identifies position of the traction pedal. Inputs indicate the state of the traction pedal position sensor. Outputs indicate whether the traction circuit is in forward, neutral or reverse.
- **Traction** identifies machine requirements to allow the traction system to be engaged. Inputs indicate the state of the traction pedal. Qualifiers include the seat switch and parking brake position. Outputs indicate whether the piston (traction) pump is engaged in forward or reverse.
- **Hi/Low Range** identifies machine requirements to allow HI or LOW speed range to be engaged. Inputs indicate the state of the hi/low switch. Qualifiers identify the position of the PTO switch and the cutting decks (raised or lowered). Outputs indicate whether HI range is engaged (solenoid S12 is energized).
- **PTO** identifies machine requirements to allow the PTO to be engaged. Inputs indicate the state of the PTO switch. Qualifiers identify whether LOW speed range is selected, if the seat is occupied and if the cutting decks are lowered. Outputs indicate which cutting decks are engaged.
- **Engine Run** identifies whether necessary TEC outputs exists to allow the engine to run. Inputs indicate the state of the key switch. Qualifiers identify whether the PTO is off, if the traction pedal is in neutral, if the seat is occupied (or parking brake is applied) and if all deck lift switches are not activated. Outputs indicate that requirements have been met to allow engine to run or start. NOTE: The components for engine operation (i.e. glow plugs, starter) are controlled by the Yanmar engine electronic control unit.
- **Cruise Control** identifies machine requirements to allow the cruise control to be engaged. Inputs indicate the state of the cruise control switch and service brakes. Qualifiers identify whether the seat is occupied, if the parking or service brakes are applied and if the traction pedal is not in neutral. Outputs indicate that the cruise function is engaged.
- **Light Kit** identifies machine requirements to allow machine lights (if equipped) to be energized. Inputs indicate the state of the light switches. Outputs indicate that the lights are energized.

To return to the main menu screen from the diagnostics screen, press the back button (left button).

Settings Screen

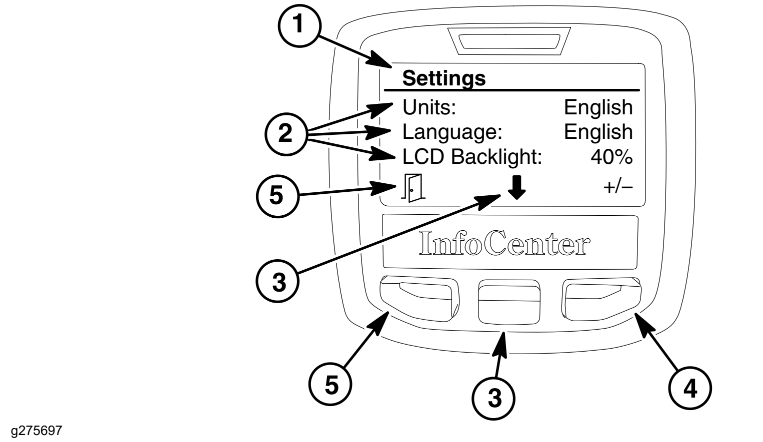


Figure 169

1. Settings menu
2. Settings items
3. Move to menu items
4. Change menu item
5. Back button

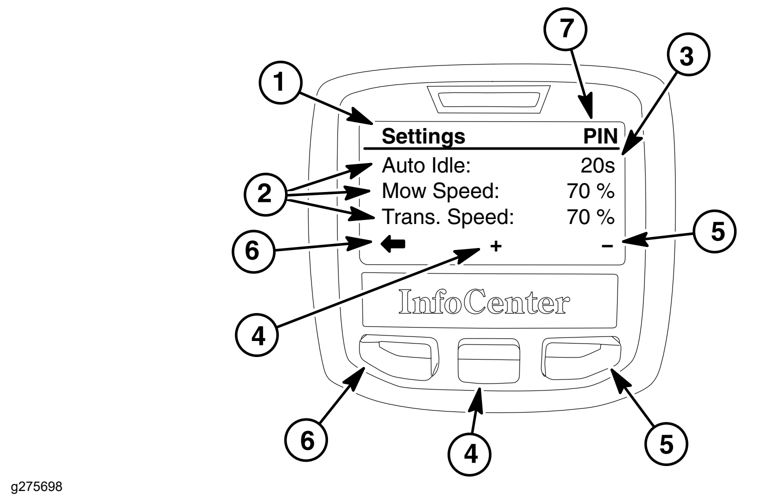


Figure 170

1. Settings menu
2. Settings items
3. Current setting
4. Increase setting
5. Decrease setting
6. Back button
7. PIN activated

The settings screen identifies the InfoCenter language and units (English or Metric). The settings screen also allows the operator to customize the backlight (brightness) and contrast settings for the InfoCenter display.

If either the backlight (brightness) or contrast items are selected, the center button (−) or right button (+) can be used to change the display settings.

Protected menus allows the machine PIN to be entered so that hidden machine service screen items can be viewed and modified. The protected service items include service interval reset, traction pedal sensor calibration, cooling fan reversal demonstration, Smart Power™ ON/OFF and exhaust system DPF regeneration (Tier 4 engines). If the protect settings is ON (see below), auto idle, mow speed, transport speed and counterbalance are also included in the protected menu.

Settings Screen (continued)

To allow access to the protected menu items, enter the four (4) digit pin PIN using the center and right InfoCenter buttons. After PIN has been entered, a check mark should be visible above center InfoCenter button. Press center button and the InfoCenter display screen should indicate “PIN” in the upper right hand corner if the correct PIN number was entered. Use back button to return to Settings menu. The protected menu items should be available in the Service menu and can be changed as long as the key switch remains in RUN.

Note: The initial PIN will either be 1234 or 0000. If the PIN has been changed and is forgotten, a temporary PIN can be obtained from your Toro distributor.

Protect settings allows the settings for auto idle, mow speed and transport speed to be hidden so they cannot be changed unless the PIN is entered. If the protect settings is ON, these settings will not be seen when using the InfoCenter until the protected menus is selected and the machine PIN is entered. If protect settings is OFF (default setting), settings for these functions will be visible on the InfoCenter and can be adjusted by the operator.

Reset Defaults allows machine settings to be returned to factory defaults.

Auto Idle causes the engine speed to decrease to low idle after the machine has not been in use for the set time delay in seconds. Auto idle can be adjusted to 8, 10, 15, 20 or 30 seconds or the auto idle feature can be turned OFF.

Mow Speed allows the maximum traction speed to be adjusted when in LOW (mow) speed. Mow speed can be adjusted to 40%, 70% or 100%.

Trans. (Transport) Speed allows the maximum traction speed to be adjusted when in HI (transport) speed. HI speed can be adjusted to 40%, 70% or 100%.

Smart Power allows the Smart Power™ feature to be turned OFF and ON.

To return to the main menu screen from the settings screen, press the back button (left button).

About Screen

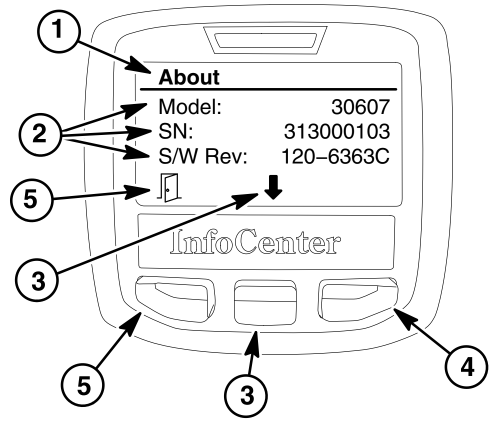


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Figure 171

1. About menu
2. About items
3. Move to menu items
4. Choose menu item
5. Back button

The about screen (Figure 171) identifies the machine model number, serial number and software revisions for the TEC controllers, InfoCenter and engine electronic control unit (if available). The about screen also lists the CAN−bus status. Additional information is identified if the about screen is accessed after the protected menus have been accessed by entering the PIN.

To return to the main menu screen from the about screen, press the back button (left button).

Adjustments

Wing Deck Position Switch Adjustment

Adjustment

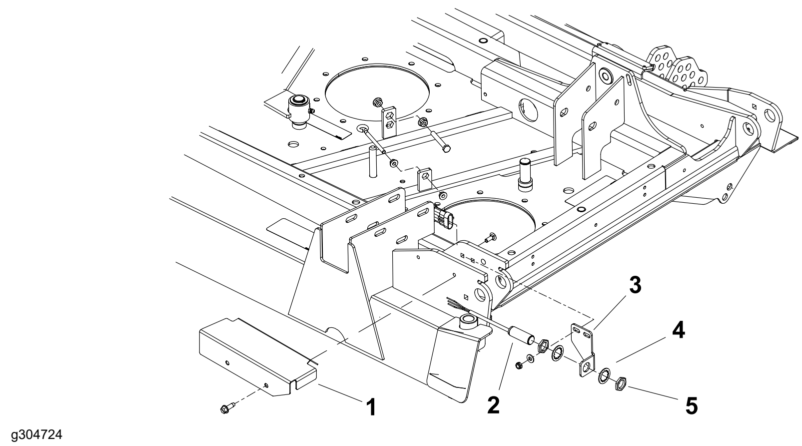

Figure 172

1. Switch cover
2. Position switch
3. Switch bracket
4. Lock washer (2 used)
5. Jam nut (2 used)

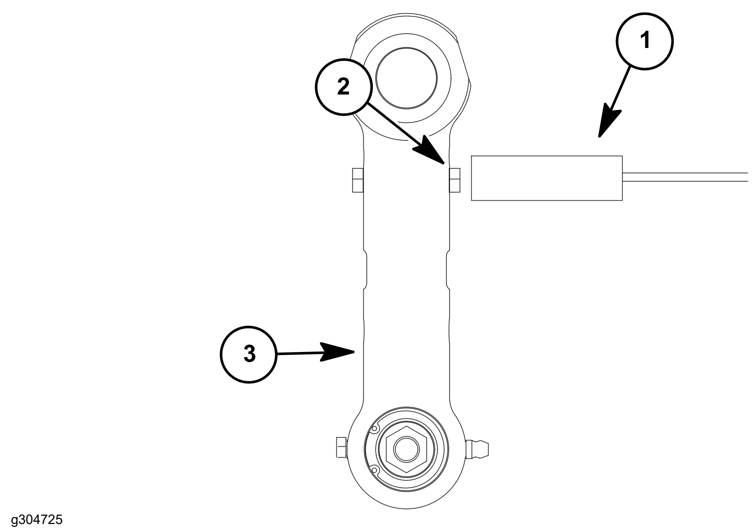

Figure 173

1. Position switch
2. Bolt head
3. Wing deck link

1. Park machine on a level surface with front cutting deck raised and side cutting decks lowered. Stop engine, engage parking brake and remove key from the key switch.
2. Remove switch cover from deck to allow access to position switch that requires adjustment.
3. Raise and lower wing deck while monitoring the wing deck latch and the position switch LED on cable end of switch:
   A. The position switch should open (switch LED is not illuminated) when the wing deck link causes the wing deck latch to disengage as wing deck is raised.

Adjustment (continued)

   B. The position switch should close (switch LED is illuminated) when the wing deck link causes the wing deck latch to engage as wing deck is lowered.

4. If necessary, adjust switch location to allow correct operation:

   A. Loosen jam nuts on switch and adjust switch location to allow proper switch operation.

   B. After switch adjustment, torque jam nuts from **18.7 to 22.0 N·m (165 to 195 in−lb)**.

   C. Make sure that position switch does not contact bolt head on wing deck link when wing deck is fully lowered.

5. After testing is complete, make sure that switch connector is plugged into deck wire harness and switch cover is secured to deck.

Traction Pedal Adjustment

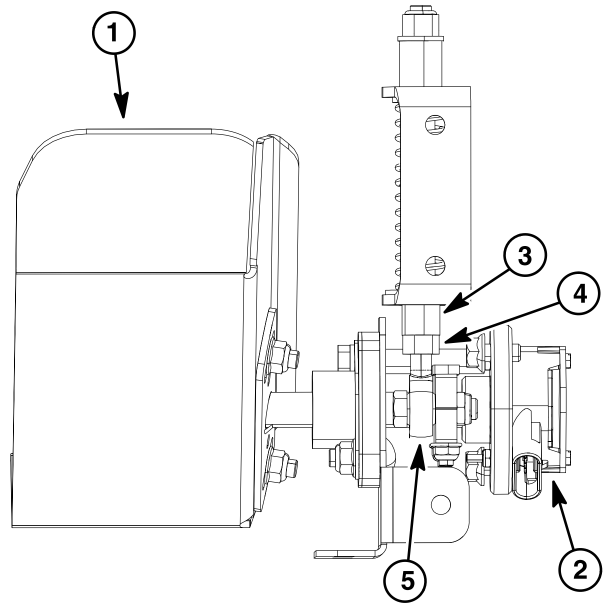

Figure 174

1. Traction pedal
2. Pedal position sensor
3. Spring shaft
4. Hex nut
5. Rod end bearing

The traction pedal includes a neutral assembly that is used to adjust the traction neutral position (Figure 174). Traction pedal adjustment may be necessary to make sure that traction pedal movement provides the correct full reverse and full forward positions for the traction pedal position sensor. The InfoCenter display can be used to check traction pedal adjustment using the following procedure.

1. Park machine on a level surface, lower cutting decks, engage parking brake and stop engine.
2. Turn key switch to RUN but do not start engine.

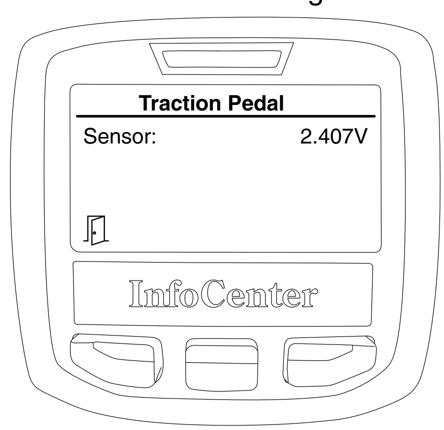

Figure 175

3. Use the InfoCenter Display Diagnostics menu (see InfoCenter Display (page 6–7)) to obtain and select the Traction Pedal menu item. Choose Inputs and the InfoCenter display should identify sensor voltage (Figure 175).
4. Move traction pedal from full reverse to full forward positions while noting the range of voltage displayed on the InfoCenter.

   A. Voltage in full reverse should be from 0.5 to 1.75V (approximate).

Traction Pedal Adjustment (continued)

B. Voltage in full forward should be from 3.5 to 4.5V (approximate).

5. If voltage range from full reverse to full forward is incorrect, adjustment of the spring shaft and rod end bearing is necessary (Figure 174).

   A. Remove steering cover to access traction pedal components (see Figure 174).

   B. Loosen hex nut that secures rod end bearing in spring shaft.

   C. Rotate spring shaft which changes traction pedal position in relation to traction pedal position sensor.

   D. Check range of voltage as described in step 4 above and make additional adjustments to the spring shaft until range of voltage is within specifications.

   E. Tighten hex nut to secure rod end bearing. Check that traction pedal range of voltage is still correct after hex nut is tightened.

   F. Install steering cover (see Steering Tower (For machines serial number below: 400000000) (page 8–3)).

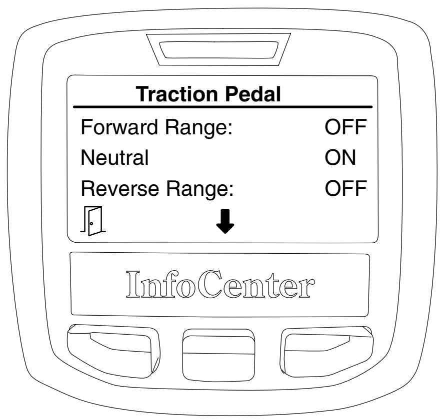

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Figure 176

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6. After any adjustment of the spring shaft and rod end bearing, use the InfoCenter Display Diagnostics menu (see InfoCenter Display (page 6–7)) to obtain and select the Traction Pedal menu item. Choose Outputs and the InfoCenter display will identify the traction pedal position (Figure 176).

   A. When the traction pedal is in the neutral position, the InfoCenter should display Neutral as ON and both Forward Range and Reverse Range as OFF.

   B. Move traction pedal in the forward direction and the InfoCenter should display the Forward Range as ON and both Neutral and Reverse Range as OFF.

   C. Return the traction pedal to neutral and then move pedal in the reverse direction. The InfoCenter should display the Reverse Range as ON and both Neutral and Forward Range as OFF.

   D. If outputs are incorrect, additional adjustment of the spring shaft and rod end bearing are necessary.

7. After completing all adjustments and before returning the machine to operation, calibrate traction pedal position sensor (see Traction Pedal Position Sensor Calibration (page 6–23)).

Traction Pedal Position Sensor Calibration

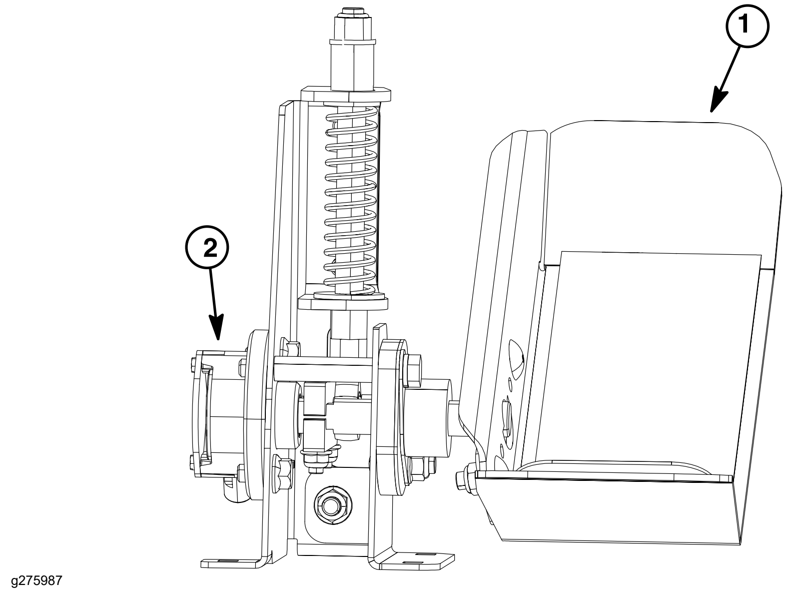


Figure 177

1. Traction pedal
2. Pedal position sensor

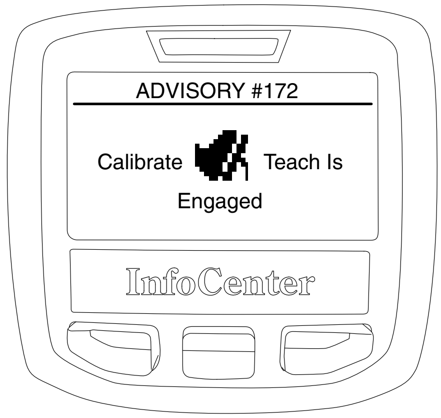
IMPORTANT

A properly installed and calibrated traction pedal position sensor is critical to accurate traction system response and for reliable sensor life. Use care when removing, installing and calibrating the traction pedal position sensor.

Calibration of the traction pedal position sensor ensures that the TEC controller can identify the traction neutral, forward and reverse positions.

1. Park machine on a level surface, lower cutting decks, engage parking brake and stop engine.
2. Turn key switch to RUN but do not start engine.
3. Use the InfoCenter Display Settings menu (see InfoCenter Display (page 6–7)) to obtain and select Protected Menus. Enter valid PIN for the machine to allow access to protected menu items including calibration of the traction pedal position sensor. The InfoCenter display screen should indicate “PIN” in the upper right hand corner when the correct PIN number has been entered.

Traction Pedal Position Sensor Calibration (continued)



g275988

Figure 178

4. Use the InfoCenter Display Service menu (see InfoCenter Display (page 6–7)) to obtain and select the Traction Pedal menu item. The InfoCenter display should indicate that the traction pedal calibration process is engaged (Figure 178).
5. Follow the prompts on the InfoCenter display screen to calibrate the traction pedal position sensor. The calibration steps are listed below:
   A. Slowly press traction pedal to the forward direction.
   B. Press and hold traction pedal to the full forward position.
   C. Allow traction pedal to return to the neutral position.
   D. Slowly press traction pedal to the reverse direction.
   E. Press and hold traction pedal to the full reverse position.

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Figure 179

   F. Check that InfoCenter display indicates a successful calibration process (Figure 179).
6. Turn key switch to OFF which exits the traction pedal calibration menu.

Electrical System Quick Checks

Battery Test (Open Circuit)

Use a multimeter to measure the voltage between the battery terminals.

Set multimeter to the DC volts setting. The battery should be at a temperature of 16 to 38 ºC (60 to 100 ºF). The key should be off and all accessories turned off. Connect the positive (+) multimeter lead to the positive battery post and the negative (−) multimeter lead to the negative battery post. The multimeter will display battery voltage.

Note: This test provides a relative condition of the battery. Load testing of the battery will provide additional and more accurate information.

Voltage Measured	Battery Charge Level
12.68 V (or higher)	Fully charged (100%)
12.45 V	75% charged
12.24 V	50% charged
12.06 V	25% charged
11.89 V	0% charged

Charging System Test

This is a simple test used to determine if a charging system is functioning. It will tell you if the charging system has an output, but not its capacity.

Note: The InfoCenter display can be used to identify battery voltage during machine operation.

Use a digital multimeter set to DC volts. Connect the positive (+) multimeter lead to the positive battery post and the negative (−) multimeter lead to the negative battery post. Keep the test leads connected to the battery posts and record the battery voltage.

Note: Upon starting the engine, the battery voltage will drop and then should increase once the engine is running.

Note: Depending upon the condition of the battery charge and battery temperature, the battery voltage will increase at different rates as the battery charges.

Start the engine and run at high idle. Allow the battery to charge for at least three (3) minutes. Record the battery voltage.

After running the engine for at least three (3) minutes, battery voltage should be at least 0.50 volt higher than initial battery voltage.

An example of a charging system that is functioning:

At least 0.50 volt over initial battery voltage.	
Initial Battery Voltage	= 12.30 V
Battery Voltage after 3 Minute Charge	= 12.95 V
Difference	= +0.65 V

Check Operation of Interlock Switches

⚠ CAUTION ⚠

Do not disconnect safety switches. They are for the operator's protection. Check the operation of the interlock switches daily for proper operation. Replace any malfunctioning switches before operating the machine.

Interlock switch operation is described in the Traction Unit *Operator's Manual*. Your Groundsmaster is equipped with two (2) Toro Electronic Controllers (TEC) which monitor interlock switch operation. Testing of individual interlock switches and relays is included in the Component Testing section of this Chapter.

Note: Use the InfoCenter Display when troubleshooting an electrical problem on your Groundsmaster.

Component Testing

For accurate resistance and/or continuity checks, electrically disconnect the component being tested from the circuit (e.g. unplug the key switch connector before checking continuity on the switch).

For engine component testing information, see the *Yanmar Workshop Manual* and *Yanmar Troubleshooting Manual*.

CAUTION

When testing electrical components for continuity with a multimeter (ohms setting), make sure that power to the circuit has been disconnected.

Key Switch

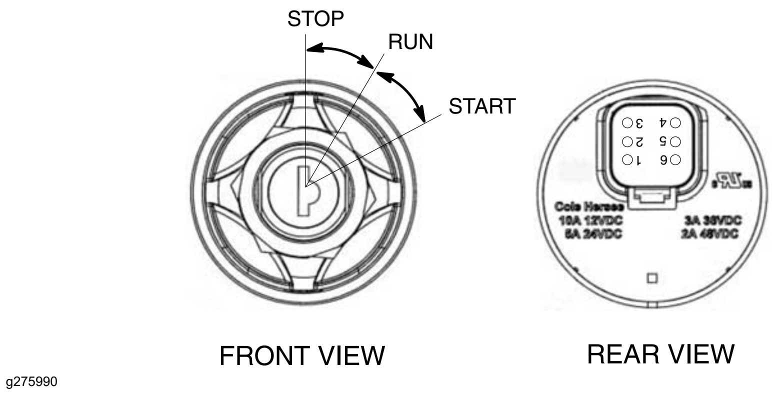

Figure 180

The key switch is located on the control panel and has three (3) positions: STOP, RUN and START (Figure 180). The Toro Electronic Controller (TEC) monitors the operation of the key switch.

Testing

1. Park machine on a level surface, lower cutting decks, engage parking brake and stop engine. Remove key from key switch.
2. Before disconnecting the key switch for testing, the switch and its circuit wiring should be tested as a TEC electrical input using the InfoCenter Display (see InfoCenter Display (page 6–7)). If input testing verifies that the key switch and circuit wiring are functioning correctly, no further key switch testing is necessary. If, however, input testing determines that the key switch and circuit wiring are not functioning correctly, proceed with the following key switch testing procedure.
3. Remove control arm covers to gain access to key switch (see Control Arm (page 8–12)).
4. Make sure the key switch is in the OFF position. Disconnect wire harness connector from key switch.
5. The key switch terminals are identified in Figure 180 and the circuitry of the switch is shown in below chart. With the use of a multimeter (ohms setting), the switch functions can be tested to determine whether continuity exists between the various terminals for each switch position. Verify continuity between switch terminals.

SWITCH POSITION	CIRCUITS
STOP	1 + 6
RUN	1 + 3 + 4 + 5 + 6
START	1 + 2 + 4 + 5 + 6

Note: The key switch terminals 1 and 6 are connected internally. Terminals 4 and 5 are also connected internally. These terminals should have continuity regardless of switch position.

6. Replace key switch if testing determines that it is faulty.
7. If the key switch tests correctly and a circuit problem still exists, check wire harness (see Appendix A (page A–1)).
8. After testing is complete, connect machine wire harness connector to key switch. Secure control arm covers to machine with removed fasteners (see Control Arm (page 8–12)).

Fuses

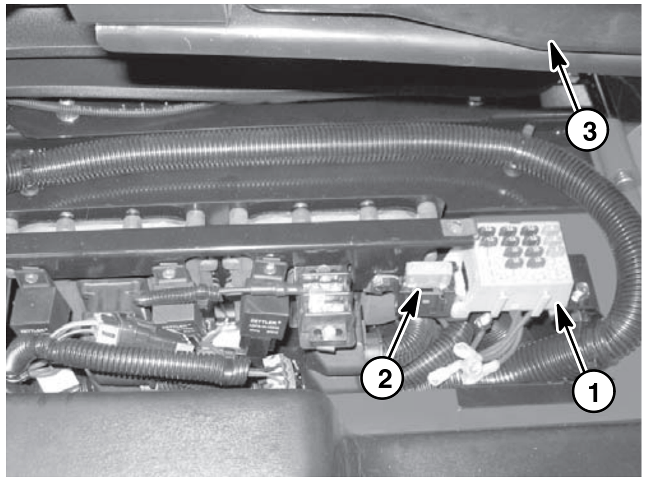

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Figure 181

1. Fuse block
2. 60 Amp fuse
3. Operator seat

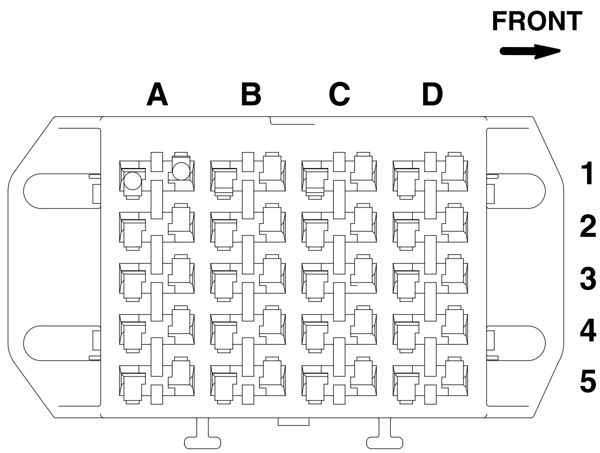

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Figure 182

The fuse block is located under the controller cover next to the operator seat (Figure 181).

In addition to the fuses in the fuse block, a 60 Amp fuse is included in the wire harness to protect the power circuit for the operator cab. This fuse resides in a fuse holder near the fuse block (Figure 181).

Fuse Identification and Function

Use Figure 182 to identify each individual fuse and its correct amperage in the fuse block. The fuses have the following functions.

Fuse A−1 (7.5 Amp) protects power supply for the outputs of the front TEC controller.

Fuse A−2 (7.5 Amp) protects power supply for the outputs of the rear TEC controller.

Fuse A−3 (10 Amp) protects turn signal light circuit (if equipped on models 30602, 30604 and 30643).

Fuse A−4 (15 Amp) protects headlight circuit (if equipped).

Fuse Identification and Function (continued)

Fuse A−5 (2 Amp) protects telematics circuit (if equipped).

Fuse B−1 (7.5 Amp) protects power supply for the outputs of the front TEC controller.

Fuse B−2 (7.5 Amp) protects power supply for the outputs of the rear TEC controller.

Fuse B−3 (10 Amp) protects power supply to the engine ECU.

Fuse B−4 (10 Amp) protects operator air−ride seat circuit.

Fuse B−5 (10 Amp) protects beacon circuit (if equipped).

Fuse C−1 (7.5 Amp) protects power supply for the outputs of the front TEC controller.

Fuse C−2 (7.5 Amp) protects power supply for the outputs of the rear TEC controller.

Fuse C−3 (10 Amp) protects main power supply circuit.

Fuse C−4 (10 Amp) protects power point circuit.

Fuse D−1 (2 Amp) protects logic power circuit to the front TEC controller.

Fuse D−2 (2 Amp) protects logic power circuit to the rear TEC controller.

Fuse D−3 (2 Amp) protects power supply for the InfoCenter display.

Fuse D−4 (10 Amp) protects power supply for the horn (if equipped).

Fuse Testing

Turn key switch to the RUN position (do not start engine). With the fuse installed in the fuse block, use a multimeter to verify that 12 VDC exists at both of the terminal test points on the fuse. If 12 VDC exists at one of the fuse test points but not at the other, the fuse is faulty.

If necessary, remove the fuse from the fuse block for testing. The fuse should have continuity between the fuse terminals.

1. Ensure that the key switch is in OFF position and the key is removed from the key switch.
2. Remove the fuse(s) from the fuse holder for testing. The fuse should have continuity between the fuse terminals.

IMPORTANT

If fuse replacement is necessary, ensure that replacement fuse has the correct Amp rating.

3. Replace the fuse if testing determines that it is damaged.

Operator Cab Fuses (Groundsmaster 4110−D)

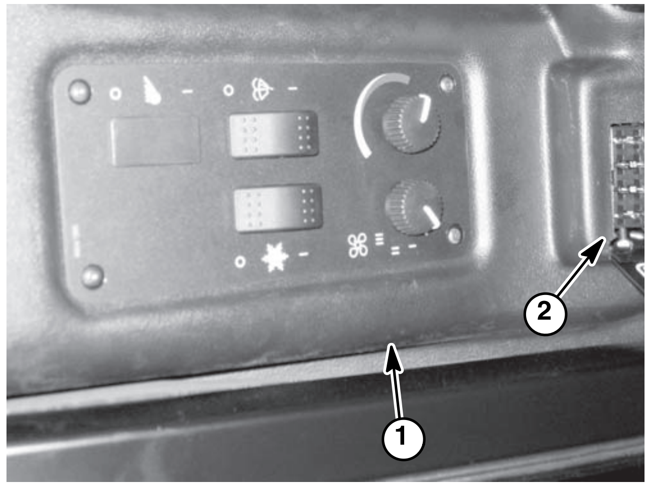

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Figure 183

1. Cab headliner
2. Cab fuse blocks

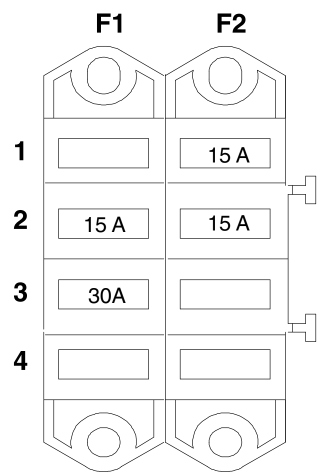

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Figure 184

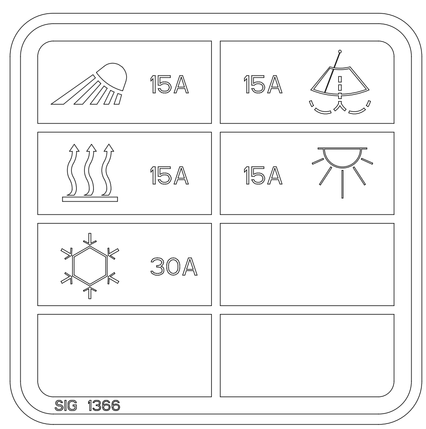

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Figure 185

The operator cab fuse blocks are located in the cab headliner (Figure 183).

Identification and Function (Figure 183 and Figure 184) for models 30602 and 30606

Fuse F1−1 (15 Amp) protects the cab work lights circuit.

Fuse F1−2 (15 Amp) protects the cab fan circuit.

Fuse F1−3 (30 Amp) protects the air conditioner circuit.

Fuse F2−1 (15 Amp) protects the windshield wiper/ washer circuit.

Fuse F2−2 (15 Amp) protects the cab dome light circuit.

Fuses F1−4, F2−3 and F2−4 are available for optional equipment.

Identification and Function for models 30635 and 30636

Fuse F1−1 (20 Amp) protects the cab work lights circuit.

Fuse F1−2 (25 Amp) protects the cab heater circuit.

Fuse F1−3 (30 Amp) protects the air conditioner circuit.

Fuse F2−1 (15 Amp) protects the windshield wiper/ washer circuit.

Fuse F2−2 (15 Amp) protects the cab dome light circuit.

Fuse F2−3 (15 Amp) protects the cab radio circuit (optional).

Fuses F1−4 and F2−4 are available for optional equipment.

Testing

Turn the key switch to the RUN position (do not start engine). With the fuse installed in the fuse block, use a multimeter to verify that 12 VDC exists at both of the terminal test points on the fuse. If 12 VDC exists at one of the fuse test points but not at the other, the fuse is faulty.

If necessary, make sure that the key switch is OFF and key is removed from switch. Remove fuse from fuse block and check that fuse has continuity across the fuse terminals.

Fusible Link Harness

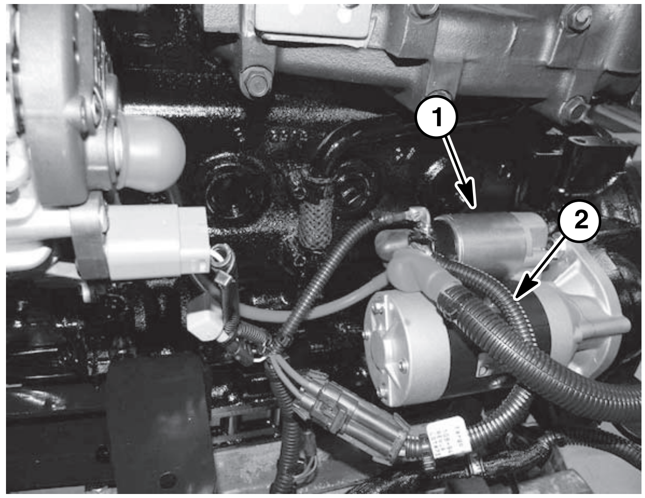

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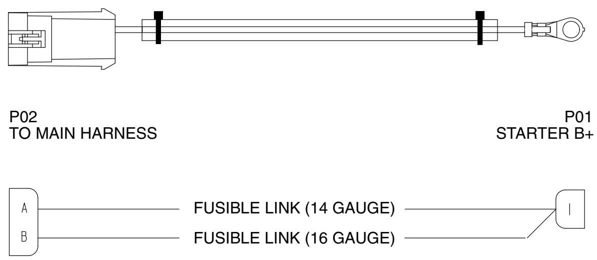
Figure 186

1. Starter motor
2. Fusible link harness



g275997

Figure 187

Your Groundsmaster uses two (2) fusible links for circuit protection. These fusible links are located in a harness that connects the starter B+ terminal to the wire harness (Figure 186). If either of these links should fail, current to the protected circuits will cease. Refer to Appendix A (page A–1) for wire harness drawings for additional fusible link information.

Testing

Make sure that key switch is OFF. Disconnect negative battery cable from battery terminal and then disconnect positive cable from battery (see Battery Service (page 6–91)). Locate and unplug fusible link connector from machine wire harness. Use a multimeter to make sure that continuity exists between the fusible link terminals. If either fusible link is open, replace the fusible link harness.

Note: It is not recommended to replace individual fusible link conductors of the fusible link harness. If any of the harness links are open (failed), replace the entire fusible link harness.

After fusible link testing is complete, make sure that fusible link harness is securely attached to starter B+ terminal and wire harness. Connect positive battery cable to battery terminal first and then connect negative cable to battery.

PTO Switch

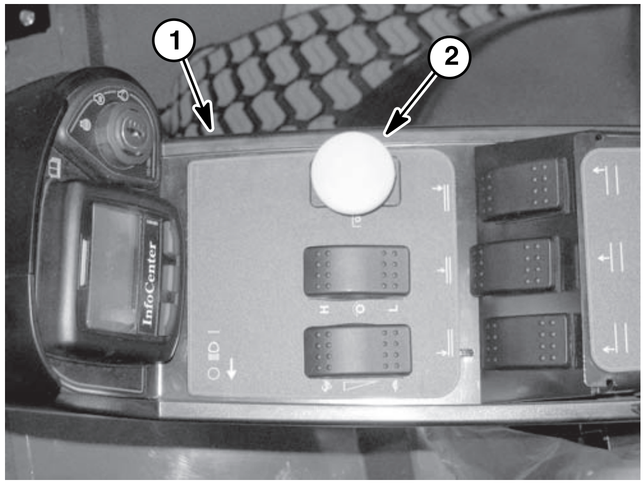


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Figure 188

1. Control arm
2. PTO switch

The PTO switch is located on the control arm (Figure 188). The PTO switch is pulled up to engage the PTO and pushed in to disengage the PTO.

The TEC controller monitors the position of the PTO switch (up or down). Using inputs from the PTO switch and other switches in the interlock system, the TEC controller controls the energizing of the hydraulic solenoid valves used to drive the cutting deck motors.

Note: To engage the PTO, the seat has to be occupied, traction speed has to be in LOW range and the cutting decks have to be fully lowered.

Testing

1. Before disconnecting the PTO switch for testing, the switch and its circuit wiring should be tested as a TEC input with the InfoCenter Display (see InfoCenter Display (page 6–7)). If the InfoCenter verifies that the PTO switch and circuit wiring are functioning correctly, no further switch testing is necessary. If, however, the InfoCenter determines that the PTO switch and circuit wiring are not functioning correctly, proceed with test.
2. Make sure key switch is OFF. Remove key from key switch.
3. Disassemble control arm to gain access to PTO switch (see Control Arm (page 8–12)).
4. Disconnect harness electrical connector from the PTO switch.

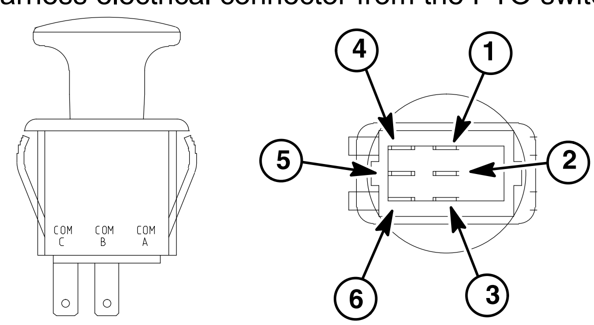

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Figure 189

1. COM B terminal
2. NO B terminal
3. NC B terminal
4. COM C terminal
5. NO C terminal
6. NC C terminal

Testing (continued)

5. The switch terminals are marked as shown in Figure 189. The circuit logic of the PTO switch is shown in the chart below. With the use of a multimeter (ohms setting), the switch functions can be tested to determine whether continuity exists between the various terminals for each switch position. Verify continuity between switch terminals. Replace PTO switch if testing identifies that switch is faulty.

SWITCH POSITION	CLOSED CIRCUITS	OPEN CIRCUITS
OFF (DOWN)	COM B + NC B COM C + NC C	COM B + NO B COM C + NO C
ON (UP)	COM B + NO B COM C + NO C	COM B + NC B COM C + NC C

6. If PTO switch tests correctly and circuit problem still exists, check wire harness (see Appendix A (page A–1)).
7. After testing is completed, connect the wire harness connector to the PTO switch.
8. Assemble control arm (see Control Arm (page 8–12)).

HI/LOW Speed, Engine Speed and Cutting Deck Lift Switches

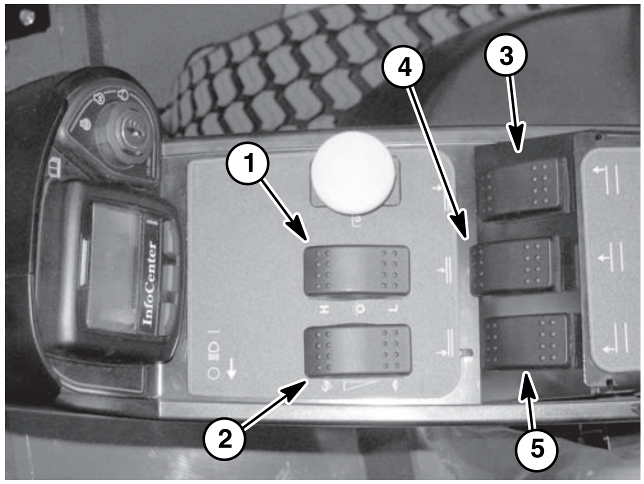

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Figure 190

1. HI/LOW speed switch
2. Engine speed switch
3. RH deck lift switch
4. Center deck lift switch
5. LH deck lift switch

The HI/LOW, engine speed and cutting deck lift switches are all identical momentary switches. These switches are located on the control arm (Figure 190).

The HI/LOW speed switch is used as an input for the TEC controller to select either the HI (transport) or LOW (mow) traction speed.

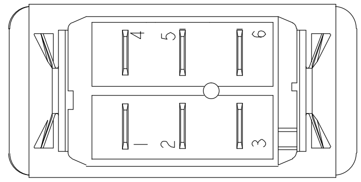
The engine speed switch is used as an input for the engine electronic control unit to raise or lower the engine speed. When the switch is depressed and held in the forward position, the engine speed will increase. Conversely, when the rear of the switch is depressed, engine speed will decrease.

The cutting deck lift switches are used as inputs for the TEC controller to raise or lower the cutting decks. When the front of a lift switch is depressed, the controlled decks will lower. When the rear of a lift switch is depressed and held, the controlled decks will raise.

Note: To raise or lower the decks, the operator seat has to be occupied. Also, to lower the cutting decks, the traction speed has to be in LOW (mow) range.

Testing

1. Before disconnecting a switch for testing, the switch and its circuit wiring should be tested as a TEC input with the InfoCenter Display (see InfoCenter Display (page 6–7)). If the InfoCenter verifies that the switch and circuit wiring are functioning correctly, no further switch testing is necessary. If, however, the InfoCenter determines that the switch and circuit wiring are not functioning correctly, proceed with test.
2. Make sure key switch is OFF. Remove key from key switch.
3. Disassemble control arm to gain access to switch that is to be tested (see Control Arm (page 8–12)).
4. Disconnect harness electrical connector from the switch that is to be tested.



BACK OF SWITCH

g276001

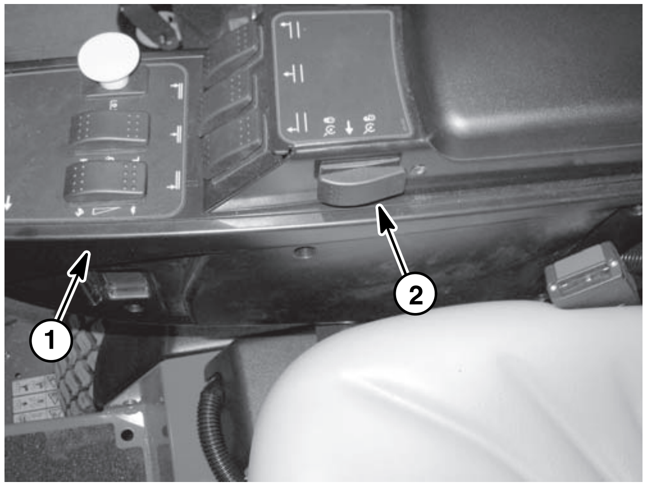
Figure 191

5. The switch terminals are marked as shown in Figure 191. The circuit logic of the switch is shown in the chart below. With the use of a multimeter (ohms setting), the switch functions may be tested to determine whether continuity exists between the various terminals for each position. Verify continuity between switch terminals. Replace switch if testing identifies a faulty switch.

SWITCH POSITION	CLOSED CIRCUITS	OPEN CIRCUITS
FRONT OF SWITCH PRESSED	2 + 3 5 + 6	2 + 1 5 + 4
NEUTRAL	NONE	ALL
REAR OF SWITCH PRESSED	2 + 1 5 + 4	2 + 3 5 + 6

6. If switch tests correctly and circuit problem still exists, check wire harness (see Appendix A (page A–1)).
7. After testing is completed, connect wire harness connector to the switch.
8. Assemble control arm (see Control Arm (page 8–12)).

Cruise Control Switch



g276002

Figure 192

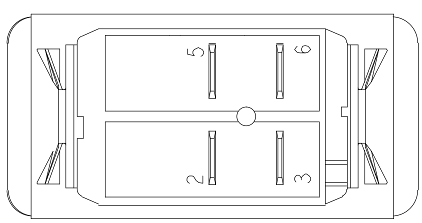
1. Control arm
2. Cruise control switch

The cruise control switch is used as an input for the TEC controller to maintain ground speed when engaged. The cruise control function is enabled when the switch is in the ON (center) position. Pressing the front of the switch to the momentary position sets the desired ground speed. The cruise control function is disengaged when the rear of the cruise control switch is depressed. On machine with serial numbers below 314000000, the cruise control switch is located on the operator side of the console arm (as shown in Figure 192). On machine with serial numbers above 314000000, the cruise control switch is located on the outside the console arm.

Note: The cruise control function can also be disengaged if either brake pedal is pressed or if the traction pedal is pressed and held in the reverse direction.

Testing

1. Before disconnecting the cruise control switch for testing, the switch and its circuit wiring should be tested as a TEC input with the InfoCenter Display (see InfoCenter Display (page 6–7)). If the InfoCenter Display verifies that switch and circuit wiring are functioning correctly, no further switch testing is necessary. If, however, the Display determines that the switch and circuit wiring are not functioning correctly, proceed with test.
2. Make sure key switch is OFF. Remove key from key switch.
3. Disassemble control arm to gain access to the cruise control switch (see Control Arm (page 8–12)).
4. Disconnect harness electrical connector from the switch.



BACK OF SWITCH

g276003

Figure 193

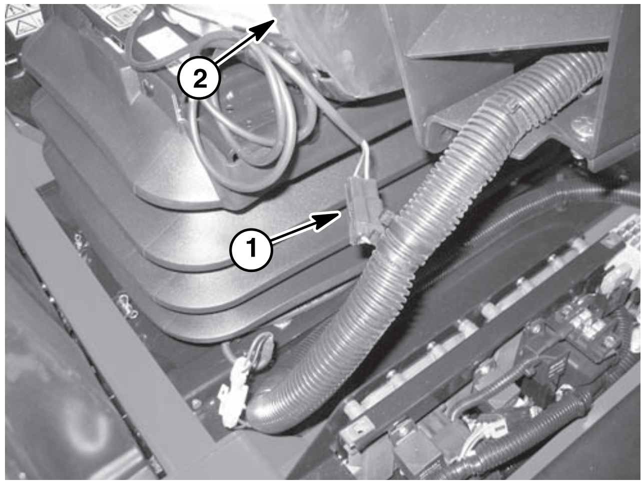
Testing (continued)

5. With the use of a multimeter (ohms setting), the switch functions may be tested to determine whether continuity exists between the various terminals for each position. The switch terminals are marked as shown in Figure 193. The circuitry of the cruise control switch is shown in the chart below. Verify continuity between switch terminals.

SWITCH POSITION	CLOSED CIRCUITS	OPEN CIRCUITS
CRUISE DISENGAGE	NONE	ALL
CRUISE ON (CENTER)	2 + 3	5 + 6
SPEED SET (MOMENTARY)	2 + 3 5 + 6	NONE

6. If switch tests correctly and circuit problem still exists, check wire harness (see Appendix A (page A–1)).
7. After testing is completed, connect wire harness connector to the cruise control switch.
8. Assemble control arm (see Control Arm (page 8–12)).

Seat Switch



g276004

Figure 194

1. Seat switch electrical connector
2. Operator seat

The seat switch is normally open and closes when the operator is on the seat. This switch is used as an input for the TEC controller. The seat switch and its electrical connector are located in the seat assembly. If the traction system or PTO switch is engaged when the operator raises out of the seat, an operator advisory will be displayed on the InfoCenter. Testing of the switch can be done without seat removal by disconnecting the switch wire from the machine wire harness (Figure 194).

Testing

1. Before disconnecting the seat switch for testing, the switch and its circuit wiring should be tested as a TEC input with the InfoCenter Display (see InfoCenter Display (page 6–7)). If the InfoCenter verifies that the seat switch and circuit wiring are functioning correctly, no further switch testing is necessary. If, however, the InfoCenter determines that the seat switch and circuit wiring are not functioning correctly, proceed with test.
2. Make sure key switch is OFF. Remove key from key switch.
3. Disconnect seat switch connector from the machine wire harness connector.
4. Check the continuity of the switch by connecting a multimeter (ohms setting) across the seat switch connector terminals.
5. With no pressure on the seat, there should be no continuity between the seat switch terminals.
6. Press directly onto the seat switch through the seat cushion. There should be continuity as the seat cushion approaches the bottom of its travel.
7. If testing determines that seat switch is faulty, replace seat switch (see Operator Seat Service (page 8–27)).
8. Connect seat switch connector to wire harness connector after testing is complete.

Parking Brake Switch

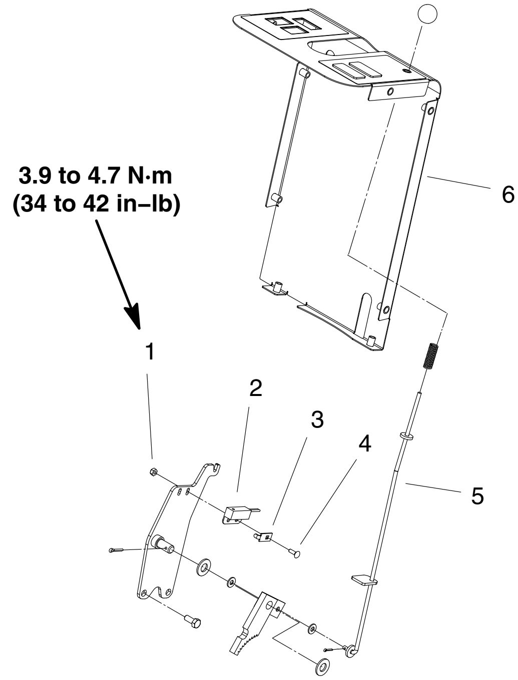


Figure 195

1. Lock nut
2. Parking brake switch
3. Switch plate
4. Carriage bolt
5. Parking brake rod
6. Steering tower cover

The switch used for the parking brake is a normally open proximity switch that is located under the steering tower cover (Figure 195). The parking brake switch is an input for the TEC controller. When the parking brake is not applied, a tab on the brake rod is positioned near the switch sense zone which causes the switch to close (continuity). When the parking brake is applied, the brake rod tab is positioned away from the switch allowing the switch to be in its normal, open position (no continuity).

Switch Testing

1. Before disconnecting the parking brake switch for testing, the switch and its circuit wiring should be tested as a TEC input with the InfoCenter Display (see InfoCenter Display (page 6–7)). If the InfoCenter verifies that the brake switch and circuit wiring are functioning correctly, no further switch testing is necessary. If, however, the InfoCenter determines that the brake switch and circuit wiring are not functioning correctly, proceed with test.
2. Make sure key switch is OFF. Remove key from key switch.
3. Remove front steering tower cover (see Steering Tower (For machines serial number below: 400000000) (page 8–3)).
4. Locate parking brake switch and unplug wire harness connector from switch.
5. Check the continuity of the switch by connecting a multimeter (ohms setting) across the connector terminals.
6. When the parking brake is not applied (brake rod tab close to brake switch), there should be continuity (zero resistance) between the switch terminals.
7. When the parking brake is applied (brake rod tab away from brake switch), there should be no continuity (infinite resistance) between the switch terminals.

Switch Testing (continued)

8. Replace parking brake switch if necessary.
9. Correctly connect the wire harness connector to the parking brake switch after testing is completed.
10. Install front steering tower cover (see Steering Tower (For machines serial number below: 400000000) (page 8–3)).

Switch Adjustment

With the parking brake not applied (brake rod tab near the switch), there should be a **1.6 mm (0.062 in)** gap between the switch and the brake rod tab.

Service Brake Switches

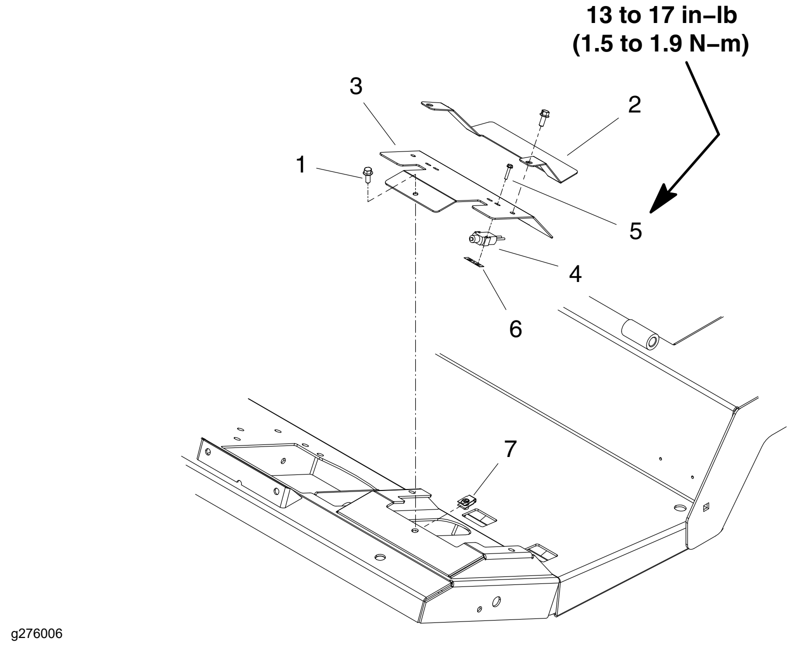


Figure 196

1. Flange screw (3 used)
2. Cover
3. Switch bracket
4. Brake switch (2 used)
5. Screw (2 per switch)
6. Switch nut (2 used)
7. Clip (3 used)

The two (2) switches used for the service brakes are normally open switches that are located under the footrest panel (Figure 196). The service brake switches provide inputs for the TEC controller. When a brake pedal is not depressed, the brake pedal assembly contacts the switch plunger to close the switch. When a brake is applied, the brake pedal assembly moves away from the switch plunger, allowing the switch plunger to extend and the switch to open.

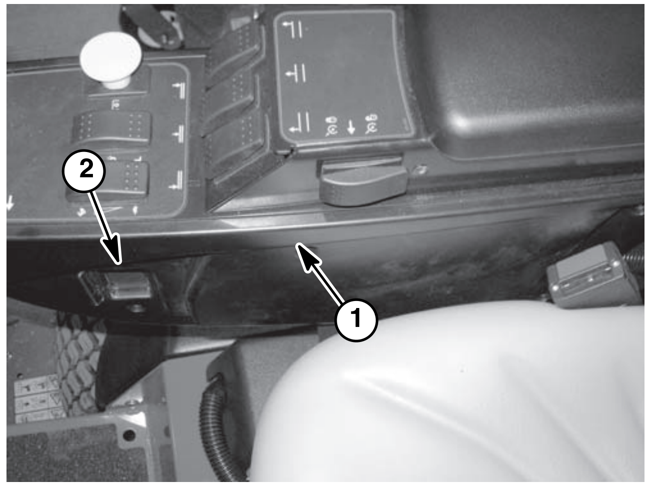
Testing

1. Before disconnecting a service brake switch for testing, the switch and its circuit wiring should be tested as a TEC input with the InfoCenter Display (see InfoCenter Display (page 6–7)). If the InfoCenter verifies that the brake switch and circuit wiring are functioning correctly, no further switch testing is necessary. If, however, the InfoCenter determines that the brake switch and circuit wiring are not functioning correctly, proceed with test.
2. Make sure key switch is OFF. Remove key from key switch.
3. Remove brake cover and switch plate on operator platform to access service brake switches (Figure 196).
4. Disconnect switch electrical connector from the machine wire harness.
5. Check the continuity of the switch by connecting a multimeter (ohms setting) across the connector terminals.
6. When the service brake switch plunger is depressed, there should be continuity (zero resistance) between the switch terminals.
7. When the service brake switch plunger is extended, there should be no continuity (infinite resistance) between the switch terminals.
8. Replace service brake switch if necessary.
9. Connect switch electrical connector to the machine wire harness after testing. Secure brake cover and switch plate to operator platform.

Adjustment

Adjust the service brake switch so that the switch plunger always makes full contact with the brake pedal. Tighten fasteners from **1.5 to 1.9 N·m (13 to 17 in−lb)**.

Headlight Switch (Groundsmaster 4110-D)



g276007

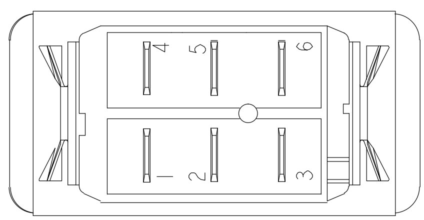
Figure 197

1. Control arm
2. Headlight switch

The Groundsmaster 4110−D headlight switch is a two (2) position rocker switch that is located on the inside of the control arm. The headlight switch allows the headlights and taillights to be turned on and off.

Testing

1. Make sure key switch is OFF. Remove key from key switch.
2. Disassemble control arm to gain access to headlight switch (see Control Arm (page 8–12)).
3. Disconnect harness electrical connector from the headlight switch.



BACK OF SWITCH

g276008

Figure 198

Note: Switch terminals 1, 4, 5 and 6 are not used on Groundsmaster 4110−D machines.

4. With the use of a multimeter (ohms setting), the switch functions may be tested to determine whether continuity exists between the various terminals for each switch position. The switch terminals are marked as shown in Figure 198. The circuitry of the switch is shown in the chart below. Verify continuity between switch terminals. Replace switch if testing identifies a faulty switch.

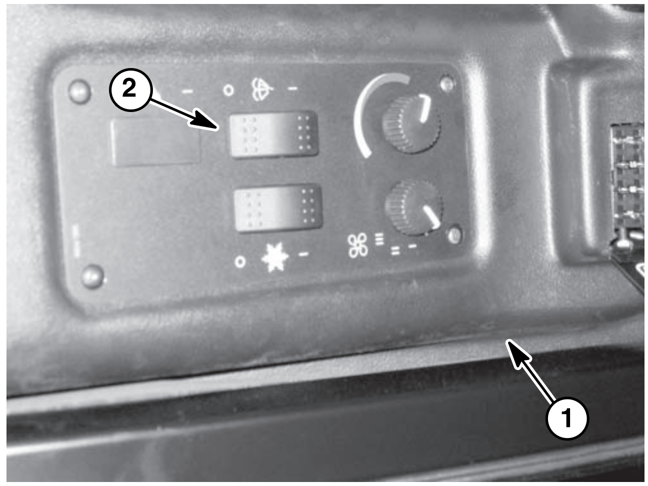
SWITCH POSITION	CIRCUIT 1	CIRCUIT 2
ON	2 + 3	5 + 6
OFF	2 + 1	5 + 4

5. If the headlight switch tests correctly and circuit problem still exists, check wire harness (see Appendix A (page A–1)).

Testing (continued)

6. After testing is completed, connect wire harness connector to the headlight switch.
7. Assemble control arm (see Control Arm (page 8–12)).

Windshield Wiper/Washer Switch (Groundsmaster 4110-D)



g276009

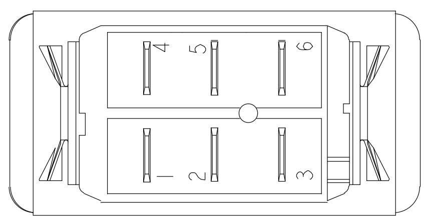
Figure 199

1. Cab headliner
2. Wiper/washer switch

The windshield wiper/washer switch is used to control operation of the windshield wiper and washer pump on the Groundsmaster 4110−D. The windshield wiper/washer switch is located in the cab headliner (Figure 199).

Testing

1. Make sure key switch is OFF. Remove key from key switch.
2. Remove switch plate from cab headliner.
3. Locate windshield wiper/washer switch and unplug wire harness connector from switch.



BACK OF SWITCH

g276010

Figure 200

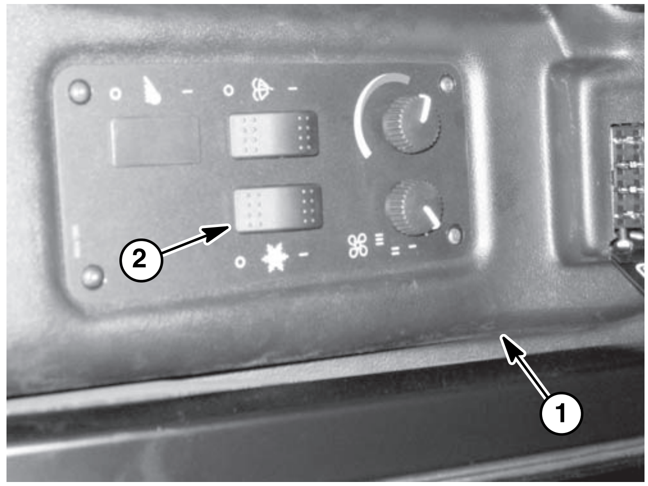
4. The switch terminals are marked as shown in Figure 200. The circuit logic of the wiper/washer switch is shown in the chart below. With the use of a multimeter (ohms setting), the switch functions may be tested to determine whether continuity exists between the various terminals for each position. Verify continuity between switch terminals. Replace wiper/washer switch if testing identifies a faulty switch.

SWITCH POSITION	CLOSED CIRCUITS	OPEN CIRCUITS
OFF	2 + 1	5 + 6
WIPER ON	2 + 3	5 + 6
WASHER and WIPER ON (MOMENTARY)	2 + 3 5 + 6	2 + 1

Testing (continued)

5. If switch tests correctly and circuit problem still exists, check wire harness (see Appendix A (page A–1)).
6. Connect the wire harness connector to the switch after testing.
7. Install switch plate to cab headliner after switch testing is complete.

Air Conditioning Switch (Groundsmaster 4110-D)



g276011

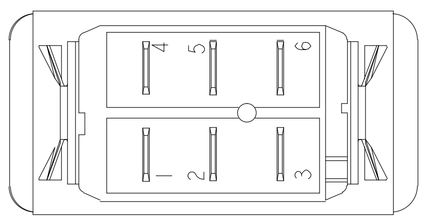
Figure 201

1. Cab headliner
2. Air conditioning switch

The air conditioning switch is used to control operation of the air conditioning system on the Groundsmaster 4110−D. The switch is located in the cab headliner (Figure 201).

Testing

1. Make sure key switch is OFF. Remove key from key switch.
2. Remove switch plate from cab headliner.
3. Locate air conditioning switch and unplug wire harness connector from switch.



BACK OF SWITCH

g276012

Figure 202

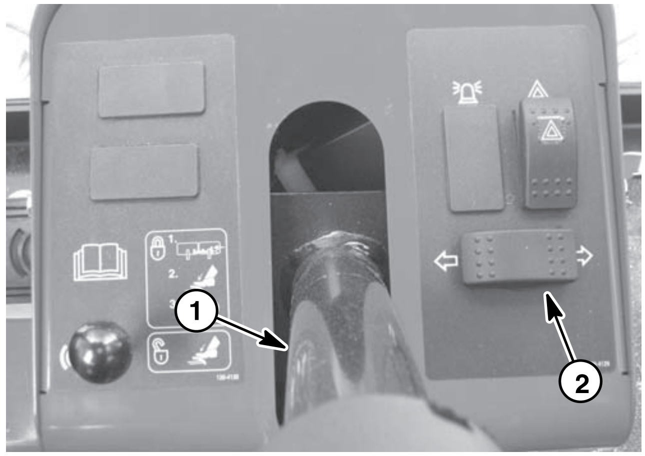
4. The switch terminals are marked as shown in Figure 202. The circuit logic of the air conditioning switch is shown in the chart below. With the use of a multimeter (ohms setting), the switch functions may be tested to determine whether continuity exists between the various terminals for each position. Verify continuity between switch terminals. Replace switch if testing identifies a faulty switch.

SWITCH POSITION	CLOSED CIRCUITS	OPEN CIRCUITS
AC OFF	2 + 1 5 + 4	2 + 3 5 + 6
AC ON	2 + 3 5 + 6	2 + 1 5 + 4

Testing (continued)

5. If switch tests correctly and circuit problem still exists, check wire harness (see Appendix A (page A–1)).
6. Connect the wire harness connector to the air conditioning switch after testing.
7. Install switch plate to cab headliner after switch testing is complete.

Turn Signal Switch (Groundsmaster 4110−D)



g276013

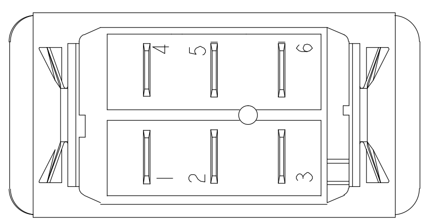
Figure 203

1. Steering column
2. Turn signal switch

On Groundsmaster 4110−D machines, the turn signal switch is used as an input for the TEC controller to provide power for the turn signals. The switch is located on the steering tower (Figure 203).

Testing

1. Before disconnecting the turn signal switch for testing, the switch and its circuit wiring should be tested as a TEC input with the InfoCenter Display (see InfoCenter Display (page 6–7)). If the InfoCenter verifies that the turn signal switch and circuit wiring are functioning correctly, no further switch testing is necessary. If, however, the InfoCenter determines that the turn signal switch and circuit wiring are not functioning correctly, proceed with test.
2. Make sure key switch is OFF. Remove key from key switch.
3. Remove front steering tower cover (see Steering Tower (For machines serial number below: 400000000) (page 8–3)).
4. Locate turn signal switch and unplug wire harness connector from switch.



BACK OF SWITCH

g276014

Figure 204

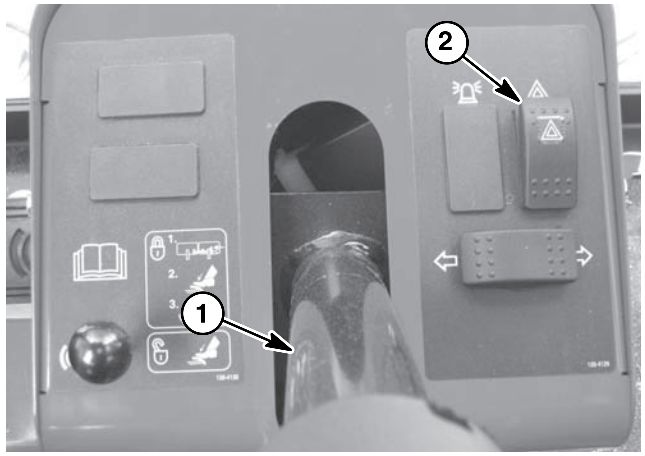
5. The switch terminals are marked as shown in Figure 204. The circuit logic of the turn signal switch is shown in the chart below. With the use of a multimeter (ohms setting), the switch functions may be tested to determine whether continuity exists between the various terminals for each position. Verify continuity between switch terminals. Replace turn signal switch if testing identifies a faulty switch.

Testing (continued)

SWITCH POSITION	CLOSED CIRCUITS	OPEN CIRCUITS
RIGHT TURN	2 + 3 5 + 6	2 + 1 5 + 4
NEUTRAL	NONE	ALL
LEFT TURN	2 + 1 5 + 4	2 + 3 5 + 6

6. Connect the harness connector to the switch after testing.
7. If switch tests correctly and circuit problem still exists, check wire harness (see Appendix A (page A–1)).
8. Install front steering tower cover (see Steering Tower (For machines serial number below: 400000000) (page 8–3)).

Flasher Switch (Groundsmaster 4110−D)



g276015

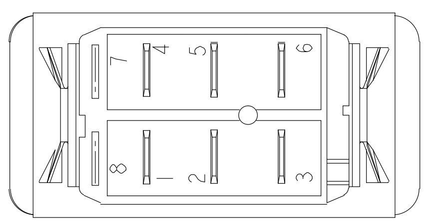
Figure 205

1. Steering column
2. Flasher switch

On Groundsmaster 4110−D machines, the flasher switch is used as an input for the TEC controller to provide power for the four way flashers. The switch is located on the steering tower (Figure 205).

Testing

1. Before disconnecting the flasher switch for testing, the switch and its circuit wiring should be tested as a TEC input with the InfoCenter Display (see InfoCenter Display (page 6–7)). If the InfoCenter verifies that the flasher switch and circuit wiring are functioning correctly, no further switch testing is necessary. If, however, the InfoCenter determines that the flasher switch and circuit wiring are not functioning correctly, proceed with test.
2. Make sure key switch is OFF. Remove key from key switch.
3. Remove front steering tower cover (see Steering Tower (For machines serial number below: 400000000) (page 8–3)).
4. Locate flasher switch and unplug wire harness connector from switch.



BACK OF SWITCH

g276016

Figure 206

5. The switch terminals are marked as shown in Figure 206. The circuit logic of the flasher switch is shown in the chart below. With the use of a multimeter (ohms setting), the switch functions may be tested to determine whether continuity exists between the various terminals for each position. Verify continuity between switch terminals. Replace flasher switch if testing identifies a faulty switch.

Testing (continued)

SWITCH POSITION	CLOSED CIRCUITS	OPEN CIRCUITS
ON (LIGHT END DEPRESSED)	2 + 3 5 + 6	2 + 1 5 + 4
OFF	2 + 1 5 + 4	2 + 3 5 + 6

6. Connect the harness connector to the switch after testing.
7. If switch tests correctly and circuit problem still exists, check wire harness (see Appendix A (page A–1)).
8. Install front steering tower cover (see Steering Tower (For machines serial number below: 400000000) (page 8–3)).

Traction Pedal Position Sensor

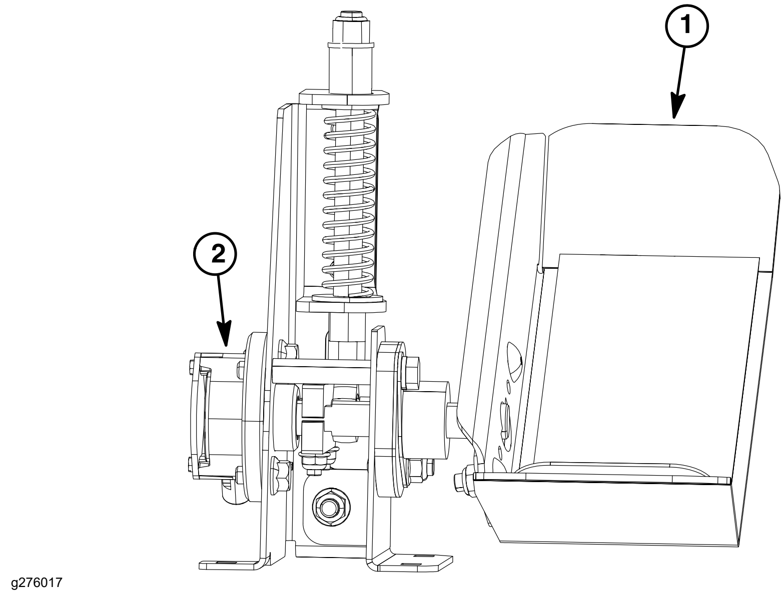


Figure 207

1. Traction pedal
2. Pedal position sensor

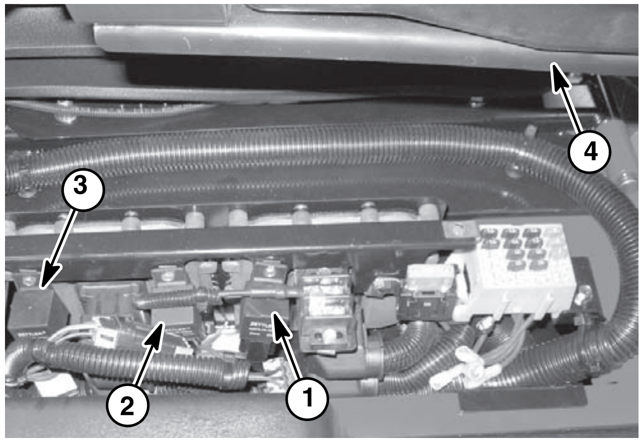
The traction pedal position sensor is connected to the traction pedal assembly (Figure 207). This position sensor determines the neutral band for the traction pedal, the direction of travel desired by the operator and the traction speed. The position sensor is a single analog, dual digital signal electronic device. The position sensor portion is a variable resistor that provides an analog signal for the TEC controller to determine the desired ground speed based on how far the traction pedal is moved. The traction pedal position sensor also houses two (2) switches that are used to determine the neutral position (dead band) and the indicated direction of travel (forward or reverse). As the traction pedal is depressed, the internal wiper of the position sensor moves and sends the analog signal to the TEC controller to determine machine direction and speed.

The traction pedal position sensor must be calibrated with the TEC controller to determine the neutral and full speed set points for both the forward and reverse directions. The position sensor calibration process can be completed using the InfoCenter display.

A properly installed and calibrated traction pedal position sensor is critical to accurate traction response and position sensor life. Use care when installing and calibrating the position sensor.

Before suspecting a faulty position sensor, the sensor and its circuit wiring should be tested as a TEC input with the InfoCenter Display (see InfoCenter Display (page 6–7)). If necessary, follow calibration procedures for the traction pedal position sensor found in the Adjustments section of this chapter. If position sensor replacement is necessary, refer to Traction Pedal (page 8–14).

Relays with Four (4) Terminals



g276018

Figure 208

1. Main power relay
2. TEC power relay
3. Cab power relay
4. Operator seat

Your Groundsmaster uses a number of electrical relays that have four (4) terminals. A tag near the wire harness relay connector can be used to identify each relay.

The main power relay is used to provide current to most of the fuse protected circuits (operator seat, InfoCenter display, power point and optional electric equipment). The main power relay is energized when the key switch is in the RUN or START position.

The TEC power relay is used to provide current to the fuse protected circuits for the TEC controller. The TEC power relay is energized when the key switch is in the RUN or START position.

The cab power relay is used on Groundsmaster 4110−D machines to provide current to the operator cab electrical components. The cab power relay is energized when the key switch is in the RUN or START position.

The start relay is used to provide current to the engine starter motor solenoid. The start relay is energized by the engine ECU.

The air heater relay is used on models 30602, 30604 and 30643 to provide current for the engine air heater used for starting a cold engine. When necessary, the air heater relay is energized by the engine ECU.

The glow relay is used on models 30606, 30608 and 30644 to provide current to the engine glow plugs when energized by the engine ECU.

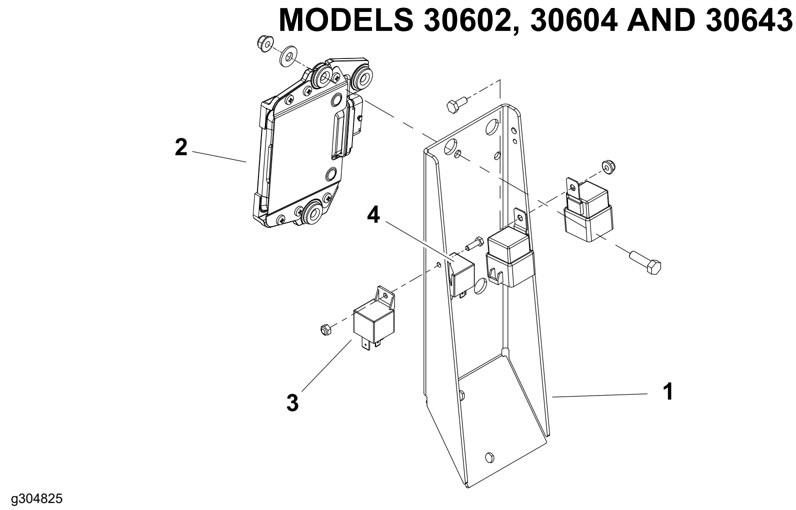


Figure 209

1. Controller mount
2. Engine ECU
3. Start relay
4. Air heater relay

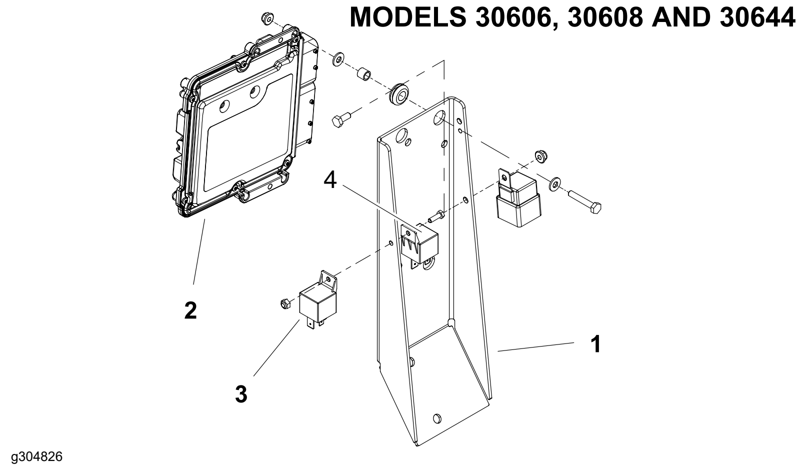


Figure 210

1. Controller mount
2. Engine ECU
3. Start relay
4. Glow relay

The main power, TEC power and cab power relays are located under the controller cover next to the operator seat (Figure 208). The start, air heater and glow relays are attached to the controller mount on the right side of the engine (Figure 209 or Figure 210).

Testing

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the key switch.
2. To make sure that machine operation does not occur unexpectedly, disconnect negative (−) cable from battery and then disconnect positive (+) cable from battery (see Battery Service (page 6–91)).
3. Locate relay that is to be tested.
4. Disconnect wire harness connector from relay. Remove relay from mounting bracket for testing.

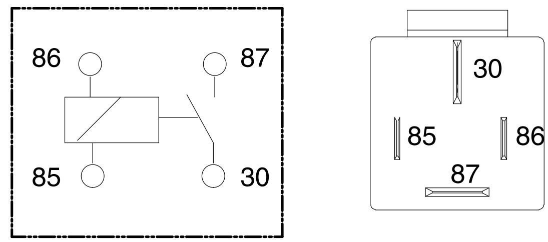


Figure 211

5. Using a multimeter, verify that coil resistance between terminals 86 and 85 is approximately 72 ohms.
6. Connect multimeter (ohms setting) leads to relay terminals 30 and 87. Ground terminal 86 and apply +12 VDC to terminal 85. The relay should make and break continuity between terminals 30 and 87 as +12 VDC is applied and removed from terminal 85.
7. Disconnect voltage and test leads from the relay terminals.
8. Secure relay to mounting bracket and connect wire harness connector to relay.
9. Secure all removed components to machine.
10. Connect positive (+) cable to battery and then connect negative (−) cable to battery (see Battery Service (page 6–91)).

Relays with Five (5) Terminals

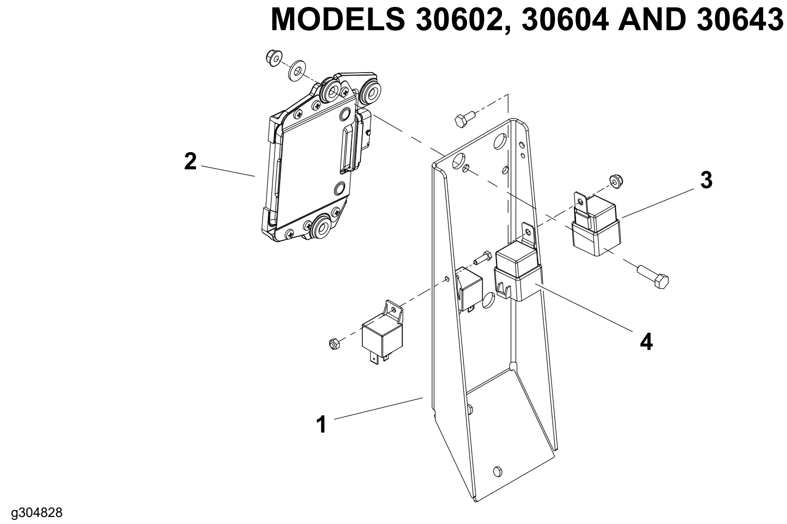


Figure 212

1. Controller mount
2. Engine ECU
3. Main relay
4. Rack actuator relay

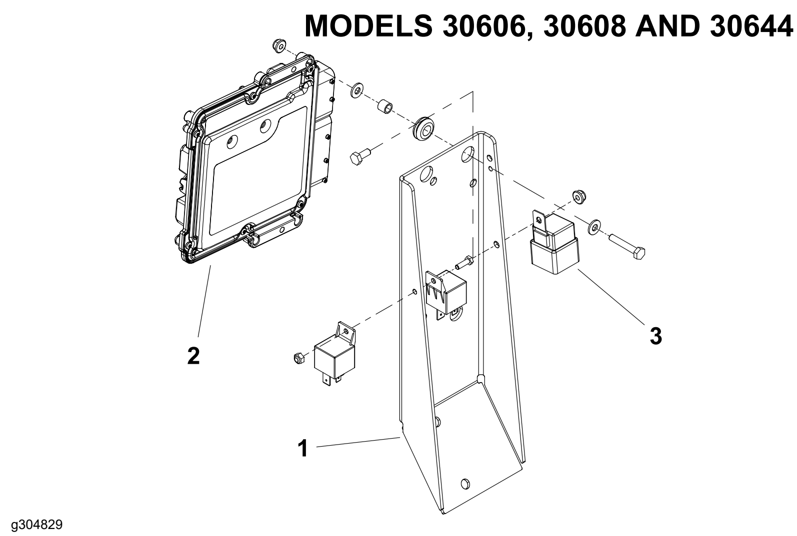


Figure 213

1. Controller mount
2. Engine ECU
3. EGR relay

Your Groundsmaster uses a number of electrical relays that have five (5) terminals. A tag near the wire harness relay connector can be used to identify each relay.

The air conditioning relay is used to control the air conditioning electrical power circuit on the Groundsmaster 4110−D. When energized by the air conditioning switch, the relay provides current for the air conditioning components.

The main relay is used on models 30602, 30604 and 30643 to provide current for several engine components when energized by the engine ECU.

The rack actuator relay is used on models 30602, 30604 and 30643 to provide current for the engine rack actuator when energized by the engine ECU.

The EGR relay is used on models 30606, 30608 and 30644 to provide current to the engine EGR valve when energized by the engine ECU.

The air conditioning relay is attached to the cab headliner above the switch panel. The main, rack actuator and EGR relays are attached to the controller mount on the right side of the engine (Figure 212 or Figure 213).

Testing

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the key switch.
2. To make sure that machine operation does not occur unexpectedly, disconnect negative (−) cable from battery and then disconnect positive (+) cable from battery (see Battery Service (page 6–91)).
3. Locate relay that is to be tested.
4. Disconnect wire harness connector from relay. Remove relay from mounting bracket for testing.

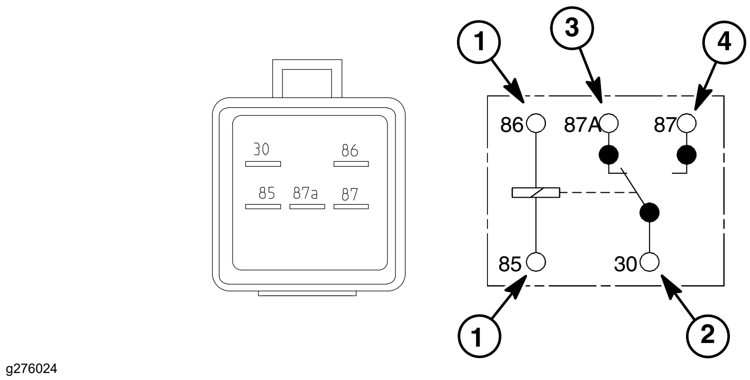


Figure 214

1. Coil terminal
2. Common terminal
3. Normally closed term.
4. Normally open term.

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5. Using a multimeter, verify that coil resistance between terminals 85 and 86 is from 71 to 88 ohms.
6. Connect multimeter (ohms setting) leads to relay terminals 30 and 87. Ground terminal 86 and apply +12 VDC to terminal 85. The relay should make and break continuity between terminals 30 and 87 as +12 VDC is applied and removed from terminal 85.
7. Disconnect voltage from terminal 85 and multimeter lead from terminal 87.
8. Connect multimeter (ohms setting) leads to relay terminals 30 and 87A. Apply +12 VDC to terminal 85. The relay should make and break continuity between terminals 30 and 87A as +12 VDC is applied and removed from terminal 85.
9. After testing, disconnect voltage and multimeter test leads from the relay terminals. Secure relay to mounting bracket and connect wire harness connector to relay.
10. Secure all removed components to machine.
11. Connect positive (+) cable first to battery and then connect negative (−) cable to battery (see Battery Service (page 6–91)).

Toro Electronic Controllers (TEC)

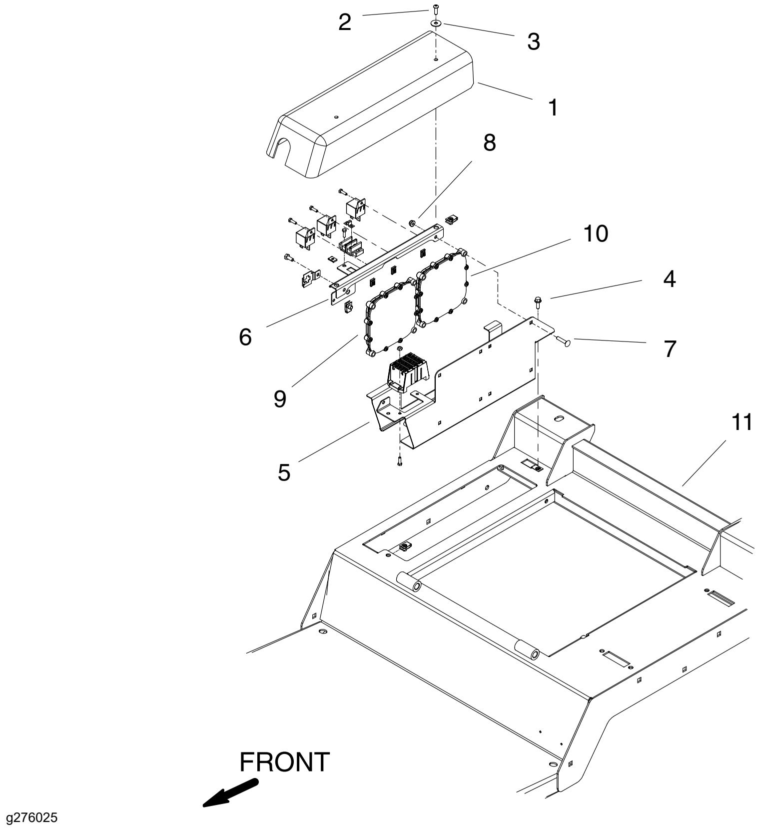
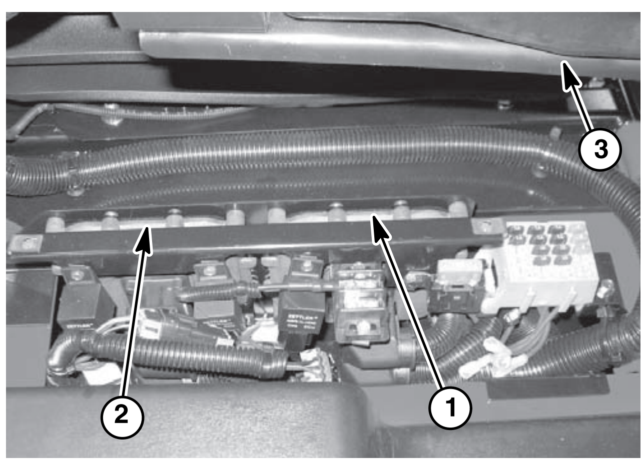


Figure 215

1. Controller cover
2. Screw (2 used)
3. Flat washer (2 used)
4. Flange screw (2 used)
5. Power mount
6. Relay mount
7. Carriage screw (8 used)
8. Flange nut (8 used)
9. Front TEC controller (Master)
10. Rear TEC controller (Slave)
11. Operator platform



g276026

Figure 216

1. Front TEC controller
2. Rear TEC controller
3. Operator seat

Groundsmaster 4100−D and 4110−D machines use two (2) Toro Electronic Controllers (TEC) to control electrical system operation. The controllers are attached to the operator platform under the controller cover (Figure 215 and Figure 216).

Logic power is provided to the controllers as long as the battery cables are connected to the battery. A pair of 2 Amp fuses (fuse D−1 for the front controller and fuse D−2 for the rear controller) provide circuit protection for this logic power to the controllers.

The front TEC controller (master) monitors the states of the following components as inputs: key switch, traction pedal position sensor, parking brake switch, HI/LOW speed switch, service brake switches, seat switch, engine speed switch, hydraulic temperature sender, turn signal switch (if equipped) and hazard switch (if equipped).

The front TEC controller controls electrical output to the engine ECU (start and run functions), fan drive solenoid coils (direction and flow source), traction (piston) pump solenoids (forward and reverse) and traction solenoid coil (HI/LOW speed). Additionally, electrical outputs for brake lights, turn lights and warning lights on Groundsmaster 4110−D machines are provided by the front TEC controller. Circuit protection for front TEC outputs is provided by three (3) 7.5 Amp fuses (fuse locations A−1, B−1 and C−1).

The rear TEC controller (slave) monitors the states of the following components as inputs: key switch, cutting deck lift switches, PTO switch, cruise control switch and deck position switches.

The rear TEC controller controls electrical output to the PTO solenoid coils, lift/lower solenoid coils and fan drive solenoid coil (speed). Circuit protection for rear TEC outputs is provided by three (3) 7.5 Amp fuses (fuse locations A−2, B−2 and C−2).

The InfoCenter display should be used to check inputs and outputs of the TEC controllers. Information on using the InfoCenter is included in the InfoCenter Display section of this chapter.

Toro Electronic Controllers (TEC) (continued)

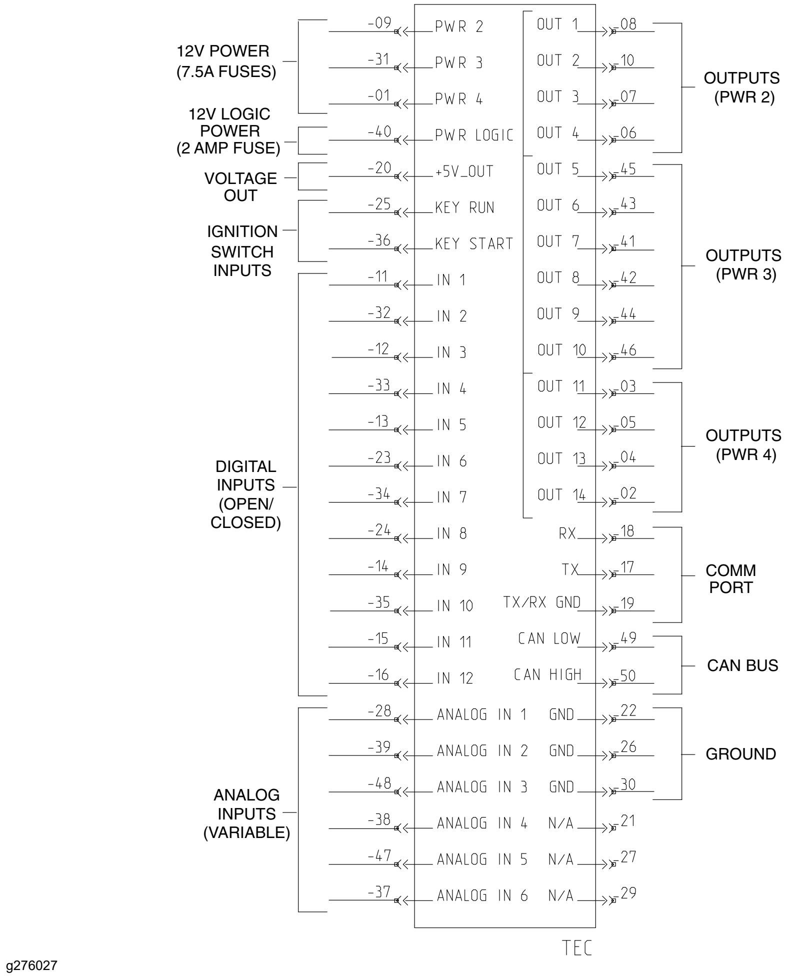


Figure 217

The diagram in Figure 217 depicts the connection terminal functions for the TEC controllers. Note that electrical power for controller outputs is provided through three (3) connectors (PWR 2, PWR 3 and PWR 4) each protected with a 7.5 amp fuse. A fifty (50) pin wire harness connector attaches to the controller. The connector pins are identified in the diagram in Figure 217. The layout of the wire harness connectors that plug into the TEC controllers is shown in Figure 218.

WIRE HARNESS CONNECTOR FOR TEC CONTROLLERS

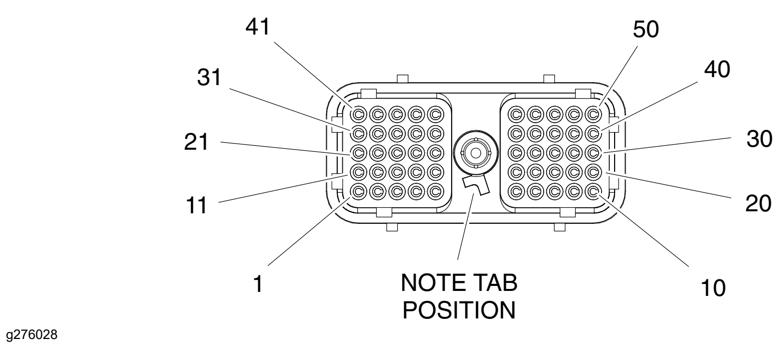


Figure 218

IMPORTANT

When testing for wire harness continuity at the connector for the TEC controller, take care to not damage the connector pins with multimeter test leads. If connector pins are enlarged or damaged during testing, connector repair will be necessary for proper machine operation.

The machine electrical schematic and wire harness drawings in Appendix A (page A–1) can be used to identify possible circuit problems between the controllers and the input/output devices (e.g. switches and solenoid coils).

Because of the solid state circuitry built into the TEC controllers, there is no method to test a controller directly. A controller may be damaged if an attempt is made to test it with an electrical test device (e.g. digital multimeter or test light).

If removal of the TEC controllers is necessary, label the controllers to make sure they are properly connected to the machine. The two (2) TEC controllers are visually identical but they have different software and therefore cannot be interchanged. The power mount (item 5 in Figure 215) can be separated from the operator platform and carefully lifted from the platform to access the controller fasteners.

Note: The TEC controllers used on the Groundsmaster 4100−D and 4110−D are matched for correct machine operation. If either of these components are replaced for any reason, system software needs to be reprogrammed by your Toro Distributor.

IMPORTANT

Before performing any welding on your Groundsmaster, disconnect both positive and negative battery cables from the battery, disconnect the wire harness connector from both of the TEC controllers and disconnect the terminal connector from the alternator. Also, disconnect and remove the engine ECU from the machine before welding. These steps will prevent damage to the machine electrical system.

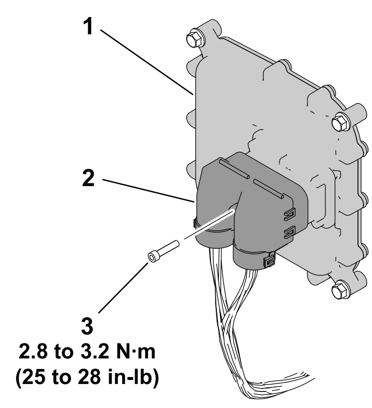


Figure 219

1. TEC controller
2. Machine harness connector
3. Socket head screw

Toro Electronic Controllers (TEC) (continued)

If the wire harness connector is removed from the TEC controller for any reason, tighten the harness connector screw from **2.8 to 3.2 N·m (25 to 28 in-lb)**.

Hydraulic Solenoid Valve Coils

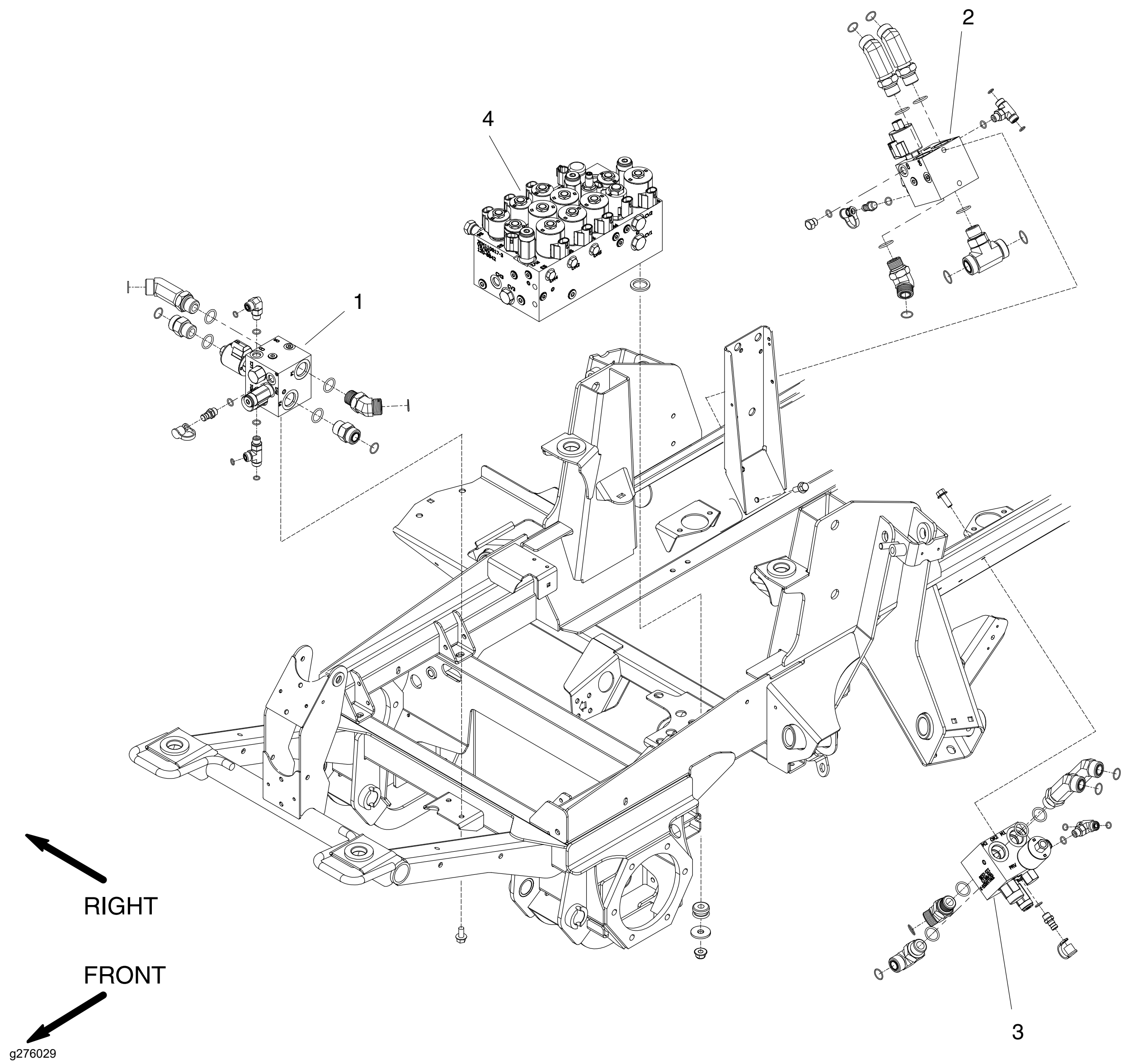


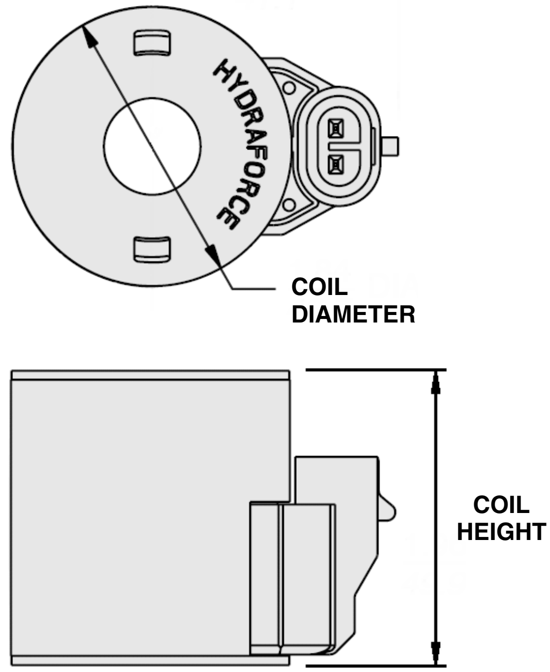
Figure 220

1. Front PTO manifold
2. RH PTO manifold
3. LH PTO manifold
4. Combination manifold

Several hydraulic solenoid valve coils are used on the hydraulic control manifolds of Groundsmaster 4100−D and 4110−D machines. When energized by the TEC controller, these coils provide hydraulic circuit control.

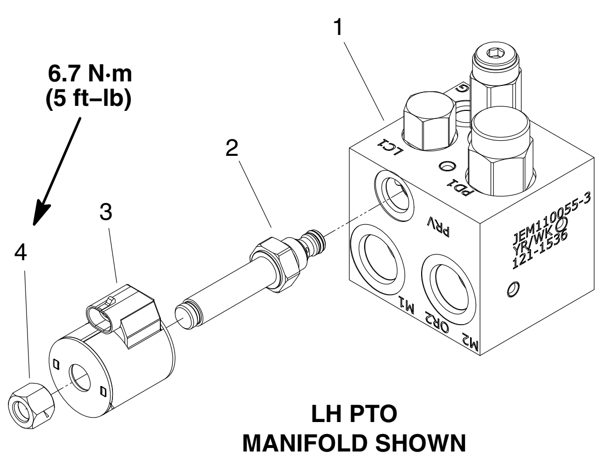
Solenoid valve coils with two (2) different resistance specifications are used on the 4100−D and 4110−D. The correct resistance of a coil can be identified by measuring the height and diameter of the coil (Figure 221). Resistance testing of the coils can be done with the coil remaining on the hydraulic valve.

Note: To assist in troubleshooting, identical solenoid coils can be exchanged. If the problem follows the exchanged coil, a problem with the coil likely exists. If the problem remains unchanged, something other than the solenoid coil is the problem source (e.g. switch, circuit wiring, hydraulic problem). Refer to your *Parts Catalog* to determine if solenoid coils are identical.



g276030

Figure 221



g276031

Figure 222

1. Hydraulic manifold
2. Cartridge valve
3. Solenoid coil
4. Nut

Testing

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the key switch.
2. Locate hydraulic solenoid valve coil to be tested (Figure 220). Disconnect wire harness connector from coil.
3. Identify coil resistance specification by measuring the coil diameter and coil height (Figure 221).

Testing (continued)

Note: Prior to taking small resistance readings with a digital multimeter, short the meter test leads together. The meter will display a small resistance value (usually 0.5 ohms or less). This resistance is due to the internal resistance of the meter and test leads. Subtract this value from the measured value of the component you are testing.

4. Using a multimeter (ohms setting), measure resistance between the two (2) connector terminals on the solenoid valve coil. The correct resistance for the solenoid coil is identified below:

COIL DIAMETER	COIL HEIGHT	COIL RESISTANCE
34.0 mm (1.34 in)	38.9 mm (1.53 in)	5.4 ohm
46.7 mm (1.84 in)	49.9 mm (1.96 in)	7.1 ohm
35.8 mm (1.41 in)	36.3 mm (1.43 in)	8.8 ohm

Note: Solenoid valve coil resistance should be measured with solenoid at approximately 20 ºC (68 ºF). Resistance may be slightly different than listed at different temperatures. Typically, a failed solenoid coil will either be shorted (very low or no resistance) or open (infinite resistance).

5. If solenoid valve coil resistance is incorrect, replace solenoid coil:

   A. Remove nut securing solenoid coil to the cartridge valve. Carefully slide coil off the valve.

   B. Install new solenoid coil to the cartridge valve. Install and torque nut **6.7 N·m (5 ft−lb)**. Over−tightening may damage the solenoid coil or cause the cartridge valve to malfunction.

6. After testing is completed, connect wire harness connector to the solenoid coil.

Piston (Traction) Pump Control Solenoid Coils

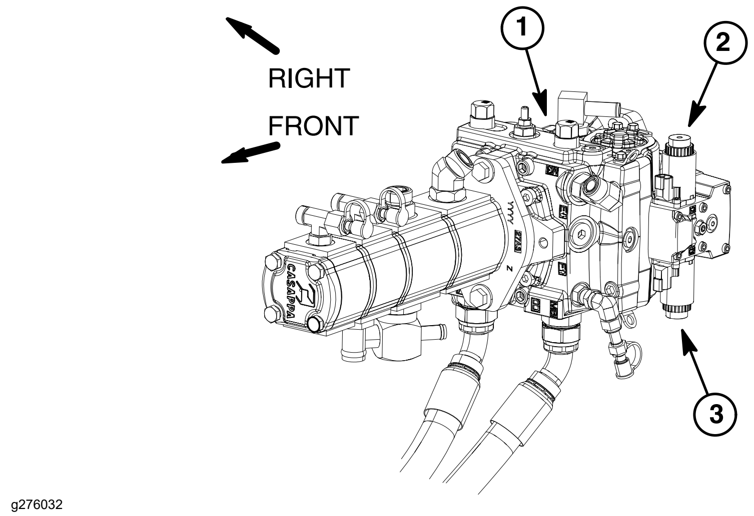


Figure 223

(For machines serial number below: 400000000)

1. Piston pump
2. Forward solenoid coil
3. Reverse solenoid coil

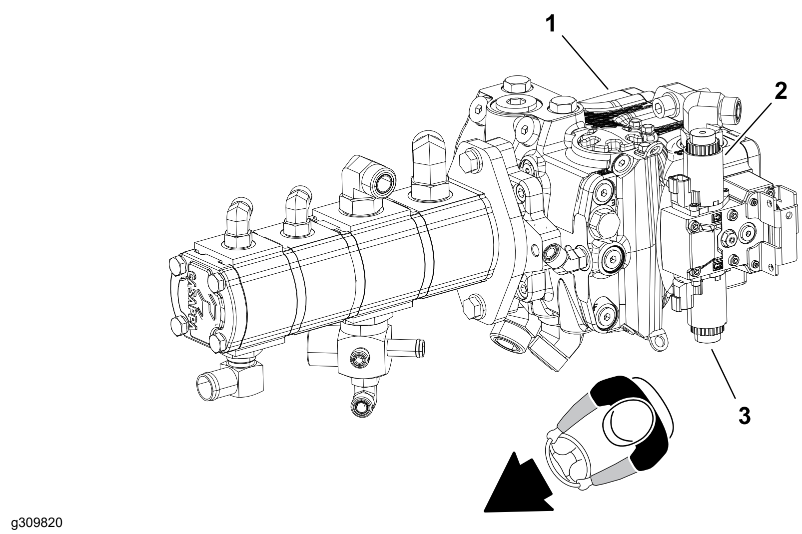


Figure 224

(For machines serial number above: 400000000)

1. Piston pump
2. Forward solenoid coil
3. Reverse solenoid coil

The piston (traction) pump uses an electronic control assembly for swash plate rotation. Electrical outputs from the machine TEC controller are provided to two (2) solenoid coils for pump control. The piston pump control assembly is attached to the left side of the piston pump (Figure 223 or Figure 222).

Note: To assist in troubleshooting, the piston pump solenoid coils can be exchanged because they are identical. If the problem follows the exchanged coil, a problem with the coil likely exists. If the problem remains unchanged, something other than the solenoid coil is the problem source (e.g. traction pedal, circuit wiring, hydraulic problem).

Solenoid Coil Testing

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the key switch.
2. Locate piston pump solenoid coil to be tested (Figure 223 or Figure 222). Disconnect wire harness connector from solenoid coil.

   Note: Prior to taking small resistance readings with a digital multimeter, short the meter test leads together. The meter will display a small resistance value (usually 0.5 ohms or less). This resistance is due to the internal resistance of the meter and test leads. Subtract this value from the measured value of the component you are testing.

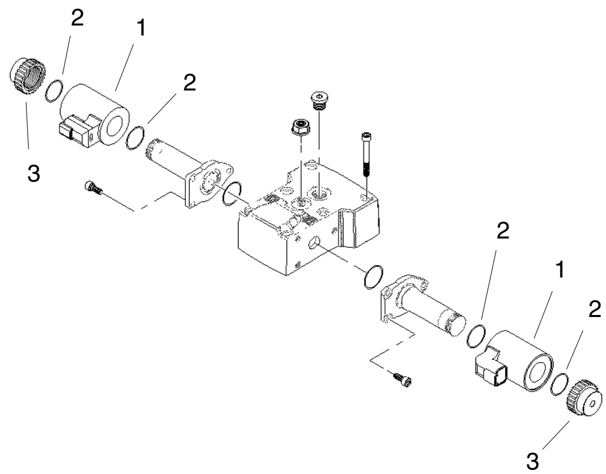


Figure 225

1. Solenoid coil
2. O−ring
3. Coil nut

3. Using a multimeter (ohms setting), measure resistance between the two (2) connector terminals on the solenoid coil. Solenoid coil resistance should be 3.66 ohms.

   Note: Solenoid coil resistance should be measured with solenoid at approximately 20 ºC (68 ºF). Resistance may be slightly different than listed at different temperatures. Typically, a failed solenoid coil will either be shorted (very low or no resistance) or open (infinite resistance).

4. If solenoid coil resistance is incorrect, replace coil:
   A. Use a 12 point, 26 mm socket to loosen and remove the coil nut that secures solenoid coil.
   B. Slide solenoid coil and O−rings from valve stem. Clean all corrosion or dirt from the valve.
   C. Slide new coil with O−rings onto the solenoid stem.
   D. Use a 12 point, 26 mm socket to install and torque coil nut to **5 N·m (44 in−lb)** (do not over−tighten coil nut).
5. After testing is completed, connect wire harness connector to the solenoid coil.

CAN−bus Termination Resistor

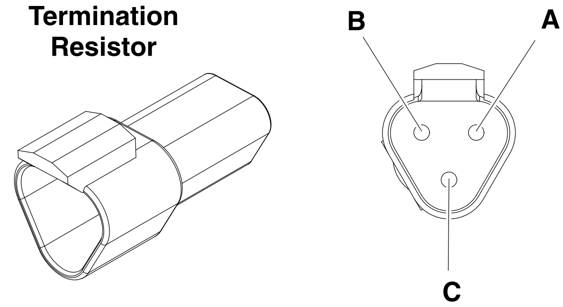


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Figure 226

System communication between electrical components on Groundsmaster 4100−D and 4110−D machines is accomplished on a CAN−bus communication system. Two (2) specially designed, twisted wires form the bus for the network used on the machine. These wires provide the data pathways between machine components. At the end of the twisted pair of bus wires near the InfoCenter display is a 120 ohm termination resistor.

The CAN−bus termination resistor plugs into the platform wire harness in the control arm. The resistor can be accessed by removing the cover plate on the right side of the control arm. The wire harness connector has a blue insert to identify the proper location for the termination resistor.

Note: The Groundsmaster 4100−D and 4110−D engine ECU includes the second CAN−bus system termination resistor. This resistor cannot be accessed for testing.

Note: Refer to the Electrical Schematics and Wire Harness Drawings in Appendix A (page A–1) for additional information on termination resistor location and wire connections.

IMPORTANT

The termination resistor is required for proper electrical system operation.

Termination Resistor Test

The termination resistor (Figure 226) can be tested using a digital multimeter (ohms setting). There should be 120 ohms resistance between terminals A and B of the termination resistor. Terminal C is not used on Groundsmaster 4100−D and 4110−D machines.

Diode Assemblies

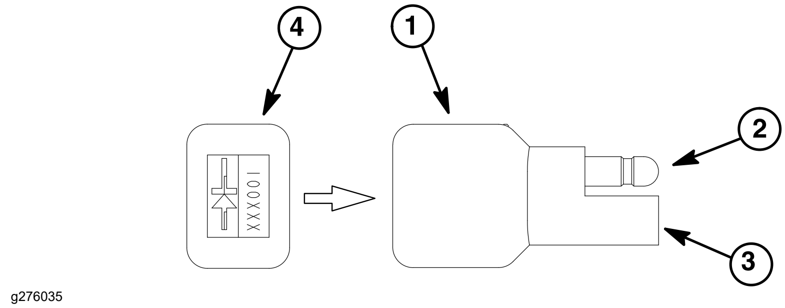


Figure 227

1. Diode assembly
2. Male terminal
3. Female terminal
4. End of diode body

The Groundsmaster engine wire harness contains a diode assembly that is used for circuit protection from voltage spikes when the engine starter solenoid is de−energized.

Groundsmaster models 30606, 30608 and 30644 use an additional diode assembly in the engine wire harness that protects the engine EGR circuit from reverse polarity.

The diode assemblies plug into the wiring harness near the engine starter motor (see Appendix A (page A–1)). The diode assemblies can be identified by a black color and diode symbol on end of diode assembly body.

Testing

The diode can be tested using a digital multimeter (diode test or ohms setting) and the table to the right.

Multimeter Red Lead (+) on Terminal	Multimeter Black Lead (−) on Terminal	Continuity
Female	Male	YES
Male	Female	NO

Resistor Assembly

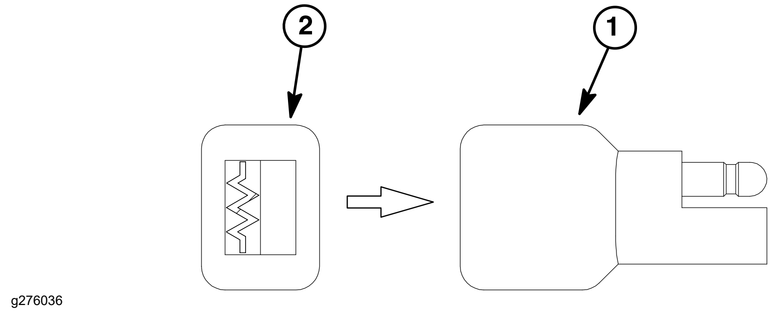


Figure 228

1. Resistor assembly
2. End of resistor body

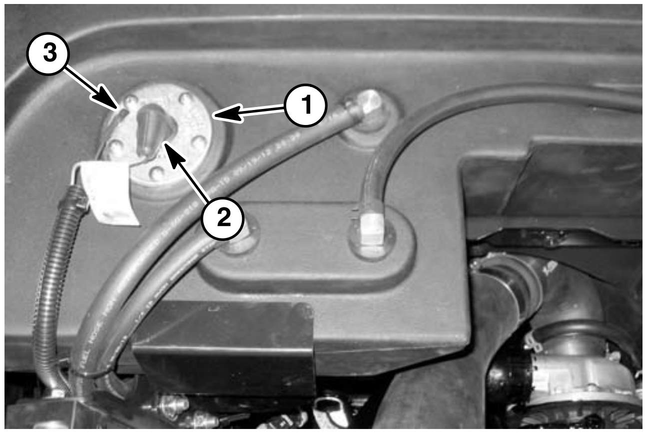
On Groundsmaster machines with an 80 Amp alternator (see Engine (Models 30602, 30604 and 30643) (page 2–4) and Engine (Models 30606, 30608 and 30644) (page 2–5)), the engine wire harness contains a resistor that is necessary for key switch operation. The resistor plugs into the wiring harness near the engine starter motor (see Appendix A (page A–1)).

The resistor assembly can be identified by its gray color and resistor symbol on end of resistor assembly body.

Testing

The resistor can be tested using a digital multimeter (ohms setting). The resistance across the resistor terminals should be 1.6K ohms.

Fuel Sender



g276037

Figure 229

1. Fuel sender
2. White (+) lead
3. Black (−) lead

The fuel sender is attached to the top of the fuel tank. The resistance of the fuel sender increases as the fuel level in the fuel tank decreases. The resistance signals from the fuel sender used as an input to generate an output for the InfoCenter fuel gauge.

Two (2) styles of fuel senders have been used on Groundsmaster 4100−D and 4110−D machines. Early production machines are equipped with a pivoting float design that has two (2) wire harness terminals (shown in Figure 229). Later machines have a sliding float design and a single harness connector.

Testing

1. Make sure key switch is OFF. Remove key from key switch.
2. Disconnect wire harness connector(s) at fuel sender.

CAUTION

If testing circuit wiring, make sure wire connections at fuel sender are secure before turning key switch to RUN to prevent an explosion or fire from sparks.

3. To test the circuit wiring and InfoCenter fuel gauge, use a jumper wire to connect the two (2) harness wires leading to the fuel sender and turn key switch to RUN. InfoCenter fuel gauge should indicate full. Turn key switch OFF and continue testing fuel sender if circuit wiring and gauge are acceptable.

Testing (continued)

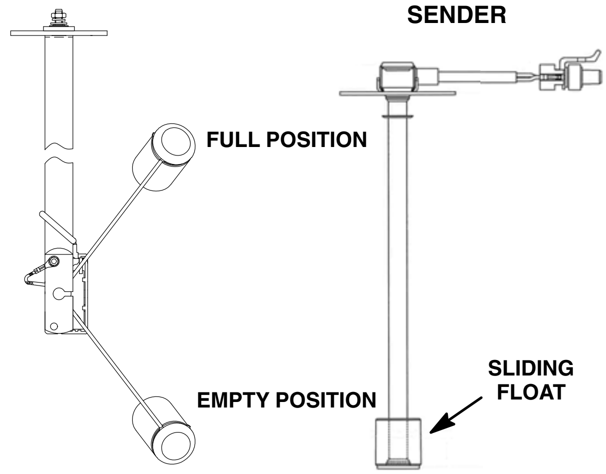


Figure 230

4. Remove screws and lock washers that secure the fuel sender to the fuel tank.
5. Carefully remove fuel sender and gasket from the fuel tank. Clean all fuel from the sender.

   Note: Before taking small resistance readings with a digital multimeter, short meter test leads together. The meter will display a small resistance value. This internal resistance of the meter and test leads should be subtracted from the measured value of the component.

CAUTION

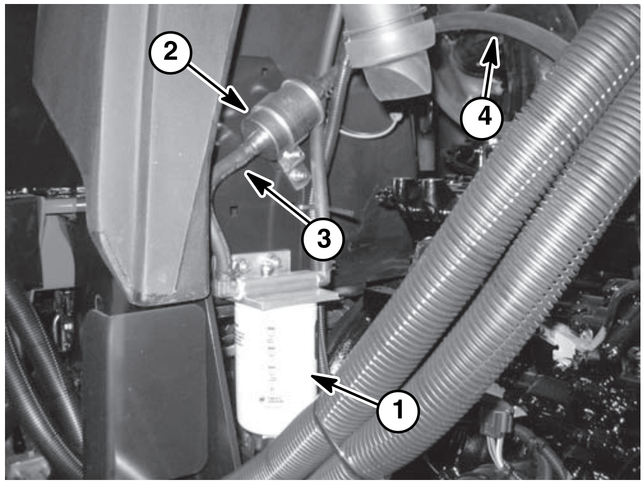
Make sure fuel sender is completely dry (no fuel on it) before testing. Perform test away from the fuel tank to prevent an explosion or fire from sparks.

6. Using a multimeter, check resistance of the sender with the float in the full and empty positions. Expected resistance values are shown in the table below.

CONNECTOR STYLE	RESISTANCE (FULL)	RESISTANCE (EMPTY)
Two Terminals	27.5 to 39.5 Ohms	240 to 260 Ohms
Single Connector	28 to 33 Ohms	240 to 250 Ohms

7. Replace sender as necessary. Carefully install sender into fuel tank and secure with removed fasteners.
8. Secure wire harness connector(s) to fuel sender. On two (2) terminal senders, apply skin−over grease (see Special Tools (page 2–17)) to sender terminals.

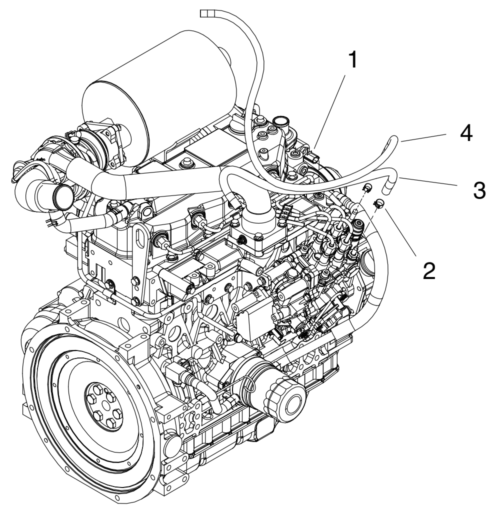
Fuel Pump (Models 30602, 30604 and 30643)



g276039

Figure 231

1. Fuel water separator
2. Fuel pump
3. Pump inlet hose
4. Pump discharge hose



g276040

Figure 232

1. Tier 4i engine
2. Hose clamp
3. Fuel supply hose
4. Fuel return hose

The fuel pump is attached to the fuel tank support above the fuel water separator (Figure 231).

Operational Test

1. Park machine on a level surface, lower cutting decks, stop engine and apply parking brake. Raise hood to access fuel pump.
2. Disconnect fuel pump discharge hose from the fuel injection pump fitting on the engine (Figure 232).
3. Make sure fuel hoses attached to the fuel pump are free of obstructions.
4. Place disconnected end of fuel pump discharge hose into a large, graduated cylinder sufficient enough to collect 0.95 liter (1 quart).

IMPORTANT

When testing fuel pump output, do not turn key switch to the START position.

5. Collect fuel in the graduated cylinder by turning key switch to the RUN position. Allow pump to run for fifteen (15) seconds, then turn switch to OFF.
6. The amount of fuel collected in the graduated cylinder should be approximately 475 ml (16 fl oz) after fifteen (15) seconds.
7. Replace fuel pump as necessary.

   Note: If fuel pump is replaced, make sure that replacement pump is the correct pump for your Groundsmaster by using your Parts Catalog. If incorrect pump is used, fuel system components can be damaged.
8. Install fuel hose to the water separator and secure with hose clamp.
9. Prime fuel system (see Priming the Fuel System (page 4–15)).
10. Lower and secure hood.

Fuel Pump Specifications

Pump Capacity	1.9 l/min (64 fl oz/min)
Pressure	48.3 kPa (7 PSI)
Current Draw	2.0 Amp

Fuel Pump (Models 30606, 30608 and 30644)

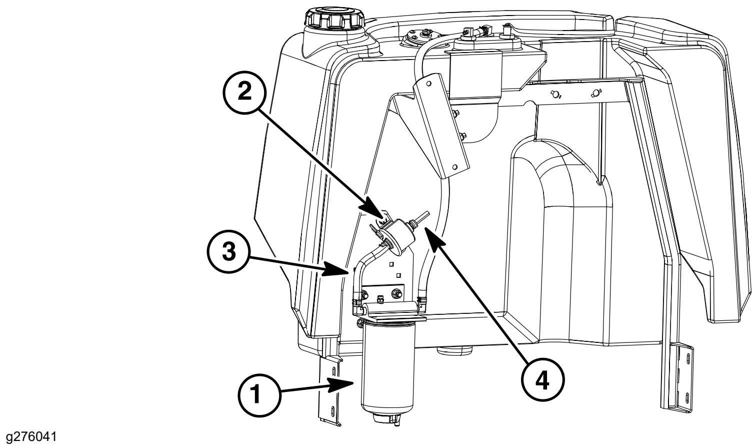


Figure 233

1. Fuel water separator
2. Fuel pump
3. Pump inlet hose
4. Pump discharge

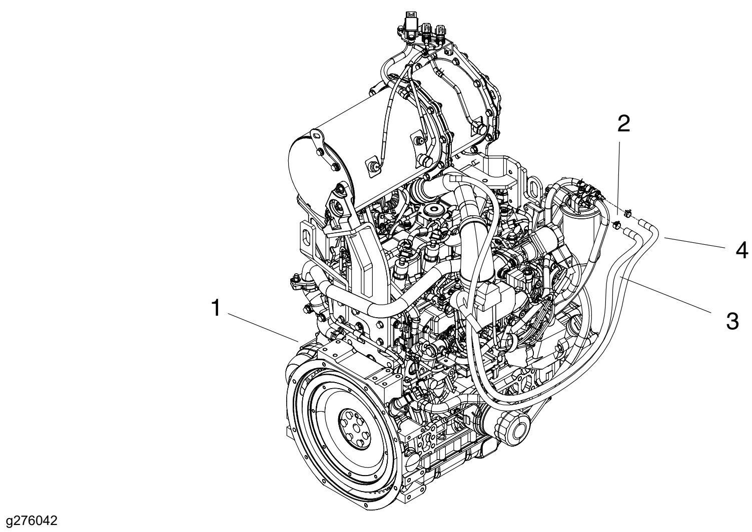


Figure 234

1. Tier 4 engine
2. Hose clamp
3. Pump discharge hose
4. Fuel return hose

The fuel pump is attached to the fuel tank support above the fuel water separator (Figure 233).

Operational Test

1. Park machine on a level surface, lower cutting decks, stop engine and apply parking brake. Raise hood to access fuel pump.
2. Disconnect fuel pump discharge hose from the fuel filter attached to the engine (Figure 234).
3. Make sure fuel hoses attached to the fuel pump are free of obstructions.
4. Place disconnected end of fuel pump discharge hose into a large, graduated cylinder sufficient enough to collect 0.95 liter (1 quart).

Operational Test (continued)

IMPORTANT

When testing fuel pump output, do not turn key switch to the START position.

5. Collect fuel in the graduated cylinder by turning key switch to the RUN position. Allow pump to run for thirty (30) seconds, then turn switch to OFF.
6. The amount of fuel collected in the graduated cylinder should be approximately 350 ml (11.8 fl oz) after thirty (30) seconds.
7. Replace fuel pump as necessary.

IMPORTANT

If fuel pump is replaced, make sure that replacement pump is the correct pump for your Groundsmaster by using your Parts Catalog. If incorrect pump is used, fuel system components can be damaged.

8. Install fuel hose to the engine mounted fuel filter and secure with hose clamp.
9. Prime fuel system (see Priming the Fuel System (page 4–15)).
10. Lower and secure hood.

Fuel Pump Specifications

Pump Capacity	700 ml/min (23.5 fl oz/min)
Pressure	22.8 kPa (3.3 PSI)
Current Draw	0.9 Amp

Wing Deck Position Switches

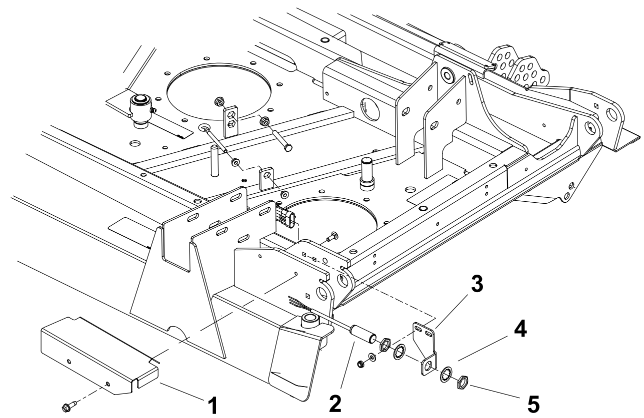


Figure 235

1. Switch cover
2. Position switch
3. Switch bracket
4. Lock washer (2 used)
5. Jam nut (2 used)

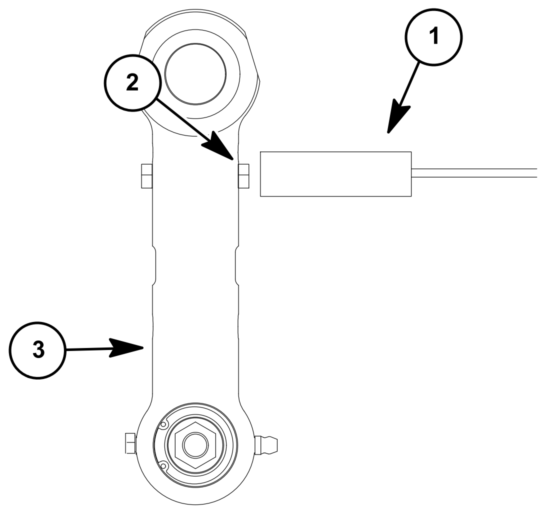


Figure 236

(For machines serial numbers below: 400000000)

1. Position switch
2. Bolt head
3. Wing deck link
4. Gap location

Two (2) wing deck position switches are used on the Groundsmaster 4100−D and 4110−D as inputs for the TEC controller. The position switches are powered proximity switches that are normally open. The switches incorporate an internal reed switch and a LED. These switches are secured to the center section of the cutting deck (Figure 235). A bolt head on the wing deck link is the sensing plate for the position switch (Figure 236).

When a wing deck is lowered, the bolt head on the wing deck link is positioned close to the position switch causing the switch to close. The closed switch provides an input for the TEC controller to allow wing deck operation. When a wing deck is raised, the bolt head on the wing deck link is moved away from the position switch so the switch is in its normally open state. The open position switch prevents wing deck operation when the wing deck is raised.

Testing

1. Before disconnecting a wing deck position switch for testing, the switch and its circuit wiring should be tested as a TEC input with the InfoCenter Display (see InfoCenter Display (page 6–7)). If the InfoCenter verifies that the deck position switch and circuit wiring are functioning correctly, no further switch testing is necessary. If, however, the InfoCenter determines that the deck position switch and circuit wiring are not functioning correctly, proceed with test.
2. Park machine on a level surface, lower cutting deck (including wing decks), stop engine and apply parking brake. Remove switch cover from deck to allow access to switch that requires testing (Figure 235).
3. Turn ignition switch to the ON position (do not start engine) and check LED on cable end of position switches. LED should be illuminated when the wing decks are fully lowered.
4. Start engine, fully raise wing decks and then stop engine. Then, turn ignition switch to the ON position (do not start engine) and check LED on cable end of position switches. LED should not be illuminated when the wing decks are fully raised.
5. Lower wing decks and then stop engine.
6. If a position switch LED did not function correctly:
   A. Make sure that ignition switch is OFF and disconnect the switch connector from deck wire harness.
   B. Using a multimeter, verify that wire harness connector terminal for pink wire has 12 VDC when the ignition switch is ON.
   C. Make sure that gap between end of position switch and bolt head on wing deck link when the wing deck is lowered is from **1.8 to 3.3 mm (0.070 to 0.130 in)** (Figure 236).
   D. If pink wire has system voltage present and gap is correct but switch LED did not function, replace position switch.
7. After testing is complete, make sure that switch connector is plugged into deck wire harness. Install switch cover to deck.

Hydraulic Oil Temperature Sender

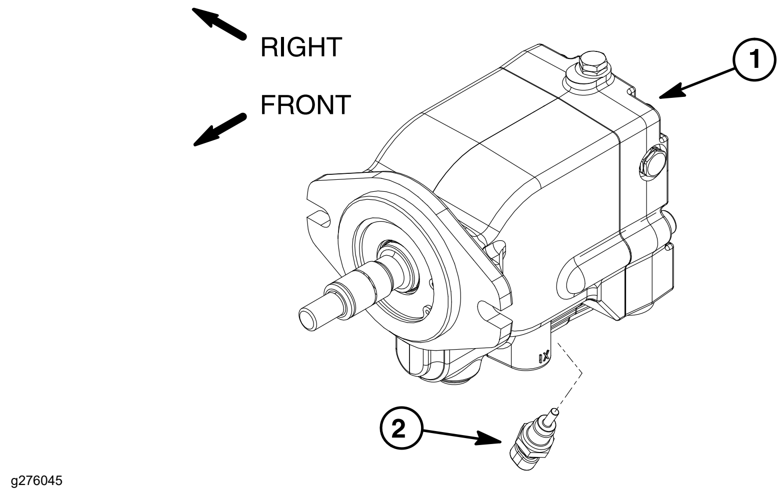


Figure 237

1. Rear axle motor
2. Oil temp sender

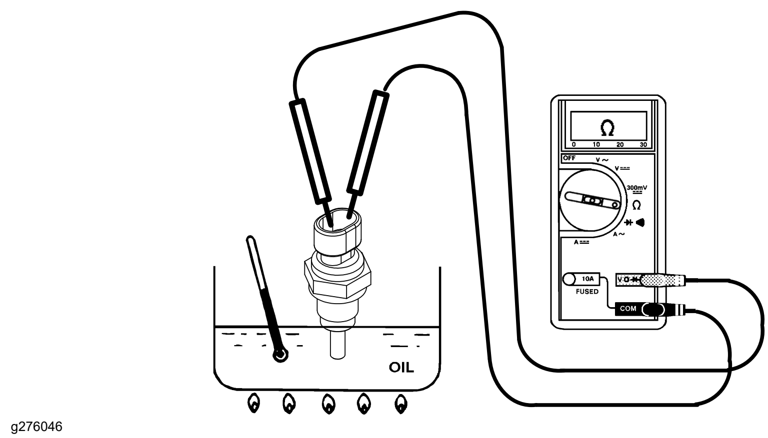


Figure 238

The Groundsmaster 4100−D and 4110−D use a temperature sender as an input for the TEC controller to identify if the hydraulic oil temperature has reached an excessive level. The hydraulic oil temperature sender is attached to the bottom of the rear axle motor (Figure 237).

The InfoCenter will display fault code 18 if the hydraulic oil temperature sender inputs to the TEC controller are not in the normal range.

Testing

1. Locate temperature sender in rear axle motor. Disconnect wire harness connector from sender and inspect connector or wiring for damage.
2. Place suitable drain pan under temperature sender in rear axle motor. Thoroughly clean area around temperature sender and remove sender from axle motor.
3. Put sensing end of sender in a container of oil with a thermometer and slowly heat the oil (Figure 238).

CAUTION

Handle the hot oil with extreme care to prevent personal injury or fire.

Note: Prior to taking resistance readings with a digital multimeter, short the meter test leads together. The meter will display a small resistance value (usually 0.5 ohms or less). This resistance is due to the internal resistance of the meter and test leads. Subtract this value from the measured value of the component you are testing.

Note: Use an infrared temperature instrument to measure the oil temperature.

4. Check resistance of the sender with a multimeter (ohms setting) as the oil temperature increases.
   A. The meter should indicate from 11.6 to 13.5 kilo ohms at 20 ºC (68 ºF).
   B. The meter should indicate from 2.3 to 2.5 kilo ohms at 60 ºC (140 ºF).
   C. The meter should indicate from 605 to 669 ohms at 100 ºC (212 ºF).
   D. Replace sender if specifications are not met.
5. After allowing the sender to cool, install sender:
   A. Install new O−ring on sender.
   B. Install sender into port and torque from **12.3 to 14.9 N·m (9 to 11 ft−lb)**.
   C. Connect wire harness connector to sender.
6. Check and fill hydraulic system to proper level.

Fan Speed Switch (Machines with Two−Post ROPS Extension Operator Fan Kit)

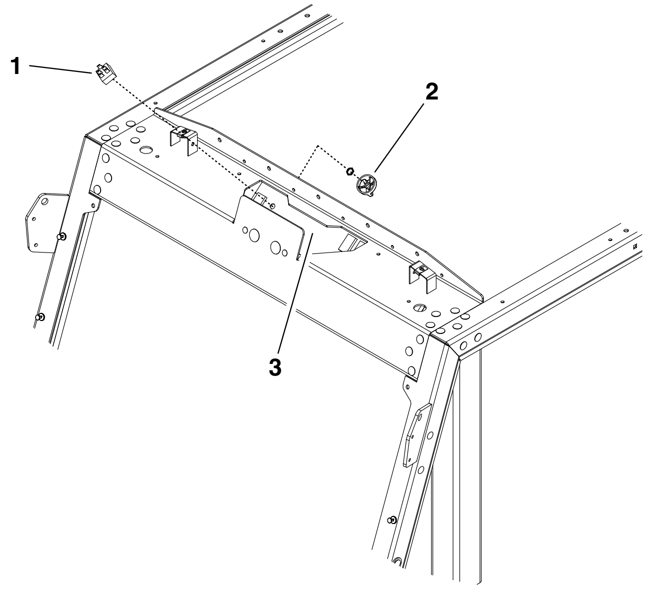


Figure 239

1. Fan speed switch
2. Control knob
3. Control panel

The fan speed switch is attached to the overhead control panel (Figure 239). The switch is used to select the fan speed (off, low, medium or high).

Testing

1. Park the machine on a level surface, lower the cutting decks, and shut off the engine. Remove the key from the key switch.
2. To access the switch, remove the sunshade from the top of the ROPS extension.
3. Disconnect the machine wire harness from the fan speed switch.

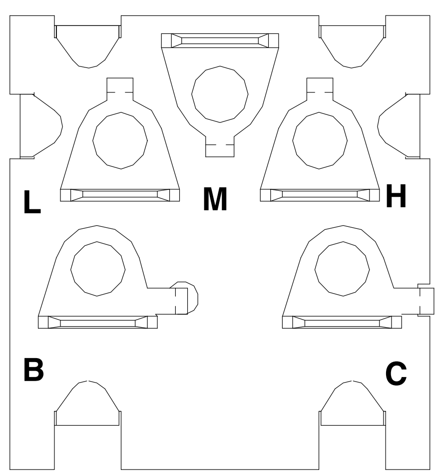


Figure 240

Testing (continued)

4. The switch terminals are identified in (Figure 240). With the use of a multimeter (ohms setting), test the switch functions to determine if continuity exists between only the terminals listed for each switch position. Check the continuity between the switch terminals.

Switch Position	Closed Circuits
OFF	L+H
LOW	B+C+L
MEDIUM	B+C+M
HIGH	B+C+H

5. Replace the fan speed switch if testing determines that the switch is damaged.
6. If the fan speed switch testing is correct and a circuit problem still exists, check the wire harness; refer to Electrical Schematics and Wire Harness Drawings in Appendix A (page A–1)-Foldout Drawings.
7. After you complete the testing, connect the machine wire harness to the switch and install the sunshade.

Resistor Module (Machines with Two−Post ROPS Extension Operator Fan Kit)

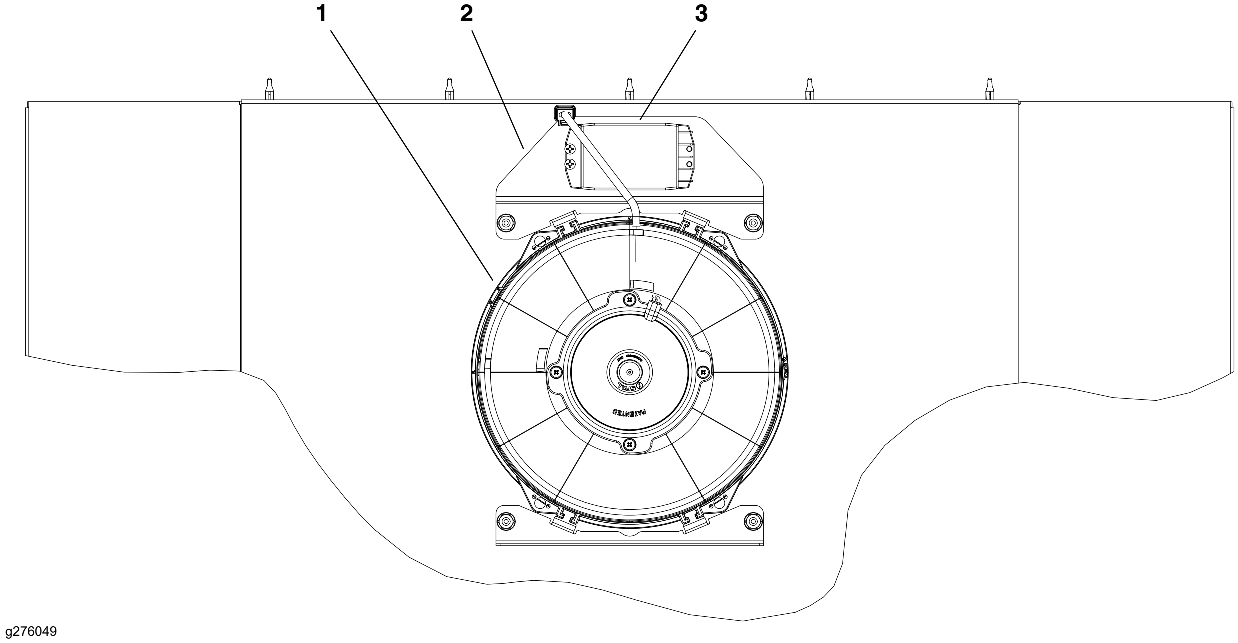


Figure 241

1. Operator’s fan
2. Fan mount bracket
3. Resistor module

The resistor module is attached to the rear of the fan mounting bracket (Figure 241). The resistor module is used for operation of the operator’s fan.

Testing

1. Park the machine on a level surface, lower the cutting decks, and shut off the engine. Remove the key from the key switch.
2. To access the resistor, remove the sunshade from the top of the ROPS extension.
3. Disconnect the wire harness connectors from the resistor module terminals.

Testing (continued)

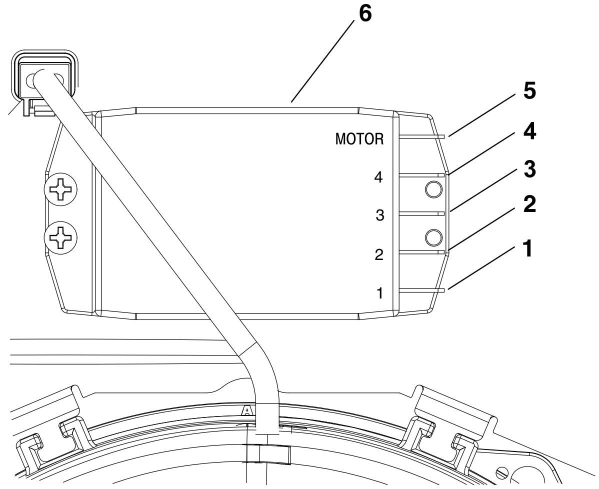


Figure 242

1. Pin 1 (Violet wire)
2. Pin 2 (Brown wire)
3. Pin 3 (Orange wire)
4. Pin 4 (Not used)
5. Motor pin
6. Resistor module

4. Use a multimeter to check that the resistance values of the resistor module as below (Figure 242).

Test Point 1	Test Point 2	Expected Reading
Motor Pin	Pin 1	Less than 9 ohms
Motor Pin	Pin 2	Less than 6 ohms
Motor Pin	Pin 3	Less than 3 ohms

5. Replace the resistor module if it fails the test.
6. If the resistor module testing is correct and a circuit problem still exists, check the wire harness; refer to Electrical Schematics and Wire Harness Drawings in Appendix A (page A–1)-Foldout Drawings.
7. After you complete the testing, connect the wire harness connectors to the resistor module terminals (Figure 242) and install the sunshade.

Audio Alarm

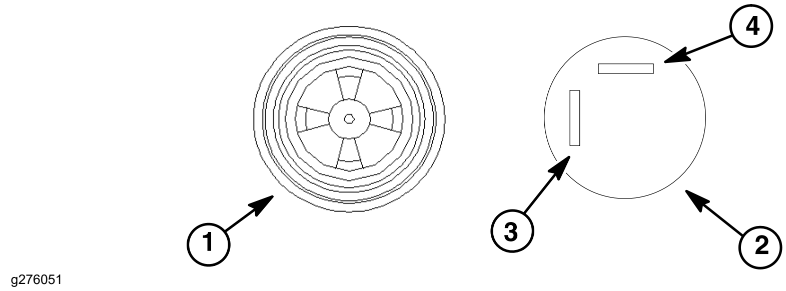


Figure 243

1. Alarm top view
2. Alarm bottom view
3. Positive (+) terminal
4. Negative (−) terminal

The audio alarm sounds to notify the operator when a machine problem exists. TEC controller detects the requirement for alarm and sends signals to InfoCenter. The InfoCenter provides the ground to the electrical current for the alarm. The alarm is attached to the control arm next to the operator seat.

If the alarm is “stuck on”, the ground wire is shorted between the InfoCenter and the alarm or the InfoCenter is internally shorted. between the terminals 5 and 1. Test for outside circuit load/spike causing this internal damage.

Testing

1. Make sure key switch is OFF. Remove key from key switch.
2. Disassemble control arm to gain access to the audio alarm (see Control Arm (page 8–12)).
3. Disconnect wire harness connector from alarm.

IMPORTANT

Make sure to observe polarity on the alarm terminals when testing. Damage to the alarm may result from an improper connection.

4. Correctly connect 12VDC source to the alarm terminals (Figure 243).
5. Alarm should sound as long as 12VDC is connected to the alarm terminals.
6. Disconnect voltage source from the alarm. Reconnect harness connector to alarm.
7. Assemble control arm (see Control Arm (page 8–12)).

Service and Repairs

Note: For engine component repair information (e.g. starter motor), refer to the *Yanmar Workshop Manual* that is correct for your Groundsmaster model.

Battery Care

1. The top of the battery must be kept clean. If the machine is stored in a location where temperatures are extremely high, the battery will discharge more rapidly than if the machine is stored in a location where temperatures are cool.

WARNING

Wear safety goggles and rubber gloves when working with electrolyte. Charge battery in a well ventilated place so gasses produced while charging can dissipate. Since the gases are explosive, keep open flames and electrical sparks away from the battery; do not smoke. Nausea may result if the gases are inhaled. Unplug charger from electrical outlet before connecting or disconnecting charger leads to or from battery posts.

IMPORTANT

Do not remove fill caps (if equipped) while cleaning the battery.

2. Check battery condition weekly or after every 50 hours of operation. Keep terminals and entire battery case clean because a dirty battery will discharge slowly.

   A. Clean battery by washing entire case with a solution of baking soda and water. Rinse with clear water.

   B. Coat battery posts and cable connectors with battery terminal protector (Toro Part No. 107−0392) or petroleum jelly to prevent corrosion.

3. Battery cables must be tight on terminals to provide good electrical contact.

WARNING

Connecting battery cables to the wrong battery post could result in personal injury and/or damage to the electrical system.

4. If corrosion occurs at terminals, disconnect cables. Always disconnect negative (−) cable first. Clean clamps and terminals separately. Reconnect cables with positive (+) cable first. Coat battery posts and cable connectors with battery terminal protector (Toro Part No. 107−0392) or petroleum jelly to prevent corrosion.

5. If the battery electrolyte is accessible, check electrolyte level every 25 operating hours and every 30 days if machine is in storage. Maintain cell level with distilled water. Do not fill cells above the fill line.

Battery Storage

If the machine will be stored for more than 30 days:

1. Remove the battery and charge it fully (see Battery Service (page 6–91)).
2. Either store battery on a shelf or on the machine.
3. Leave battery cables disconnected if the battery is stored on the machine.
4. Store battery in a cool atmosphere to avoid quick deterioration of the battery charge.
5. To help prevent the battery from freezing, make sure it is fully charged (see Battery Service (page 6–91)).

Battery Service

The battery is the heart of the electrical system. With regular and proper service, battery life can be extended. Additionally, battery and electrical component failure can be prevented.

CAUTION

When working with batteries, use extreme caution to avoid splashing or spilling electrolyte. Electrolyte can destroy clothing and burn skin or eyes. Always wear safety goggles and a face shield when working with batteries.

Battery Specifications	BCI Group Size 34 690 CCA at −18 ºC (0 ºF) 110 minutes reserve capacity at 27 ºC (80 ºF)
Electrolyte Specific Gravity	Fully charged: 1.265 corrected to 27 ºC (80 ºF) Discharged: less than 1.240

Battery Removal and Installation (Figure 244)

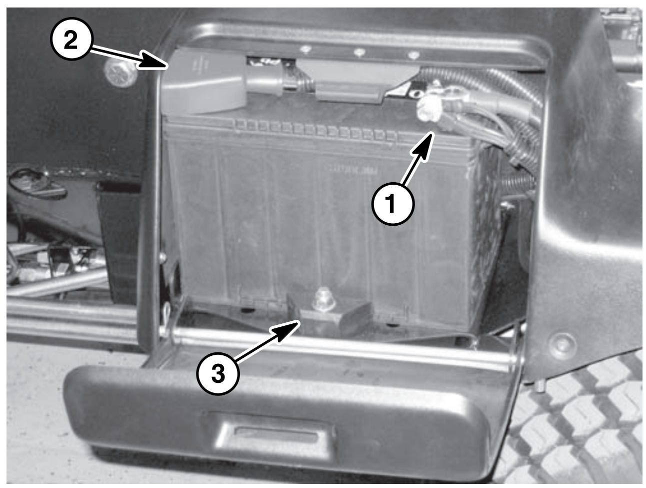


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Figure 244

1. Negative battery post
2. Positive battery post
3. Battery retainer

1. Open battery cover to access battery.
2. Loosen and remove negative cable from battery. After negative cable is removed, loosen and remove positive cable.
3. Loosen battery retainer and then carefully remove battery from machine.
4. Install battery in reverse order making sure to connect and tighten positive cable to battery before connecting negative cable.

   Note: Before connecting the negative (ground) cable to the battery, connect a digital multimeter (set to DC Amps) between the negative battery post and the negative (ground) cable connector. The reading should be less than 0.1 Amp. If the reading is 0.1 Amp or more, the machine's electrical system should be tested for short circuits or faulty components and repaired.
5. Secure battery to machine with battery retainer. Close battery cover.

Battery Inspection and Maintenance

1. Check battery for cracks. Replace battery if cracked or leaking.
2. Check battery terminal posts for corrosion. Use wire brush to clean corrosion from posts.

IMPORTANT

Before cleaning the battery, tape or block vent holes to the filler caps and make sure the caps are on tightly.

3. Check for signs of wetness or leakage on the top of the battery which might indicate a loose or missing filler cap, overcharging, loose terminal post or overfilling. Also, check battery case for dirt and oil. Clean the battery with a solution of baking soda and water, then rinse it with clean water.
4. Check that the cover seal is not broken away. Replace the battery if the seal is broken or leaking.
5. If the battery electrolyte is accessible, check the electrolyte level in each cell. If the level is below the tops of the plates in any cell, fill all cells with distilled water between the minimum and maximum fill lines. Charge at 15 to 25 Amps for fifteen (15) minutes to allow sufficient mixing of the electrolyte.

Battery Testing

1. Perform a high−discharge test with an adjustable load tester. This is one of the most reliable means of testing a battery as it simulates the cold−cranking test. A commercial battery load tester is required to perform this test.

CAUTION

Follow the manufacturer's instructions when using a battery load tester.

A. Check the voltage across the battery terminals prior to testing the battery. If the voltage is less than 12.4 VDC, charge the battery before performing a load test.

B. If the battery has recently been charged, use a battery load tester following the manufacturer's instructions to apply a 150 Amp load for fifteen (15) seconds. This step will remove the surface charge.

C. Make sure battery terminals are free of corrosion.

D. Estimate the internal temperature of the battery to the nearest 10 ºF.

E. Connect a battery load tester to the battery terminals following the manufacturer's instructions. Connect a digital multimeter to the battery terminals.

F. Apply a test load of 345 Amps (one half the cranking performance rating of the battery) to the battery for fifteen (15) seconds.

G. Take a battery voltage reading at fifteen (15) seconds, then remove the load.

H. Using the table in the column to the right, determine the minimum voltage for the battery temperature reading. If the test voltage is below the minimum voltage for the battery temperature, replace the battery. If the test voltage is at or above the minimum, return the battery to service.

Minimum Voltage	Battery Temperature	
9.6	70 ºF (and up)	21 ºC (and up)
9.5	60 ºF	16 ºC
9.4	50 ºF	10 ºC
9.3	40 ºF	4 ºC
9.1	30 ºF	-1 ºC
8.9	20 ºF	-7 ºC
8.7	10 ºF	-12 ºC
8.5	0 ºF	-18 ºC

2. If the battery electrolyte is accessible, the specific gravity of the electrolyte can be used to determine the battery condition.

IMPORTANT

Make sure the area around the cells is clean before opening the battery caps.

A. Measure the specific gravity of each cell with a hydrometer. Draw electrolyte in and out of the hydrometer barrel prior to taking a reading to warm− up the hydrometer. At the same time take the temperature of the cell.

B. Temperature correct each cell reading. For each 5.5 ºC (10 ºF) above 26.7 ºC (80 ºF) add 0.004 to the specific gravity reading. For each 5.5 ºC (10 ºF) below 26.7 ºC (80 ºF) subtract 0.004 from the specific gravity reading.

Example:

Cell Temperature: 100 ºF

Cell Gravity: 1.245

100 ºF minus 80 ºF equals 20 ºF

(37.7 ºC minus 26.7 ºC equals 11.0 ºC)

20 ºF multiply by 0.004/10 ºF equals 0.008

(11ºC multiply by 0.004/5.5ºC equals 0.008)

ADD (conversion above): 0.008

Correction to 26.7 ºC (80 ºF): 1.253

C. If the difference between the highest and lowest cell specific gravity is 0.050 or greater or the lowest cell specific gravity is less than 1.225, charge the battery. Charge at the recommended rate and time given in **Charging** or until all cells specific gravity is 1.225 or greater with the difference in specific gravity between the highest and lowest cell less than 0.050. If these charging conditions can not be met, replace the battery.

Battery Charging

To minimize possible damage to the battery and allow the battery to be fully charged, the slow charging method is presented here. This charging method can be accomplished with a constant current battery charger which is readily available.

CAUTION

Follow the manufacturer's instructions when using a battery charger.

Note: Using specific gravity of the battery electrolyte is the most accurate method of determining battery condition.

1. Determine the battery charge level from either its open circuit voltage or electrolyte specific gravity (if electrolyte is accessible).

Battery Charge Level	Open Circuit Voltage	Specific Gravity
100%	12.6	1.265
75%	12.4	1.225
50%	12.2	1.190
25%	12.0	1.155
0%	11.8	1.120

2. Determine the charging time and rate **using the battery charger manufacturer's instructions** or the following table.

Battery Reserve Capacity (Minutes)	Battery Charge Level (Percent of Fully Charged)			
	75%	50%	25%	0%
80 or less	3.8 hrs @ 3 Amps	7.5 hrs @ 3 Amps	11.3 hrs @ 3 Amps	15 hrs @ 3 Amps
81 to 125	5.3 hrs @ 4 Amps	10.5 hrs @ 4 Amps	15.8 hrs @ 4 Amps	21 hrs @ 4 Amps
126 to 170	5.5 hrs @ 5 Amps	11 hrs @ 5 Amps	16.5 hrs @ 5 Amps	22 hrs @ 5 Amps
171 to 250	5.8 hrs @ 6 Amps	11.5 hrs @ 6 Amps	17.3 hrs @ 6 Amps	23 hrs @ 6 Amps
above 250	6 hrs @ 10 Amps	12 hrs @ 10 Amps	18 hrs @ 10 Amps	24 hrs @ 10 Amps

CAUTION

Do not charge a frozen battery because it can explode and cause injury. Let the battery warm to 16 ºC (60 ºF) before connecting to a charger.

Charge the battery in a well−ventilated place to dissipate gases produced from charging. These gases are explosive; keep open flame and electrical spark away from the battery. Do not smoke. Nausea may result if the gases are inhaled. Unplug the charger from the electrical outlet before connecting or disconnecting the charger leads from the battery posts.

Battery Charging (continued)

3. Following the battery charger manufacturer's instructions, connect the charger cables to the battery. Make sure a good connection is made.

4. Charge the battery following the battery charger manufacturer's instructions.

5. While charging, occasionally check the battery. If the electrolyte is violently gassing or spewing or if the battery case feels hot to the touch, the charging rate must be lowered or temporarily stopped.

6. Determine if battery is fully charged before removing battery from charger. Either of the following procedures can be used:

   A. Continue charging and reduce charging rate as needed until a two (2) hour period results in no increase in voltage. Open circuit voltage should be approximately 12.6 volts for a fully charged battery.

   B. If the battery electrolyte is accessible, three (3) hours prior to the end of the charging, measure the specific gravity of a battery cell once per hour. The battery is fully charged when the cells are gassing freely at a low charging rate and there is less than a 0.003 change in specific gravity for three (3) consecutive readings.

Axles, Planetaries and Brakes

Table of Contents

General Information

Operator’s Manual

The *Operator’s Manual* provides information regarding the operation, adjustment procedures, and general maintenance for your Greensmaster machine. Refer to the *Operator’s Manual* for additional information when servicing the machine.

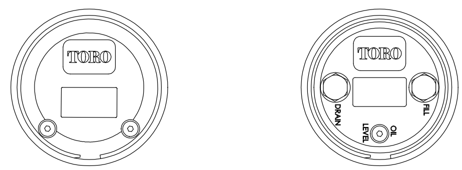
Adjustments

Planetary Drive Assembly Endplay (OPH−2 series planetary drives)

A front planetary drive assembly that is properly operating should have no endplay. Any endplay in a planetary assembly indicates that there are potential problems with the planetary. Check planetary endplay at intervals specified in your *Operator's Manual*.

Endplay Checking Procedure

1. Park machine on a level surface, lower cutting decks, stop engine and remove key from the key switch.



OPH–2 series planetary VA02 series planetary

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Figure 245

⚠ CAUTION ⚠

When raising and supporting machine, use correct jacks and supports. Make sure machine is parked on a solid, level surface such as a concrete floor. Prior to raising machine, remove any attachments that may interfere with the safe and proper raising of the machine. Always chock or block wheels. Use jack stands to support the raised machine. If the machine is not properly supported by jack stands, the machine may move or fall, which may result in personal injury.

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2. Chock rear wheels and jack up front of machine (see Jacking Instructions (page 1–7)). Support machine with jack stands.
3. Grasp front wheel and check for endplay in the planetary assembly as indicated by axial wheel movement. Make sure that there is no endplay in assembly.
4. If any endplay is detected, the planetary should be disassembled, inspected and serviced as necessary (see Planetary Drive Assembly (page 7–8)).
5. After planetary endplay checking is completed, lower machine to ground.

Service and Repairs

Brake Assembly

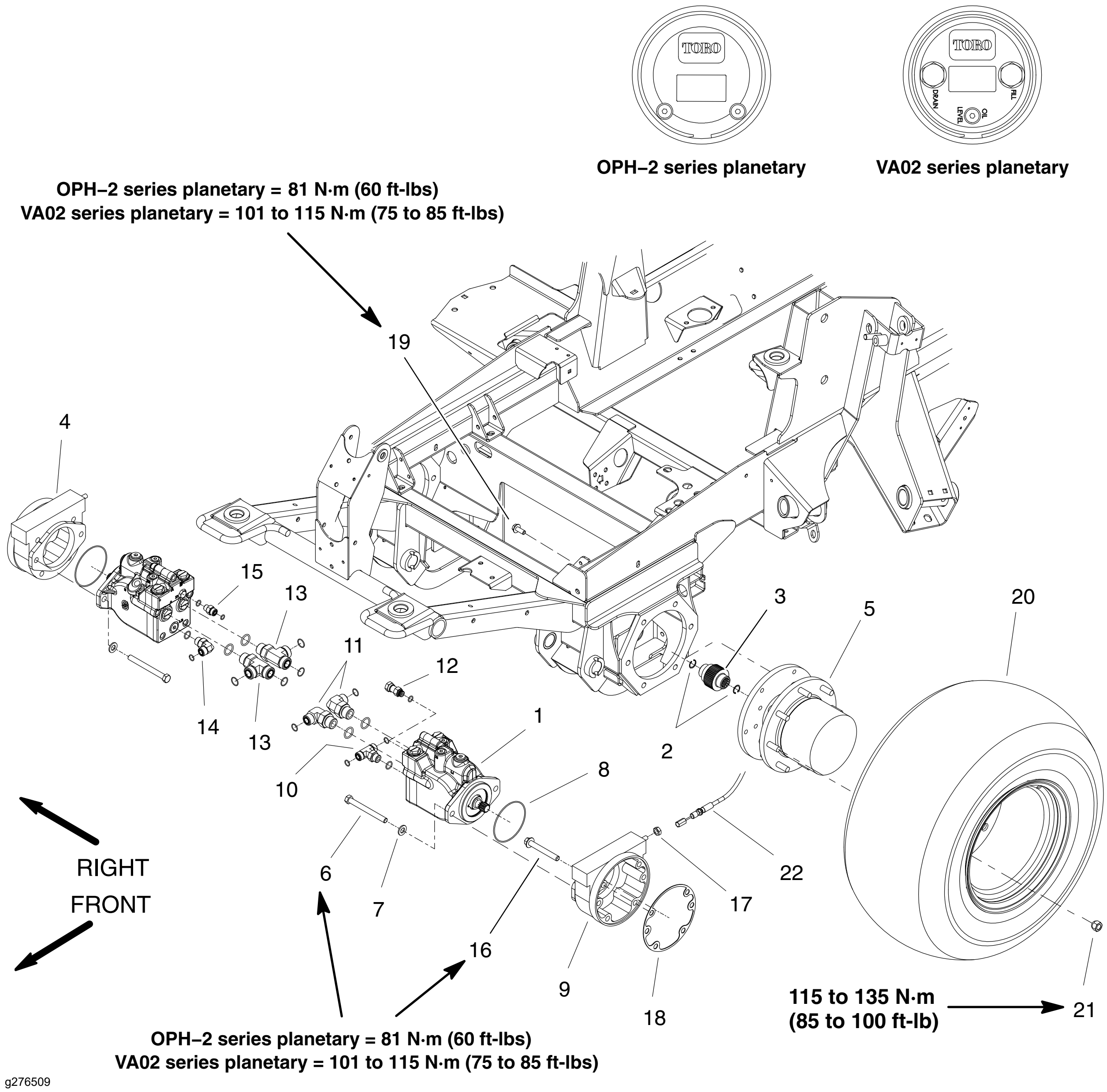

Figure 246

1. Front wheel motor
2. Internal retaining ring
3. Splined brake shaft
4. RH brake assembly
5. Planetary assembly (2 used)
6. Cap screw (2 used per motor)
   OPH−2 planetary = 120 mm lg
   VA02 planetary = 110 mm lg
7. Flat washer (2 used per motor)
8. O−ring
9. LH brake assembly
10. Hydraulic tee fitting
11. 90º hydraulic fitting (2 used)
12. Hydraulic connector
13. Hydraulic tee fitting (2 used)
14. 90º hydraulic fitting
15. Straight hydraulic fitting
16. Flange screw (4 used per brake)
    OPH−2 planetary = 90 mm lg
    VA02 planetary = 80 mm lg
17. Jam nut
18. Gasket
19. Flange screw (6 used per side)
20. Front wheel assembly
21. Lug nut (8 used per wheel)
22. Brake cable (RH shown)

Removal (Figure 246)

1. Park machine on a level surface, lower cutting decks, stop engine and remove key from the key switch.
2. Drain oil from planetary drive and brake assembly; refer to traction unit *Operator's Manual*.

CAUTION

When removing front wheel, use correct jacks and supports. Make sure machine is parked on a solid, level surface such as a concrete floor. Prior to raising machine, remove any attachments that may interfere with the safe and proper raising of the machine. Always chock or block wheels. Use jack stands to support the raised machine. If the machine is not properly supported by jack stands, the machine may move or fall, which may result in personal injury.

3. Chock rear wheels and jack up front of machine (see Jacking Instructions (page 1–7)). Support machine with jack stands.
4. Remove front wheel assembly.
5. Remove hydraulic wheel motor (see Front Wheel Motors (page 5–116)).
6. Disconnect brake cable from pull rod on brake assembly.
7. Support brake assembly to prevent it from falling.
8. Remove flange head screws (item 16) that secure brake assembly to frame.
9. Remove brake assembly from machine. Be careful to not drop splined brake shaft (item 3) as brake assembly is removed.
10. Remove splined brake shaft from brake assembly.
11. Remove and discard gasket (item 18). Make sure that all gasket material and sealant is removed from both brake and planetary assemblies.
12. Complete brake inspection and repair (see Brake Inspection and Repair (page 7–7)).

Installation (Figure 246)

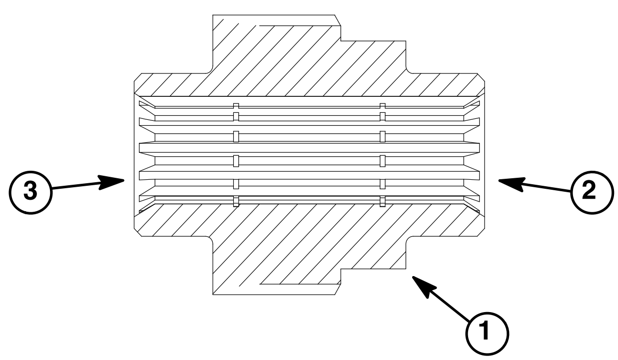

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Figure 247

1. Splined brake shaft step
2. Hydraulic motor end
3. Planetary assembly end

Note: The stepped end of the splined brake shaft must be aligned toward the hydraulic wheel motor (Figure 247).

1. Install splined brake shaft (item 3) into brake assembly. Make sure that splines engage rotating discs in brake assembly.

Installation (Figure 246) (continued)

2. Apply gasket sealant (Loctite #2 or equivalent) to sealing surfaces of new gasket (item 18). Align gasket and secure brake assembly to planetary.
   - For OPH−2 series planetary drives: tighten screws to **81 N·m (60 ft−lb)**.
   - For VA02 series planetary drives: tighten screws from **101 to 115 N·m (75 to 85 ft−lb)**.
3. Secure hex on end of brake cable to pull rod on brake assembly. Brake cable end should be completely threaded onto pull rod before tightening jam nut.
4. Make sure wheel motor O−ring (item 4) is in position and secure wheel motor to planetary with two (2) cap screws and flat washers.
   - For OPH−2 series planetary drives: tighten screws from **81 N·m (60 ft−lb)**.
   - For VA02 series planetary drives: tighten screws from **101 to 115 N·m (75 to 85 ft−lb)**.
5. Install wheel assembly.
6. Fill planetary drive with gear lube; refer to traction unit *Operator's Manual*. A portion of the gear lube will pass into the brake assembly automatically.

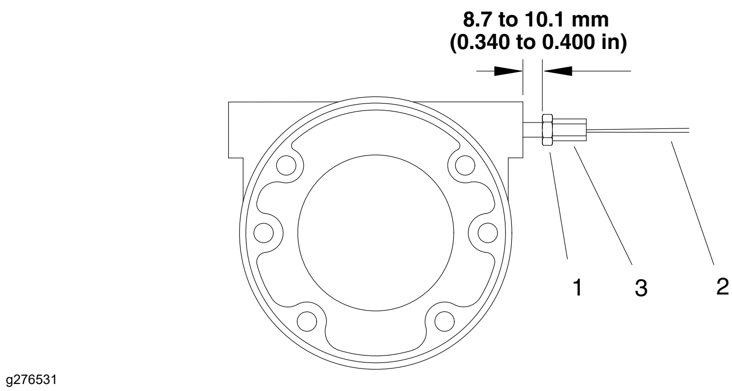

Figure 248

1. Pull rod jam nut
2. Brake cable
3. Brake cable hex

7. Check and adjust brake cables for proper brake operation. If necessary, adjust hex on end of brake cable so that pull rod jam nut is positioned from **8.7 to 10.1 mm (0.340 to 0.400 in)** from brake casting surface when brakes are disengaged (Figure 248). Brakes should be adjusted so that both brake pedals have approximately **25 mm (1 in)** of freeplay and have equal brake tension.

WARNING

Failure to maintain proper wheel lug nut torque could result in failure or loss of wheel and may result in personal injury.

8. Lower machine from jack stands. Torque lug nuts from **115 to 135 N·m (85 to 100 ft−lb)** in a crossing pattern.

Brake Inspection and Repair

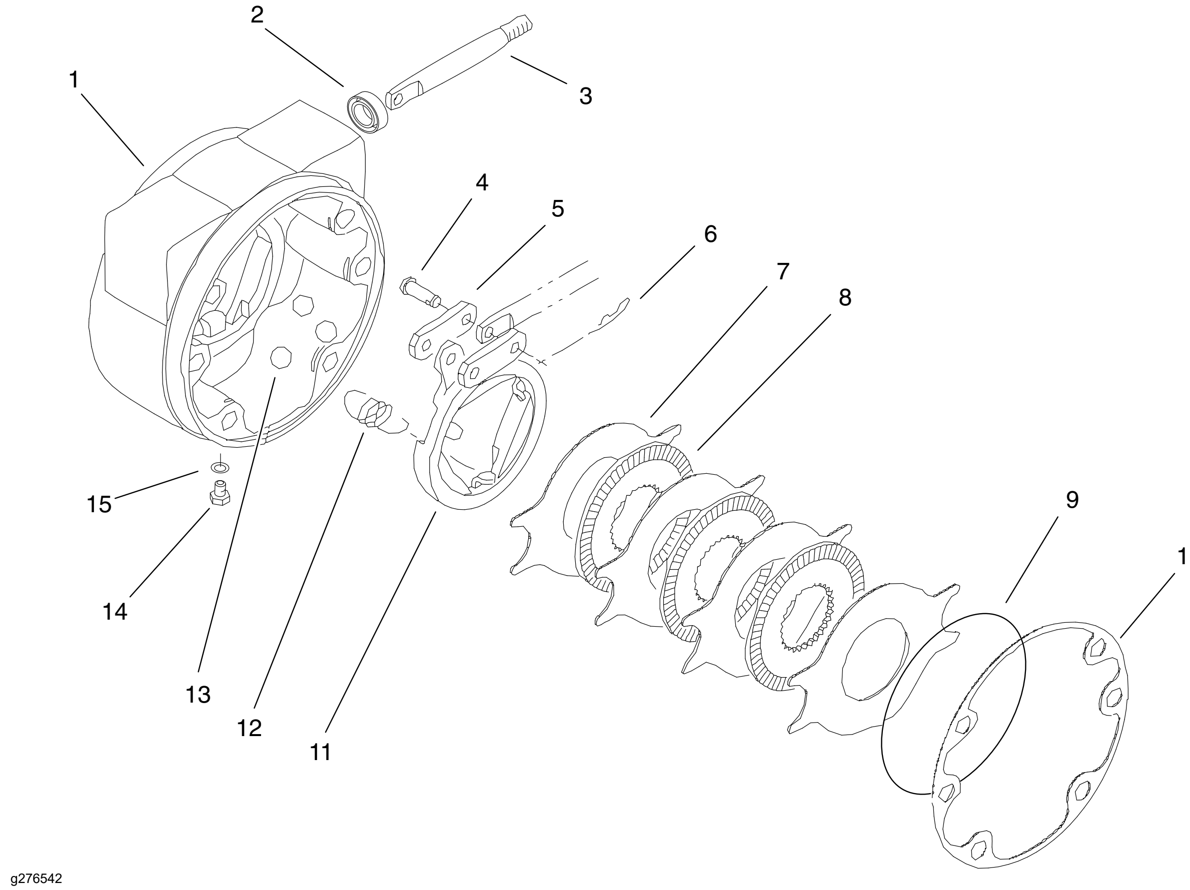

Figure 249

1. Brake housing (LH shown)
2. Seal
3. Pull rod
4. Clevis pin (2 used)
5. Link (2 used)
6. Hitch pin (2 used)
7. Stationary disc (4 used)
8. Rotating disc (3 used)
9. Retaining ring
10. Gasket
11. Rotating actuator
12. Extension spring (3 used)
13. Ball (3 used)
14. Plug
15. O−ring

Brake Inspection and Repair (Figure 249)

1. Scrape gasket material (item 10) from brake housing and planetary drive mounting surfaces.
2. Remove retaining ring (item 9) from brake housing groove.
3. Remove stationary discs (item 7) and rotating discs (item 8).
4. Remove extension springs (item 12).
5. Remove actuator assembly (items 11, 6, 5, 4 and 3) and balls (item 13).
6. Remove seal (item 2) from brake housing.
7. Wash parts in cleaning solvent. Inspect components for wear or damage.
8. Reverse steps 2 through 6 to assemble brakes, installing new parts as necessary. Install a new seal (item 2).
9. Use a new gasket (item 10) when installing brake assembly to machine.

Planetary Drive Assembly

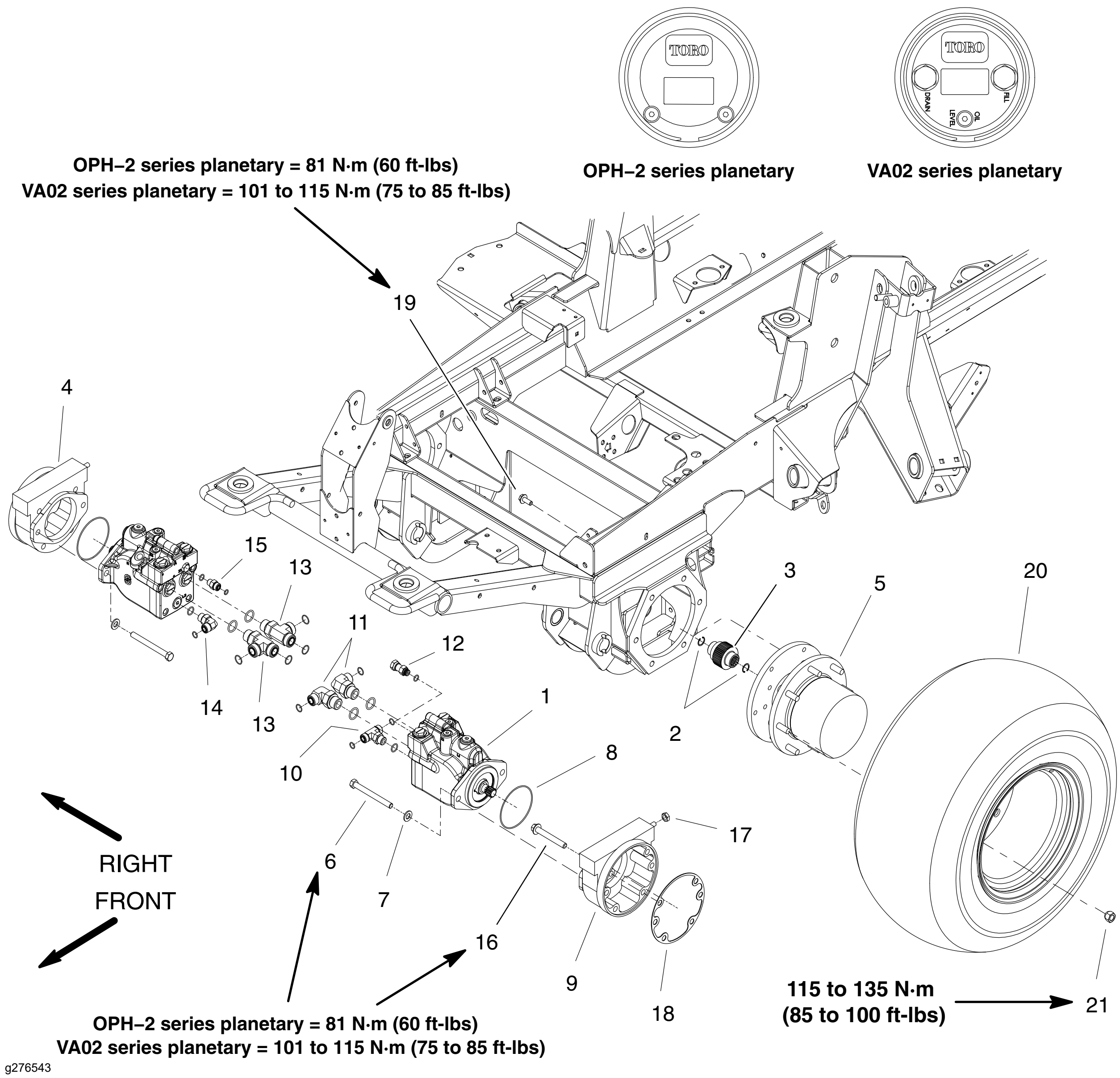

Figure 250

1. Front wheel motor
2. Internal retaining ring
3. Splined brake shaft
4. RH brake assembly
5. Planetary assembly (2 used)
6. Cap screw (2 used per motor)
   OPH−2 planetary = 120 mm lg
   VA02 planetary = 110 mm lg
7. Flat washer (2 used per motor)
8. O−ring
9. LH brake assembly
10. Hydraulic tee fitting
11. 90º hydraulic fitting (2 used)
12. Hydraulic connector
13. Hydraulic tee fitting (2 used)
14. 90º hydraulic fitting
15. Straight hydraulic fitting
16. Flange screw (4 used per brake)
    OPH−2 planetary = 90 mm lg
    VA02 planetary = 80 mm lg
17. Jam nut
18. Gasket
19. Flange screw (6 used per side)
20. Front wheel assembly
21. Lug nut (8 used per wheel)

Note: The planetary drive assembly can be serviced with the planetary installed to machine (see OPH−2 Series Planetary Drive Service (page 7–11)). Use the following procedure to remove and install the planetary drive assembly from the machine.

Removal (Figure 250)

1. Park machine on a level surface, lower cutting decks, stop engine and remove key from the key switch.
2. Drain the oil from the brake assembly and the Planetary drive; refer to the traction unit *Operator's Manual*.

⚠ CAUTION ⚠

When removing front wheel, use correct jacks and supports. Make sure machine is parked on a solid, level surface such as a concrete floor. Prior to raising machine, remove any attachments that may interfere with the safe and proper raising of the machine. Always chock or block wheels. Use jack stands to support the raised machine. If the machine is not properly supported by jack stands, the machine may move or fall, which may result in personal injury.

---

3. Chock rear wheels and jack up front of machine (see Jacking Instructions (page 1–7)). Support machine with jack stands.
4. Remove front wheel assembly.

   Note: The wheel motor and brake assembly fasteners thread into the planetary housing, and must be removed prior to removing the planetary drive from the machine.
5. Remove hydraulic wheel motor fasteners.
6. Remove brake assembly fasteners.
7. Support planetary assembly to prevent it from falling. Loosen and remove six (6) flange head screws that secure planetary assembly to frame. Remove planetary assembly from machine.
8. Remove and discard gasket (item 18). Make sure that all gasket material and sealant is removed from both the brake and the planetary assembly.

Installation (Figure 250)

1. Position planetary assembly to machine making sure to engage splined brake shaft with planetary drive shaft. Secure planetary assembly to frame with six (6) flange head screws.
   - For OPH−2 series planetary drives: tighten screws to **81 N·m (60 ft−lb)**.
   - For VA02 series planetary drives: tighten screws from **101 to 115 N·m (75 to 85 ft−lb)**.
2. Apply gasket sealant (Loctite #2 or equivalent) to sealing surfaces of new gasket (item 18). Align gasket and secure brake assembly to planetary (see Brake Assembly (page 7–4)).
   - For OPH−2 series planetary drives: tighten screws to **81 N·m (60 ft−lb)**.
   - For VA02 series planetary drives: tighten screws from **101 to 115 N·m (75 to 85 ft−lb)**.
3. Make sure wheel motor O−ring (item 4) is in position and secure wheel motor to planetary with two (2) cap screws and flat washers.
   - For OPH−2 series planetary drives: tighten screws from **81 N·m (60 ft−lb)**.
   - For VA02 series planetary drives: tighten screws from **101 to 115 N·m (75 to 85 ft−lb)**.
4. Install front wheel assembly.

Installation (Figure 250) (continued)

5. Fill planetary drive with gear lube; refer to traction unit *Operator's Manual*. A portion of the gear lube will pass into the brake assembly automatically.
6. Check and adjust the brake cables for proper brake operation.

WARNING

Failure to maintain proper wheel lug nut torque could result in failure or loss of wheel and may result in personal injury.

7. Lower machine from jack stands. Tighten lug nuts from **115 to 135 N·m (85 to 100 ft−lb)** in a crossing pattern.

OPH−2 Series Planetary Drive Service

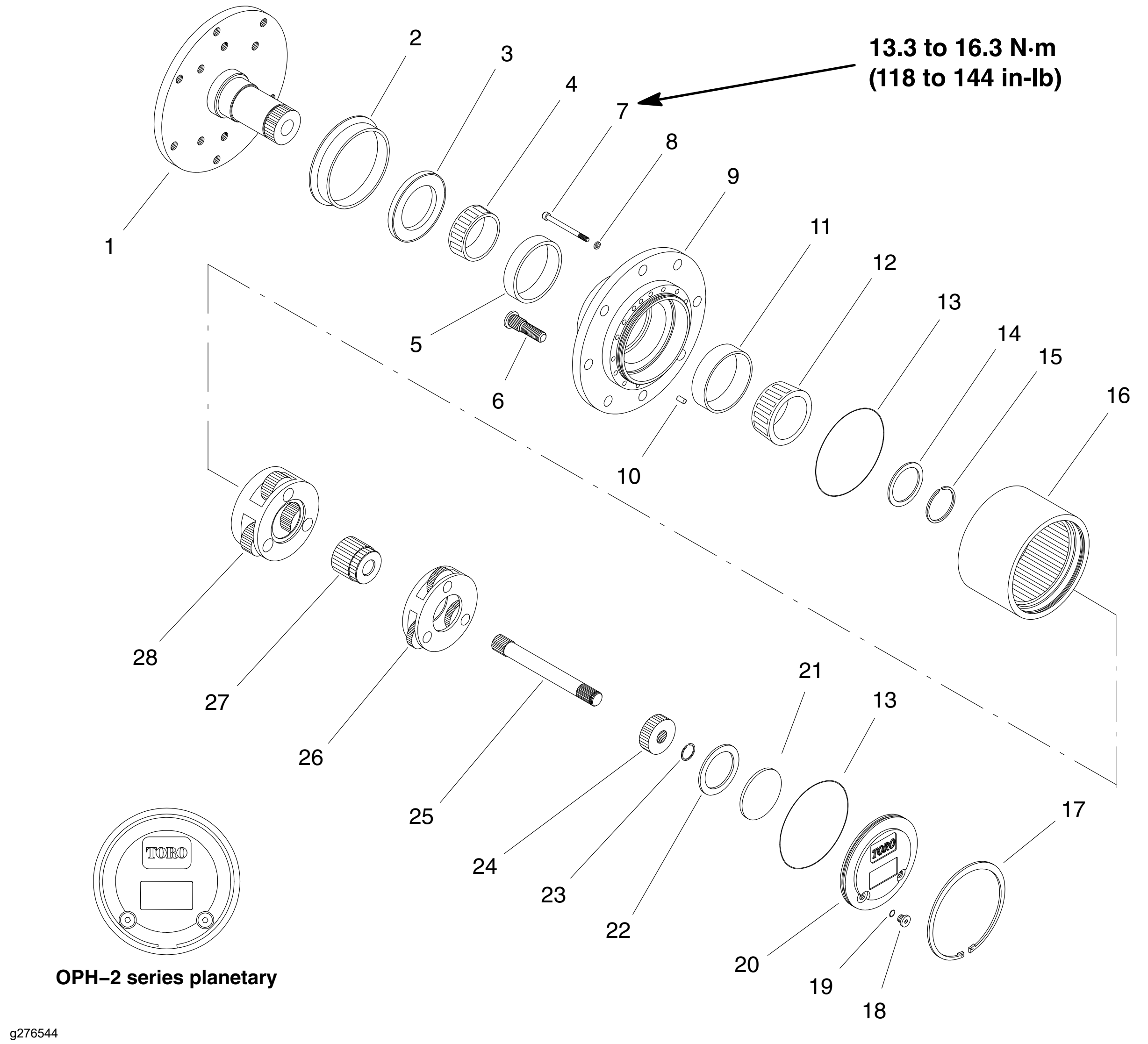

Figure 251

1. Spindle
2. Boot seal
3. Oil seal
4. Inner bearing cone
5. Inner bearing cup
6. Wheel stud (8 used)
7. Socket head screw (16 used)
8. Lock washer (16 used)
9. Housing
10. Dowel pin (2 used)
11. Outer bearing cup
12. Outer bearing cone
13. O−ring
14. Thrust washer
15. Retaining ring (external)
16. Ring gear
17. Retaining ring (internal)
18. Plug (2 used)
19. O−ring (2 used)
20. End cap
21. Thrust plug
22. Thrust washer
23. Retaining ring
24. Primary gear
25. Drive shaft
26. Primary carrier assembly
27. Secondary gear
28. Secondary carrier assembly

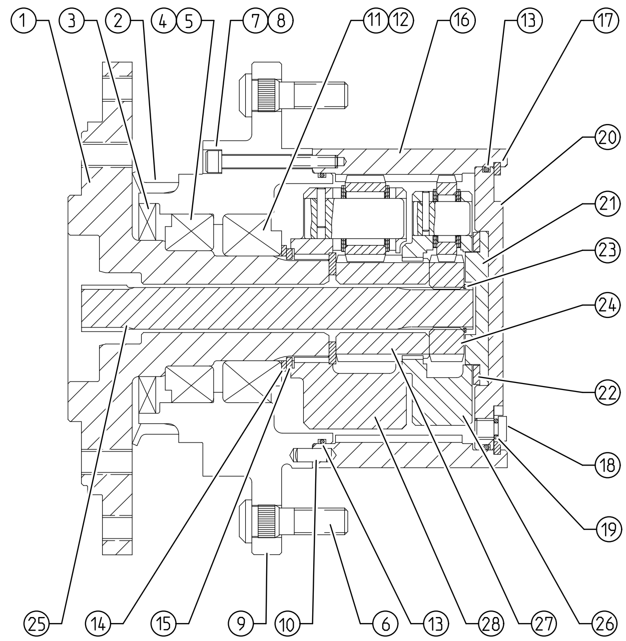

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Figure 252

1. Spindle
2. Boot seal
3. Oil seal
4. Inner bearing cone
5. Inner bearing cup
6. Wheel stud (8)
7. Socket head screw (16)
8. Lock washer (16)
9. Housing
10. Dowel pin (2)
11. Outer bearing cup
12. Outer bearing cone
13. O−ring
14. Thrust washer
15. Retaining ring (external)
16. Ring gear
17. Retaining ring (internal)
18. Plug (2)
19. O−ring (2)
20. End cap
21. Thrust plug
22. Thrust washer
23. Retaining ring
24. Primary gear
25. Drive shaft
26. Primary carrier assy.
27. Secondary gear
28. Secondary carrier assy.

Note: The planetary drive assembly can be serviced with the planetary installed to machine. If the spindle (item 1) needs to be removed, see Planetary Drive Assembly (page 7–8).

Disassembly (Figure 251 and Figure 252)

1. Park machine on a level surface, stop engine and remove key from the key switch.
2. Drain oil from planetary drive/brake assembly; refer to traction unit *Operator's Manual*.
3. Chock rear wheels and jack up front of machine (see Jacking Instructions (page 1–7)). Support machine with jack stands and remove front wheel assembly.
4. Remove retaining ring (item 17).
5. Remove end cap (item 20). Thrust plug (item 21) and thrust washer (item 22) usually remain in end cap bore and should be removed for cleaning and inspection.

Disassembly (Figure 251 and Figure 252) (continued)

6. Remove drive shaft assembly (items 23, 24 and 25) If necessary, remove retaining ring and primary gear from shaft.
7. Remove primary carrier (item 26), secondary gear (item 27) and secondary carrier (item 28).

   Note: Steps 6 through 10 are necessary only if inspecting or replacing bearings and/or seals.

IMPORTANT

Do not reuse retaining ring (item 10) after it has been removed.

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8. Remove retaining ring (item 15) and thrust washer (item 14). Discard retaining ring.
9. Carefully remove housing (item 9) from spindle (item 1). Remove outer bearing cone (item 12).
10. Remove and discard seals (items 2 and 3) and O− rings (item 13) from housing.
11. Remove inner bearing cone (item 4) from housing. If necessary, remove bearing cups (items 5 and 11) from housing.
12. If wheel stud (item 6) removal is necessary, use press to extract stud(s) from housing.
13. If necessary, remove socket head screws (item 7) with lock washers (item 8) that secure ring gear (item 16) to housing. Remove ring gear and two (2) dowel pins (item 10) from housing.

Assembly (Figure 251 and Figure 252)

1. Thoroughly clean parts in solvent and dry completely after cleaning. Inspect parts for damage or excessive wear and replace as necessary.
2. If any wheel studs were removed, use a press to install new studs into housing. Make sure that stud shoulder is fully pressed against housing surface.

   Note: Use new seal and shim kits when assembling planetary drive.

3. If spindle and housing were separated:

   A. Press bearing cups (items 5 and 11) into housing (item 9). Cups should be pressed fully to shoulder of the housing bore.

   B. Set inner bearing cone (item 4) into inner bearing cup.

   C. Make sure that seal bore in housing is thoroughly cleaned. If OD of seal (item 3) is not rubber or does not have a sealant coating, apply light coating of silicone sealant to seal bore in housing. Install seal into housing so it is flush with housing face. Lightly grease seal lips.

   D. Pack boot seal (item 2) with grease and install on housing.

   E. If ring gear was removed from housing, place dowel pins (item 10) in housing. Secure ring gear to housing with lock washers (item 8) and socket head screws (item 7). Torque socket head screws from **13.3 to 16.3 N·m (118 to 144 in−lb)**.

   F. Lightly oil bearing journals on spindle shaft. Slide housing assembly onto spindle (item 1) taking care to not damage seal or spindle. Make sure that inner bearing in housing fully seats against spindle shaft shoulder.

   G. Install outer bearing cone (item 12) onto spindle.

Assembly (Figure 251 and Figure 252) (continued)

Note: The planetary shim kit includes the retaining ring and several thrust washers with thickness in incremental steps of **0.10 mm (0.004 in)**. Refer to your *Parts Catalog* to identify the correct part number for the planetary shim kit.

H. Measure thickness of thrust washer (item 14) that was removed during disassembly. Choose new thrust washer of equal thickness or the next available thickness from thrust washers in the shim kit.

I. Apply a light coating of oil to spindle shaft, thrust washer (item 14) and new retaining ring (item 15). Install thrust washer onto spindle shaft.

WARNING

If retaining ring (item 15) is not fully installed in spindle groove, loss of wheel and personal injury may result.

J. Carefully install new retaining ring (item 15) into the spindle shaft groove taking care to not distort ring. If the proper thrust washer has been installed, the retaining ring should fit tightly between the thrust washer and spindle groove. Tap the OD of the retaining ring starting in the center and working out toward each end to ensure that the retaining ring is properly seated into the spindle groove. Make sure that retaining ring ID is fully seated to spindle shaft groove.

K. After retaining ring is installed, make sure that there is no endplay in assembly. If required, remove retaining ring and install a thrust washer of different thickness to adjust endplay.

L. Install new O−ring (item 13) into groove in housing.

4. Install secondary carrier (item 28), secondary gear (item 27) and primary carrier (item 26) making sure that carrier gear teeth align with ring gear and spline on spindle shaft.
5. If primary gear (item 24) was removed from drive shaft, slide gear onto shaft and secure with retaining ring (item 23).
6. Install drive shaft assembly (items 25, 24 and 23) making sure that drive shaft spline aligns with carrier gears.
7. Install thrust plug (item 21) and thrust washer (item 22) into end cap (item 20). Make sure that thrust plug and thrust washer are captive on inside of end cap (item 20).
8. Install new O−ring (item 13) to end cap and then install end cap. Secure cap with retaining ring (item 17).
9. Check operation of planetary drive by hand. With a constant turning force applied, rotation of the planetary should be consistent. If there is more drag at certain points, gears are not rolling freely and the planetary should be examined for improper assembly or damaged components.
10. Install wheel assembly.
11. Fill planetary drive with gear lube; refer to traction unit *Operator's Manual*. A portion of the gear lube will pass into the brake assembly automatically.
12. Test planetary drive operation.

Assembly (Figure 251 and Figure 252) (continued)

⚠ WARNING ⚠

Failure to maintain proper wheel lug nut torque could result in failure or loss of wheel and may result in personal injury.

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13. Remove jack stands and lower machine to ground. Tighten wheel lug nuts in a crossing pattern from **115 to 135 N·m (85 to 100 ft−lb)**in a crossing pattern.

VA02 Series Planetary Drive Service

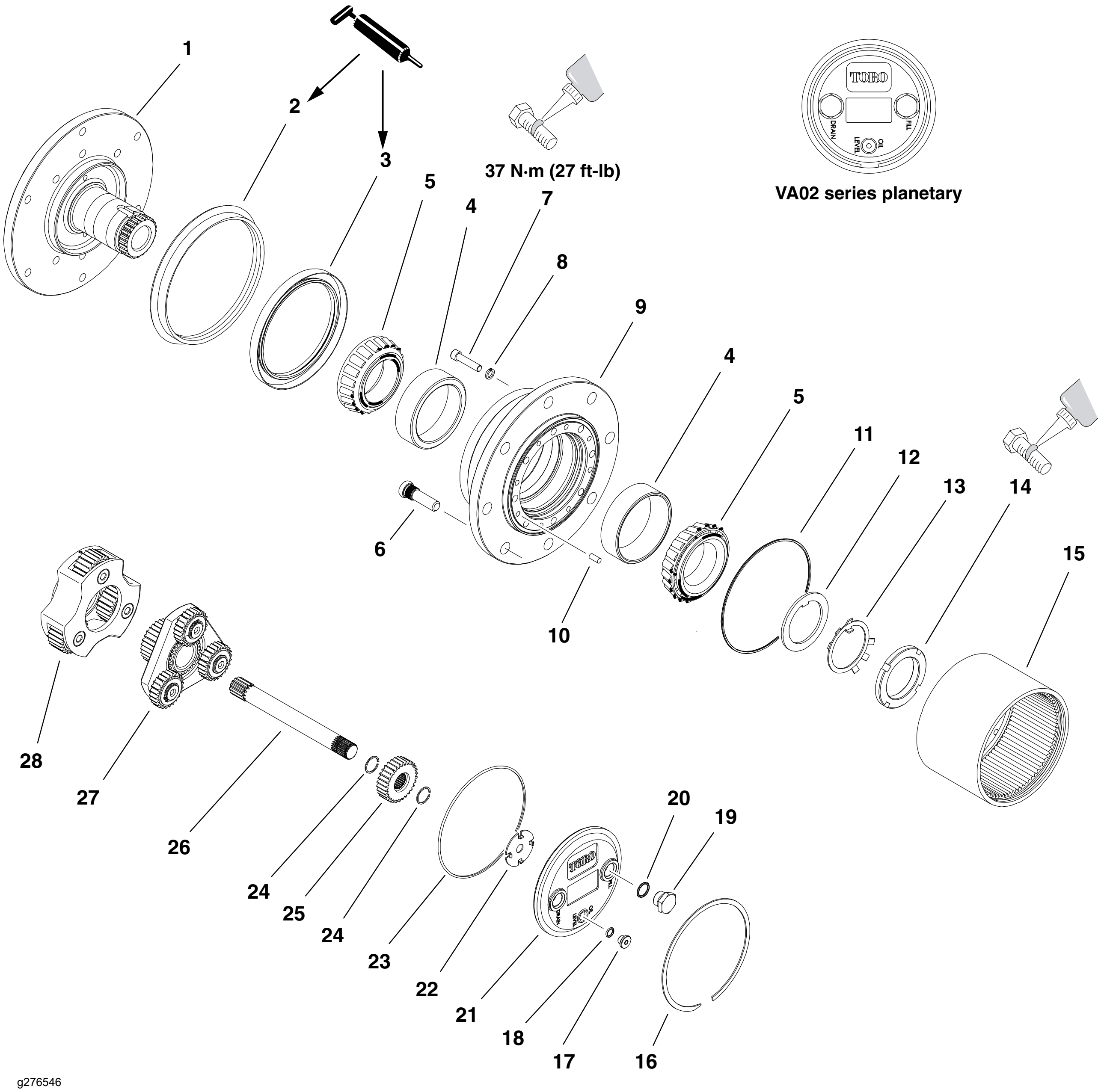

Figure 253

1. Spindle
2. Boot seal
3. Lip seal
4. Inner bearing cup (2)
5. Inner bearing cone (2)
6. Wheel stud (8)
7. Socket head screw (8)
8. Lock washer (8)
9. Housing
10. Dowel pin (4)
11. O−ring
12. Spacer
13. Locking washer
14. Lock nut
15. Ring gear
16. Retaining ring
17. Plug
18. O−ring
19. Plug (2)
20. O−Ring (2)
21. End cap
22. Thrust plate
23. O−Ring
24. Retaining ring (2)
25. Primary gear
26. Drive shaft
27. Primary carrier assembly
28. Secondary carrier assembly

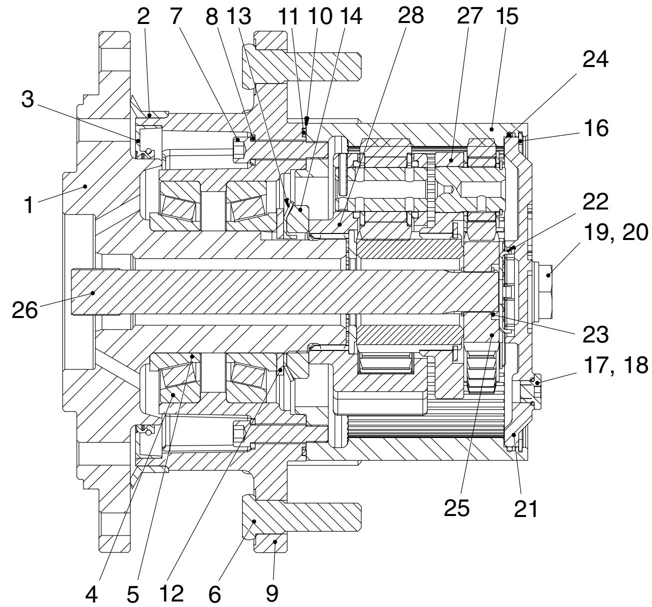

Figure 254

1. Spindle
2. Boot seal
3. Lip seal
4. Inner bearing cup (2)
5. Inner bearing cone (2)
6. Wheel stud (8)
7. Socket head screw (8)
8. Lock washer (8)
9. Housing
10. Dowel pin (4)
11. O−ring
12. Spacer
13. Locking washer
14. Lock nut
15. Ring gear
16. Retaining ring
17. Plug
18. O−ring
19. Plug (2)
20. O−Ring (2)
21. End cap
22. Thrust plate
23. O−Ring
24. Retaining ring (2)
25. Primary gear
26. Drive shaft
27. Primary carrier asm
28. Secondary carrier asm

Note: The planetary drive assembly is best serviced with the planetary installed to machine or the spindle firmly secured to a fixture or workbench. If the spindle (item 1) needs to be removed from machine, see Planetary Drive Assembly (page 7–8).

Disassembly

1. Park machine on a level surface, stop engine and remove key from the key switch.
2. Drain oil from planetary drive and brake assembly; refer to traction unit *Operator's Manual*.
3. Chock rear wheels and jack up front of machine (see Jacking Instructions (page 1–7)). Support machine with jack stands and remove rear wheel assembly.
4. Remove retaining ring (item 16).
5. Remove end cap and thrust plate. Retrieve and discard O−ring from ring gear bore.
6. Remove primary gear and drive shaft assembly (items 24−26).

Disassembly (continued)

7. Remove primary carrier and secondary carrier from ring gear.
8. Bend the locking washer tab away from the lock nut. Use a TMFS12 spanner socket to remove the 55 x 1.5 mm lock nut. Remove the locking washer and spacer. Discard the locking washer.
9. Carefully remove housing and bearing cones from spindle.
10. Remove and discard seals from housing.
11. If necessary, remove bearing cups from housing.
12. If wheel stud removal is necessary, use a press to remove the stud(s) from the housing.
13. If necessary, remove the ring gear from the housing:

    Note: High strength thread locking compound was used during assembly. It may be necessary to heat the ring gear near the mounting screws to release the screws.

    A. Remove socket head screws (item 7) and lock washers that secure the ring gear to the housing.

    B. Remove the ring gear and retrieve the four (4) dowel pins (item 10) from housing.

    C. Remove the O−ring from the housing bore and discard.

Assembly

Note: Use new seals, O−rings and locking washer when assembling the planetary drive.

1. Thoroughly clean parts in solvent and dry completely after cleaning. Inspect parts for damage or excessive wear and replace as necessary.
2. If any wheel studs were removed, use a press to install new studs into housing. Make sure that stud shoulder is fully pressed against housing surface.
3. If ring gear was removed from housing:

    A. Fit four (4) dowel pins in housing.

    B. Apply a light coat of grease to a new O−ring and install it in the housing bore.

    C. Apply high strength thread locking compound and secure ring gear to housing with lock washers and socket head screws. Tighten screws to **37 N·m (27 ft−lb)**.

4. If previously removed, press bearing cups into housing. Cups should be pressed fully to shoulder of the housing bore.
5. Fit inner bearing cone onto spindle. Make sure inner bearing cone seats fully against spindle shoulder. If inner bearing is not seated fully, lightly tap bearing cone on inner hub until it seats properly.
6. Make sure that seal bore in housing is thoroughly cleaned. If OD of seal is not rubber or does not have a sealant coating, apply a light coating of silicone sealant to seal bore in housing. Install seal into housing so it is flush with housing face.
7. Install boot seal. Cover surface of lip seal and boot seal with grease.
8. Lightly oil bearing cups then place housing assembly over spindle and inner bearing cone. Take care to not damage seals or spindle during installation.
9. Fit outer bearing cone onto spindle.
10. Align key on spacer and install spacer onto spindle shaft.

Assembly (continued)

11. Align key on locking washer and install locking washer onto spindle shaft.

IMPORTANT

Perform the following steps without interruption. Once the thread locking compound is applied, you have only a few minutes before the curing process will influence the bearing lock nut torque.

12. Install the bearing lock nut:
    A. Apply high strength thread locking compound (Loctite 263 or equivalent) and install the lock nut.
    B. Tighten the lock nut to **150 N·m (110 ft−lb)**.
    C. Rotate the housing on the spindle a few revolutions to align the bearings.
    D. Tighten the lock nut to **200 N·m (150 ft−lb)**.
    E. Rotate the housing on the spindle a few revolutions to seat the bearings.

    IMPORTANT

    If installing the bearing nut with the spindle installed on machine, have an assistant hold the housing firmly in position during the following step.

    F. Loosen the lock nut completely, then tighten to **122 N·m (90 ft−lb)**.

    IMPORTANT

    Continue to tighten the lock nut until it aligns with one of the locking washer tabs. Do Not loosen the lock nut to align it with the locking washer tabs.

    G. Secure the lock nut by bending one of the locking washer tabs into a slot in the lock nut.
13. Install secondary carrier and primary carrier making sure that carrier gear teeth align with ring gear and spline on spindle shaft.
14. If primary gear (item 25) was removed from drive shaft, slide gear onto shaft and secure with retaining rings.
15. Install drive shaft assembly (items 24−26) making sure that drive shaft spline aligns with carrier gears.
16. Cover the outer face of the thrust plate with grease and fit thrust plate onto end cap. Make sure that thrust plate tabs are captive in end cap.
17. Apply a light coat of grease to a new O-ring and install it in the ring gear bore. Avoid pinching or cutting the O-ring and install the end cap. Use a soft mallet to fully seat the end cap.
18. Secure the end cap with the retaining ring. Make sure the retaining ring is fully seated in the ring groove.
19. Check operation of planetary drive by hand. With a constant turning force applied, rotation of the planetary should be consistent. If there is more drag at certain points, gears are not rolling freely and the planetary should be examined for improper assembly or damaged components.

Assembly (continued)

20. Install front wheel assembly.
21. Fill planetary drive with gear lube; refer to traction unit *Operator's Manual*. A portion of the gear lube will pass into the brake assembly automatically.
22. Test planetary drive operation.
23. Remove jack stands and lower machine to ground. Tighten wheel lug nuts in a crossing pattern from **115 to 135 N·m (85 to 100 ft−lb)**in a crossing pattern.

Rear Axle Assembly

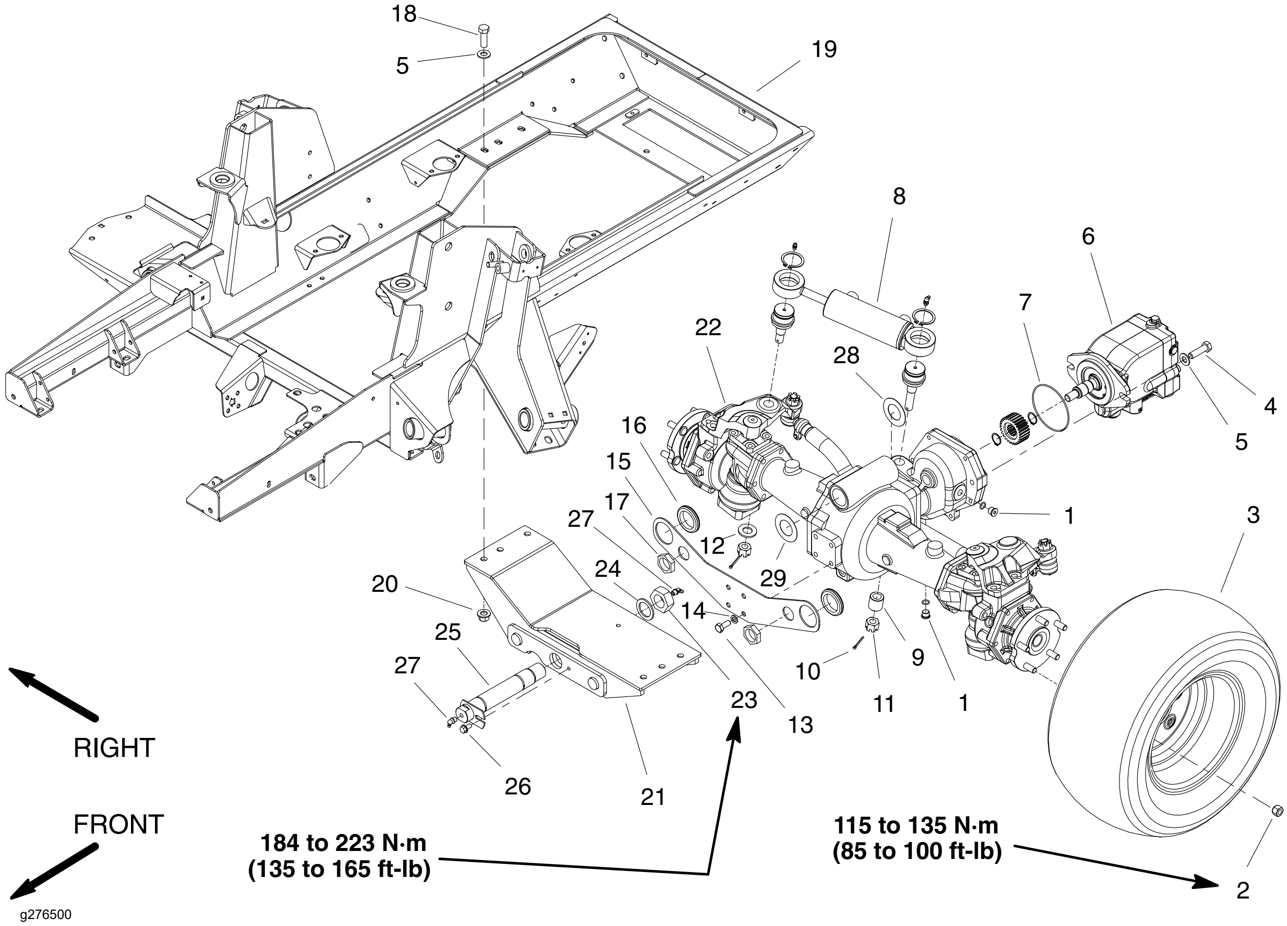

Figure 255

1. Plug with O−ring
2. Lug nut (5 used per wheel)
3. Rear wheel assembly (2 used)
4. Cap screw (2 used)
5. Flat washer (8 used)
6. Rear axle motor
7. O−ring
8. Steering cylinder
9. Spacer
10. Cotter pin (2 used)
11. Slotted hex nut (2 used)
12. Washer
13. Cap screw (4 used)
14. Lock washer (4 used)
15. Bulkhead mount plate
16. Grommet (2 used)
17. Bulkhead nut (2 used)
18. Cap screw (6 used)
19. Frame assembly
20. Lock nut (6 used)
21. Rear axle mount
22. Rear axle assembly
23. Lock nut
24. Thrust washer
25. Rear axle pin
26. Washer head screw
27. Grease fitting
28. Thrust washer (0.033”)
29. Thrust washer (0.018”)

CAUTION

When changing attachments, tires or performing other service, use correct jacks and supports. Make sure machine is parked on a solid, level surface such as a concrete floor. Prior to raising machine, remove any attachments that may interfere with the safe and proper raising of the machine. Always chock or block wheels. Use jack stands to support the raised machine. If the machine is not properly supported by jack stands, the machine may move or fall, which may result in personal injury.

Removal (Figure 255)

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the key switch.

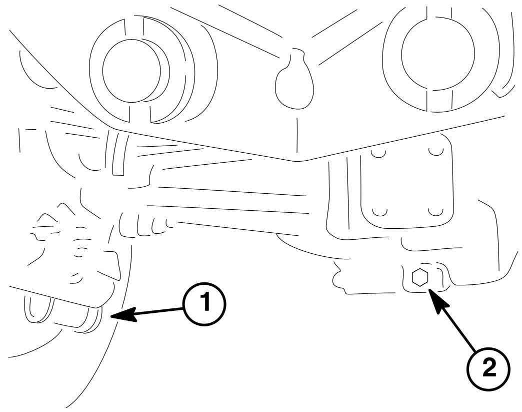

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Figure 256

1. Center axle drain plug
2. Outside plug (2 used)

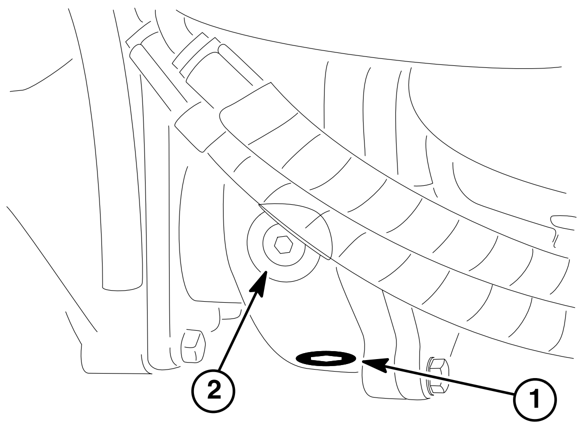

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Figure 257

1. Gearbox drain plug
2. Gearbox fill plug

2. Drain oil from rear axle and axle gearbox (Figure 256 and Figure 257).
3. Chock front wheels and jack up rear of machine (see Jacking Instructions (page 1–7)). Support machine with appropriate jack stands.
4. Remove both wheels from rear axle.
5. Remove hydraulic motor from rear axle assembly (see Rear Axle Motor (page 5–114)).
6. Remove steering cylinder from rear axle (see Steering Cylinder (page 5–138)).
7. Remove cap screws and lock washers that secure bulkhead mount plate (item 15) to rear axle. Separate mount plate from rear axle and support it along with attached hydraulic hoses and tubes to allow the rear axle to be lowered from machine.

Removal (Figure 255) (continued)

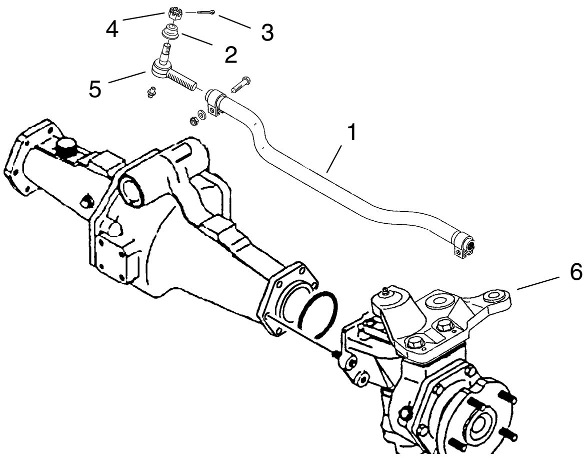

Figure 258

1. Tie rod	4. Castle nut
2. Dust cover	5. Tie rod end
3. Cotter pin	6. Steering arm (LH)

8. If required, remove tie rod ends from steering arms on rear axle (Figure 258). Remove the cotter pins and castle nuts from the tie rod ball joints. Use a ball joint fork and remove the tie rod ends from the axle steering arms.
9. Support rear axle to prevent it from falling. Remove six (6) cap screws, flat washers and lock nuts that secure rear axle mount to machine frame. Lower rear axle and rear axle mount from machine.
10. Remove lock nut and washer from rear axle pin that attaches rear axle to rear axle mount. Remove washer head screw that secures flange of rear axle pin to axle mount (Figure 259).
11. Remove rear axle pin from rear axle and mount. Separate rear axle mount from rear axle. Note location of thrust washers (items 28 and 29) on both ends of axle mounting boss.

Installation (Figure 255)

1. Position rear axle mount to axle. Install thrust washers (items 28 and 29) between axle boss and axle mount. The thicker thrust washer should be installed on the hydraulic motor end of the axle (toward the rear of the machine). With washers installed, there should be from **0.05 mm to 0.51 mm (0.002 to 0.020 in)** clearance between rear axle mount and axle mounting boss. Add thrust washers if needed to adjust clearance.

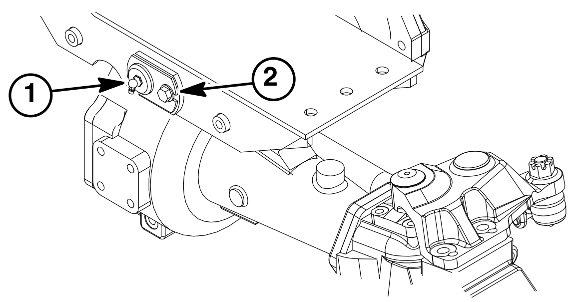

Figure 259

1. Rear axle pin	2. Washer head screw

Installation (Figure 255) (continued)

2. Secure rear axle to rear axle mount.

   A. Slide rear axle pin through rear axle mount and rear axle. Install washer and lock nut onto rear axle pin.

   B. Secure pivot pin to axle mount with washer head screw (Figure 259).

   C. Torque lock nut from **184 to 223 N·m (135 to 165 ft−lb)**. After tightening the lock nut, makes sure that the rear axle pivots freely.

3. Position rear axle with attached mount under machine. With a jack, raise assembly to machine frame and align mounting holes of rear axle mount and machine frame.
4. Secure rear axle mount to frame with six (6) cap screws, flat washers and lock nuts.
5. If removed, install the tie rod to rear axle (Figure 258). Tighten ball joint castle nuts and install new cotter pins.
6. Position bulkhead mount plate (item 15) with attached hydraulic hoses and tubes to rear axle. Secure mount plate to axle with cap screws and lock washers.
7. Install steering cylinder to rear axle assembly (see Steering Cylinder (page 5–138)).
8. Install hydraulic motor to rear axle assembly (see Rear Axle Motor (page 5–114)).

WARNING

Failure to maintain proper wheel lug nut torque could result in failure or loss of wheel and may result in personal injury.

9. Install rear wheels to axle.
10. Lower machine to ground. Torque wheel lug nuts from **115 to 135 N·m (85 to 100 ft−lb)** in a crossing pattern.

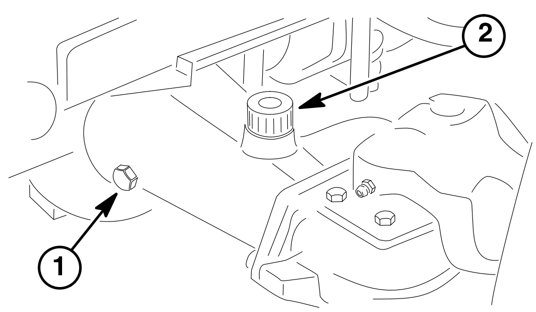

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Figure 260

1. Rear axle check plug
2. Rear axle fill plug

Installation (Figure 255) (continued)

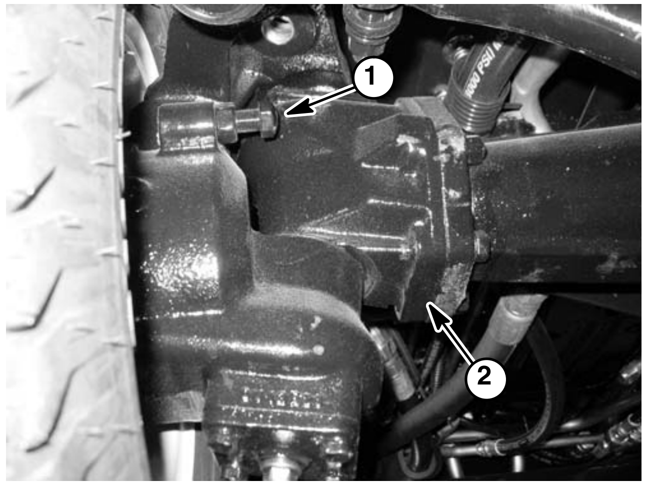

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Figure 261

1. Steering stop bolt
2. Bevel gear case (LH)

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11. Fill gearbox and rear axle with SAE 85W−140 weight gear lube (Figure 257 and Figure 260). Lubricant capacity is approximately 0.47 liters. (16 fl. oz) for the gearbox and 2.37 liters (80 fl. oz.) for the rear axle assembly.
12. Check rear wheel toe−in and adjust if necessary.
13. Check steering stop bolt adjustment. When the steering cylinder is fully extended (right turn), a gap of **1.6 mm (1/16 in)** should exist between bevel gear case casting and stop bolt on left axle case. Figure 261 shows stop bolt location.

Rear Axle Service

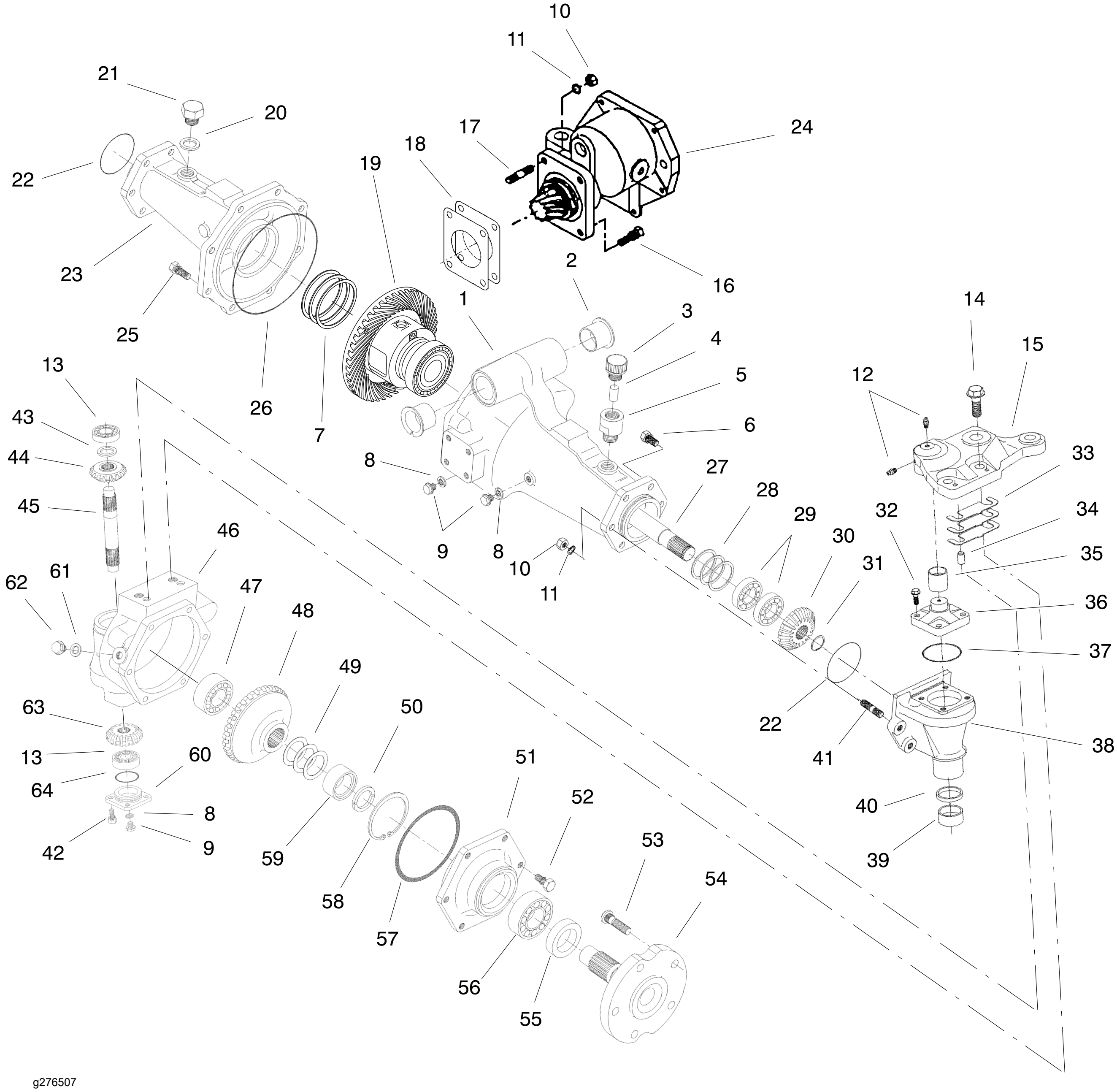

Figure 262

Figure 262 (continued)

1. LH axle support
2. Flange bushing (2 used)
3. Axle vent
4. Filter
5. Vent extension
6. Cap screw (4 used per gear case)
7. Shim set
8. Seal washer
9. Plug
10. Lock nut
11. Lock washer
12. Grease fitting
13. Ball bearing
14. Screw (2 used per steering arm)
15. Axle case support (LH shown)
16. Bolt (2 used)
17. Stud (2 used)
18. Shim set
19. Differential assembly
20. O−ring
21. Plug
22. O−ring
23. RH axle support
24. Input shaft assembly
25. Bolt (8 used)
26. O−ring
27. Differential shaft (LH shown)
28. Shim set
29. Ball bearing
30. Bevel gear (15 tooth)
31. Retaining ring
32. Bolt (4 used per knuckle)
33. Shim set
34. Dowel pin (2 used per axle case)
35. Bushing
36. Knuckle pin
37. O−ring
38. Bevel gear case (LH shown)
39. Bushing
40. Shaft seal
41. Stud (2 used per gear case)
42. Bolt (4 used per cover)
43. Collar
44. Bevel gear (17 tooth)
45. Bevel gear shaft
46. Axle case (LH shown)
47. Ball bearing
48. Bevel gear (29 tooth)
49. Shim set
50. Clip (2 used per axle case)
51. Axle cover
52. Screw (6 used per cover)
53. Wheel stud (5 used per axle)
54. Axle
55. Oil seal
56. Ball bearing
57. O−ring
58. Retaining ring
59. Spacer
60. Axle case cover
61. Seal washer
62. Plug
63. Bevel gear (17 tooth)
64. O−ring

Note: Figure 262 illustrates the rear axle used on the Groundsmaster 4100 and 4110. Service procedures for the rear axle is on the following pages of this section.

Bevel Gear Case and Axle Case

The following procedures assume the rear axle assembly has been removed from the machine.

Removal

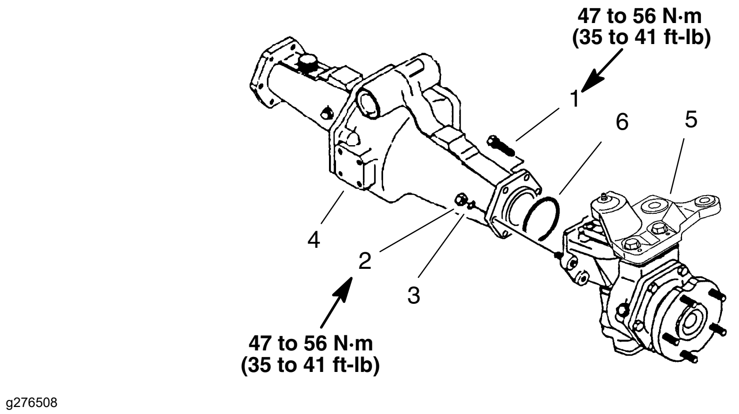

Figure 263

1. Cap screw (4 used)
2. Lock nut (2 used)
3. Lock washer (2 used)
4. Axle support
5. Bevel gear case/axle case assembly
6. O-ring

1. Remove the mounting screws, nuts and lock washers. Remove the bevel gear case/axle case assembly and O-ring from the axle support (Figure 263).
2. Mark both right and left bevel gear case/axle case assemblies.

IMPORTANT

Do not interchange right and left bevel gear case/axle case assemblies.

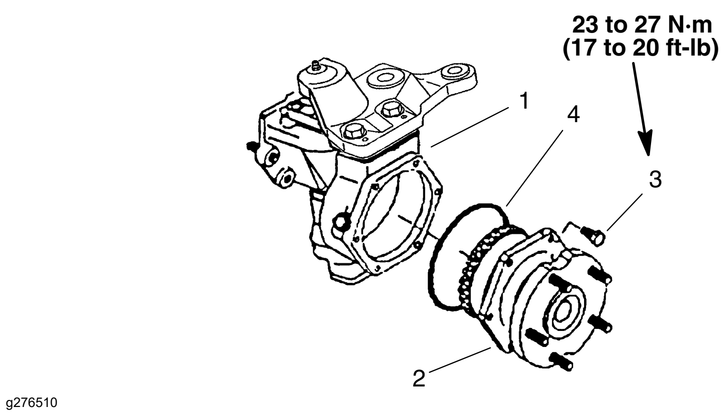

Figure 264

1. Axle case
2. Axle cover assembly
3. Screw (6 used)
4. O-ring

3. Remove the axle cover mounting screws. Remove the axle cover from the axle case as an assembly (Figure 264).

Removal (continued)

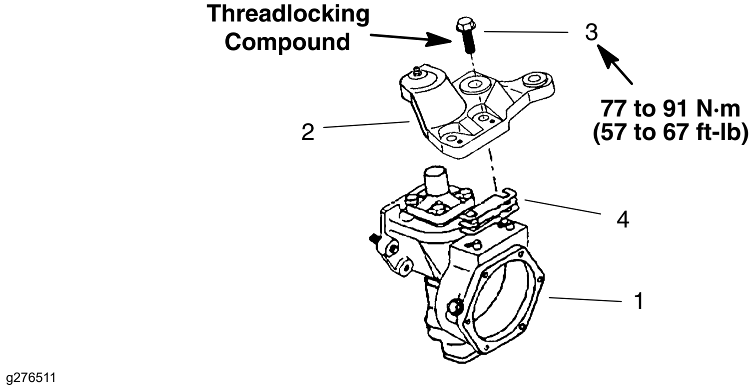

Figure 265

1. Axle case
2. Axle case support
3. Screw (2 used)
4. Support shim

---

4. Remove the axle case support mounting screws, the axle case support and the support shims (Figure 265).

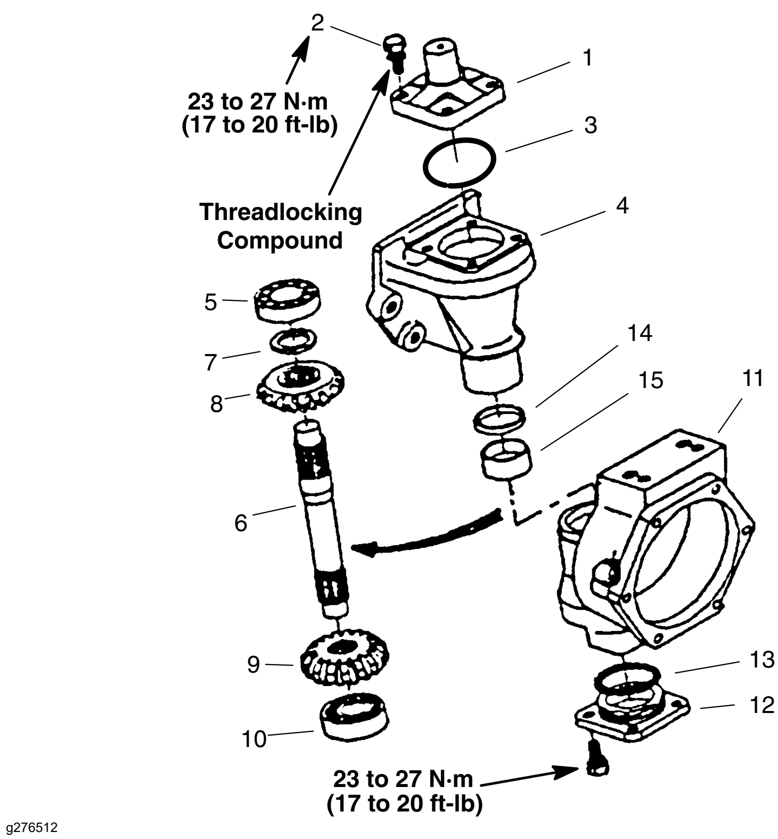

Figure 266

1. Knuckle pin
2. Mounting screw (4 used)
3. O−ring
4. Bevel gear case
5. Upper bearing
6. Bevel gear shaft
7. Collar
8. Upper bevel gear
9. Lower bevel gear
10. Lower bearing
11. Axle case
12. Axle case cover
13. O-ring
14. Shaft seal
15. Bushing

Removal (continued)

5. Remove the knuckle pin mounting screws and the knuckle pin. Remove the gasket and any remaining gasket material from either mating surface (Figure 266).
6. While holding the bevel gear case, tap the upper end of the bevel gear shaft out of the upper bearing and upper bevel gear.
7. Pull the bevel gear case from the axle case and remove the upper bevel gear and collar from the gear case.
8. Remove the axle case cover screws, cover and the O-ring from the axle case.
9. Remove the plug and sealing washer from the center of the axle case cover. While holding the axle case cover, lightly tap the lower end of the bevel gear shaft out of the lower bearing and lower bevel gear.
10. Remove and discard bevel gear shaft seal from axle case (Figure 266).

Inspection

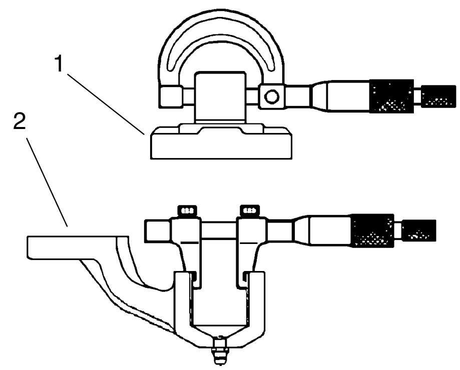

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Figure 267

1. Knuckle pin
2. Axle case support

---

1. Measure the knuckle pin O.D. and the axle case support bushing I.D. to determine the bushing to pin clearance (Figure 267). Replace components as necessary.

   BUSHING TO PIN CLEARANCE: **0.05 to 0.40 mm (0.002 to 0.016 in)**

   KNUCKLE PIN O.D. (Factory Spec.): **24.95 to 24.98 mm (0.982 to 0.983 in)**

   AXLE CASE SUPPORT BUSHING I.D. (Factory Spec.): **25.00 to 25.08 mm (0.984 to 0.987 in)**

2. Inspect all gears, shafts, bearings, cases and covers for damage and wear. Replace components as necessary.

Installation

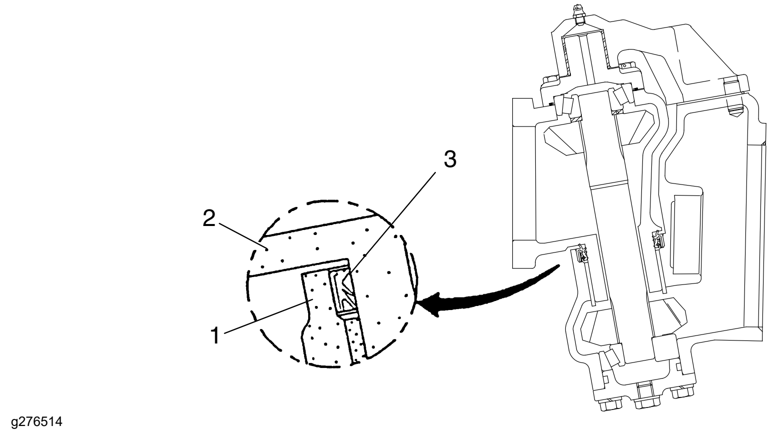

Figure 268

1. Axle case
2. Bevel gear case
3. Shaft seal

1. Coat new shaft seal with grease and install in axle case as shown (Figure 268).

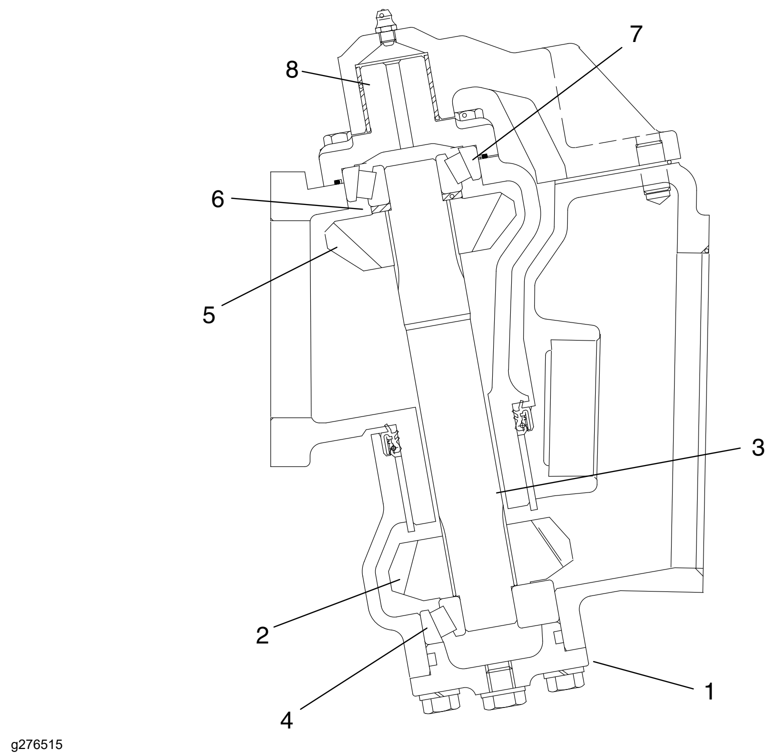

Figure 269

1. Axle case cover
2. Lower bevel gear
3. Bevel gear shaft
4. Lower bearing
5. Upper bevel gear
6. Collar
7. Upper bearing
8. Knuckle pin

2. Install the lower bevel gear and bevel gear shaft in the axle case cover. Coat a new O-ring with grease and install the axle case cover (Figure 269). Tighten cover screws from **23 to 27 N·m (17 to 20 ft-lb)**.

Installation (continued)

3. Slide the bevel gear case over the bevel gear shaft and install the bevel gear and collar. Make sure the bevel gear shaft is completely seated in the upper and lower bearings (Figure 269).
4. Install the knuckle pin. Use medium strength threadlocking compound and tighten the knuckle pin mounting screws from **23 to 27 N·m (17 to 20 ft-lb)**.

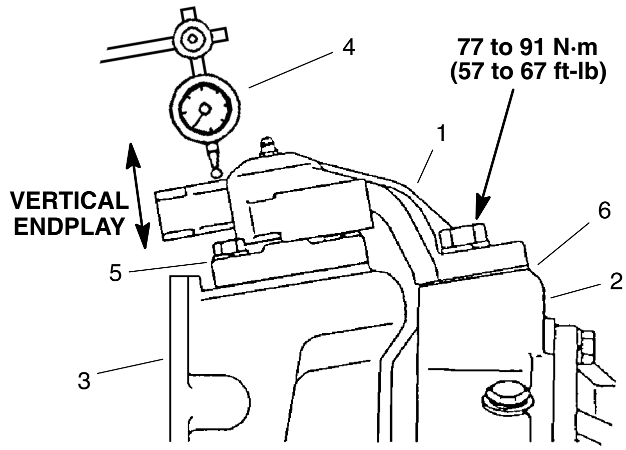

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Figure 270

1. Axle case support
2. Axle case
3. Bevel gear case
4. Dial indicator
5. Knuckle pin
6. Support shim location

5. Determine necessary quantity of support shims.
   A. Lubricate the axle case support bushing with a thin coat of grease and slide axle case support onto knuckle pin.
   B. Position support shims that were removed during disassembly between axle case support and axle case. Install mounting screws into axle case. Slowly tighten screws while frequently checking for clearance (vertical endplay) between axle case support and knuckle pin. If binding of components is noted before screws are fully tightened, add additional support shims. Torque screws from **77 to 91 N·m (57 to 67 ft−lb)**.
   C. Use dial indicator to measure vertical endplay of axle case (Figure 270).

      AXLE CASE ASSEMBLY ENDPLAY: **0.02 to 0.20 mm (0.001 to 0.008 in)**
   D. Adjust endplay by increasing or reducing number of axle case support shims.

   Note: Axle case support shims are available in **0.1 mm (0.004 in), 0.2 mm (0.008 in)** and **0.4 mm (0.016 in)** thickness.
6. After correct support shims have been determined, remove mounting screws, apply heavy strength threadlocking compound to screw threads, reinstall screws and torque from **77 to 91 N·m (57 to 67 ft−lb)**.

IMPORTANT

Correct engagement between bevel gears is critical to axle performance and durability.

Installation (continued)

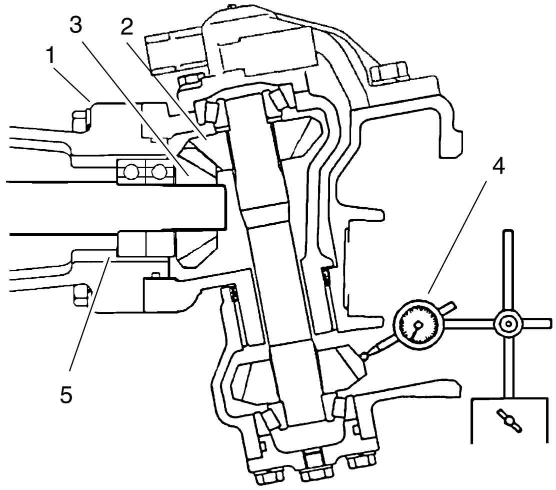

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Figure 271

1. Axle support
2. Upper bevel gear
3. Differential shaft gear
4. Dial indicator
5. Axle bearing shims

7. Temporarily install the bevel gear case/axle case assembly on the axle support. Position a dial indicator at the tooths center. Prevent the axle from turning and measure the upper bevel gear to differential shaft gear backlash (Figure 271).

   UPPER BEVEL GEAR BACKLASH: **0.10 to 0.40 mm (0.004 to 0.016 in)**

8. Adjust backlash by increasing or reducing axle bearing shim thickness (see Differential Shafts (page 7–35)).

   Note: Axle bearing shims are available in **0.1 mm (0.004 in), 0.2 mm (0.008 in)** and **0.5 mm (0.020 in)** thickness.

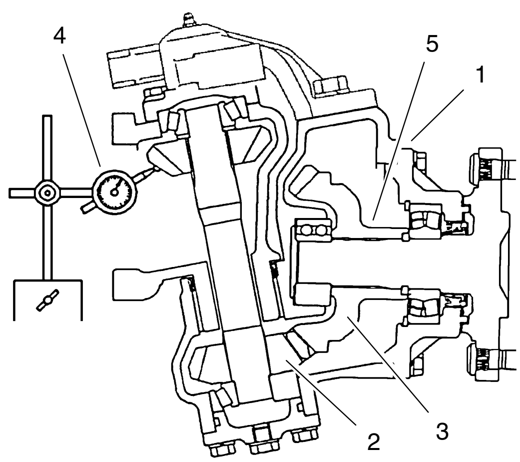

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Figure 272

1. Axle cover assembly
2. Lower bevel gear
3. Axle gear
4. Dial indicator
5. Axle bearing shims

9. Remove the bevel gear case/axle case assembly from the axle support. Coat a new O-ring with grease and temporarily install the axle cover assembly.

Installation (continued)

Position a dial indicator at the tooths center. Prevent the axle from turning and measure the lower bevel gear to axle gear backlash (Figure 272).

LOWER BEVEL GEAR BACKLASH: **0.10 to 0.40 mm (0.004 to 0.016 in)**

10. Adjust backlash by increasing or reducing axle bearing shim thickness (see Axle Shafts (page 7–37)).

    Note: Axle bearing shims are available in **0.2 mm (0.008 in), 0.3 mm (0.012 in)** and **0.5 mm (0.020 in)** thickness.

11. Tighten axle cover screws from **23 to 27 N·m (17 to 20 ft-lb)**.

12. Coat a new O-ring with grease and install the bevel gear case/axle case assembly on the axle support. Tighten mounting screws and nuts from **47 to 56 N·m (35 to 41 ft-lb)** (Figure 273).

Differential Shafts

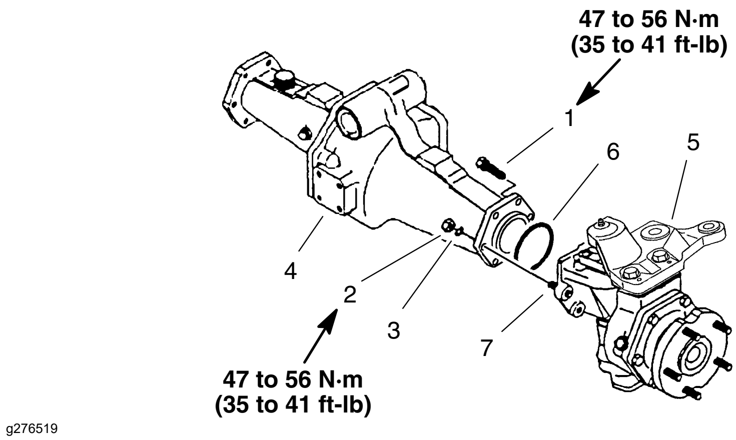

Figure 273

1. Cap screw (4 used)
2. Lock nut (2 used)
3. Lock washer (2 used)
4. Axle support
5. Bevel gear/axle case assembly
6. O-ring
7. Stud (2 used)

The following procedures assume the rear axle assembly has been removed from the machine.

Removal

IMPORTANT

Do not interchange right and left differential shaft assemblies.

1. Remove the mounting screws, nuts and lock washers. Remove the bevel gear case/axle case assembly and O-ring from the axle support (Figure 273).
2. Mark and pull the differential shaft assembly from the axle support.

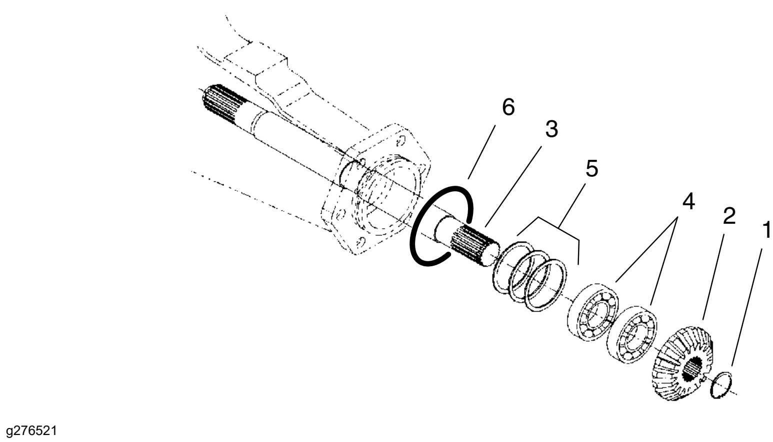

Figure 274

1. Retaining ring
2. Bevel gear
3. Differential shaft
4. Bearing
5. Bearing shims
6. O-ring

3. Remove the retaining ring and bevel gear (Figure 274).
4. Drive the differential shaft out of the bearings. Remove the bearings and bearing shims.

Removal (continued)

5. Inspect all gears, shafts, bearings and cases for damage and wear. Replace components as necessary.

Installation

1. Press bearings onto differential shaft. Place correct combination of bearing shims in axle support and drive differential shaft and bearing assembly into axle support.
2. Install bevel gear and retaining ring.
3. Coat new O-ring with grease. Align differential shaft splines with differential gear assembly and slide differential shaft assembly onto axle support.
4. Install bevel gear case/axle case assembly (see Bevel Gear Case and Axle Case (page 7–28)).

Axle Shafts

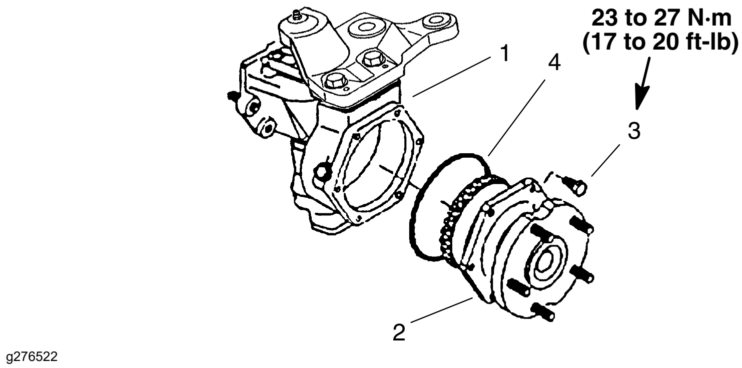

Figure 275

1.	Axle case	3.	Screw (6 used)
2.	Axle cover assembly	4.	O-ring

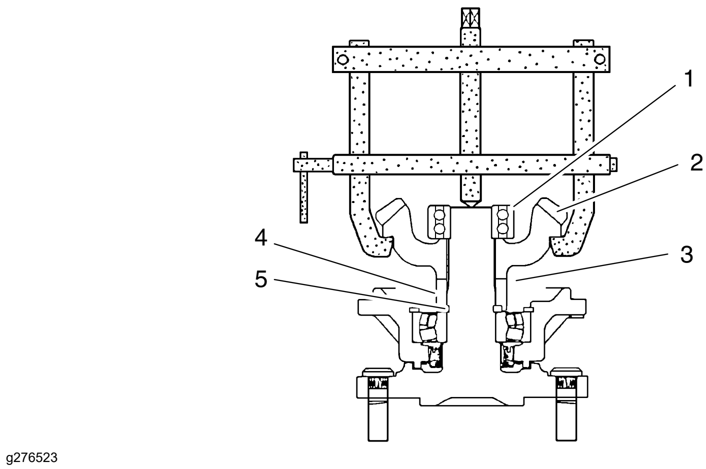

Figure 276

1.	Bearing	4.	Spacer
2.	Bevel gear	5.	Retaining ring
3.	Shims		

The following procedures assume the rear axle assembly has been removed from the machine.

Removal

1. Remove the axle cover mounting screws. Remove the axle cover from the axle case as an assembly (Figure 275).
2. Use a bearing puller to remove the bearing and bevel gear as shown (Figure 276).
3. Remove the shims, spacer and retaining ring. Drive the axle out of the bearing and cover. Remove and discard the axle shaft seal.
4. Inspect all gears, shafts, bearings, spacers and cases for damage and wear. Replace components as necessary.

Installation

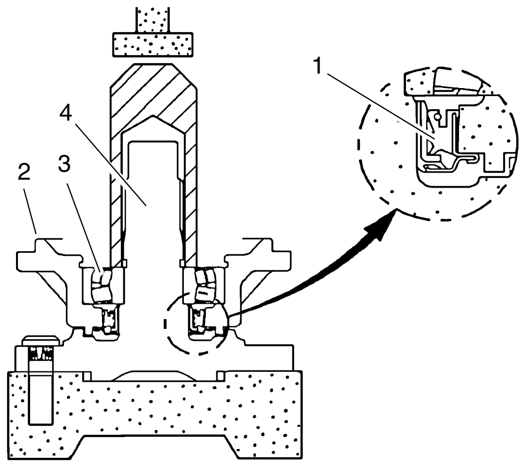

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Figure 277

1. Axle shaft seal
2. Axle cover
3. Bearing
4. Axle shaft

---

1. Coat new axle shaft seal with grease and install in axle cover as shown (Figure 277).
2. Press the axle cover and bearing assembly onto the axle shaft. Press only on the inner race of the cover bearing (Figure 277).
3. Install retaining ring, spacer and correct combination of bearing shims. Install bevel gear and bearing.
4. Coat a new O-ring with grease and install the axle cover assembly. Tighten axle cover screws from **23 to 27 N·m (17 to 20 ft-lb)**.

Input Shaft/Pinion Gear

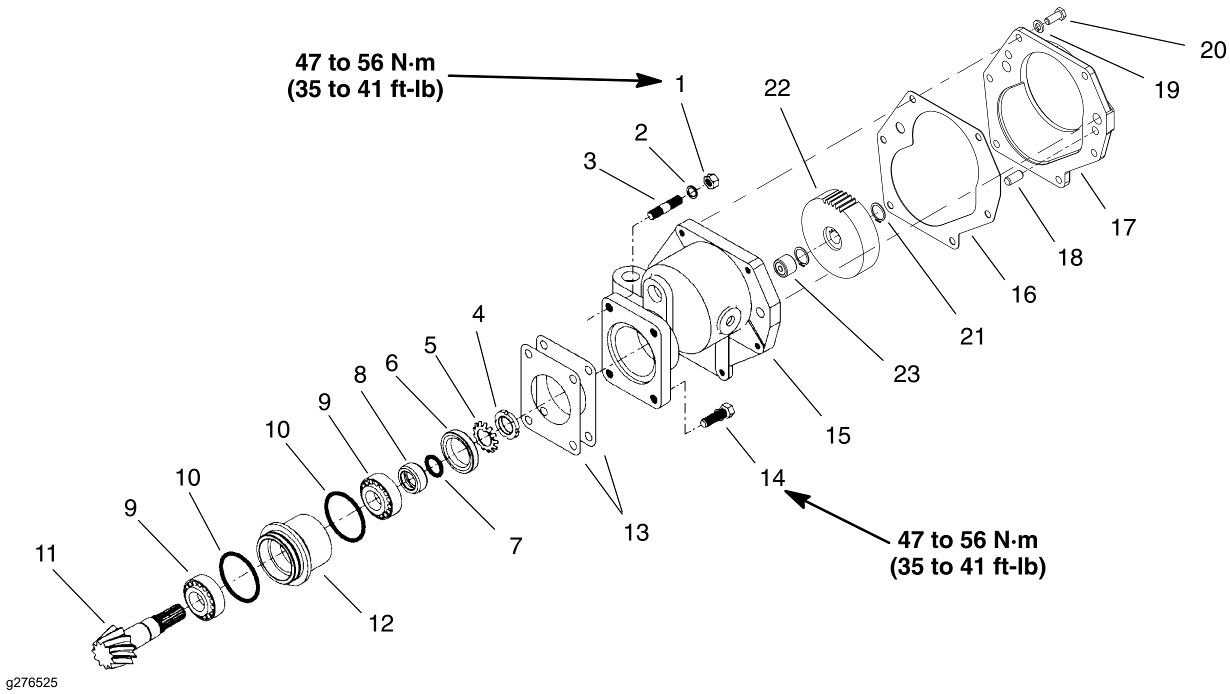

Figure 278

1. Nut (2 used)	9. Bearing	17. Cover plate
2. Lock washer (2 used)	10. O-ring	18. Dowel pin (2 used)
3. Stud (2 used)	11. Input shaft/pinion gear	19. Lock washer (6 used)
4. Lock nut	12. Bearing case	20. Cap screw (6 used)
5. Stake washer	13. Shim	21. Retaining ring (2 used)
6. Oil seal	14. Screw (2 used)	22. Driven gear (45 tooth)
7. O-ring	15. Gear case	23. Needle bearing
8. Seal collar	16. Gasket	

The following procedures assume the rear axle assembly has been removed from the machine.

Removal (Figure 278)

1. Remove the cover plate, gasket and gear case assembly from the axle assembly. Remove the gasket and any remaining gasket material.
2. Remove the retaining rings, the driven gear and the needle bearing from the input shaft/pinion gear.
3. Remove input shaft/pinion gear assembly from the gear case. Remove the shims and bearing case O-rings.
4. Release the stake washer and remove the lock nut. Remove and discard the stake washer.
5. Drive the input shaft/pinion gear out from the outer bearing cone and bearing case. Remove and discard the oil seal and O-ring.
6. Inspect all gears, shafts, bearings, spacers and cases for damage and wear. Replace components as necessary.

   Note: Replacement input shaft/pinion gear (item 11) is only available in matched set with differential ring gear.

Installation (Figure 278)

Note: When installing bearing cones onto the input shaft/pinion gear, press only on the inner race of the bearing cone.

1. If the inner bearing cone was removed, press a new bearing cone all the way onto the input shaft/pinion gear.
2. Place the shaft and bearing assembly in the bearing case and install the outer bearing cone.

   Note: The bearings must be completely seated. There should be no input shaft/pinion gear end play.

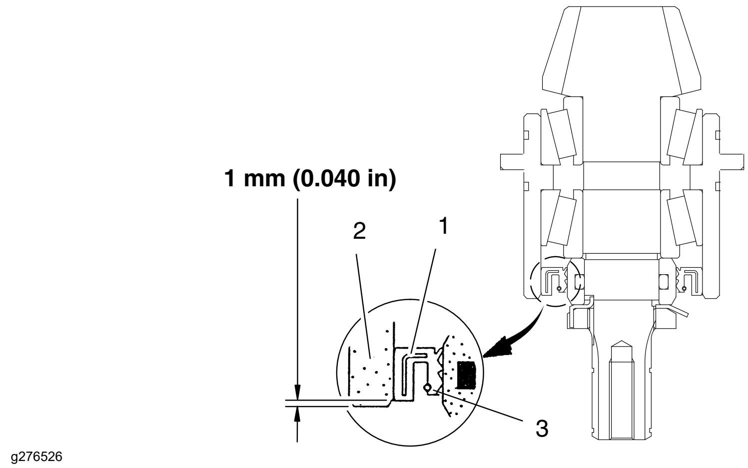

Figure 279

1. Oil seal
2. Bearing case
3. Seal garter spring

3. Coat a new oil seal with grease and install as shown in Figure 279. The seal should be installed with the garter spring towards the hydraulic motor location.
4. Coat new O-ring with grease. Install O-ring in the oil seal collar and install the collar.
5. Install a new stake washer. Install the lock nut finger tight.
6. Set the bearing preload by securing the bearing case in a vise. Thread a M12 x 1.5 hex head cap screw into the splined end of the input shaft/pinion gear and slowly tighten the lock nut until **0.4 to 0.7 N·m (4 to 6 in-lb)** of force is required to rotate the input shaft/pinion gear in the bearing case.
7. Secure the lock nut with the stake washer.

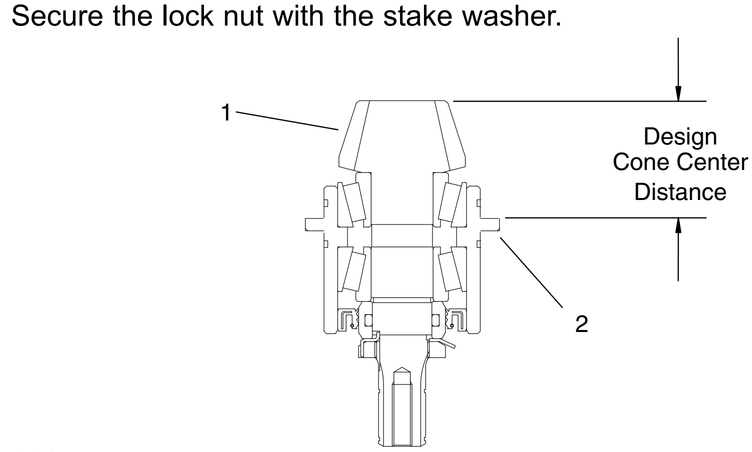

Figure 280

1. Input shaft/pinion gear
2. Bearing case

Installation (Figure 278) (continued)

8. Use a depth gauge to measure the distance from the end face of the input shaft/pinion gear to the mating surface of the bearing case. Subtract the "Design Cone Center Distance" from this distance to determine initial shim thickness (Figure 280).

   DESIGN CONE CENTER DISTANCE (distance from mating surface of axle support to end face of pinion gear): **47.5 + 0.05 mm (1.870 + 0.002 in)**.

   Note: Bearing case shims are available in **0.1 mm (0.004 in)** and **0.2 mm (0.008 in)** thickness.

9. Coat new O-rings with grease and install the bearing case in the gear case. Place shims on the gear case and temporarily install gear case assembly into axle case. Tighten mounting nuts and screws from **47 to 56 N·m (35 to 41 ft-lb)**.

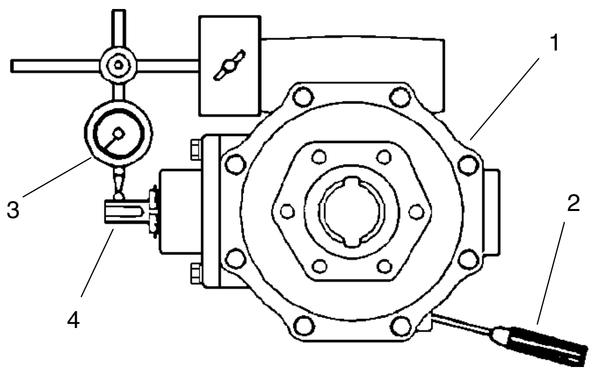

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Figure 281

1.	Axle case	3.	Dial indicator
2.	Screwdriver	4.	Input shaft/pinion gear

10. Insert a screwdriver through the drain plug hole to hold ring gear and measure the pinion gear to ring gear backlash (Figure 281).

    PINION GEAR TO RING GEAR BACKLASH: **0.10 to 0.40 mm (0.004 to 0.016 in)**

11. Adjust backlash by increasing or reducing gear case shim thickness.

12. Check pinion gear to ring gear engagement (see Pinion Gear to Ring Gear Engagement (page 7–48)).

13. Place the correct combination of shims on the gear case. Tighten mounting nuts and screws from **47 to 56 N·m (35 to 41 ft-lb)**.

14. Install retaining rings and driven gear on input shaft/ pinion gear.

15. If the drive gear (on drive motor shaft) was removed, install the retaining rings and drive gear on the motor shaft.

16. Use a new gasket and install the cover plate. Use a new O-ring and install the drive motor.

Differential Gear

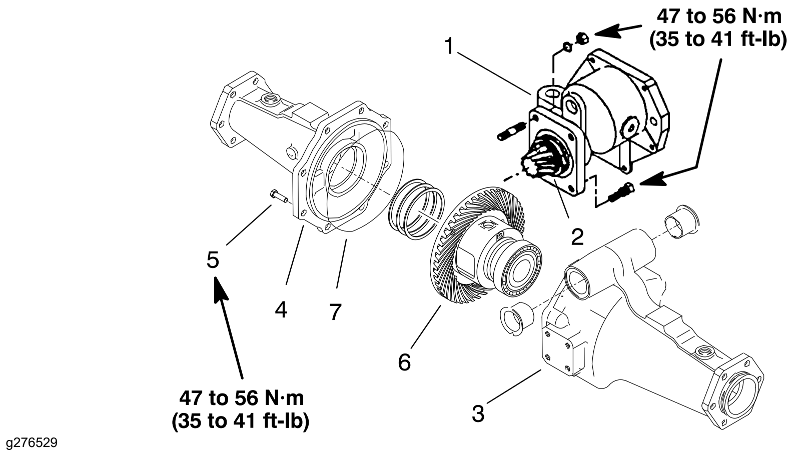

Figure 282

1. Gear case
2. Pinion gear
3. Axle support (left)
4. Axle support (right)
5. Case screw (8 used)
6. Differential gear
7. O-ring

The following procedures assume the rear axle assembly has been removed from the machine.

Removal

1. Remove bevel gear case/axle case assemblies (see Bevel Gear Case and Axle Case (page 7–28)).

IMPORTANT

Do not interchange right and left differential shafts assemblies.

2. Mark and pull the differential shaft assemblies from the axle support.
3. Remove input shaft/pinion gear assembly, shims and O-ring from the axle support (Figure 282).
4. Remove the axle support case screws. Separate the axle support halves and remove the O-ring.
5. Remove the differential gear assembly, bearings and adjusting shims from the axle case.

Removal (continued)

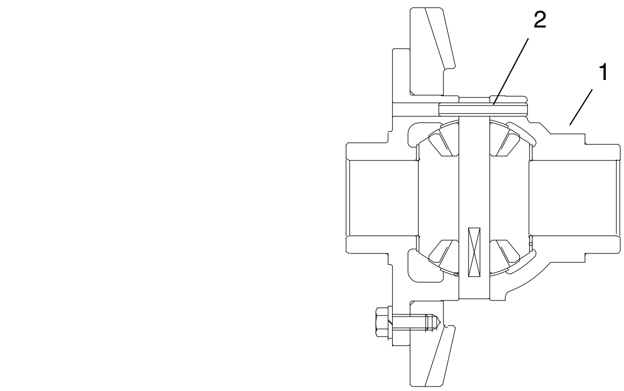

Figure 283

1. Differential case
2. Spring pin

6. Drive the spring pin from the differential case with a punch and hammer. Discard the spring pin (Figure 283).

   Note: Mark and arrange all components so they can be reassembled in their original position.

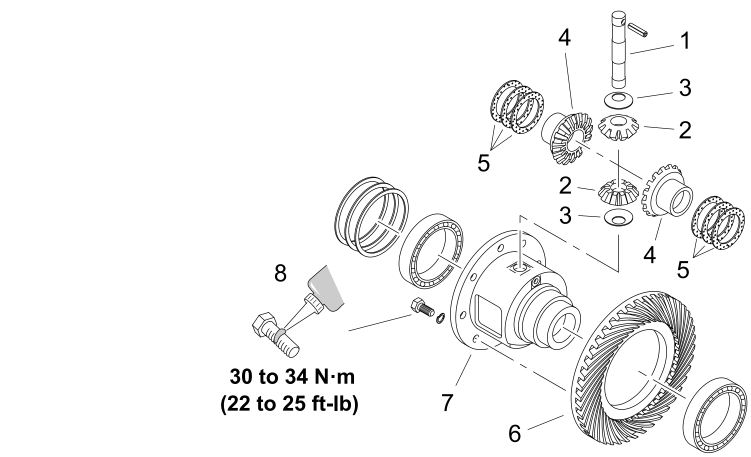

Figure 284

1. Differential pinion shaft
2. Pinion gear
3. Pinion washer
4. Side gear
5. Side gear shims
6. Ring gear
7. Differential case
8. Bolt/washer (8 used)

7. Remove the differential pinion shaft, pinion gears and pinion washers. Remove the differential side gears and side gear shims. Remove the ring gear only if it will be replaced (Figure 284).

   Note: Replacement ring gears are only available in matched ring and pinion sets.

Inspection

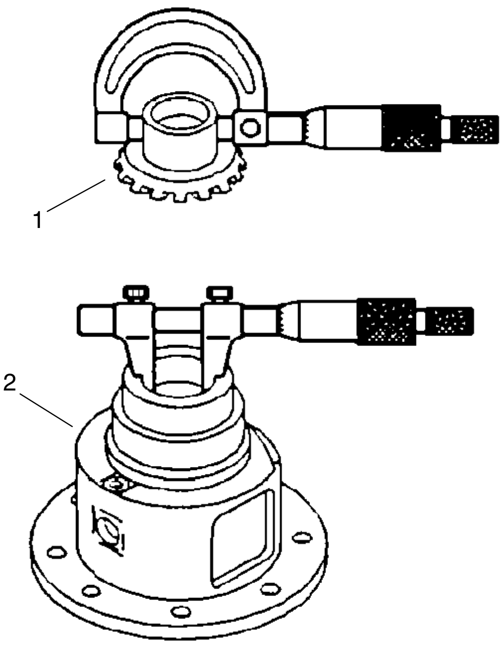

Figure 285

1. Side gear
2. Differential case

1. Measure the differential side gear O.D. and the differential case I.D. to determine the side gear to case clearance (Figure 285). Replace components as necessary.

   SIDE GEAR TO CASE CLEARANCE: **0.05 to 0.30 mm (0.002 to 0.012 in)**

   SIDE GEAR O.D. (Factory Spec.): **33.91 to 33.95 mm (1.335 to 1.337 in)**

   DIFFERENTIAL CASE I.D. (Factory Spec.): **34.00 to 34.06 mm (1.339 to 1.341 in)**

Inspection (continued)

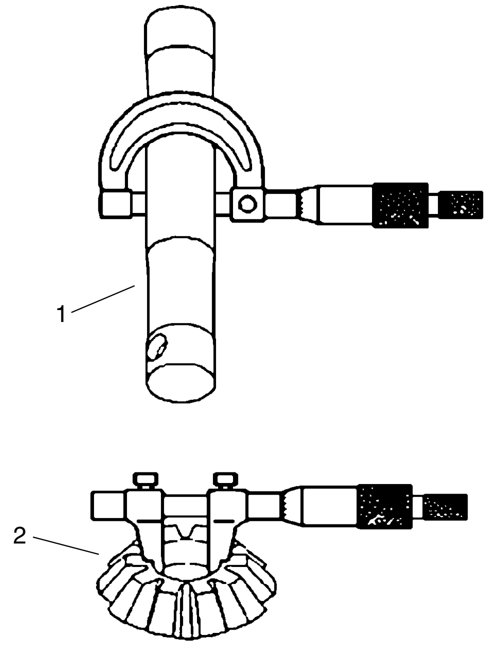

Figure 286

1. Pinion shaft
2. Pinion gear

2. Measure the differential pinion shaft O.D. and the pinion gear I.D. to determine the pinion shaft to pinion gear clearance (Figure 286). Replace components as necessary.

   PINION SHAFT TO PINION GEAR CLEARANCE: **0.03 to 0.25 mm (0.001 to 0.010 in)**

   PINION SHAFT O.D. (Factory Spec.): **13.97 to 13.10 mm (0.550 to 0.551 in)**

   PINION GEAR I.D. (Factory Spec.): **13.10 to 14.02 mm (0.551 to 0.552 in)**

3. Inspect all gears, shafts, bearings, cases and covers for damage and wear. Replace components as necessary.

Installation

1. If the ring gear was removed from the differential case, use medium strength Loctite thread locker and tighten the mounting screws from **30 to 34 N·m (22 to 25 ft-lb)**.

2. Apply molybdenum disulfide lubricant (Three Bond 1901 or equivalent) to the splines and bearing surfaces of the differential pinion gears, pinion washers and side gears.

3. Install the side gear shims and side gears in their original location in the differential case.

4. Place the differential pinion gears and pinion washers in their original location in the differential case. Temporarily install the differential pinion shaft.

Installation (continued)

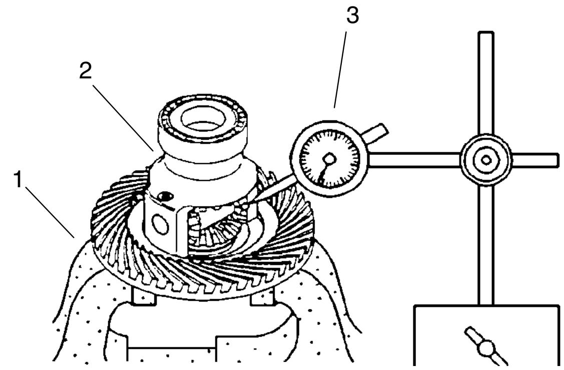

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Figure 287

1. Vise
2. Differential gear case
3. Dial indicator

5. Secure the differential case in a soft jawed vise. Position a dial indicator on a tooth of the differential pinion gear. Press the pinion and side gear against the differential case and measure the pinion gear to side gear backlash (Figure 287).

   PINION GEAR TO SIDE GEAR BACKLASH: **0.10 to 0.40 mm (0.004 to 0.016 in)**

6. Adjust backlash by increasing or reducing side gear shim thickness.

   Note: Side gear shims are available in **1.10 mm (0.043 in)**, **1.20 mm (0.047 in)** and **1.30 mm (0.051 in)** thickness.

7. Apply gear marking compound, such as DyKem Steel Blue lightly over several gear teeth.
8. While applying a light load to either side gear, rotate either pinion gear until the side gears have made one complete revolution.

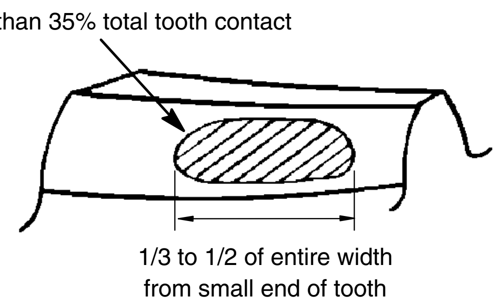

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Figure 288

9. Ideal tooth contact should cover more than 35% of each tooth surface. The contact area should be in the center of each tooth and extend 1/3 to 1/2 way across each tooth from the toe (small) end (Figure 288).
10. Adjust side gear shims if necessary to correct tooth contact. Recheck differential pinion gear to side gear backlash if any changes are made.
11. After backlash and tooth contact have been adjusted, align the hole in the differential pinion shaft with the hole in the differential case and install a new spring pin.
12. Install differential gear assembly in right side axle support half.

Installation (continued)

13. Coat a new o-ring with grease and install left side axle support half. Tighten axle support case screws from **47 to 56 N·m (35 to 41 ft-lb)**.
14. Install input shaft/pinion gear assembly (see Input Shaft/Pinion Gear (page 7–39)).
15. Coat new o-rings with grease, align differential shaft splines with differential gear assembly and slide differential shaft assemblies onto axle support.
16. Install bevel gear case/axle case assemblies (see Bevel Gear Case and Axle Case (page 7–28)).

Pinion Gear to Ring Gear Engagement

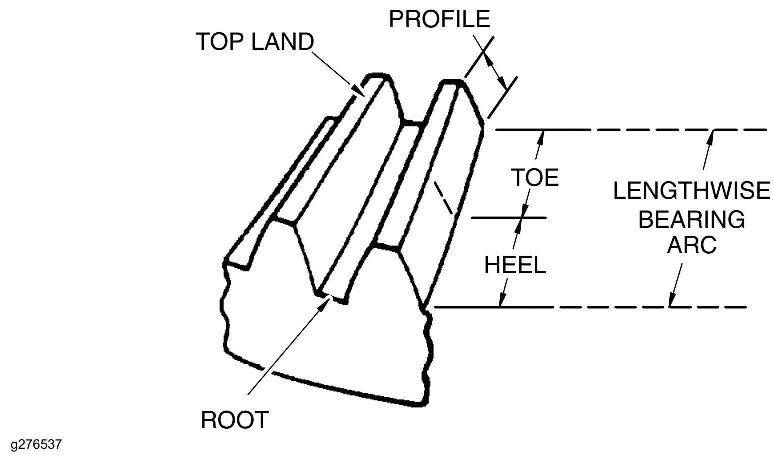

Figure 289

The final position of the pinion gear is verified by using the gear contact pattern method as described in the following procedure.

GEAR TOOTH DEFINITIONS (Figure 289):

Toe − the portion of the tooth surface at the end towards the center.

Heel − the portion of the gear tooth at the outer end.

Top Land − top surface of tooth.

1. Paint the teeth of the ring gear, both drive and coast side, with a gear marking compound, such as DyKem Steel Blue.
2. Install the input shaft/pinion gear assembly into axle case.

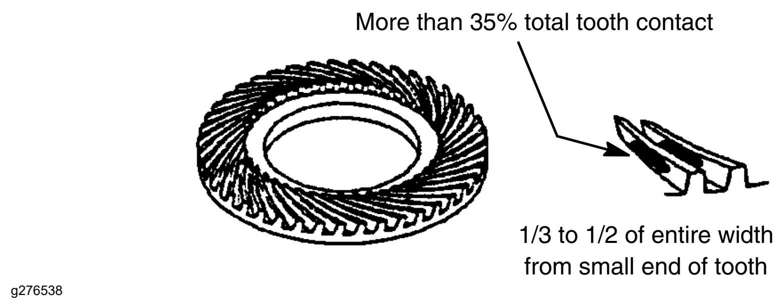

Figure 290

Pinion Gear to Ring Gear Engagement (continued)

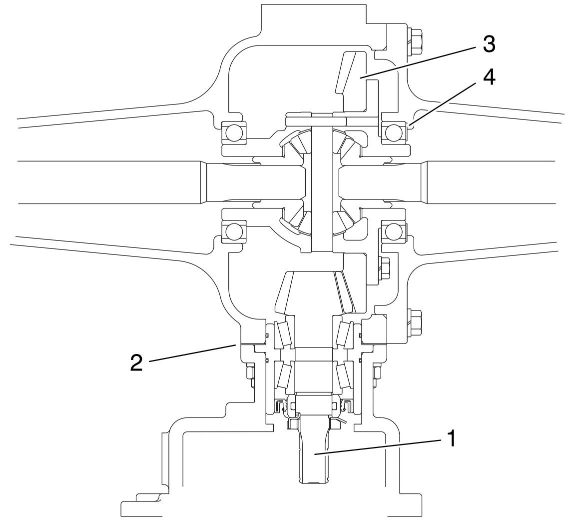

Figure 291

1.	Input shaft/pinion gear	3.	Differential gear case
2.	Bearing case shims	4.	Differential bearing shims

3. While applying a light load to the ring gear, rotate the pinion gear in the direction of forward travel until the ring gear has made one complete revolution.

   Ideal tooth contact observed on the ring gear should cover more than 35% of each tooth surface. The contact area should be in the center of each tooth and extend 1/3 to 1/2 way across each tooth from the toe end (Figure 290).

   Adjustments to the gear contact position are made by moving the input shaft/pinion gear (bearing case shims) or by moving the differential gear case (differential bearing shims) (Figure 291).

   Note: Bearing case shims are available in **0.10 mm (0.004 in)** and **0.20 mm (0.008 inch)** thickness.

   Note: Differential bearing shims are available in **0.10 mm (0.004 in), 0.20 mm (0.008 in)** and **0.40 mm (0.016 in)** thickness.

   Study the different contact patterns (Figure 292 and Figure 293) and correct gear engagement as necessary.

   Note: When making changes, note that two variables are involved (see Gear Pattern Movement Summary (page 7–50)).

   Example: If the pinion gear to ring gear backlash is set correctly to specifications and the bearing case shim is changed to adjust tooth contact, it may be necessary to readjust backlash to the correct specification before checking the contact pattern.

Gear Pattern Movement Summary

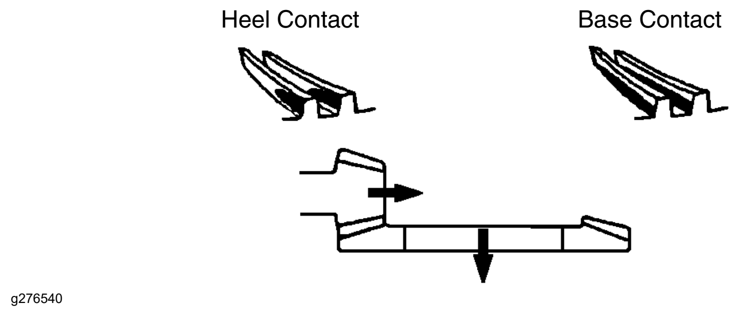

Figure 292

Every gear has a characteristic pattern. The illustrations show typical patterns only and explain how patterns shift as gear location is changed.

1. If contact is toward the heel or base of the gear (Figure 292):

   A. Install thicker or additional bearing case shim(s) to move pinion shaft toward ring gear.

   B. Install thinner or remove differential bearing shim(s) to move ring gear backward.

   C. Repeat until proper tooth contact and pinion gear to ring gear backlash are correct.

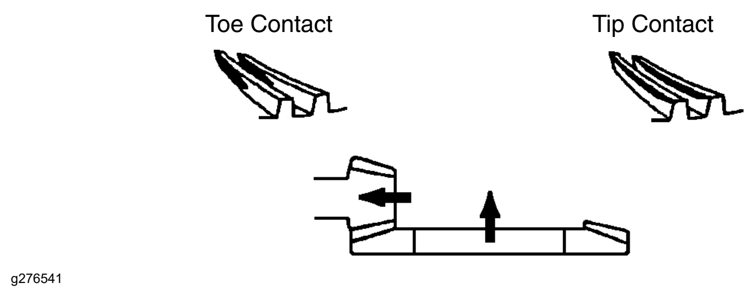

Figure 293

2. If contact is toward the toe or tip of the gear (Figure 293):

   A. Install thinner or remove bearing case shim(s) to move pinion shaft away from ring gear.

   B. Install thicker or additional differential bearing shim(s) to move ring gear forward.

   C. Repeat until proper tooth contact and pinion gear to ring gear backlash are correct.

Chapter 8

Chassis

Table of Contents

General Information

Operator's Manual

The *Operator's Manual* provides information regarding the operation, adjustment procedures, and general maintenance for your Greensmaster machine. Refer to the *Operator's Manual* for additional information when servicing the machine.

Service and Repairs

Steering Tower (For machines serial number below: 400000000)

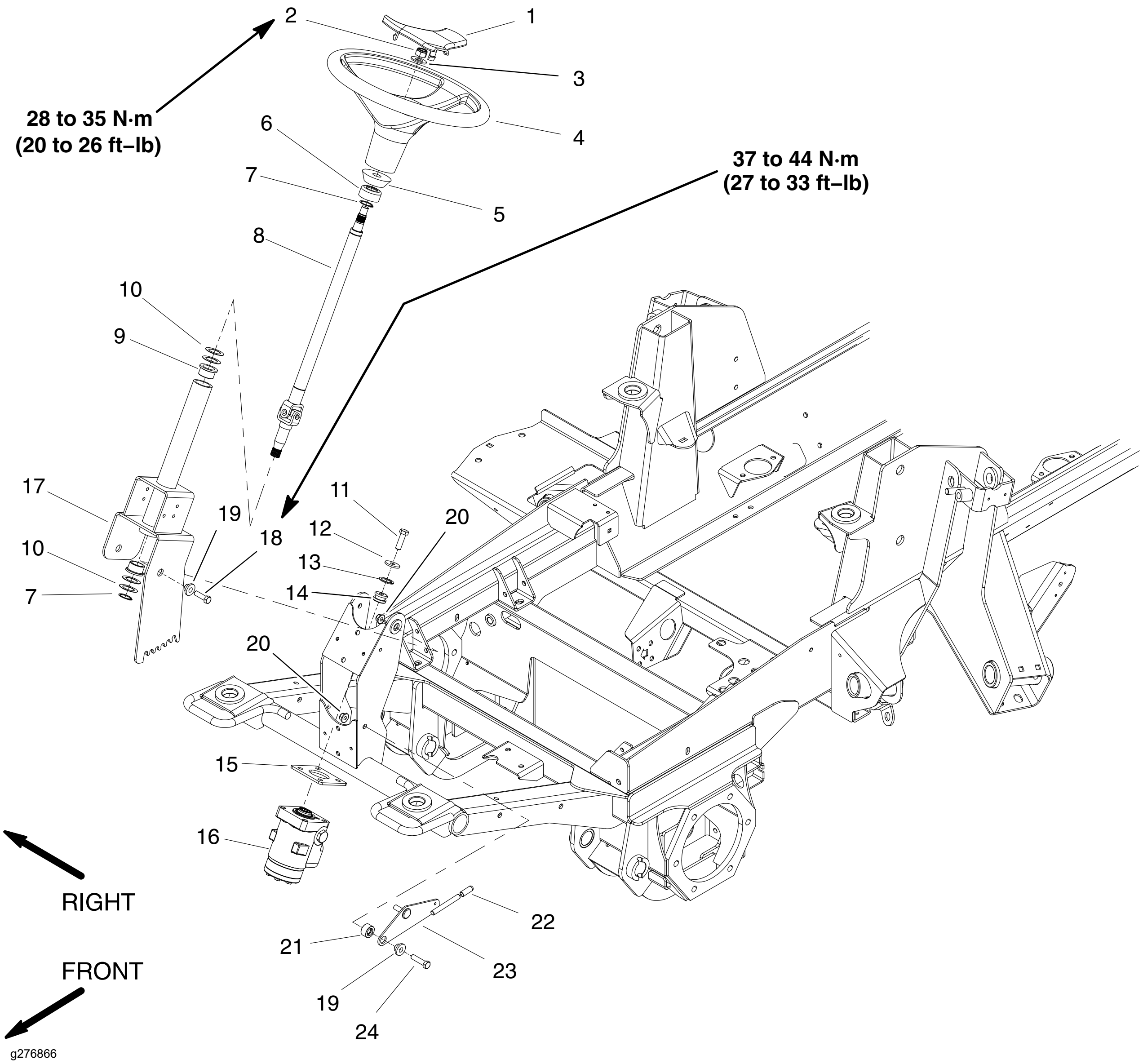

Figure 294

1. Steering wheel cover
2. Hex nut
3. Flat washer
4. Steering wheel
5. Foam collar
6. Steering seal
7. External snap ring (2 used)
8. Steering shaft
9. Flange bushing
10. Thrust washer (as needed)
11. Cap screw (4 used)
12. Washer (4 used)
13. Washer (4 used)
14. Mount (4 used)
15. Valve mount plate
16. Steering control valve
17. Steering column
18. Cap screw (2 used)
19. Pivot hub (3 used)
20. Flange nut (3 used)
21. Spacer
22. Cap
23. Tilt lever
24. Cap screw

Disassembly (Figure 294)

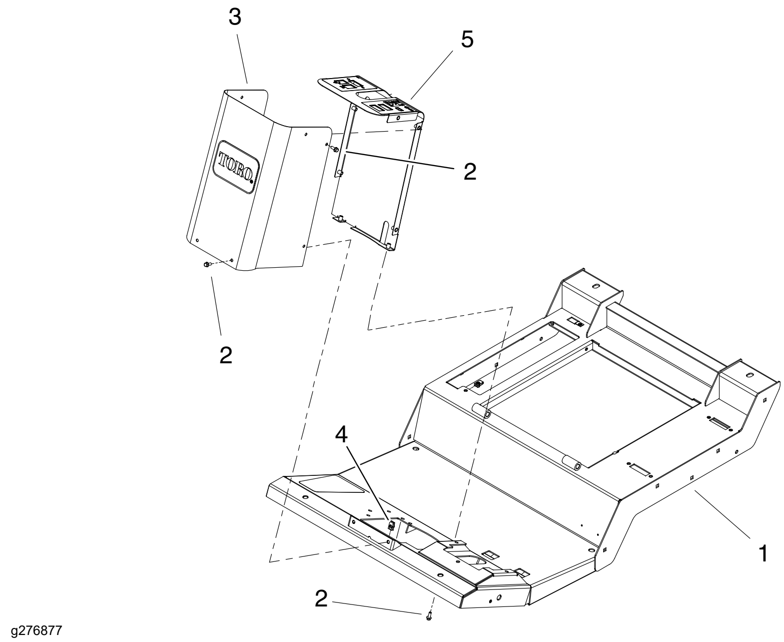

Figure 295

1. Operator platform
2. Flange screw (10 used)
3. Front cover
4. Clip (2 used)
5. Rear cover

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the key switch.
2. Remove steering tower covers to access steering tower components (Figure 295).
3. Disassemble steering tower as needed using Figure 294 as a guide.

Assembly (Figure 294)

Assemble steering tower using Figure 294 and Figure 295 as guides.

1. If steering column (item 17) was removed, torque cap screws (item 18) that secure steering column to frame bracket from **37 to 44 N·m (27 to 33 ft−lb)**.
2. Thrust washer(s) (item 10 in Figure 294) on steering column are used as needed to remove end play of steering shaft.
3. If steering wheel was removed, torque hex nut that secures steering wheel from **28 to 35 N·m (20 to 26 ft−lb)**.

Steering Tower (For machines serial number above: 400000000)

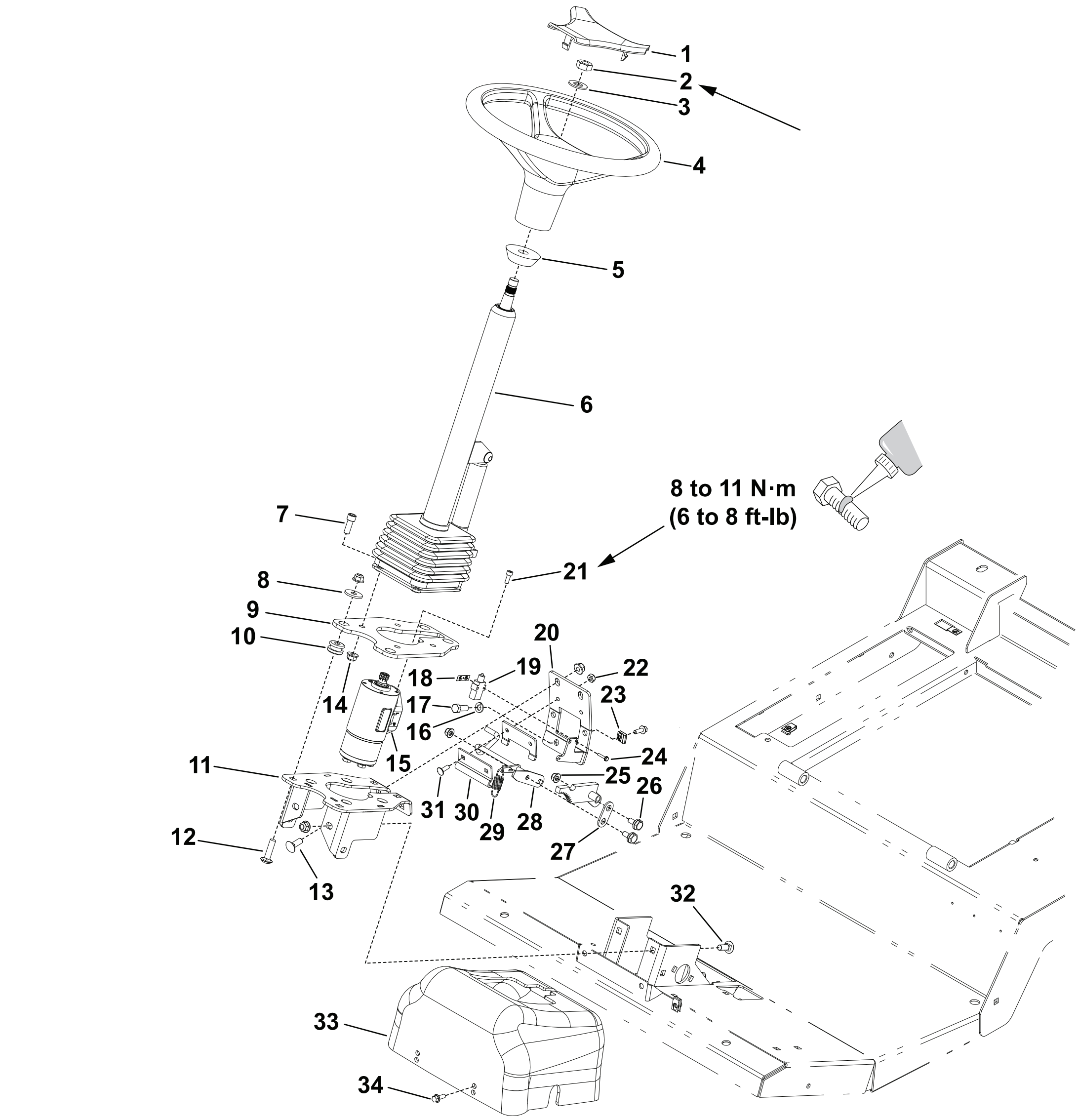

Figure 296

1. Steering wheel cover
2. Hex nut
3. Flat washer
4. Steering wheel
5. Foam collar
6. Steering shaft
7. Bolt (4 each)
8. Washer (4 each)
9. Steering mount plate
10. Mount (4 each)
11. Mount assembly
12. Carriage bolt (4 each)
13. Carriage bolt (6 each)
14. Nut (4 each)
15. Steering control valve
16. Lock washer (2 each)
17. Bolt (2 each)
18. Switch nut
19. Switch
20. Rear support
21. Bolt (4 each)
22. Lock nut (2 each)
23. Speed nut
24. Bolt (2 each)
25. Nut (2 each)
26. Shoulder bolt (2 each)
27. Brake link
28. Brake rod
29. Extension spring
30. Brake plate
31. Carriage bolt (2 each)
32. Carriage bolt (6 each)
33. Steering cover
34. Bolt (6 each)

Removal (Figure 296)

1. Park the machine on a level surface, set the parking brake, lower the cutting units, shut off the engine, and remove the key from the key switch.

Removal (Figure 296) (continued)

2. Remove steering tower covers to access steering tower components.
3. Remove the locknut and flat washer that secures the steering wheel to the steering tower.
4. Use a suitable puller to remove the steering wheel from the steering tower assembly.
5. Slide the rubber bellows up the steering tower to get access to the fasteners that secure the steering tower to the machine.
6. Support the steering control valve to prevent it from falling during the steering tower removal.

   Note: Do not allow the steering control valve to hang from the hydraulic lines.
7. Remove the steering tower as need using the Figure 296 as a guide.

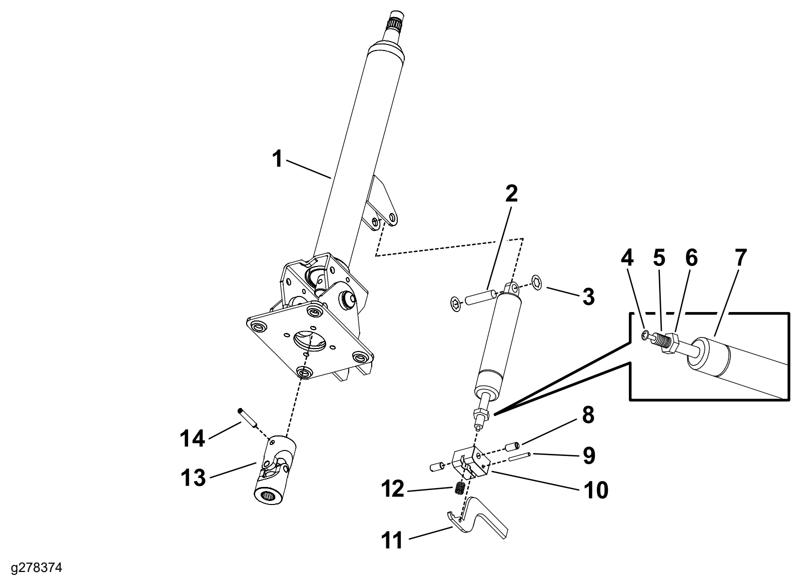

Figure 297

1.	Steering tower	8.	Bolt (2 each)
2.	Pin	9.	Pin
3.	Lock washer (2 each)	10.	Pedal block
4.	Release pin	11.	Pedal
5.	Cylinder shaft	12.	Spring
6.	Jam nut	13.	Universal joint
7.	Cylinder	14.	Pin

8. Disassemble the steering tower assembly as necessary; refer to Figure 297.

Installation (Figure 296)

1. Assemble the steering tower; refer to Figure 297.
2. After assembly, ensure that the release pin on the end of the cylinder shaft is positioned against the pedal. The jam nut on the cylinder shaft can be used to adjust the location of the release pin.
3. Install the steering tower using the Figure 296 as a guide.
4. Secure the steering wheel tot he steering column assembly with the flat washer and locknut; torque the locknut to **28 to 35 N·m (20 to 26 ft-lb)**.
5. Install the steering wheel cover onto the steering wheel.

Center Deck Lift Arms

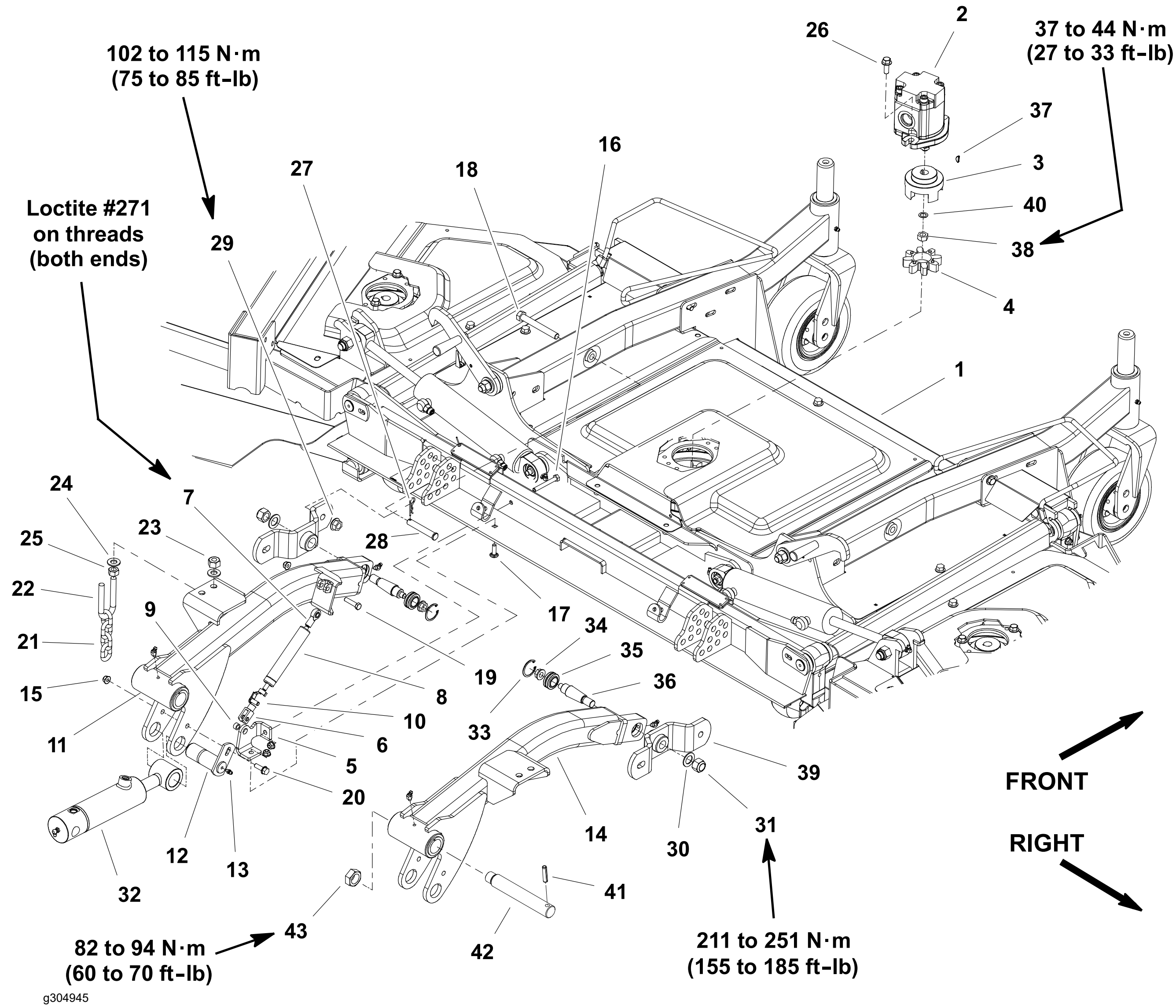

Figure 298

1. Deck assembly
2. Deck motor (3 used)
3. Spider hub (3 used)
4. Spider (3 used)
5. Damper support
6. Clevis rod end
7. Spherical rod end
8. Damper
9. Spacer
10. Spring pin
11. LH lift arm
12. Pin (2 used)
13. Grease fitting (2 used)
14. RH lift arm
15. Flange nut (5 used)
16. Cap screw
17. Carriage screw
18. Cap screw (4 used)
19. Cap screw
20. Flange head screw (2 used)
21. HOC chain (2 used)
22. U-bolt (2 used)
23. Lock nut (4 used)
24. Flat washer (8 used)
25. Hex nut (4 used)
26. Flange head screw (6 used)
27. Hair pin (2 used)
28. Clevis pin (2 used)
29. Flange nut (4 used)
30. Flat washer (2 used)
31. Lock nut (2 used)
32. Hydraulic lift cylinder (2 used)
33. Retaining ring (2 used)
34. Flange nut (2 used)
35. Spherical bearing (2 used)
36. Tapered stud (2 used)
37. Woodruff key (3 used)
38. Lock nut (3 used)
39. Support hub (2 used)
40. Hardened washer (3 used)
41. Spring pin (2 used)
42. Lift arm pin (2 used)
43. Lock nut (2 used)

Removal (Figure 298)

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the key switch.
2. Remove center cutting deck (see Center Cutting Deck (page 9–3)).

CAUTION

When changing attachments, tires or performing other service, use correct jacks and supports. Make sure machine is parked on a solid, level surface such as a concrete floor. Prior to raising machine, remove any attachments that may interfere with the safe and proper raising of the machine. Always chock or block wheels. Use jack stands to support the raised machine. If the machine is not properly supported by jack stands, the machine may move or fall, which may result in personal injury.

3. Chock rear wheels and jack up front of machine. Support machine on jack stands. Remove front wheel next to lift arm that is being removed.
4. Remove flange head screw and lock nut that secure lift cylinder pin to lift arm. Remove pin and separate lift cylinder from lift arm.
5. Remove lock nut that secures lift arm pin. Support lift arm and slide pin from frame and lift arm. Remove lift arm from frame.
6. As needed, disassemble lift arm:
   A. Remove height-of-cut chain (items 21 and 22 in Figure 298).
   B. Remove damper assembly (items 6, 7 and 8 in Figure 298).
   C. Remove flange nut, flat washer and support hub (item 39 in Figure 298) from tapered stud in end of lift arm.

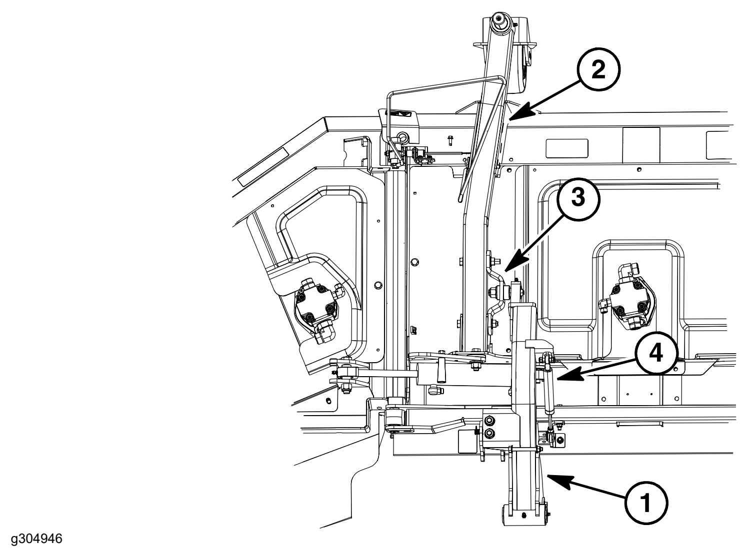

Figure 299

1. Lift arm	3. Support hub
2. Deck castor arm	4. Damper

Removal (Figure 298) (continued)

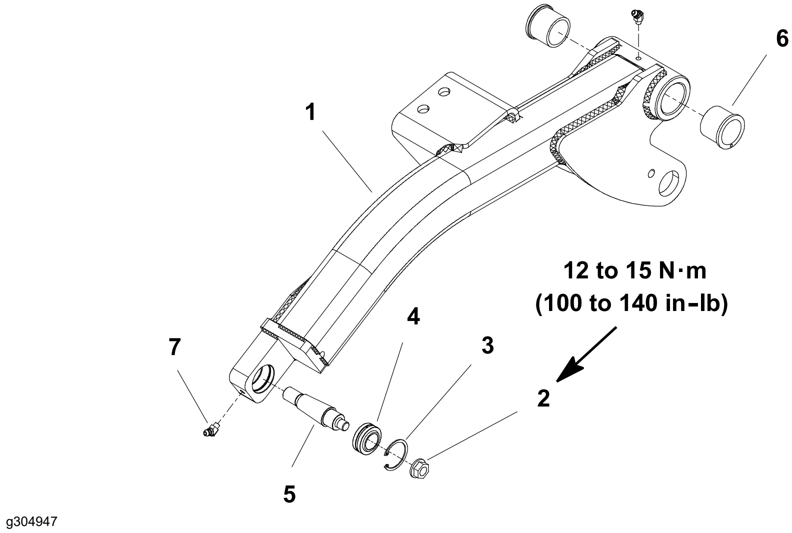

Figure 300

1. Lift arm (RH shown)
2. Flange nut
3. Retaining ring
4. Spherical bearing
5. Tapered stud
6. Flange bushing (2 used)
7. Grease fitting (2 used)

D. Remove tapered stud with spherical bearing from lift arm after removing retaining ring from lift arm (Figure 300). Remove flange nut and spherical bearing from stud.

E. Press flange bushings from lift arm (Figure 300).

Installation (Figure 298)

1. If removed, install components to lift arm.

   A. Press flange bushings into lift arm.

   B. Install spherical bearing on tapered stud and secure with flange nut. Torque flange nut from **41 to 54 N·m (30 to 40 ft-lb)**. Install stud with spherical bearing into lift arm and secure with retaining ring.

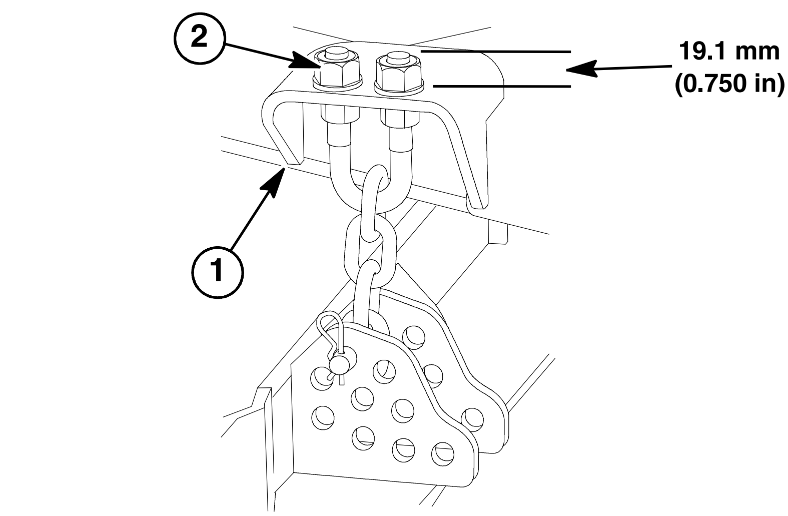

Figure 301

1. Lift arm
2. U-bolt threads

Installation ([Figure 298](#)) (continued)

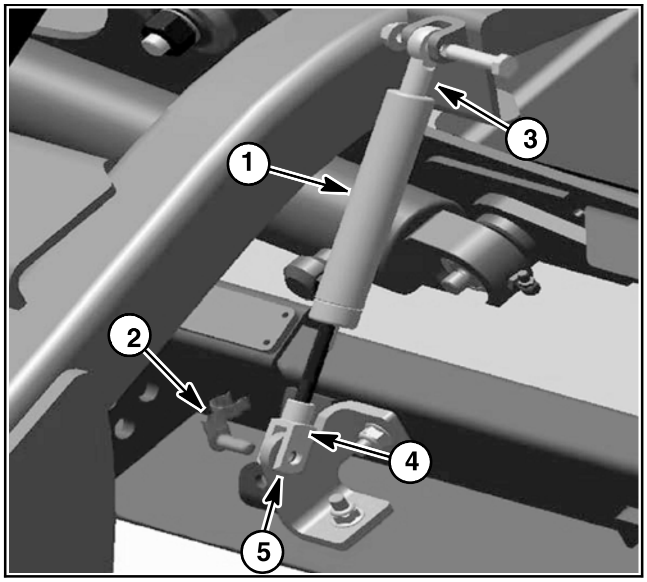

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Figure 302

1. Damper
2. Spring pin
3. Damper rod end
4. Damper clevis end
5. Spacer location

C. If rod and clevis ends were removed from damper, apply Loctite #271 (or equivalent) to threads on damper shaft and stud. Install ends on damper. Install damper assembly to lift arm with damper clevis end toward deck location (Figure 302).

D. Assemble height-of-cut chain U-bolt so that threaded portion of U-bolt extends 19.1 mm (0.750 in) above mounting plate on lift arm (Figure 301). This dimension is a starting point that might need additional adjustment for deck pitch correction (see step 8 below).

E. Thoroughly clean tapered surfaces of stud and mounting boss of support hub. Secure support hub (position slotted hole in hub toward rear of deck) to tapered stud with flat washer and flange nut. Torque flange nut from **211 to 251 N·m (155 to 185 ft-lb)**.

2. Position lift arm to frame and insert lift arm pin. Engage roll pin in lift arm pin into frame slots and install lock nut on pin. Torque lock nut from **82 to 94 N·m (60 to 70 ft-lb)**.

3. Align lift cylinder with lift arm. Slide lift cylinder pin through lift arm and cylinder end. Secure pin with flange head screw and lock nut.

WARNING

Failure to maintain proper wheel lug nut torque could result in failure or loss of wheel and may result in personal injury.

4. Install front wheel assembly. Lower machine to the ground. Torque wheel lug nuts from **115 to 135 N·m (85 to 100 ft-lb)**.

5. Install cutting deck (see Center Cutting Deck (page 9–3)).

Installation (Figure 298) (continued)

6. Lubricate lift arm grease fittings.
7. After assembly is completed, raise and lower the cutting deck to verify that hydraulic hoses and fittings do not contact anything.
8. Check height-of-cut and deck pitch adjustment.

Control Arm

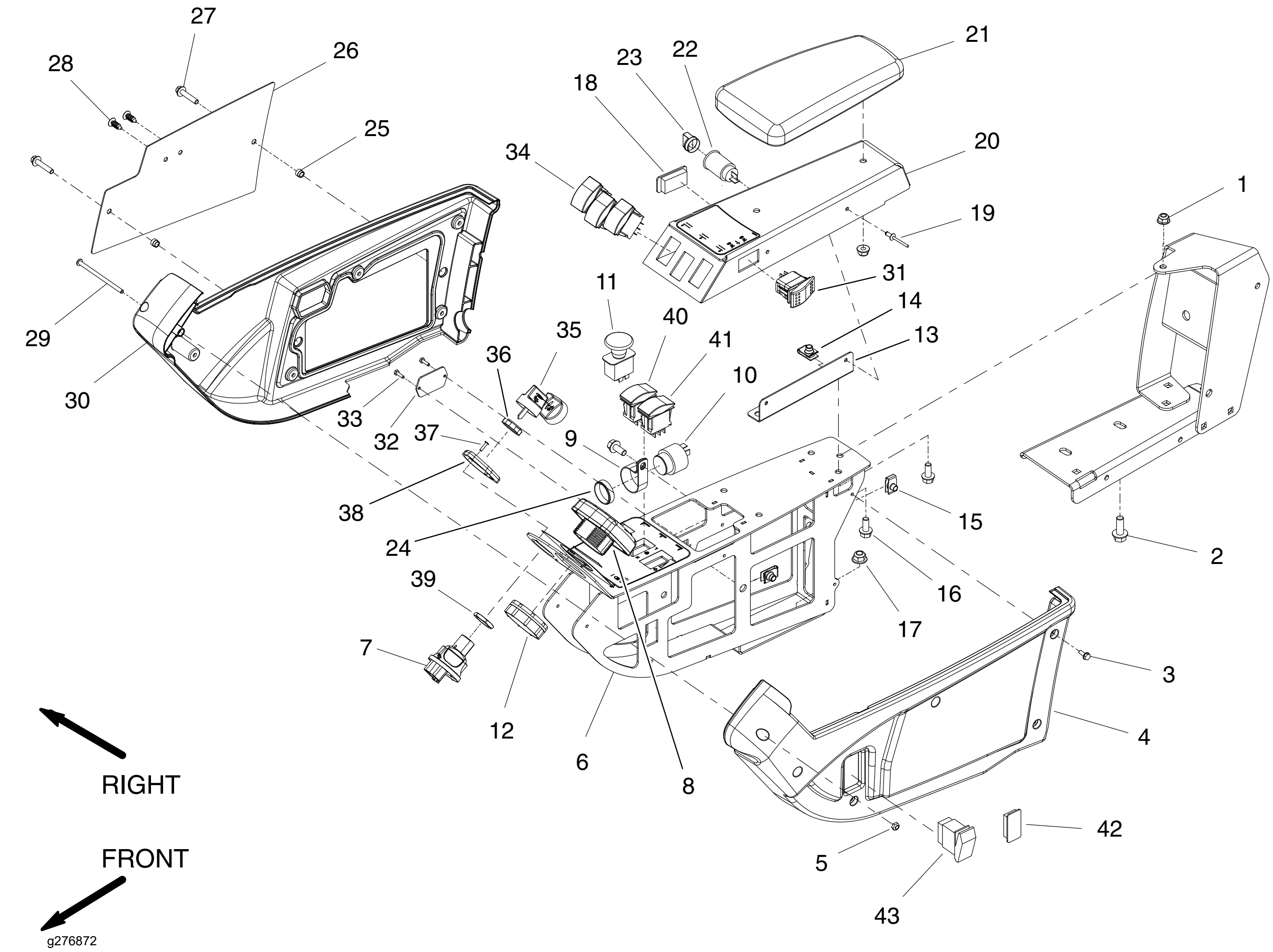

Figure 303

1. Flange nut (3 used)
2. Flange head screw (2 used)
3. Washer head screw (10 used)
4. LH cover
5. Lock nut
6. Control arm panel
7. Key switch
8. InfoCenter display
9. R−clamp
10. Audio alarm
11. PTO switch
12. Nut
13. Bracket
14. U−nut (5 used)
15. Clip (2 used)
16. Flange head screw (6 used)
17. Flange nut (2 used)
18. Hole plug
19. Rivet (2 used)
20. Switch panel
21. Arm rest
22. Power point
23. Cap
24. Nut
25. Flange spacer (2 used)
26. Cover plate
27. Flange head screw (2 used)
28. Plug (2 used)
29. Screw
30. RH cover
31. Cruise control switch
32. Cover plate
33. Cap screw (2 used)
34. Lift/lower switch (3 used)
35. Key
36. Nut
37. Screw (2 used)
38. Switch step
39. Hex nut
40. Hi−low speed switch
41. Engine speed switch
42. Hole plug (GM4100−D)
43. Headlight switch (GM4110−D)

Disassembly (Figure 303)

1. Park machine on a level surface, lower cutting units, stop engine and engage parking brake. Remove key from key switch.
2. Remove two (2) flange head screws (item 27) and then cover plate (item 26) from outside of control arm. Locate and retrieve two (2) spacers (item 25).

Disassembly (Figure 303) (continued)

3. At front of control arm, remove screw (item 29) and lock nut (item 5) that secure control arm covers to each other.
4. Remove five (5) washer head screws (item 3) that secure each cover to control arm panel.
5. Remove control arm covers from machine. As LH cover (item 4) is removed from control arm, unplug wire harness connector from headlight switch if equipped.
6. Remove electrical components from control arm as needed using Figure 303 as a guide.
7. If necessary, remove control arm panel and supports from machine using Figure 303 and Figure 304 as guides.

Assembly (Figure 303)

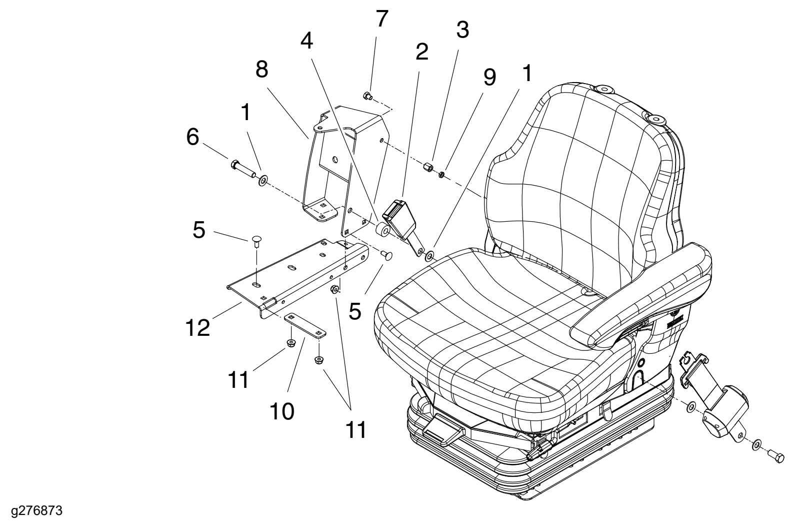

Figure 304

1.	Flat washer	7.	Screw
2.	Seat belt buckle	8.	Arm support
3.	Coupling nut	9.	Hex nut
4.	Spacer	10.	Support bracket
5.	Carriage screw (5 used)	11.	Flange nut (5 used)
6.	Cap screw	12.	Support channel

1. Install all removed electrical and control arm components using Figure 303 and Figure 304 as guides.
2. Position covers to control arm. As LH cover (item 4) is placed, plug wire harness connector to headlight switch if equipped.
3. Secure each cover to control arm with five (5) washer head screws (item 3). Install screw (item 29) and lock nut (item 5) to secure covers at front of control arm.
4. Position cover plate and spacers to outside of control arm. Secure with two (2) flange head screws.

Traction Pedal

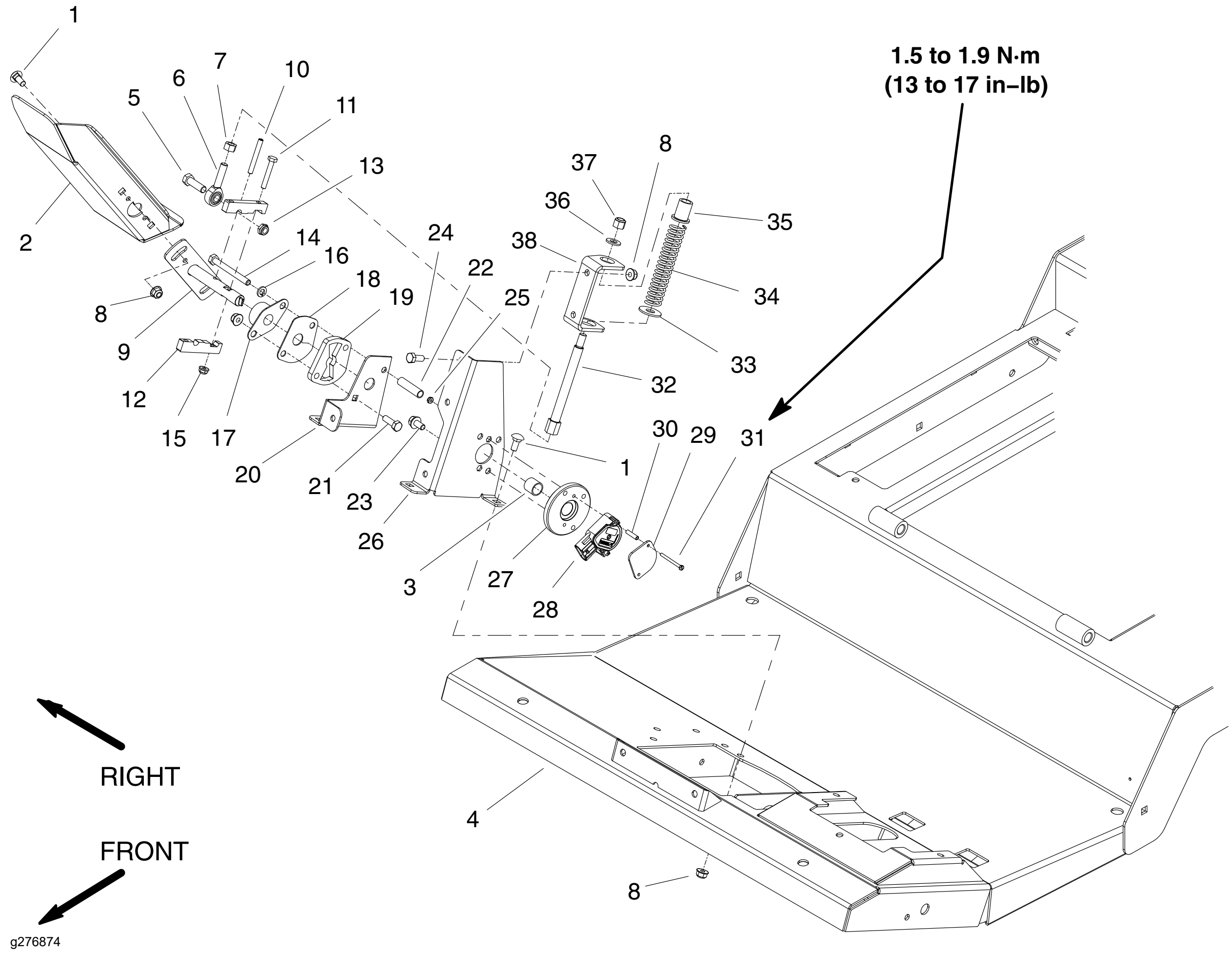

Figure 305

(For machines serial numbers below 400000000)

1. Carriage bolt (6 used)
2. Traction pedal
3. Bushing
4. Operator platform
5. Cap screw
6. Rod end bearing
7. Hex nut
8. Flange nut (10 used)
9. Traction pedal shaft
10. Roll pin
11. Cap screw (2 used)
12. Clamp block (2 used)
13. Lock nut
14. Cap screw
15. Flange nut (2 used)
16. Lock washer
17. Flange mount bearing
18. Cover plate
19. Butterfly plate
20. Butterfly bracket
21. Carriage screw
22. Spacer
23. Threadlock screw (2 used)
24. Cap screw (5 used)
25. Lock nut (6 used)
26. Sensor bracket
27. Bushing hub
28. Position sensor
29. Capture plate
30. Standoff spacer (2 used)
31. Screw (2 used)
32. Spring shaft
33. Flat washer
34. Compression spring
35. Spring retainer
36. Flat washer
37. Lock nut
38. Spring bracket

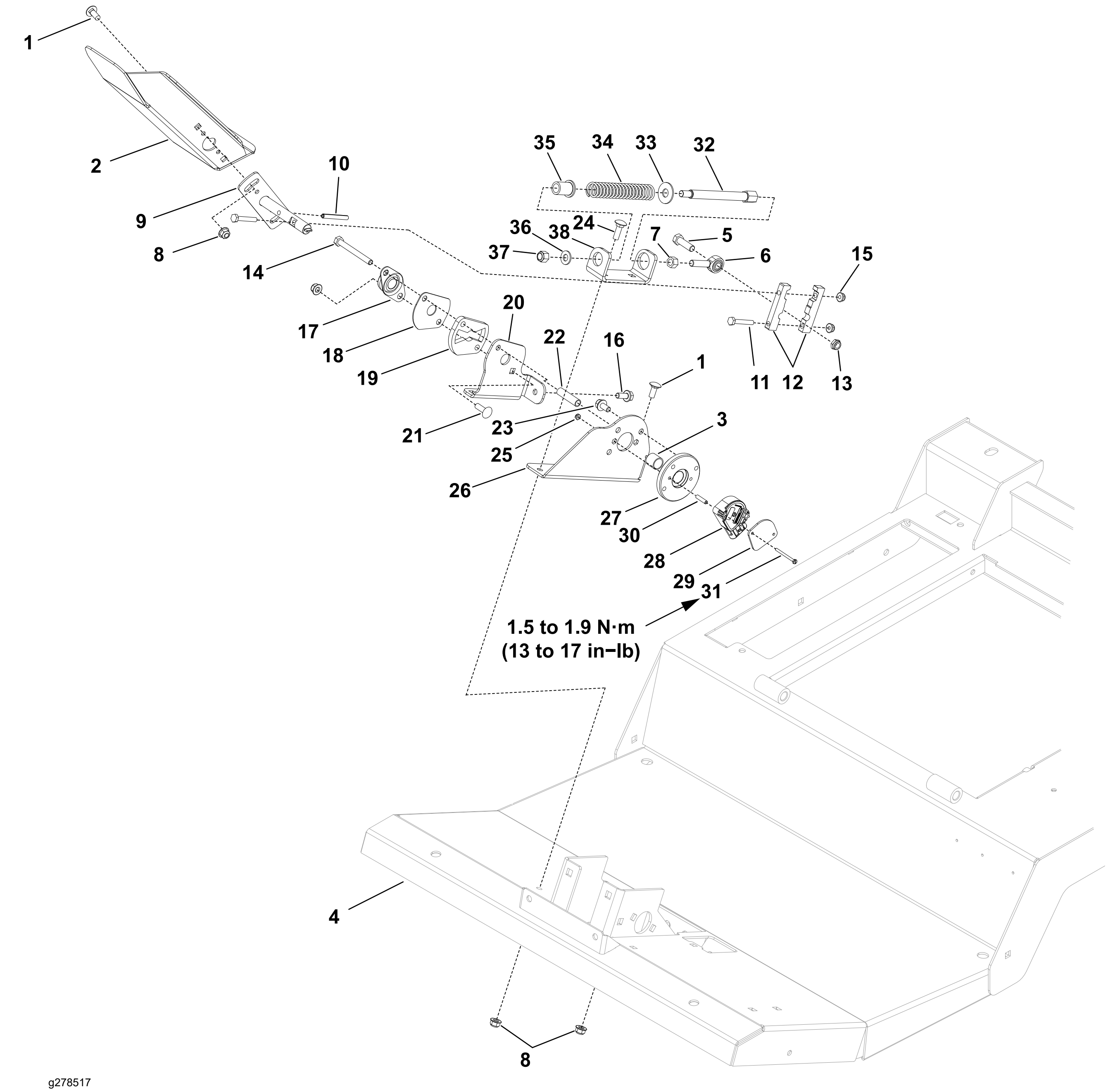

Figure 306

(For machines serial numbers above 400000000)

1. Carriage bolt (6 used)
2. Traction pedal
3. Bushing
4. Operator platform
5. Cap screw
6. Rod end bearing
7. Hex nut
8. Flange nut (10 used)
9. Traction pedal shaft
10. Roll pin
11. Cap screw (2 used)
12. Clamp block (2 used)
13. Lock nut
14. Cap screw
15. Flange nut (2 used)
16. Lock washer
17. Flange mount bearing
18. Cover plate
19. Butterfly plate
20. Butterfly bracket
21. Carriage screw
22. Spacer
23. Threadlock screw (2 used)
24. Cap screw (5 used)
25. Lock nut (6 used)
26. Sensor bracket
27. Bushing hub
28. Position sensor
29. Capture plate
30. Standoff spacer (2 used)
31. Screw (2 used)
32. Spring shaft
33. Flat washer
34. Compression spring
35. Spring retainer
36. Flat washer
37. Lock nut
38. Spring bracket

IMPORTANT

A properly installed and calibrated traction pedal position sensor is critical to accurate traction system response and for reliable sensor life. Use care when removing, installing and calibrating the traction pedal position sensor.

Disassembly (Figure 305 and Figure 306)

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the key switch.
2. Remove front steering tower cover (see Steering Tower (For machines serial number below: 400000000) (page 8–3)).
3. Disconnect machine wire harness connector from position sensor (item 28) on traction pedal.
4. If the traction pedal is to be removed from the traction pedal shaft, use a marker or paint pen on pedal and shaft to identify location of pedal for assembly purposes.

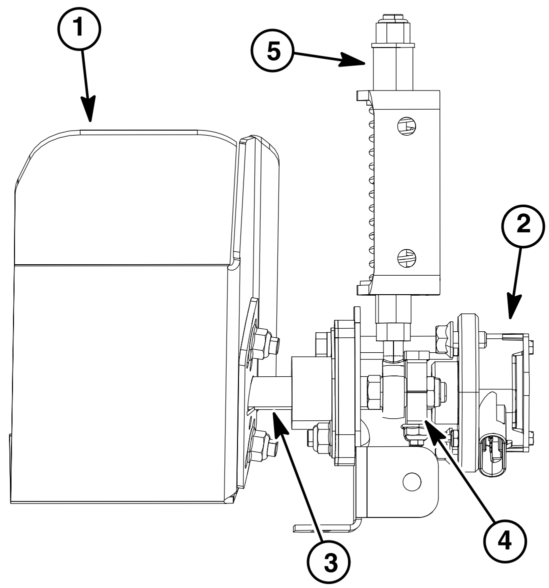

Figure 307

1. Traction pedal
2. Pedal position sensor
3. Traction pedal shaft
4. Clamp block (2 used)
5. Spring shaft assembly

5. Disassemble traction pedal as needed using Figure 306 and Figure 307 as guides. When removing roll pin (item 10 in Figure 305), make sure to support shaft to prevent component damage.

Assembly (Figure 305 and Figure 306)

1. Assemble traction pedal using Figure 305 and Figure 307 as guides noting the following items:
   A. Apply grease to both the OD and ID of the spring retainer (item 35) before installation. Take care to not get grease on threads of spring shaft (item 32) or lock nut (item 37).
   B. If lock nut (item 37) was removed, tighten nut until washer (item 36) does not rotate.

Assembly (Figure 305 and Figure 306) (continued)

C. If traction pedal shaft (item 9) was removed, apply grease to the shaft areas that will be inside the bearings after assembly.

D. Use a press to install roll pin (item 10). DO NOT damage flange mount bearing (item 17) or cover plate (item 18) when installing roll pin. Also, take care to not distort roll pin during assembly.

E. Make sure that roll pin (item 10) is fully inside the butterfly groove of the shim plate (item 20). The roll pin should not contact the shim plate throughout the operating range.

F. To install the traction pedal position sensor (item 28), press and hold the traction pedal in the reverse direction slightly. Align the slot on the end of the pedal shaft with the slot in the position sensor. Slide position sensor onto screws and release pedal. Hold position sensor in position while installing capture plate (item 29) and lock nuts (item 25).

G. Torque screws (item 31) from **1.5 to 1.9 N·m (13 to 17 in–lb)**.

H. Leave the hex nut (item 7) loose so that the position sensor can be calibrated.

2. After traction pedal assembly, make sure that there is no binding in pedal movement and also that pedal returns to the centered position when released. Correct any sticking or binding before machine operation.
3. Plug machine wire harness connector into traction pedal position sensor (item 28).
4. After assembly of the traction pedal, adjust and calibrate the traction pedal and position sensor using the InfoCenter display (see Traction Pedal Adjustment (page 6–21) and Traction Pedal Position Sensor Calibration (page 6–23)).
5. Make sure that hex nut (item 7) is tightened after position sensor adjustment.
6. Install front steering tower cover (see Steering Tower (For machines serial number below: 400000000) (page 8–3)).

Operator Platform

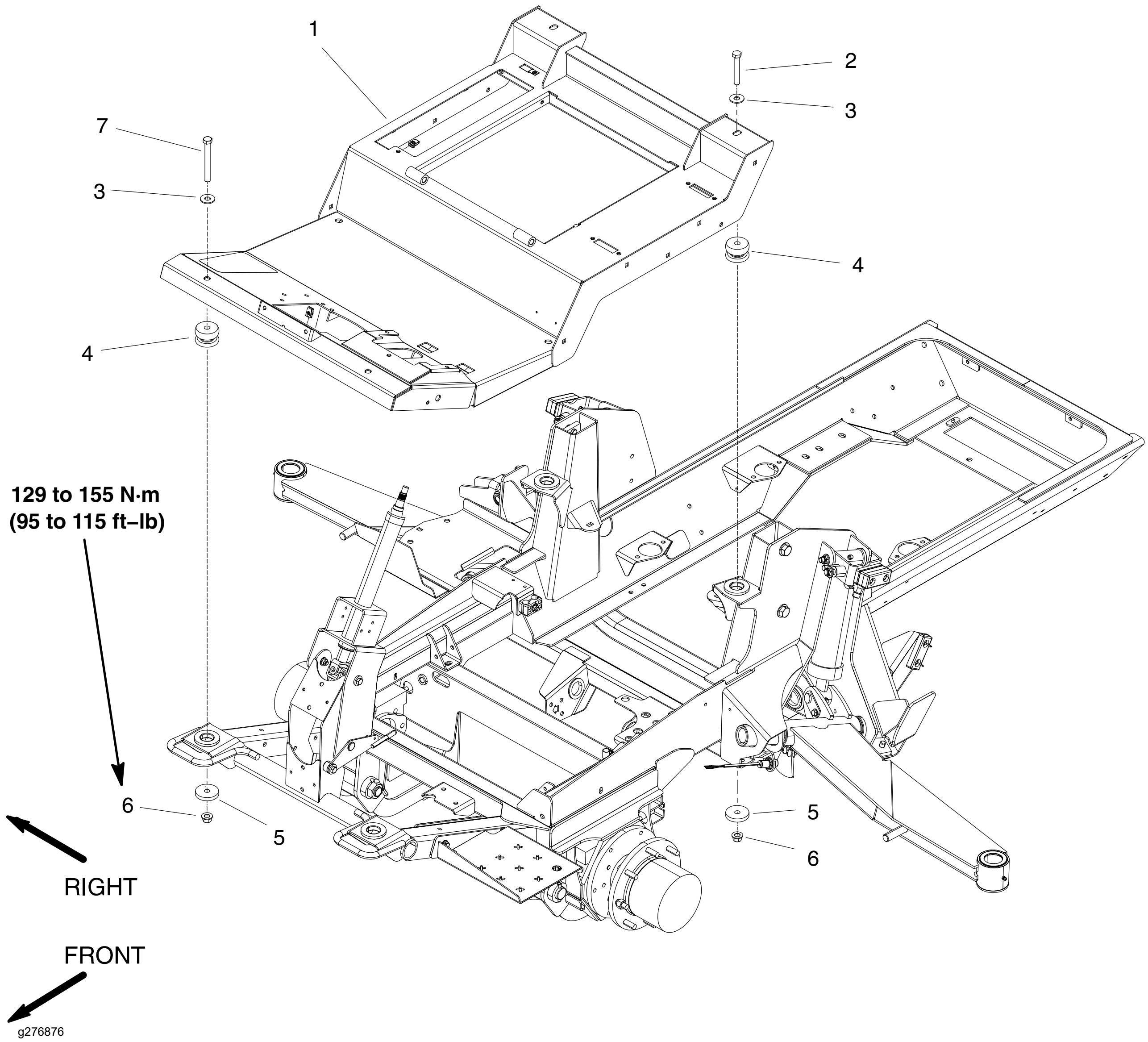

Figure 308

1. Operator platform
2. Cap screw (2 used)
3. Flat washer (4 used)
4. Center mount (4 used)
5. Plain washer (4 used)
6. Lock nut (4 used)
7. Cap screw (2 used)

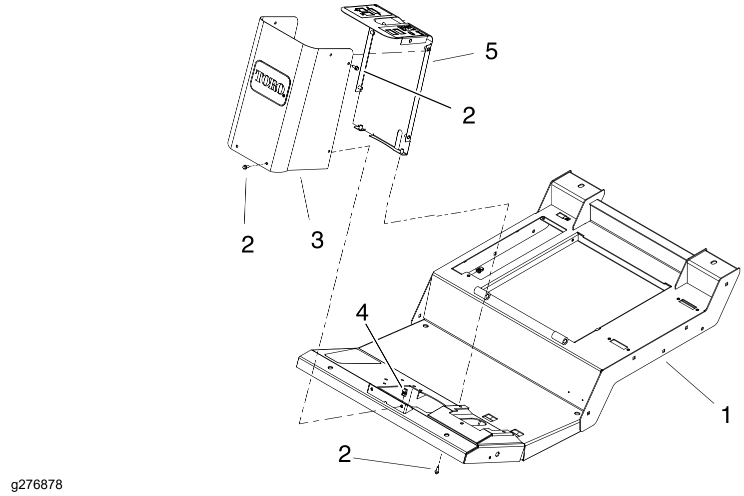

Figure 309

1. Operator platform
2. Flange screw (10 used)
3. Front cover
4. Clip (2 used)
5. Rear cover

Some service procedures (e.g. removing the hydraulic reservoir) require the operator platform to be raised. The following steps can be used to raise the platform.

Disassembly (Figure 308)

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the key switch.
2. Disconnect negative battery cable from battery terminal and then disconnect positive cable from battery (see Battery Service (page 6–91)).
3. Remove steering tower covers (see Steering Tower (For machines serial number below: 400000000) (page 8–3)).
4. Disconnect machine wire harness connector from position sensor on traction pedal assembly.

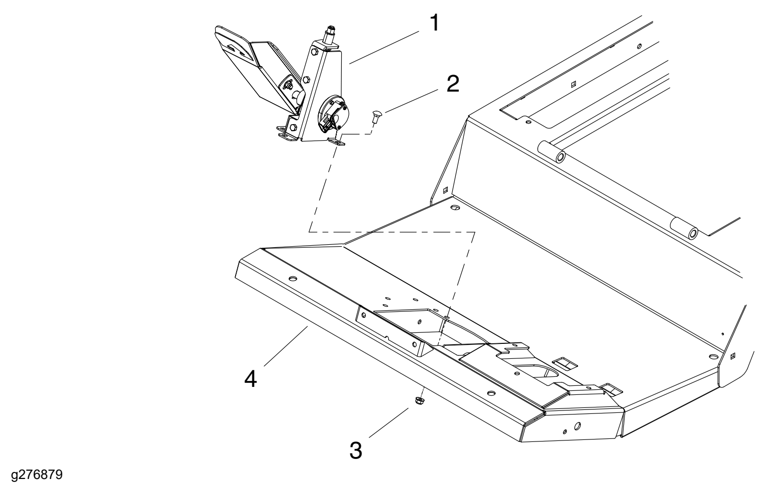

Figure 310

1. Traction pedal assembly
2. Carriage screw (4 used)
3. Flange nut (4 used)
4. Operator platform

Disassembly (Figure 308) (continued)

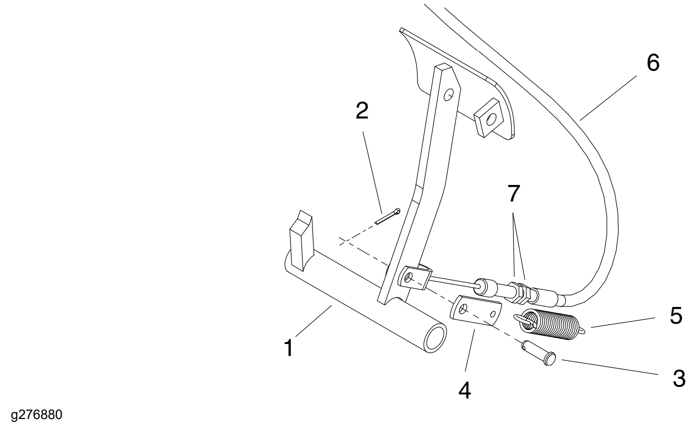

Figure 311

1. Brake pedal (RH shown)
2. Cotter pin
3. Clevis pin
4. Brake strap
5. Spring
6. Brake cable (RH shown)
7. Brake cable jam nuts

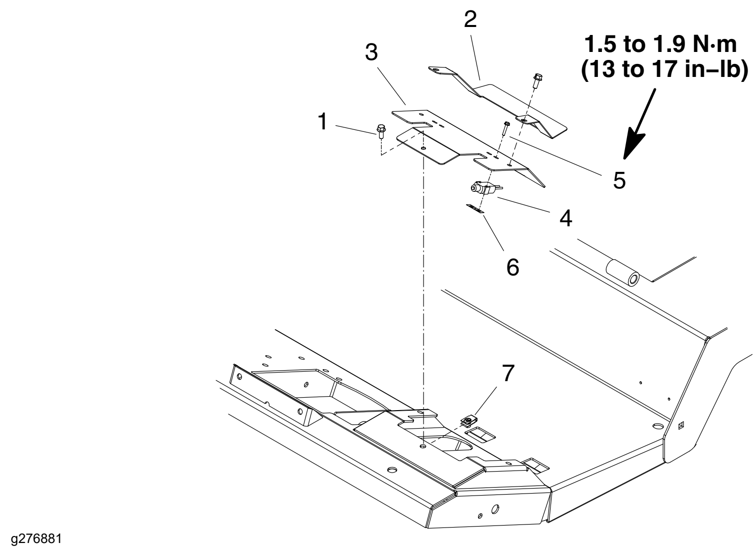

Figure 312

1. Flange screw (3 used)
2. Adjustment cover
3. Switch bracket
4. Brake switch (2 used)
5. Screw (2 per switch)
6. Switch nut (2 used)
7. Clip (3 used)

5. Remove fasteners that secure traction pedal assembly to operator platform and then remove traction pedal assembly from platform (Figure 310).

Disassembly (Figure 308) (continued)

6. Disconnect both brake cables from brake pedals and operator frame (Figure 311). Access to brake cable jam nuts can obtained by removing adjustment cover on operator platform (Figure 312). Position brake cables away from operator platform.
7. Disconnect all electrical wire harness connections between operator platform components and main frame locations. As needed, label disconnected electrical connections for proper installation.
8. On Groundsmaster 4110 machines:
   A. Remove operator cab from machine.
   B. Remove cable ties that secure operator cab coolant and air conditioner hoses in engine compartment to allow the operator platform to be raised. Note location of cable ties for assembly purposes.

   Note: If desired, operator seat can be removed from operator platform to reduce overall weight of operator platform assembly (see Operator Seat (page 8–23)).
9. Remove four (4) cap screws, flat washers, plain washers and lock nuts that secure operator platform to machine frame.

IMPORTANT

Make sure to not damage the electrical wire harness or other components while raising the operator platform.

10. Carefully raise operator platform as needed to access components to be serviced. Support platform to prevent it from moving or shifting.

Assembly (Figure 308)

1. Make sure that all machine components are installed below operator platform before platform is lowered to frame.

IMPORTANT

Make sure to not damage the electrical wire harness or other components while lowering the operator platform.

2. Carefully lower operator platform and position over center mounts (item 4) that are installed in the frame.
3. Secure operator platform to machine frame with four (4) cap screws, flat washers, plain washers and lock nuts. Torque lock nuts from **129 to 155 N·m (95 to 115 ft−lb)**.
4. Connect all electrical wire harness connections between operator platform components and main frame locations.
5. On Groundsmaster 4110 machines:
   A. Install operator cab to machine.
   B. Secure operator cab coolant and air conditioner hoses in engine compartment with cable ties in locations noted during disassembly.

Assembly (Figure 308) (continued)

6. Connect both brake cables to brake pedals and operator frame. Adjust brakes so that both pedals have **13 to 25 mm (0.5 to 1 in)** of free travel.
7. Position traction pedal assembly to operator platform and secure with removed fasteners (Figure 310). Connect machine wire harness connector to position sensor on traction pedal assembly.
8. Secure steering tower covers to machine (see Steering Tower (For machines serial number below: 400000000) (page 8–3)).
9. Connect positive battery cable from battery terminal and then connect negative cable to battery (see Battery Service (page 6–91)).

Operator Seat

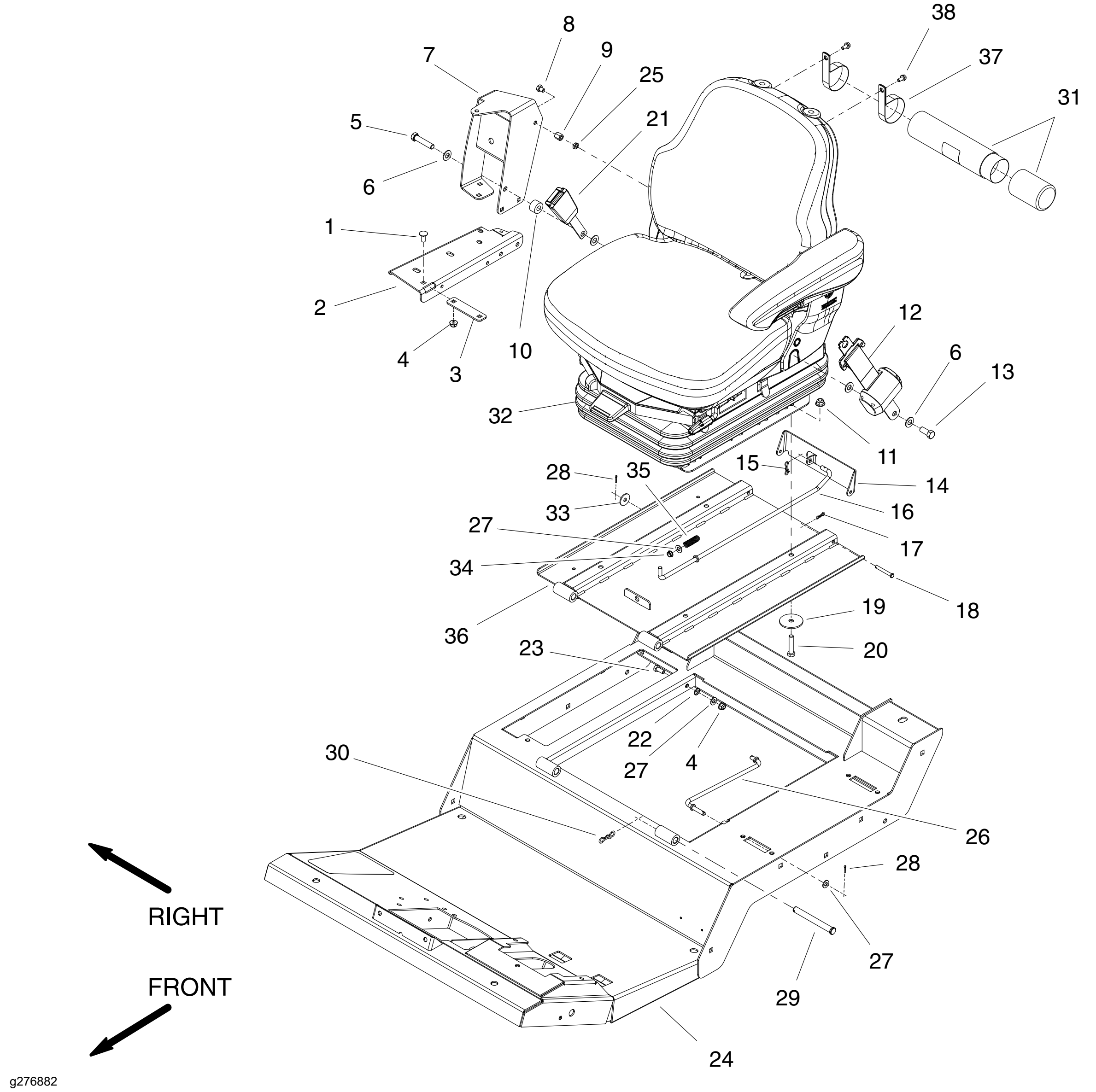

Figure 313

1. Carriage screw (5 used)	14. Seat latch	27. Flat washer (3 used)
2. Support channel	15. Locking cotter pin	28. Cotter pin (2 used)
3. Support bracket	16. Latch rod	29. Clevis pin (2 used)
4. Flange nut (6 used)	17. Locking cotter pin (2 used)	30. Locking cotter pin (2 used)
5. Cap screw	18. Clevis pin (2 used)	31. Manual tube
6. Flat washer (4 used)	19. Flat washer (4 used)	32. Seat and suspension assembly
7. Arm support	20. Cap screw (4 used)	33. Flat washer
8. Screw	21. Seat belt latch	34. Bushing
9. Coupler nut	22. Lock washer	35. Compression spring
10. Spacer	23. Cap screw	36. Seat plate
11. Flange nut (4 used)	24. Operator platform	37. R−clamp (2 used)
12. Seat belt	25. Hex nut	38. Flange head screw (2 used)
13. Cap screw	26. Prop rod	

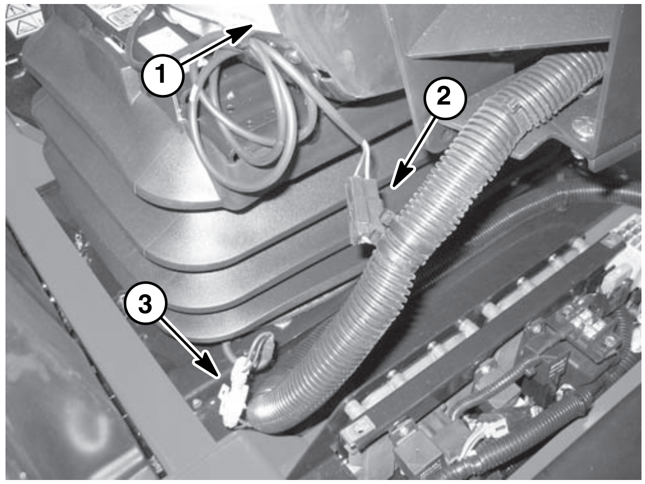

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Figure 314

1. Operator seat
2. Seat switch connector
3. Suspension connector

Removal (Figure 313)

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the key switch.
2. Disconnect seat electrical connector from machine wire harness (Figure 314).
3. Support control arm assembly to prevent it from shifting.
4. Remove flange nut (item 4) and carriage screw (item 1) that secure support bracket (item 3) to support channel (item 2).
5. Remove screw (item 8) that secures control arm support (item 7) to coupler nut (item 9).
6. Remove cap screw (item 5), flat washers (item 6), spacer (item 10) and seat belt latch (item 21) from seat and control arm support (item 7).

IMPORTANT

Make sure to not damage the electrical harness, control cable or other parts while moving the control arm assembly.

7. Carefully move control arm assembly away from seat.

Removal (Figure 313) (continued)

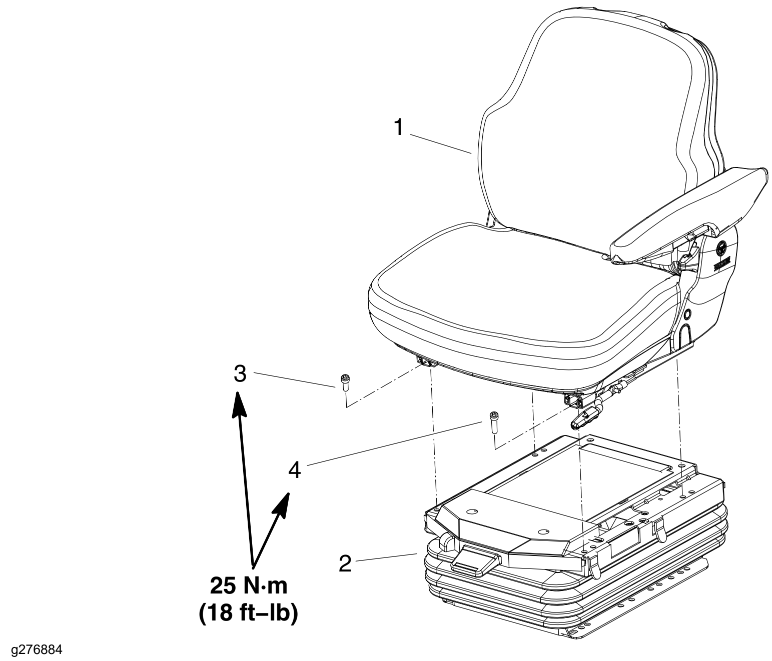

Figure 315

1. Seat
2. Suspension assembly
3. Screw (M8x12) (3 used)
4. Screw (M8x16)

---

8. Remove four (4) torx head screws that secure seat to seat suspension (Figure 315). Note that the screw near the seat adjustment handle is longer than the other three (3) screws.
9. Lift seat from seat suspension and remove from machine.

   Note: Refer to Operator Seat Suspension (page 8–29) in this section if seat suspension service is necessary.

Installation (Figure 313)

1. Carefully position seat to seat suspension.
2. Secure seat to seat suspension with four (4) torx head screws (Figure 315). Make sure that longer screw is positioned near the seat adjustment handle. Torque screws **25 N·m (18 ft−lb)**.

IMPORTANT

Make sure to not damage the electrical harness, control cable or other parts while moving the control arm assembly.

3. Position and secure control arm assembly to seat. Install all fasteners before fully tightening them.
   A. Secure support bracket (item 3) and support channel (item 2) with flange nut (item 4) and carriage screw (item 1).
   B. Secure control arm support (item 7) to coupler nut (item 9) with screw (item 8).

Installation (Figure 313) (continued)

C. Place flat washer (item 6), seat belt latch (item 21) and spacer (item 10) between seat and control arm support (item 7). Secure with cap screw (item 5) and second flat washer (item 6).

D. Fully tighten all fasteners to secure control arm assembly to seat.

4. Connect seat electrical connector to machine wire harness (Figure 314).

Operator Seat Service

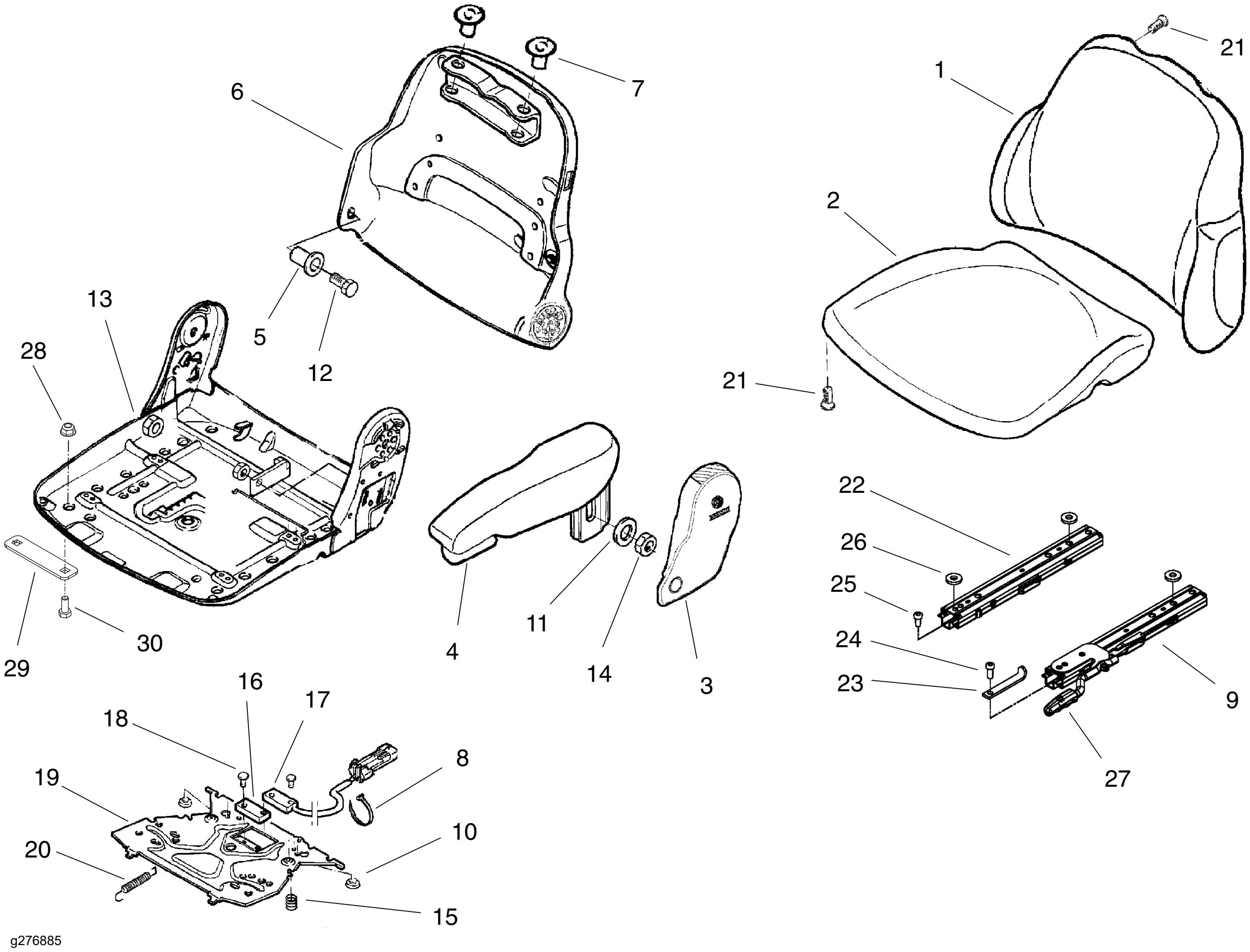

Figure 316

1.	Backrest cushion	11.	Washer	21.	Torx screw (5 used)
2.	Seat cushion	12.	Cap screw (2 used)	22.	RH adjustment rail
3.	Armrest cover	13.	Seat	23.	Rail stop
4.	LH armrest	14.	Nut	24.	Torx screw
5.	Bushing (2 used)	15.	Spring (2 used)	25.	Torx screw (3 used)
6.	Backrest	16.	Magnet	26.	Washer (3 used)
7.	Plug (2 used)	17.	Seat switch	27.	Handle
8.	Cable tie (3 used)	18.	Rivet (4 used)	28.	Nut
9.	LH adjustment rail	19.	Mounting plate	29.	Support bracket
10.	Bumper (2 used)	20.	Return spring	30.	Cap screw

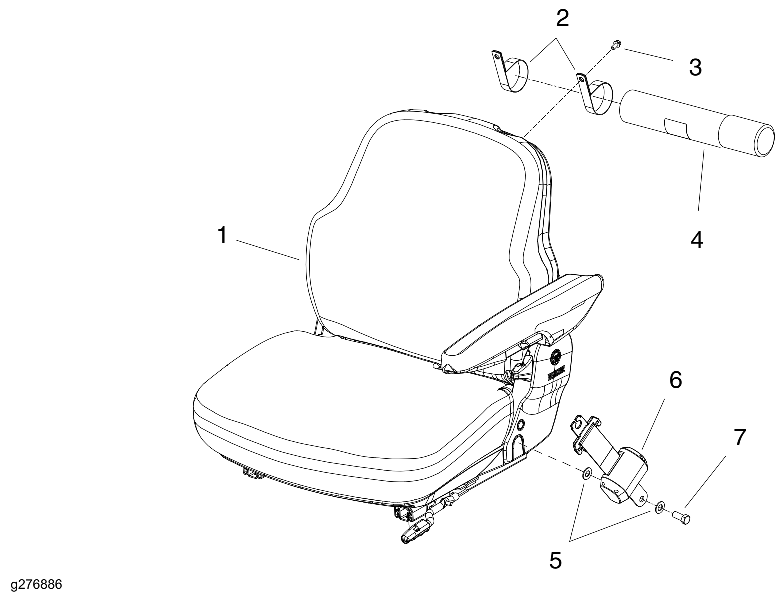

Figure 317

1. Operator seat
2. R−clamp (2 used)
3. Screw (2 used)
4. Manual tube
5. Flat washer
6. Seat belt
7. Cap screw

Disassembly (Figure 316)

Assemble operator seat using Figure 316 and Figure 317 as guides.

Assembly (Figure 316)

Assemble operator seat using Figure 316 and Figure 317 as guides.

Operator Seat Suspension

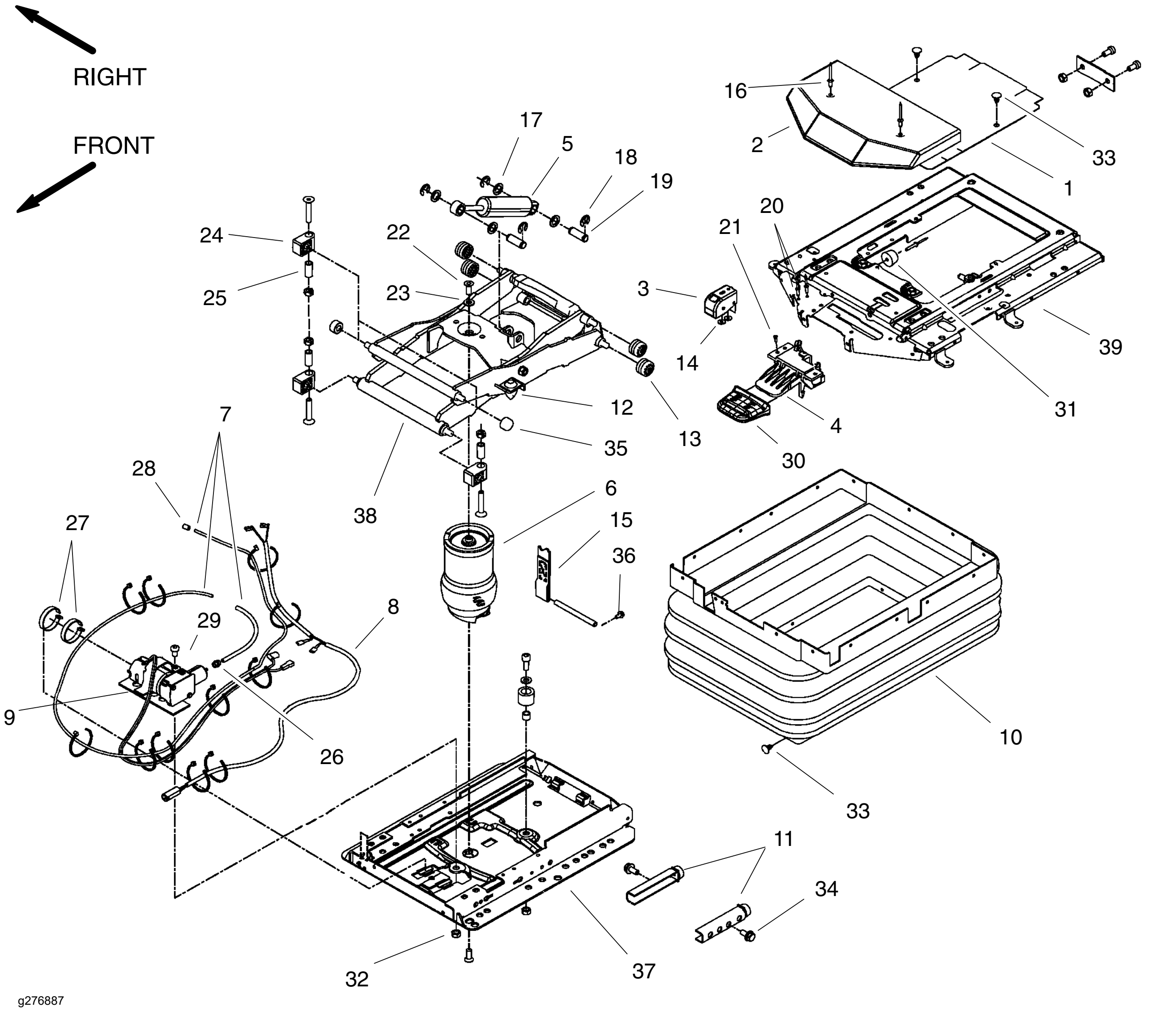

Figure 318

1. Cover
2. Cover
3. Level control
4. Air control valve
5. Shock absorber
6. Air spring
7. Air tube assembly
8. Wire harness
9. Compressor
10. Bellows
11. Stop
12. Bumper set (2 used)
13. Roller (4 used)
14. Washer (2 used)
15. Tether
16. Rivet (2 used)
17. Washer (4 used)
18. C−clip (4 used)
19. Pin (2 used)
20. Rivet (2 used)
21. Washer (3 used)
22. Screw (2 used)
23. Washer
24. Housing support (4 used)
25. Spacer (4 used)
26. Hose nipple
27. Clamp (2 used)
28. Hose nipple
29. Screw
30. Handle
31. Bumper
32. Nut
33. Plastic plug (23 used)
34. Screw (2 used)
35. Roller (2 used)
36. Screw (4 used)
37. Base plate
38. Suspension frame
39. Upper plate

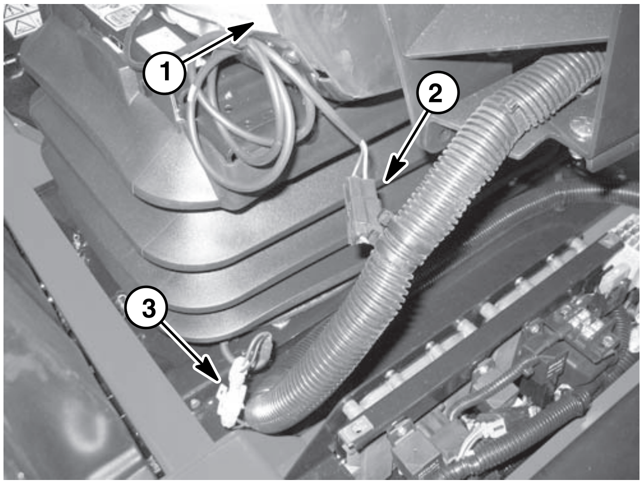

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Figure 319

1. Operator seat
2. Seat switch connector
3. Suspension connector

Note: Most of the seat suspension components can be serviced with the seat suspension base mounted to the frame platform. If the air spring assembly (item 6) requires removal, the seat suspension base will have to be removed from the seat platform.

Disassembly (Figure 318)

1. Remove operator seat from seat suspension (see Operator Seat (page 8–23)).
2. Disconnect seat suspension connector from machine wire harness (Figure 319).

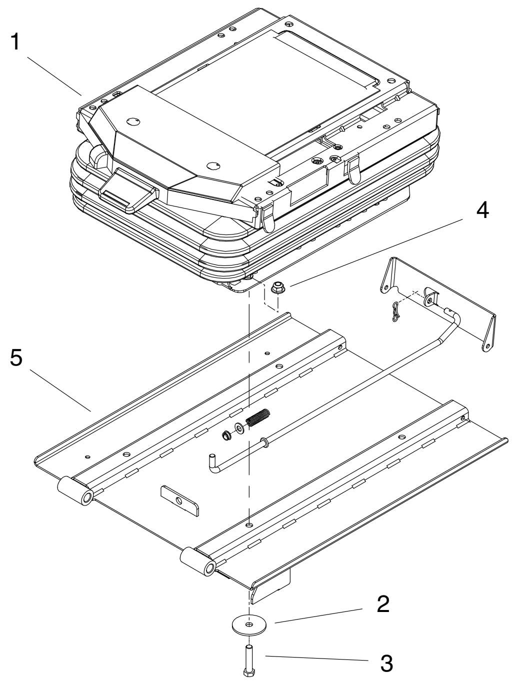

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Figure 320

1. Seat suspension
2. Flat washer (4 used)
3. Cap screw (4 used)
4. Flange nut (4 used)
5. Seat plate

Disassembly (Figure 318) (continued)

3. If the air spring assembly (item 6) or base plate (item 37) requires removal, remove seat suspension from seat plate (Figure 320):
   A. Raise and support seat plate assembly. Support seat suspension to prevent it from falling.
   B. Remove four (4) cap screws, flat washers and flange nuts that secure seat suspension to seat plate.
   C. Remove seat suspension from machine.
4. Remove seat suspension components as needed using Figure 318 as a guide.

Assembly (Figure 318)

1. Install all removed seat suspension components using Figure 318 as a guide.
2. If seat suspension was removed from seat plate, secure suspension to seat plate (Figure 320):
   A. Position seat suspension onto seat plate.
   B. Secure seat suspension to seat plate with four (4) cap screws, flat washers and flange nuts.
   C. Lower and secure seat plate assembly.
3. Install operator seat to seat suspension (see Operator Seat (page 8–23)).
4. Make sure that seat electrical connectors are connected to machine wire harness (Figure 319).

Hood

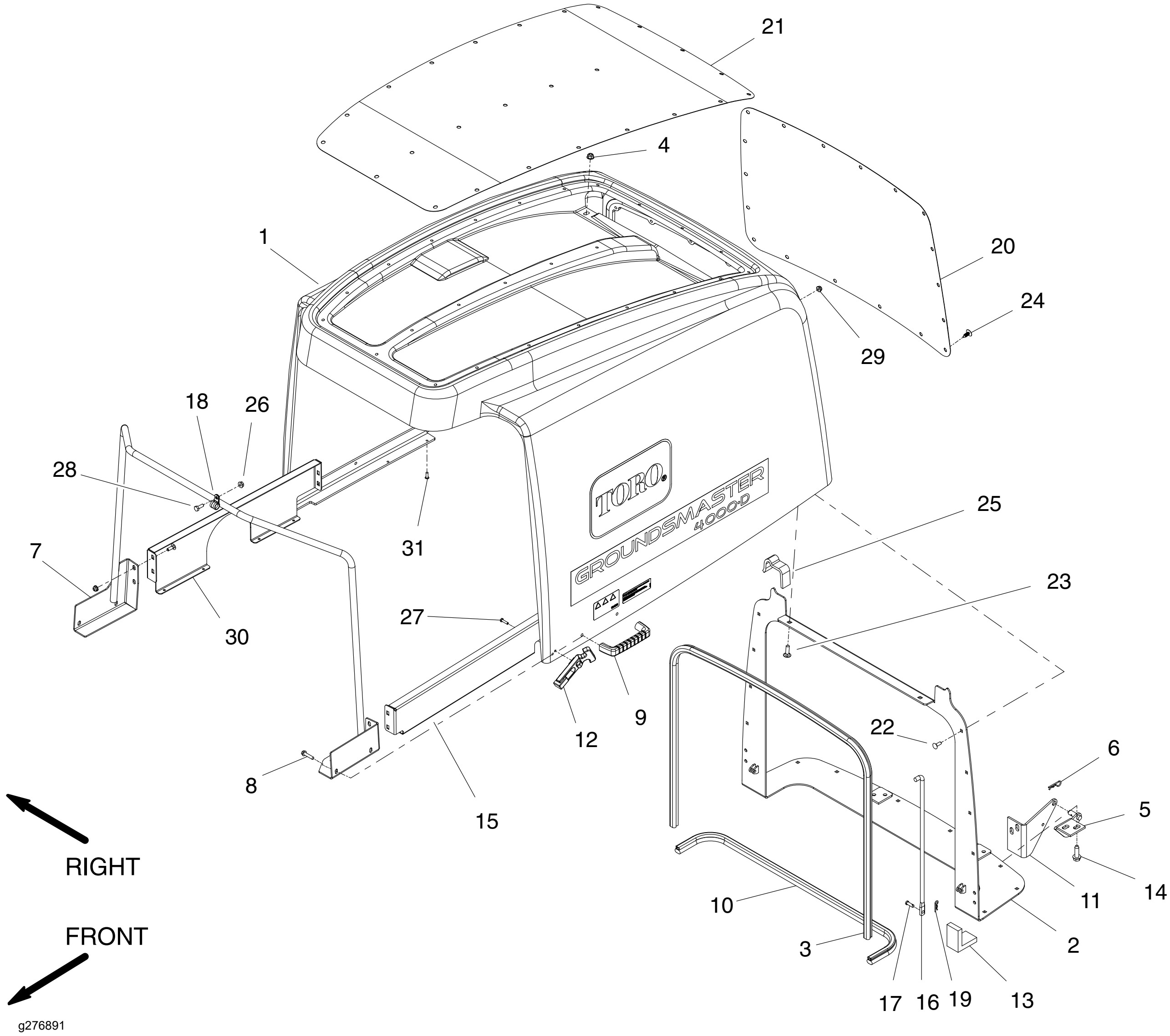

Figure 321

1.	Hood	12.	Flexible draw latch (2 used)	23.	Carriage bolt (2 used)
2.	Screen assembly	13.	Corner screen seal (2 used)	24.	Plastic plug (43 used)
3.	Bulb seal	14.	Screw (8 used)	25.	Foam seal (2 used)
4.	Flange nut (2 used)	15.	LH hood support	26.	Flange nut (2 used)
5.	Screen pivot (2 used)	16.	Hood rod (2 used)	27.	Screw (2 used)
6.	Hair pin (2 used)	17.	Clevis pin (2 used)	28.	Cap screw (2 used)
7.	Hood support	18.	R−clamp (2 used)	29.	Flange nut (24 used)
8.	Plastite screw (4 used)	19.	Hair pin (2 used)	30.	RH hood support
9.	Door handle (2 used)	20.	Rear screen	31.	Pop rivet (8 used)
10.	Bulb seal	21.	Top screen		
11.	Hood pivot (2 used)	22.	Carriage bolt (24 used)		

Removal

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the key switch.
2. Remove hood assembly from machine:

Removal (continued)

A. Remove hair pins (item 6) that retain screen pivots to hood pivots.

B. Slide hood assembly to disengage screen pivots from hood pivots and lift hood from machine.

3. Disassemble hood as needed using Figure 321 as a guide.

Installation

1. Assemble hood using Figure 321 as a guide.
2. Install hood to machine:

   A. Position hood to machine and engage screen pivots to hood pivots.

   B. Install hair pins (item 6) to secure screen pivots to hood pivots.

3. Align hood to machine to allow correct operation of hood latch and dust seals:

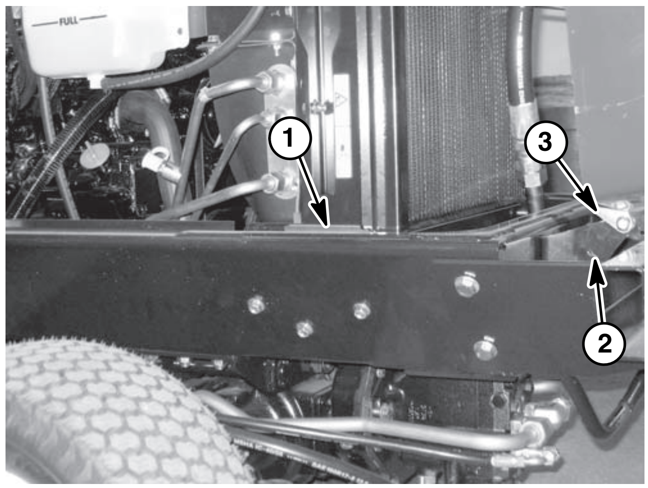

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Figure 322

1. LH shim location
2. LH hood pivot
3. LH screen pivot

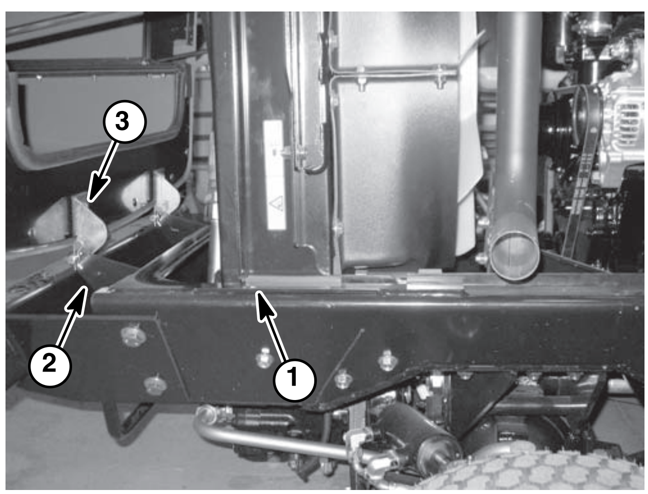

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Figure 323

1. RH shim location
2. RH hood pivot
3. RH screen pivot

Installation (continued)

A. Place shim that is from 9.5 to **11.1 mm (3/8 to 7/16 in)** thick on top of frame (both RH and LH sides) near the sides of radiator/oil cooler (Figure 322 and Figure 323).

B. Close hood so that it rests on shims and fasten the hood latches.

C. Loosen hood pivots at frame to adjust vertical placement of pivots. Re−tighten hood pivot fasteners.

D. Loosen screen pivots to allow hood latches to pull hood against radiator support. Re−tighten screen pivot fasteners.

4. After hood is assembled to machine, check for the following:

   A. Check that bulb and foam seals are equally compressed at all contact points with hood. Bulb and foam seals should compress from **3.2 to 9.5 mm (0.125 to 0.375 in)** when hood assembly is correct.

   B. Hood should open and close without contacting oil cooler hardware.

   C. Hood should fit to fuel tank with no open gaps.

TORO

Chapter 9

Cutting Decks

Table of Contents

General Information

Operator's Manual

The *Operator's Manual* provides information regarding the operation, adjustment procedures, and general maintenance for your Greensmaster machine. Refer to the *Operator's Manual* for additional information when servicing the machine.

Castor Wheel Tire Pressure

Castor tires on the front and side decks should be inflated to **345 kPa (50 PSI)**.

Blade Stopping Time

The blades of the cutting deck are to come to a complete stop in approximately five (5) seconds after the cutting deck engagement switch is shut down.

Note: Make sure the decks are lowered onto a clean section of turf or hard surface to avoid dust and debris.

To verify this stopping time, have a second person stand back from the deck at least twenty (20) feet and watch the blades on one of the cutting decks. Have the operator shut the cutting decks down and record the time it takes for the blades to come to a complete stop. If this time is greater than seven (7) seconds, the braking valve on the hydraulic manifold may need adjustment.

Service and Repairs

⚠ CAUTION ⚠

Never install or work on the cutting decks or lift arms with the engine running. Always stop engine and remove key from key switch first.

Center Cutting Deck

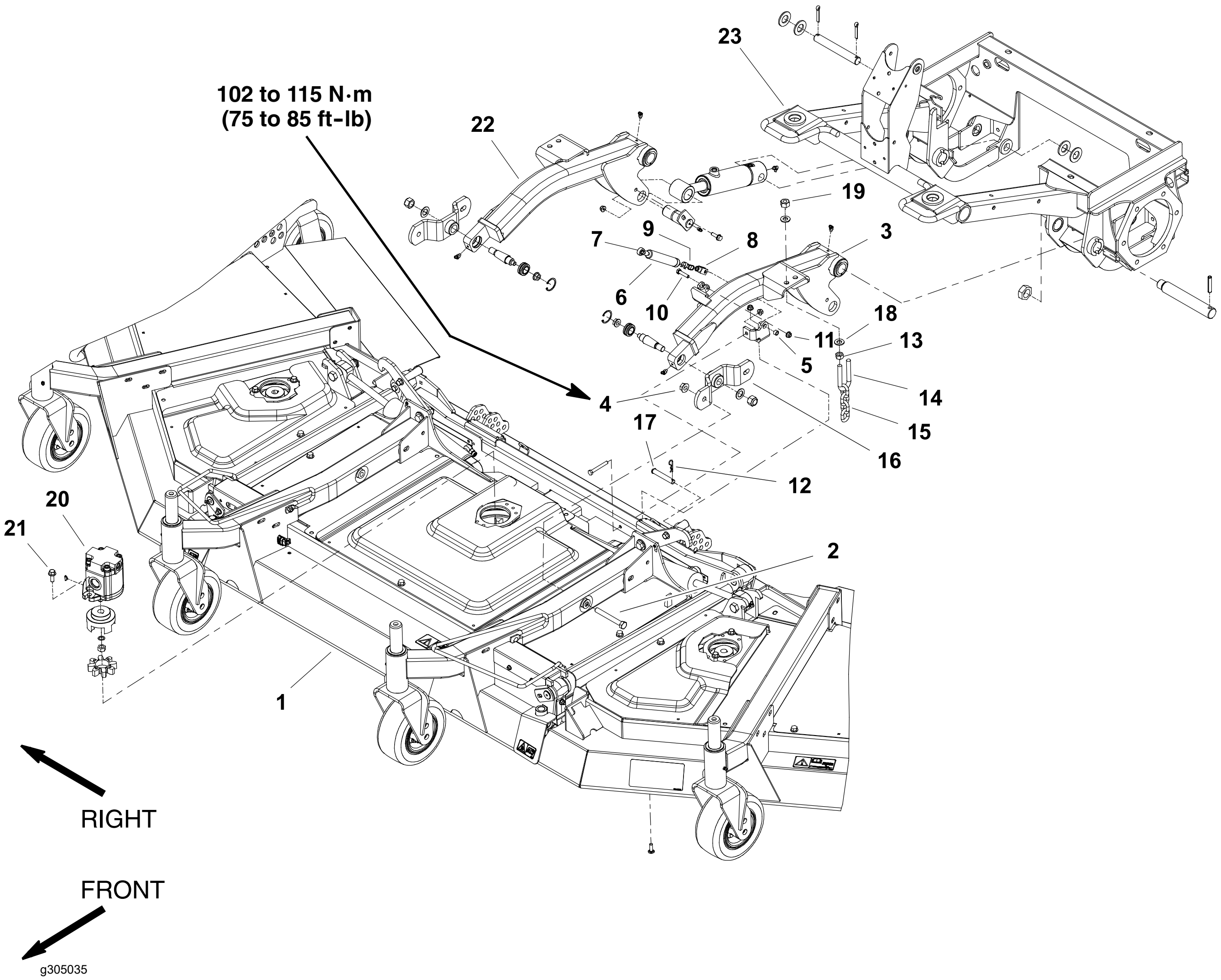

Figure 324

1. Cutting deck
2. Cap screw (4 used)
3. LH lift arm
4. Flange nut (4 used)
5. Spacer
6. Damper
7. Damper rod end
8. Damper clevis end
9. Spring pin
10. Cap screw
11. Flange nut
12. Hair pin
13. Hex nut (2 per U-bolt)
14. U-bolt (2 used)
15. Height of cut chain (2 used)
16. Support hub (2 used)
17. Clevis pin (2 used)
18. Flat washer (4 per U-bolt)
19. Lock nut (2 per U-bolt)
20. Hydraulic motor (3 used)
21. Flange head screw (2 per motor)
22. RH lift arm
23. Front frame

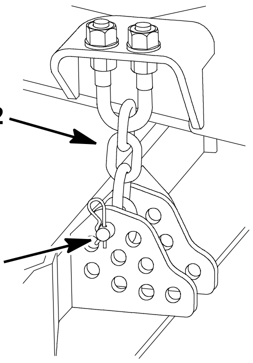

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Figure 325

1. Hairpin and clevis pin
2. Height-of-cut chain

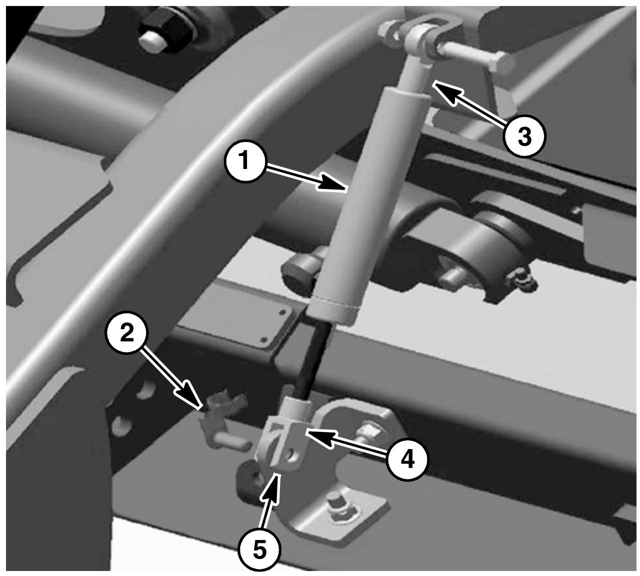

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Figure 326

1. Damper
2. Spring pin
3. Damper rod end
4. Damper clevis end
5. Spacer location

Removal (Figure 324)

1. Position machine on a clean, level surface. Lower cutting deck, stop engine, engage parking brake and remove key from the ignition switch.

   Note: Removal of clevis pins from deck and height- of-cut chains is easier if deck is lifted slightly.

2. Note location of clevis pins that secure height of cut chains to the rear of the cutting deck. Remove hairpins and clevis pins that secure the height-of-cut chains to the cutting deck (Figure 325).
3. Remove hydraulic motors from cutting deck (see Cutting Deck Motors (page 5–151)). Position motors away from cutting deck.
4. Remove spring pin that secures damper assembly to bracket on cutting deck (Figure 326). Locate and retrieve spacer from between damper clevis and bracket. Separate damper from cutting deck bracket.

Removal (Figure 324) (continued)

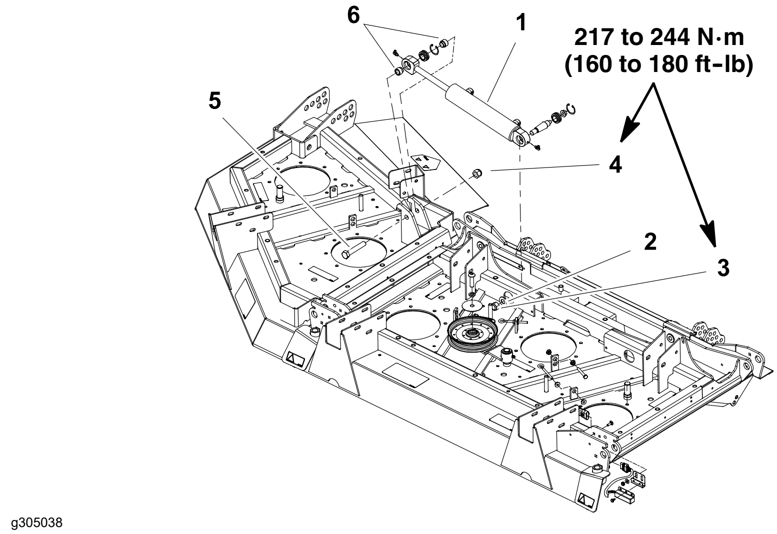


Figure 327

1. Wing deck lift cylinder
2. Flat washer
3. Lock nut
4. Lock nut
5. Cap screw
6. Spacer

5. Remove hydraulic hoses from wing deck lift cylinders (Figure 327):
   A. Remove deck covers to allow access to wing deck lift cylinders.
   B. Thoroughly clean exterior of wing deck lift cylinders and fittings. For assembly purposes, label hydraulic hoses to show their correct position on the lift cylinders.
   C. Disconnect hydraulic hoses from wing deck lift cylinders. Cap hoses and fittings to prevent contamination.
6. Disconnect cutting deck wire harness from machine wire harness.

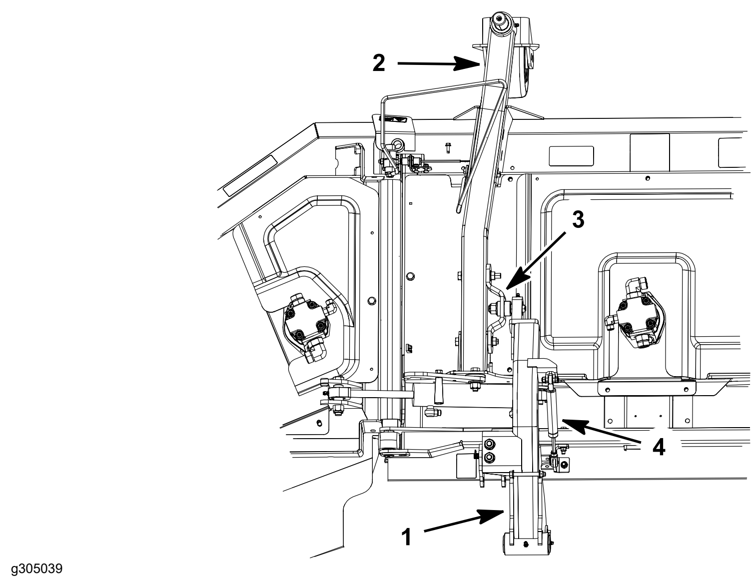


Figure 328

1. Lift arm
2. Castor arm
3. Support hub
4. Damper assembly

7. Remove cap screws and flange nuts that secure support hubs to cutting deck castor arms (Figure 328).

Removal (Figure 324) (continued)

8. Slide the cutting deck away from the traction unit.

Installation (Figure 324)

1. Position machine on a clean, level surface. Lower lift arms, stop engine, engage parking brake and remove key from the ignition switch.
2. Position the cutting deck to the lift arms.
3. Align support hub to cutting deck castor arms making sure that slotted mounting hole of hub is orientated toward rear of cutting deck. Secure hubs with cap screws and flange nuts (Figure 328). Torque flange nuts from **102 to 115 N·m (75 to 85 ft-lb)**.

   Note: Installation of clevis pins to deck and height-of- cut chains is easier if deck is lifted slightly.
4. Install clevis pins and hairpins that secure the height-of-cut chains to the rear of the cutting deck (Figure 325).
5. Remove plugs from hydraulic hoses and fittings on wing deck lift cylinders. Using labels placed during removal, correctly attach hydraulic hoses to lift cylinders.
6. Connect cutting deck wire harness to machine wire harness.
7. Position damper to cutting deck bracket. Place spacer between cutting deck bracket and damper clevis end. Secure damper to bracket with spring pin (Figure 328).
8. Install all removed cutting deck covers.
9. Install hydraulic motors to cutting deck (see Cutting Deck Motors (page 5–151)).
10. Lubricate grease fittings on cutting deck and lift assemblies.
11. Check and fill hydraulic reservoir with hydraulic fluid as required.

Wing Deck Service

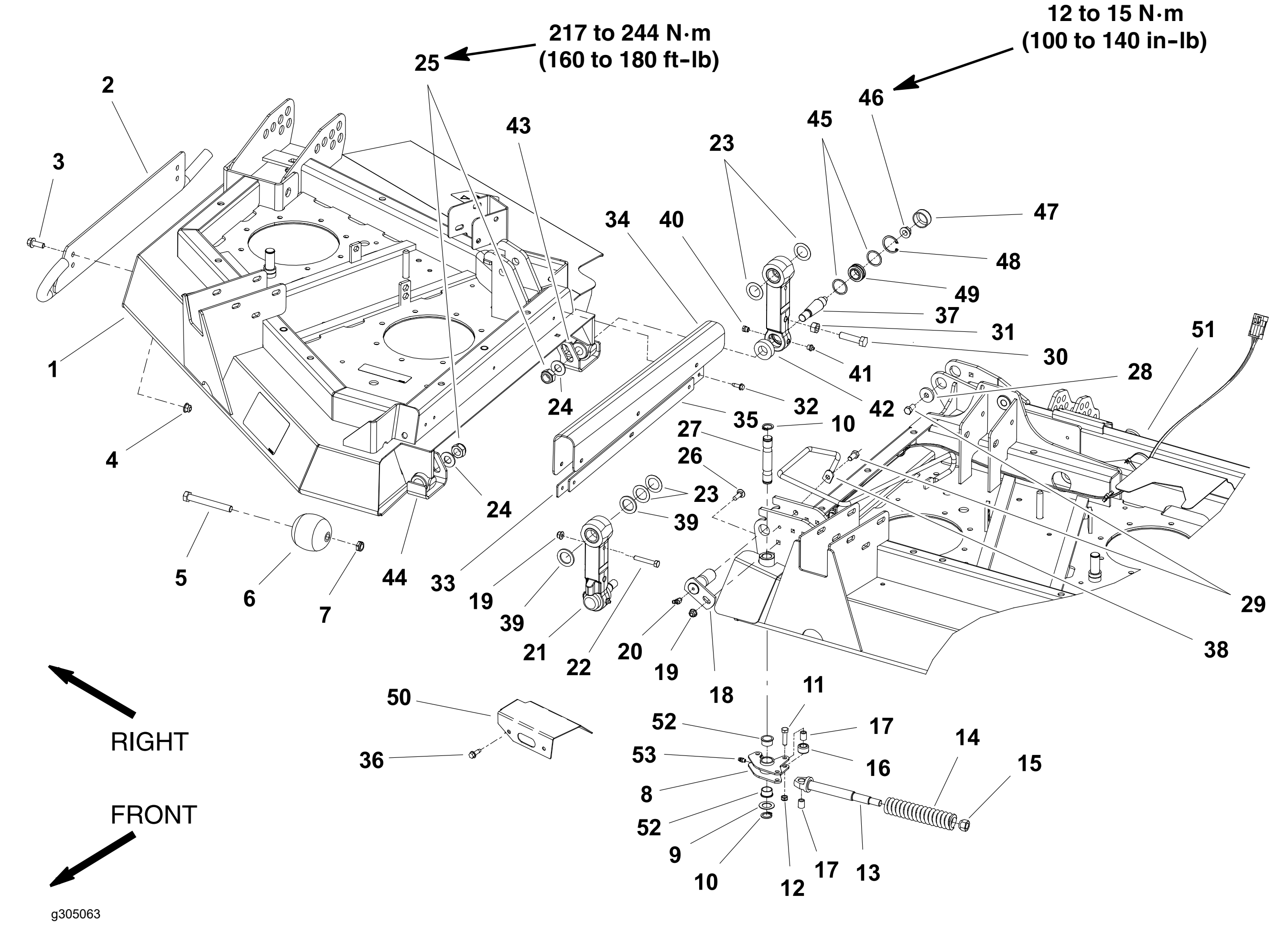


Figure 329

1. Wing deck (RH shown)
2. Skid (RH shown)
3. Flange screw (2 used per skid)
4. Flange nut (2 used per skid)
5. Cap screw
6. Roller (2 used)
7. Lock nut
8. Pivot latch (2 used)
9. Flat washer
10. Retaining ring (2 used per latch)
11. Cap screw (3 used per latch)
12. Lock nut (3 used per latch)
13. Spring support
14. Compression spring
15. Lug nut
16. Lock roller (2 used per latch)
17. Bushing (3 used per latch)
18. Pivot pin (4 used)
19. Flange nut (front links)
20. Grease fitting
21. Link assembly (4 used)
22. Cap screw (front links)
23. Thrust washer (0.030” thick)
24. Flat washer (4 used)
25. Lock nut (4 used)
26. Carriage bolt (4 used)
27. Latch pin
28. Flat washer (2 used)
29. Cap screw (4 used)
30. Cap screw (rear links)
31. Hex jam nut (rear links)
32. Washer head screw (12 used)
33. Wing strap (2 used)
34. Flex shield (2 used)
35. Shield strap (center deck)
36. Washer head screw (2 per shield)
37. Tapered stud
38. Hose guide
39. Hardened spacer (0.120” thick)
40. Plug
41. Grease fitting
42. Foam washer (4 used)
43. Link skid (2 used)
44. Link skid (2 used)
45. Flat washer
46. Flange nut
47. Dust cap
48. Retaining ring
49. Spherical bearing
50. Switch shield (RH shown)
51. Center deck
52. Flange bushing
53. Grease fitting

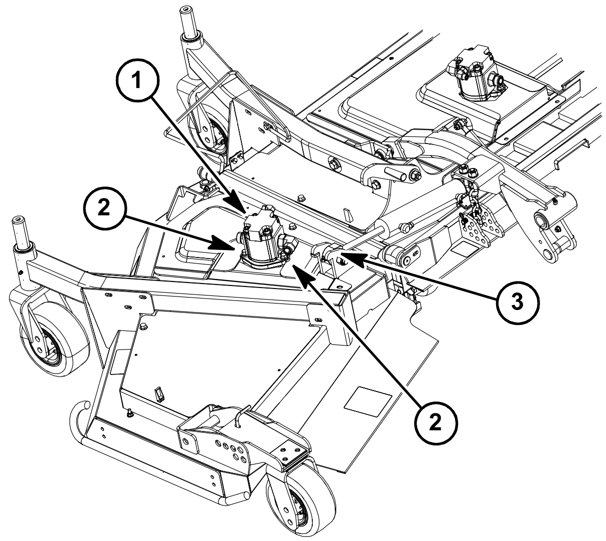


Figure 330

1. Hydraulic motor
2. Flange head screw
3. Lift cylinder clevis

Removal (Figure 329)

1. Position machine on a clean, level surface. Lower cutting deck and engage parking brake.
2. Fully raise wing deck, stop engine and remove key from the ignition switch. Remove three (3) washer head screws and shield strap that secure flex shield to wing deck. Lower wing deck.
3. Remove hydraulic motor from wing deck (see Cutting Deck Motors (page 5–151)).
4. Remove cap screw and lock nut that secure lift cylinder clevis to the wing deck (Figure 330).
5. Remove switch shield (item 50) from center deck.
6. Support wing deck to prevent it from falling as link assemblies (item 21) are removed.
7. Remove cap screw (item 29) from pivot pin on upper end of both link assemblies. Cap screw on rear link also uses a flat washer (item 28).

   Note: When removing pivot pins from deck, note location of thrust washers (item 6) and hardened spacers (item 42) for assembly purposes.
8. Remove flange nut (item 19) from carriage bolt (item 26) and pull pivot pins (item 18) from deck. Locate and retrieve thrust washers (item 6) and hardened spacers (item 42) from between links and deck brackets.
9. Slide the wing deck away from the center deck.
10. If required, remove link(s) from wing deck by removing lock nut and flat washer that secure tapered stud to deck. Press tapered stud from deck to remove link assembly. Remove foam washer (item 42) and link skid.

Installation (Figure 329)

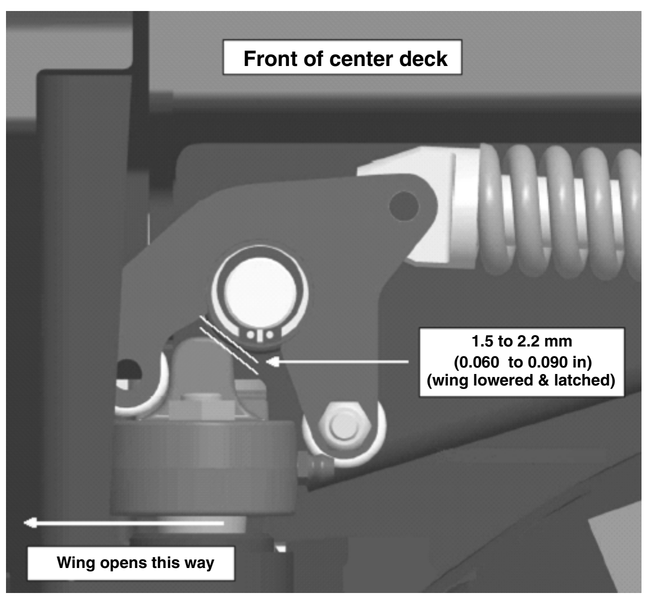
1. Park machine on a clean, level surface. Stop engine, engage parking brake and remove key from the ignition switch.
2. If links were removed from wing deck, thoroughly clean tapered stud on link and mounting boss of wing deck. Place foam washer on tapered stud

Installation (Figure 329) (continued)

and insert stud into deck mounting boss. Make sure that plug (item 40) is orientated toward wing deck and grease fitting (item 41) is toward center deck. Position link skid to stud and secure with flat washer and lock nut. Torque lock nut from **217 to 244 N·m (160 to 180 ft-lb)**.

Note: Pivot latches (item 8) may need to be manually opened prior to wing deck installation. If necessary, use a pry bar to carefully open latch.

3. Position the wing deck to the center deck.
4. Position upper end of link assemblies to center cutting deck brackets.
5. Align upper end of link assemblies with mounting holes in center deck. While installing pivot pins to center deck and links, insert spacers and washers as follows:
   A. Place one (1) hardened spacer (item 42) on each side of the front link. Use two (2) thrust washers on rear side of assembly so that link is snug between deck brackets. Additional thrust washers should be installed, if necessary, to remove excess clearance.
   B. Place one (1) thrust washer (item 6) on each side of rear link. Clearance between rear link and deck bracket is acceptable.
6. Secure pins with carriage screw and flange head screw.
7. Install cap screw (item 29) to pivot pin on both links. Cap screw on rear link uses a flat washer (item 28). Cap screw on front link also secures hose guide (item 38).
8. Position lift cylinder clevis to the wing deck and secure with cap screw and lock nut (Figure 330).
9. Install hydraulic motor to cutting deck (see Cutting Deck Motors (page 5–151)).
10. Fully raise wing deck, stop engine and remove key from the ignition switch. Secure flex shield to wing deck with shield strap and three (3) washer head screws. Lower wing deck.



g305065

Figure 331

Installation (Figure 329) (continued)

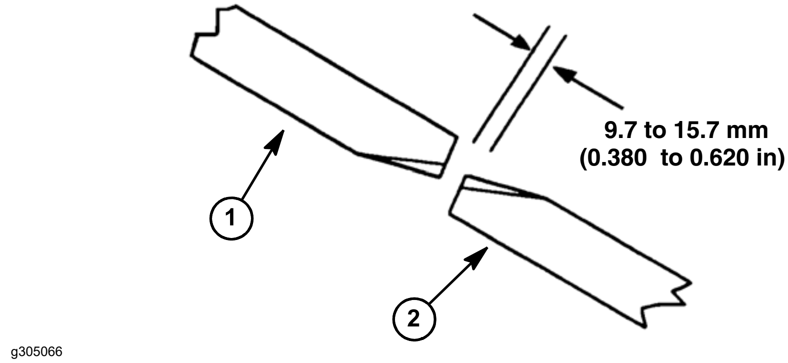


Figure 332

1. Wing deck blade
2. Center deck blade

11. Inspect deck latch assembly to insure that front link is locked when the wing deck is in the lowered position. There should be a gap from **1.5 to 2.2 mm (0.060 to 0.090 in)** between the arm latch actuator and the latch pivot (Figure 331). If gap is incorrect, adjust link position by repositioning the location of the hardened spacers (item 42) and thrust washers (item 6). At a minimum, there must be one (1) hardened spacer positioned to the rear of the front link.
12. Lubricate grease fittings on cutting deck and lift components.
13. Check distance between inner deck blade on wing deck and outer deck blade on center deck. Distance between blades should be **9.7 to 15.7 mm (0.380 to 0.620 in)** (Figure 332). If blade distance is incorrect, loosen hex jam nut (item 32) on rear link assembly and adjust cap screw (item 31). Tighten jam nut when blade distance is correct.
14. Check operation of wing deck position switch. Adjust if necessary (see Wing Deck Position Switch Adjustment (page 6–19)).
15. Secure switch shield (item 50) to center deck.

Cutting Deck Link Service

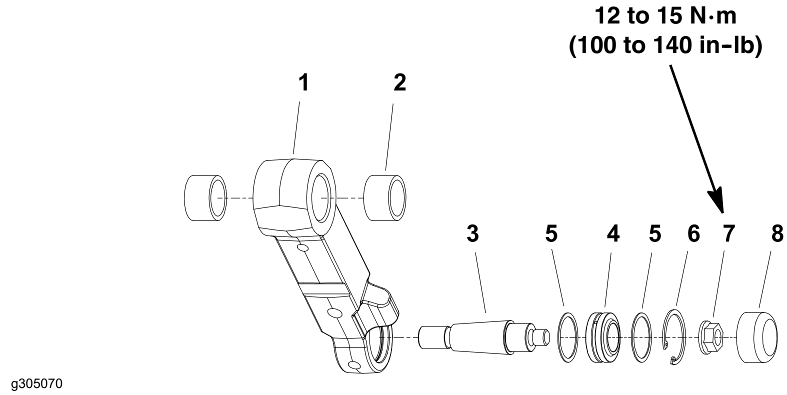


Figure 333

1. Link
2. Bushing (2 used)
3. Tapered stud
4. Spherical bearing
5. Flat washer (2 used)
6. Retaining ring
7. Flange nut
8. Dust cap

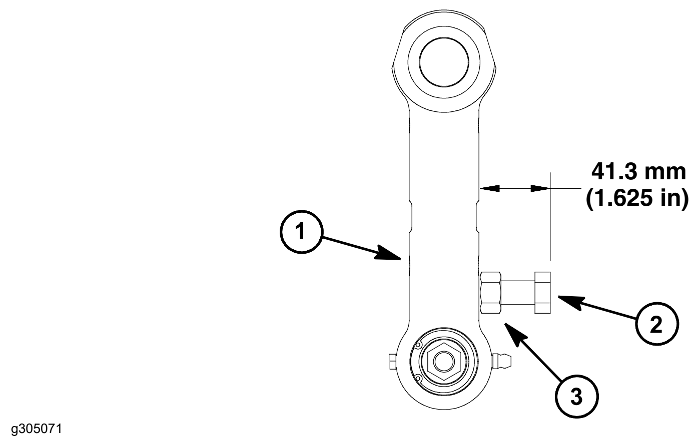


Figure 334

1. Rear link
2. Cap screw
3. Hex jam nut

Disassembly (Figure 333)

1. Press bushings from top of link.
2. Remove dust cap and retaining ring from link.
3. Press tapered stud with spherical bearing, flat washers and flange nut from link.
4. Remove flange nut and press spherical bearing from tapered stud.

Assembly (Figure 333)

1. Install new spherical bearing onto tapered stud. Secure bearing with flange nut. Torque nut from **12 to 15 N·m (100 to 140 in-lb)**.
2. Position flat washer in both sides of spherical bearing.
3. Press tapered stud with spherical bearing, flat washers and flange nut into link. Secure spherical bearing into link with retaining ring.
4. Press bushings into top bore of link.

Assembly (Figure 333) (continued)

5. If cap screw and jam nut were removed from rear link, install cap screw to allow **41.3 mm (1.625 in)** between the head of the screw and the side of the link (Figure 334).

6. After link is installed on deck, check distance between center deck blade and wing deck blade. Readjust cap screw and jam nut on rear link if needed (see Wing Deck Service (page 9–7)).

Wing Deck Latch

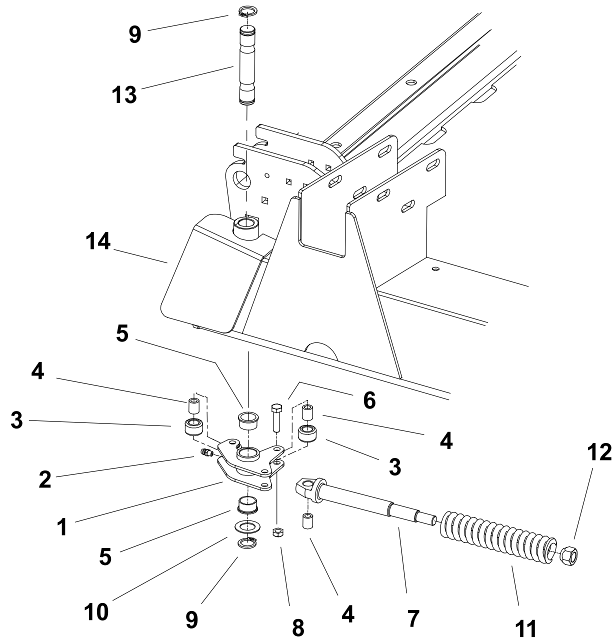


Figure 335

1. Latch
2. Grease fitting
3. Lock roller
4. Bushing
5. Flange bushing
6. Cap screw (3 used)
7. Spring support
8. Lock nut (3 used)
9. Retaining ring
10. Flat washer
11. Compression spring
12. Lug nut
13. Latch pin
14. Center deck

Disassembly (Figure 335)

1. Raise wing deck to transport position. Carefully rotate latch to closed position.
2. Loosen lug nut to release compression spring tension.
3. Remove retaining ring and flat washer from bottom of latch pin. Rotate lug nut enough to allow latch pin to be removed from latch.
4. Remove lug nut from spring support. Remove latch assembly from deck.
5. Disassemble latch (items 1 through 8) using Figure 335 as a guide.

Assembly (Figure 335)

1. Assemble latch (items 1 through 8) using Figure 335 as a guide.
2. Slide spring onto spring support and insert end of spring support into hole located on underside of center deck. Start lug nut (tapered side towards plate on deck) onto spring support.
3. Tighten lug nut until holes in front of deck align with bushings in latch. Insert latch pin with retaining ring down through deck and latch. Secure latch pin on underside of deck with flat washer and retaining ring.
4. Carefully rotate latch to the open position. Lower wing deck to allow link to engage latch.
5. Lubricate latch grease fitting.

Blade Spindle

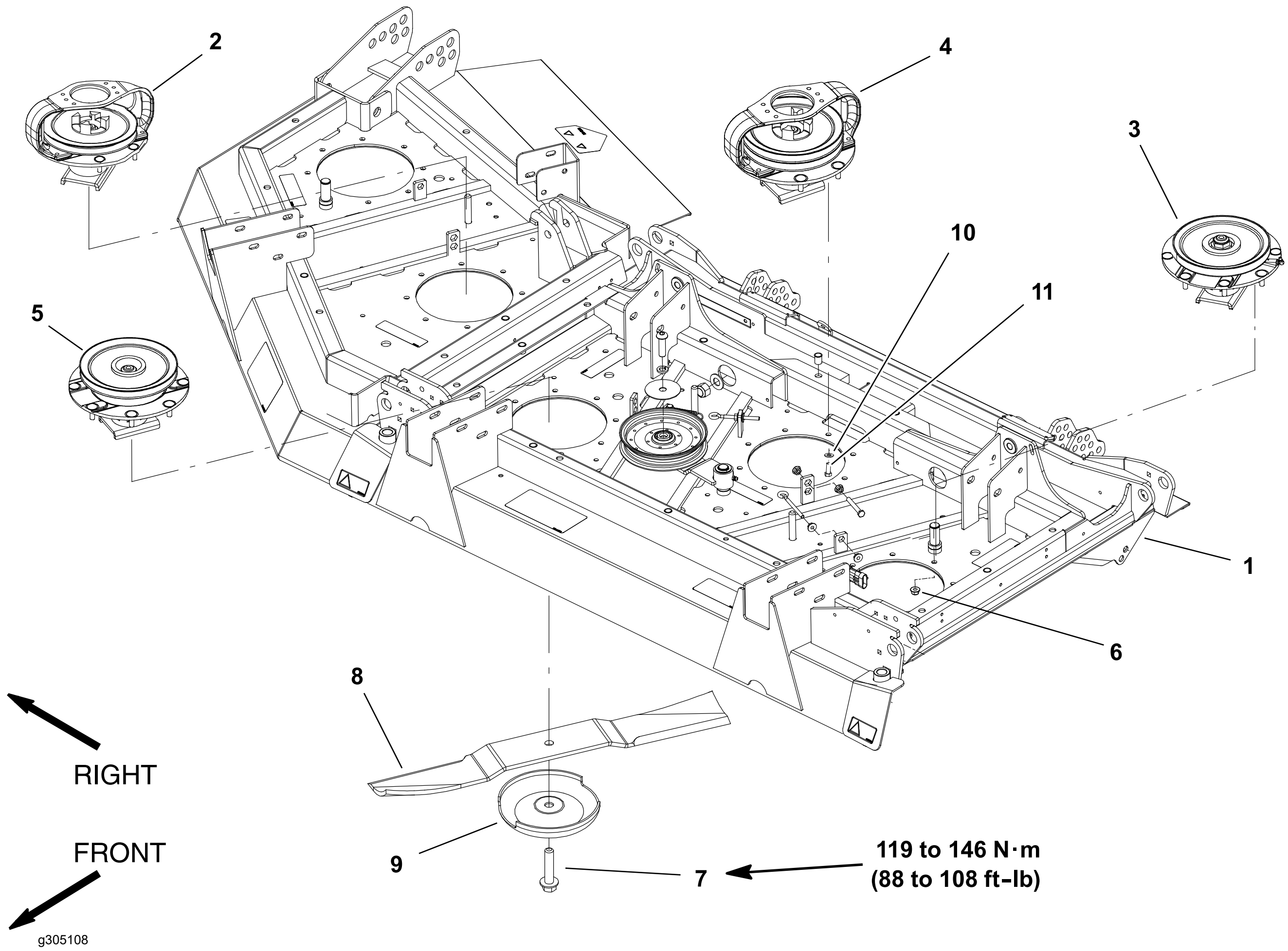


Figure 336

1. Cutting deck
2. Drive spindle: single pulley (2 used)
3. Low driven spindle (3 used)
4. Drive spindle: double pulley (1 used)
5. High driven spindle (1 used)
6. Flange nut
7. Blade bolt
8. Cutting blade (7 used)
9. Anti-scalp cup
10. Flat washer
11. Cap screw

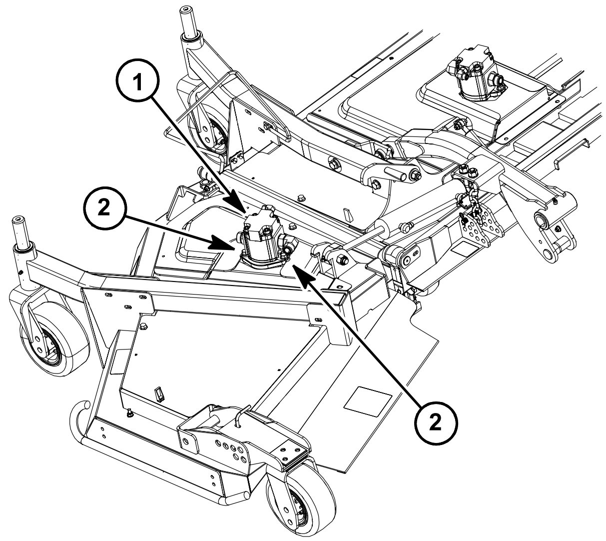


Figure 337

1. Hydraulic motor
2. Flange head screw

Removal (Figure 336)

1. Park machine on a level surface, lower cutting deck, stop engine, engage parking brake and remove key from the ignition switch.
2. If drive spindle is to be serviced, remove hydraulic motor from cutting deck (see Cutting Deck Motors (page 5–151)). Position motor away from spindle.
3. Remove belt covers from top of cutting deck. Loosen idler pulley to release belt tension (see Idler Assembly (page 9–21)). Remove drive belt from spindle to be serviced.
4. Start the engine and raise the cutting deck. Stop engine and remove key from the ignition switch. Latch or block up the cutting deck so it cannot fall accidentally.
5. Remove cutting blade, anti-scalp cup and blade bolt from spindle to be serviced.
6. Remove spindle housing assembly from deck:
   A. For driven spindle assemblies, remove eight (8) flange nuts that secure spindle to deck.
   B. For drive spindle assemblies, loosen and remove four (4) flange nuts that secure spindle to deck. Then, remove four (4) cap screws with flat washers that secure spindle and motor mount to deck.
7. If necessary, press screws from spindle housing.

Installation (Figure 336)

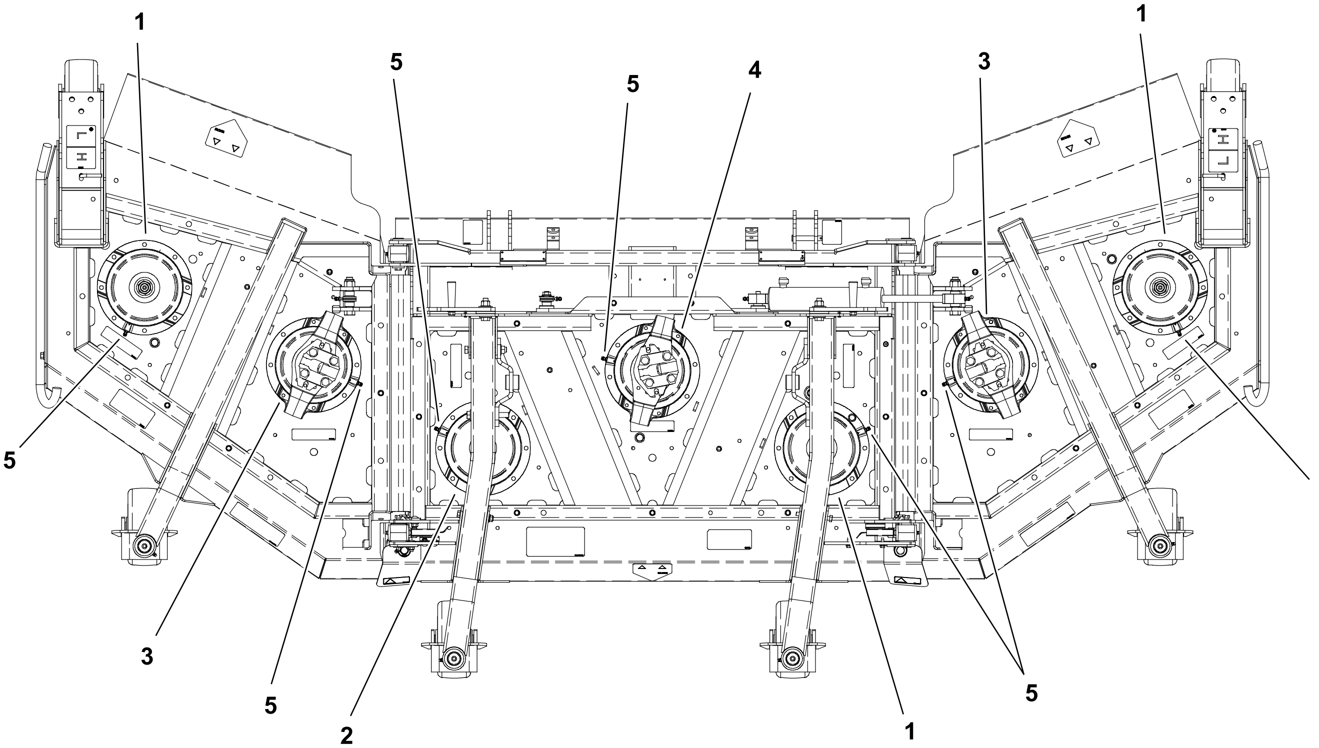


Figure 338

1. Driven spindle
2. Driven spindle (high pulley)
3. Drive spindle (wing deck)
4. Drive spindle (center deck)
5. Spindle grease fitting location

1. If screws were removed from spindle housing, press new screws into housing. Make sure that screw head is squarely seated against housing after installation.
2. Position spindle on cutting deck noting orientation of grease fitting (Figure 338). Secure spindle assembly to deck with removed fasteners.
3. Install cutting blade, anti-scalp cup and blade bolt. Tighten blade bolt from **119 to 146 N·m (88 to 108 ft-lb)**.
4. Slowly rotate cutting blades to verify that blades do not contact any deck component(s).
5. Install drive belt and adjust belt tension (see Idler Assembly (page 9–21)).
6. If drive spindle was removed, install hydraulic motor to cutting deck (see Cutting Deck Motors (page 5–151)).

IMPORTANT

Pneumatic grease guns can produce air pockets when filling large cavities and therefore, are not recommended to be used for proper greasing of spindle housings.

7. Attach a hand pump grease gun to grease fitting on spindle housing and fill housing cavity with grease until grease starts to come out of lower seal.
8. Install belt covers to cutting deck.

Blade Spindle Service

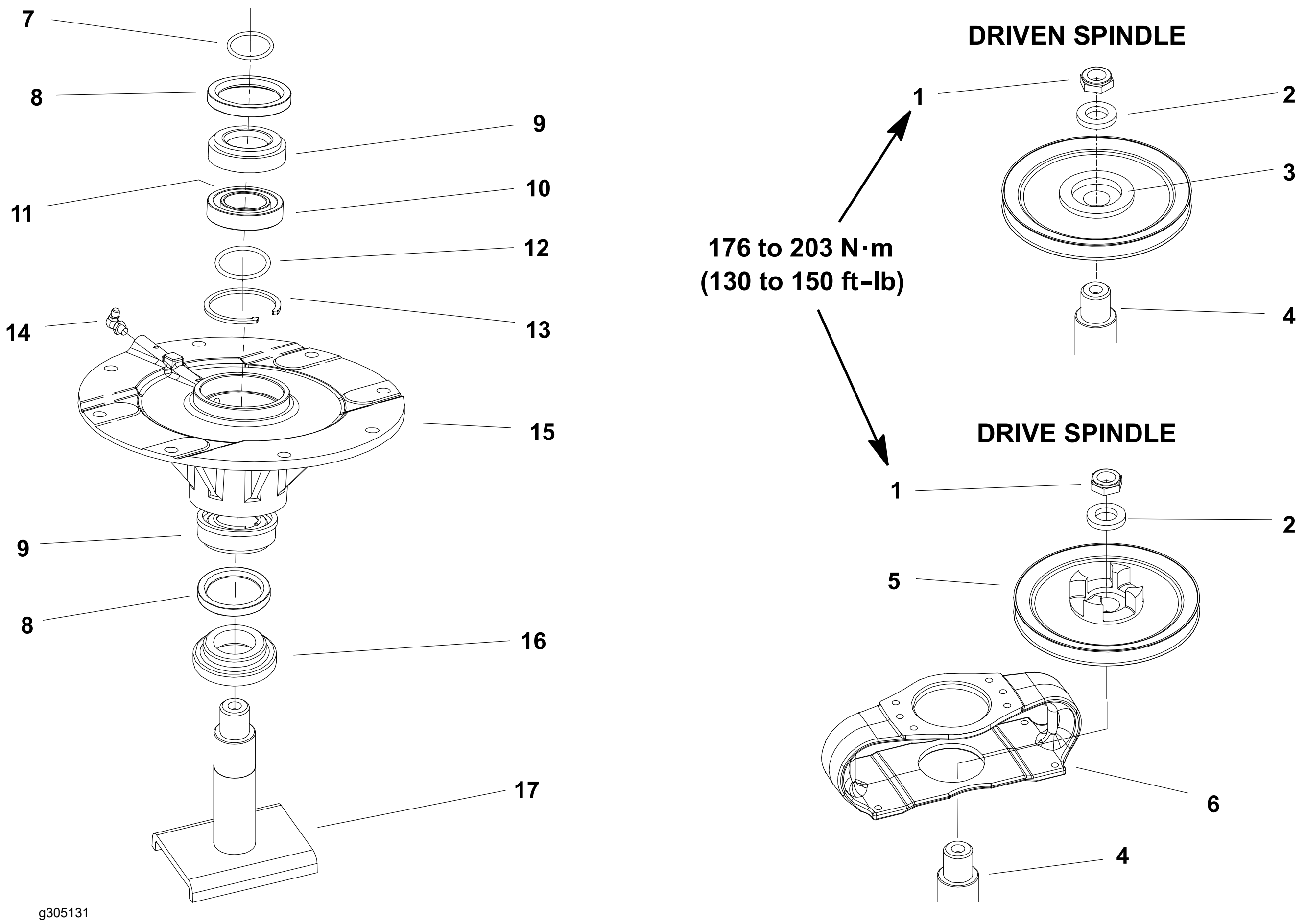


Figure 339

1. Lock nut
2. Flat washer
3. Driven pulley
4. Spindle shaft
5. Drive pulley (single shown)
6. Hydraulic motor mount
7. O-ring
8. Oil seal
9. Bearing cup and cone
10. Outer bearing spacer
11. Inner bearing spacer
12. Spacer ring
13. Snap ring
14. Grease fitting
15. Spindle housing
16. Spindle shaft spacer
17. Spindle shaft

Disassembly (Figure 339)

1. Loosen and remove lock nut from top of spindle shaft. Remove hardened washer and pulley from spindle. For drive spindle, remove hydraulic motor mount.
2. Remove the spindle shaft from the spindle housing which may require the use of an arbor press. The spindle shaft spacer should remain on the spindle shaft as the shaft is being removed.
3. Carefully remove oil seals from spindle housing taking care to not damage seal bore in housing.

Disassembly (Figure 339) (continued)

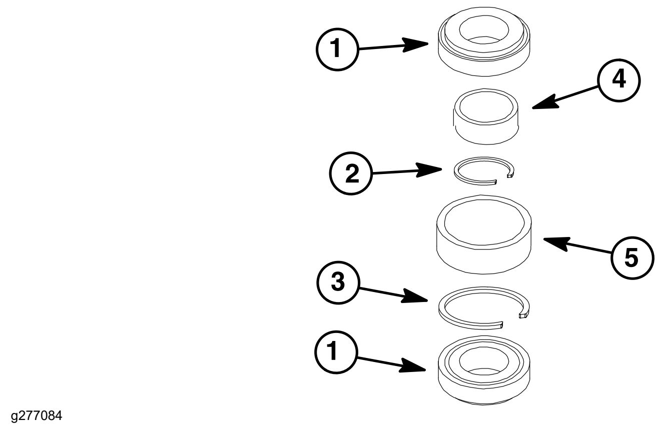


Figure 340

1. Bearing
2. Spacer ring
3. Large snap ring
4. Inner bearing spacer
5. Outer bearing spacer

4. Allow the bearing cones, inner bearing spacer and spacer ring to drop out of the spindle housing (Figure 340).
5. Using an arbor press, remove both of the bearing cups and the outer bearing spacer from the housing.
6. The large snap ring can remain inside the spindle housing. Removal of this snap ring is very difficult.

Assembly (Figure 339)

Note: A replacement spindle bearing set contains two (2) bearings, a spacer ring and a large snap ring (items 1, 2 and 3 in Figure 340). These parts cannot be purchased separately. Also, do not mix bearing set components from one deck spindle to another.

Note: A replacement bearing spacer set includes the inner spacer and outer spacer (items 4 and 5 in Figure 340). Do not mix bearing spacers from one deck spindle to another.

IMPORTANT

If new bearings are installed into a used spindle housing, it may not be necessary to replace the original large snap ring. If the original snap ring is in good condition with no evidence of damage (e.g. spun bearing), leave the snap ring in the housing and discard the snap ring that comes with the new bearings. If the large snap ring is found to be damaged, replace the snap ring.

1. If large snap ring was removed from spindle housing, install snap ring into housing groove. Make sure snap ring is fully seated in housing groove.
2. Install outer bearing spacer into top of spindle housing. The spacer should fit against the snap ring.

Assembly (Figure 339) (continued)

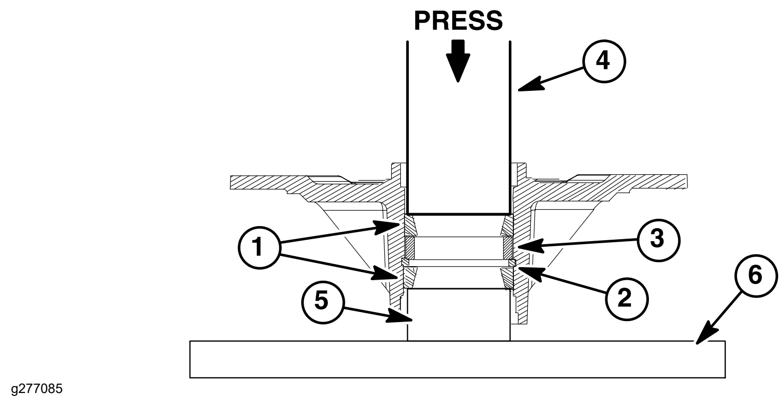


Figure 341

1. Bearing cups
2. Large snap ring
3. Outer bearing spacer
4. Arbor press
5. Support
6. Arbor press base

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3. Using an arbor press, push the bearing cups into the top and bottom of the spindle housing. The top bearing cup must contact the outer bearing spacer previously installed, and the bottom bearing cup must contact the snap ring. Make sure that the assembly is correct by supporting the first bearing cup and pressing the second cup against it (Figure 341).
4. Pack the bearing cones with grease. Apply a film of grease on lips of oil seals and O−ring.

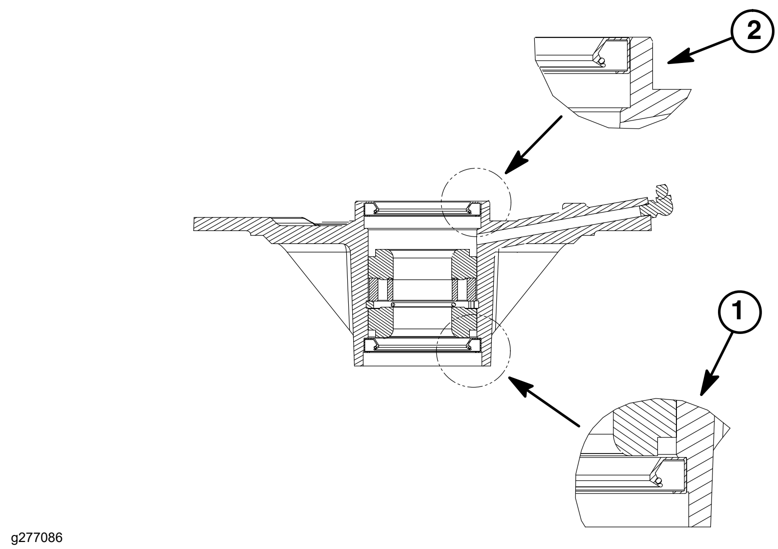

Figure 342

1. Bottom seal installation
2. Upper seal installation

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5. Install lower bearing cone and oil seal into bottom of spindle housing. Note: The bottom seal must have the lip facing out (down) (Figure 342). This seal installation allows grease to purge from the spindle during the lubrication process.

IMPORTANT

If bearings are being replaced, make sure to use the spacer ring that is included with new bearing set (Figure 340).

Assembly (Figure 339) (continued)

6. Slide spacer ring and inner bearing spacer into spindle housing, then install upper bearing cone and oil seal into top of housing. Note: The upper seal must have the lip facing in (down) (Figure 342). Also, upper seal should be flush or up to **1.5 mm (0.060 in)** recessed into housing.
7. Inspect the spindle shaft and shaft spacer to make sure there are no burrs or nicks that could possibly damage the oil seals. Lubricate the shaft and spacer with grease.
8. Install spindle shaft spacer onto shaft. Place thin sleeve or tape on spindle shaft splines to prevent seal damage during shaft installation.
9. Carefully slide spindle shaft with spacer up through spindle housing. The bottom oil seal and spindle spacer fit together when the spindle is fully installed.
10. Install O−ring to top of spindle shaft. For drive spindle, position hydraulic motor mount to top of spindle.
11. Install pulley (hub down), hardened washer and lock nut to spindle shaft. Tighten lock nut from **176 to 203 N·m (130 to 150 ft−lb)**.

IMPORTANT

Pneumatic grease guns can produce air pockets when filling large cavities and therefore, are not recommended to be used for proper greasing of spindle housings.

12. Attach a hand pump grease gun to grease fitting on housing and fill housing cavity with grease.
13. Rotate spindle shaft to make sure that it turns freely.

Idler Assembly

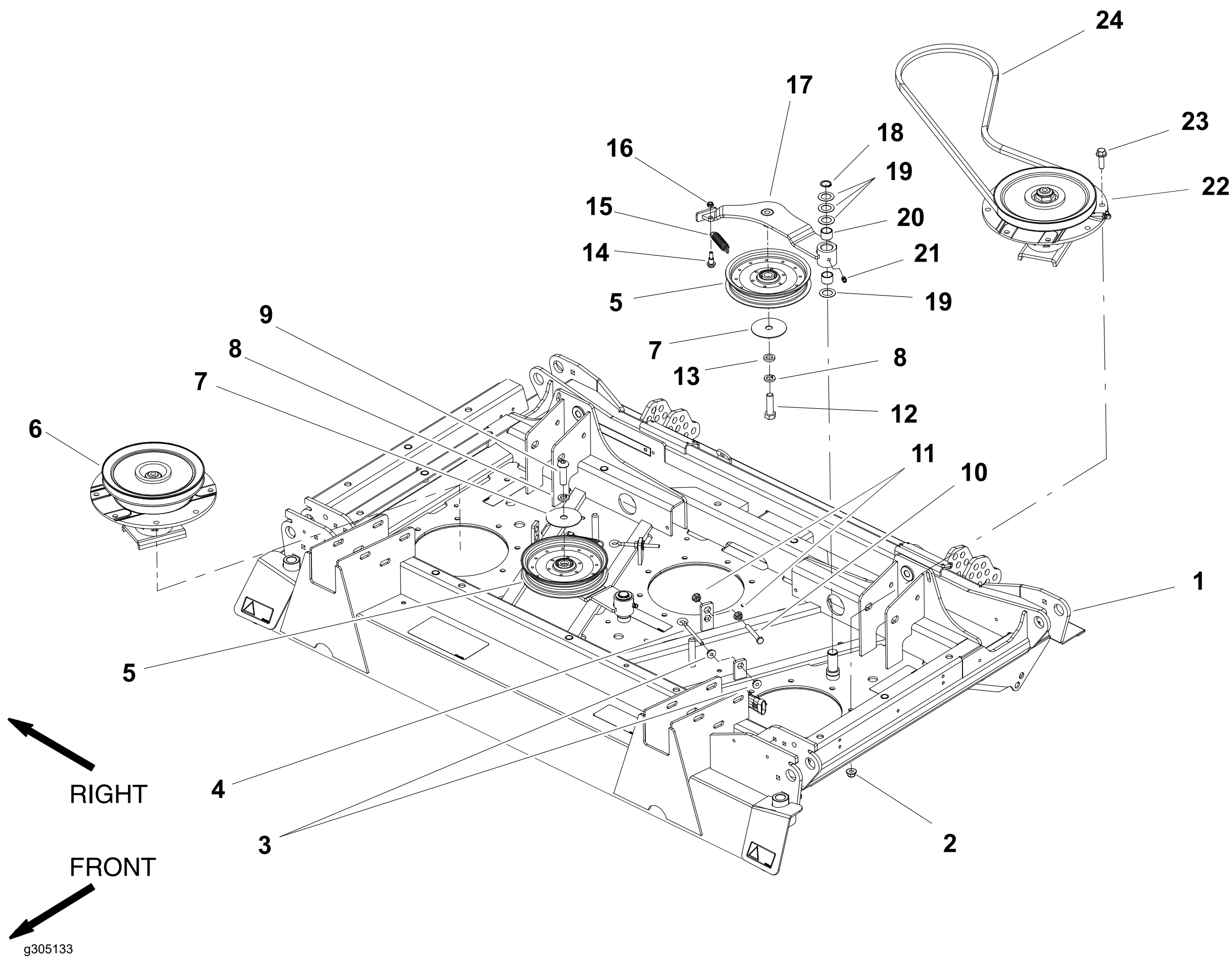

Figure 343

1. Center deck
2. Flange nut
3. Flange nut
4. Adjusting screw
5. Idler pulley
6. High driven pulley
7. Flat washer
8. Lock washer
9. Socket head screw
10. Idler stop bolt
11. Flange nut
12. Cap screw
13. Spacer
14. Shoulder bolt
15. Idler spring
16. Lock nut
17. Idler arm
18. Retaining ring
19. Thrust washer (4 used per idler)
20. Bushing (2 used per idler)
21. Grease fitting
22. Low driven pulley
23. Flange head screw
24. Drive belt

Note: The center deck is shown in Figure 343. The idler assemblies used on the wing decks use the same idler components.

Removal (Figure 343)

1. Park machine on a level surface, lower cutting deck, stop engine, engage parking brake and remove key from the ignition switch.
2. Remove deck covers from top of cutting deck.

Removal (Figure 343) (continued)

CAUTION

Be careful when removing idler spring. The spring is under heavy load and may cause personal injury.

3. Use spring hook tool to unhook the idler spring (item 15) from the adjusting screw (item 4).
4. Remove drive belt(s) from deck pulleys.
5. Loosen flange nuts (item 11) that secure idler stop bolt (item 10) to cutting deck to allow clearance between idler arm and stop bolt.
6. Remove idler components as needed using Figure 20Figure 343 as a guide. Note location of washers, idler spacer and screw as idler assemblies are being removed.

Installation (Figure 343)

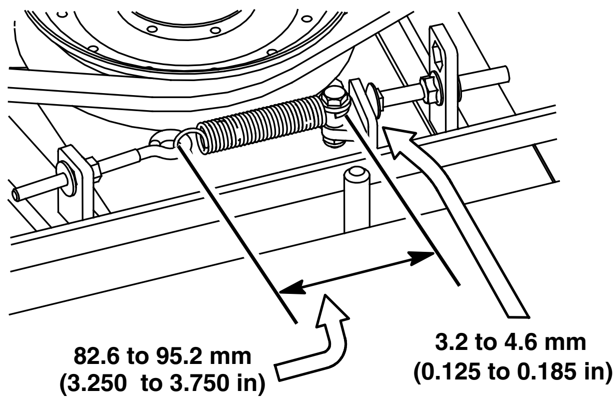

Figure 344

1. Install removed idler components using Figure 343 as a guide.
   A. Make sure that one (1) thrust washer (item 19) is placed below the idler arm and three (3) thrust washers are placed between the idler and retaining ring location.
   B. Secure idler arm assembly to cutting deck with retaining ring.
   C. If idler stop bolt (item 10)was removed from deck, make sure that it is installed in the hole that allows the stop bolt head to align with the idler arm.
2. Install drive belt to pulleys.
3. Use spring hook tool to attach the idler spring (item 15) onto the adjusting screw (item 4) and shoulder bolt on idler arm. With the idler arm tensioning the drive belt, the spring hook to hook length should be from **82.6 to 95.2 mm (3.250 to 3.750 in)** (Figure 344). If necessary, disconnect spring and change position of adjusting screw. When idler spring is the correct length, tighten second flange nut to secure adjustment.
4. Adjust location of idler stop bolt (item 10) so that the clearance between idler arm and idler stop bolt head is from **3.2 to 4.6 mm (0.125 to 0.185 in)** (Figure 344).
5. Lubricate idler arm grease fitting.
6. Install deck covers to cutting deck.

Castor Forks and Wheels

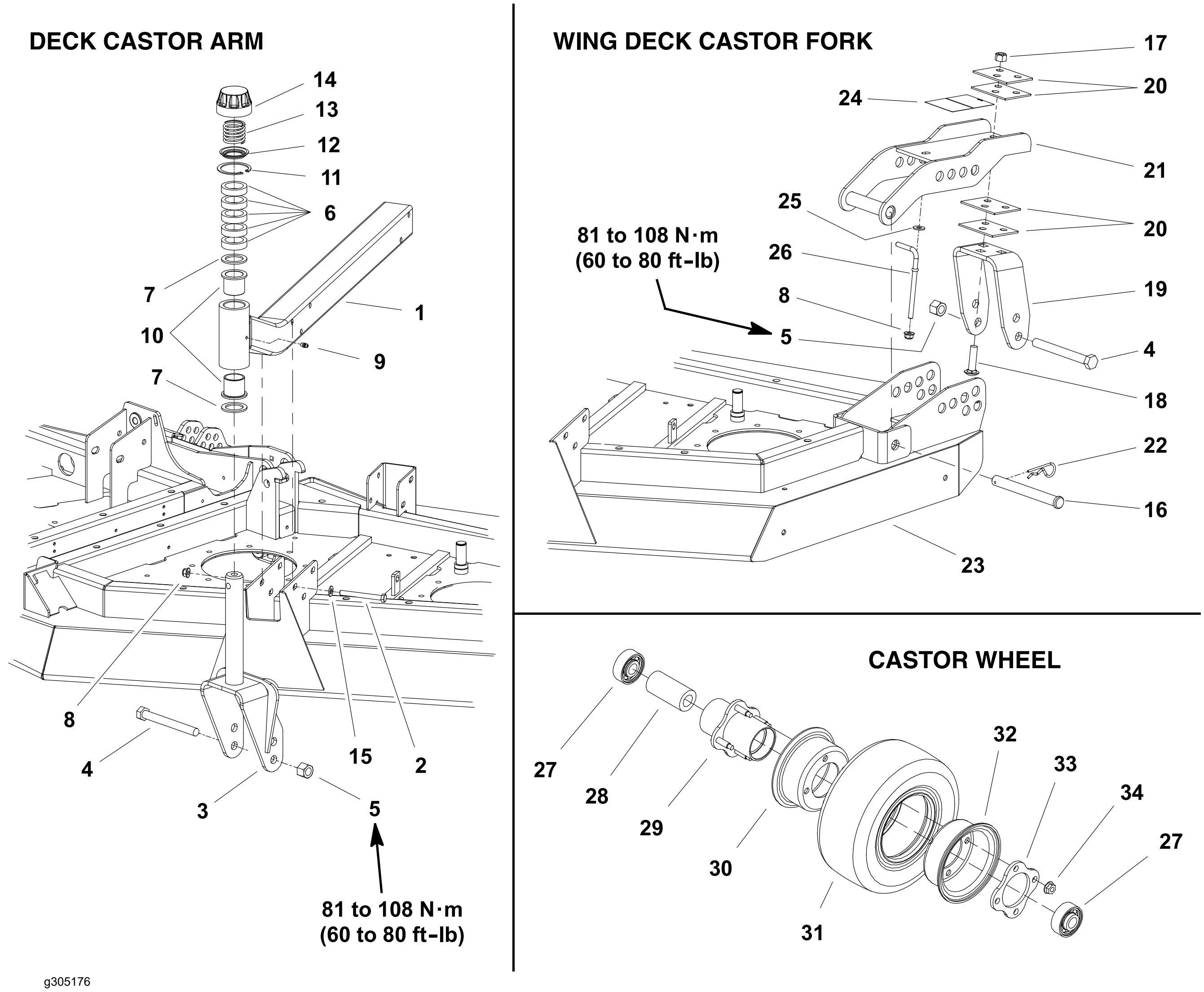

Figure 345

1. Castor arm (wing deck shown)
2. Cap screw (6 per arm)
3. Castor fork
4. Castor wheel bolt
5. Lock nut
6. Castor spacer
7. Thrust washer
8. Flange lock nut
9. Grease fitting
10. Flange bushing
11. Retaining ring .
12. Cap washer
13. Compression spring
14. Cap
15. Flat washer (6 per arm)
16. Clevis pin (2 used per fork)
17. Lock nut
18. Carriage screw (3 used per fork)
19. Castor fork bracket
20. Shim
21. Castor fork bracket
22. Hairpin
23. Cutting deck (LH shown)
24. Decal
25. Flat washer
26. Tension rod
27. Bearing
28. Inner bearing spacer
29. Wheel hub
30. Wheel rim half
31. Castor tire/tube
32. Wheel rim half
33. Plate
34. Flange nut (4 used per wheel)

Disassembly (Figure 345)

1. Park machine on a level surface, lower cutting deck, stop engine, engage parking brake and remove key from the ignition switch.
2. Disassemble castor forks and wheels using Figure 345 as a guide.

Assembly (Figure 345)

1. Assemble castor forks and wheels using Figure 345 as a guide.
2. Torque castor wheel lock nut from **81 to 108 N·m (60 to 80 ft-lb)**.
3. If castor fork was removed, lubricate grease fitting.
4. See *Operator’s Manual* for castor wheel adjustment.

Deck Rollers and Skids

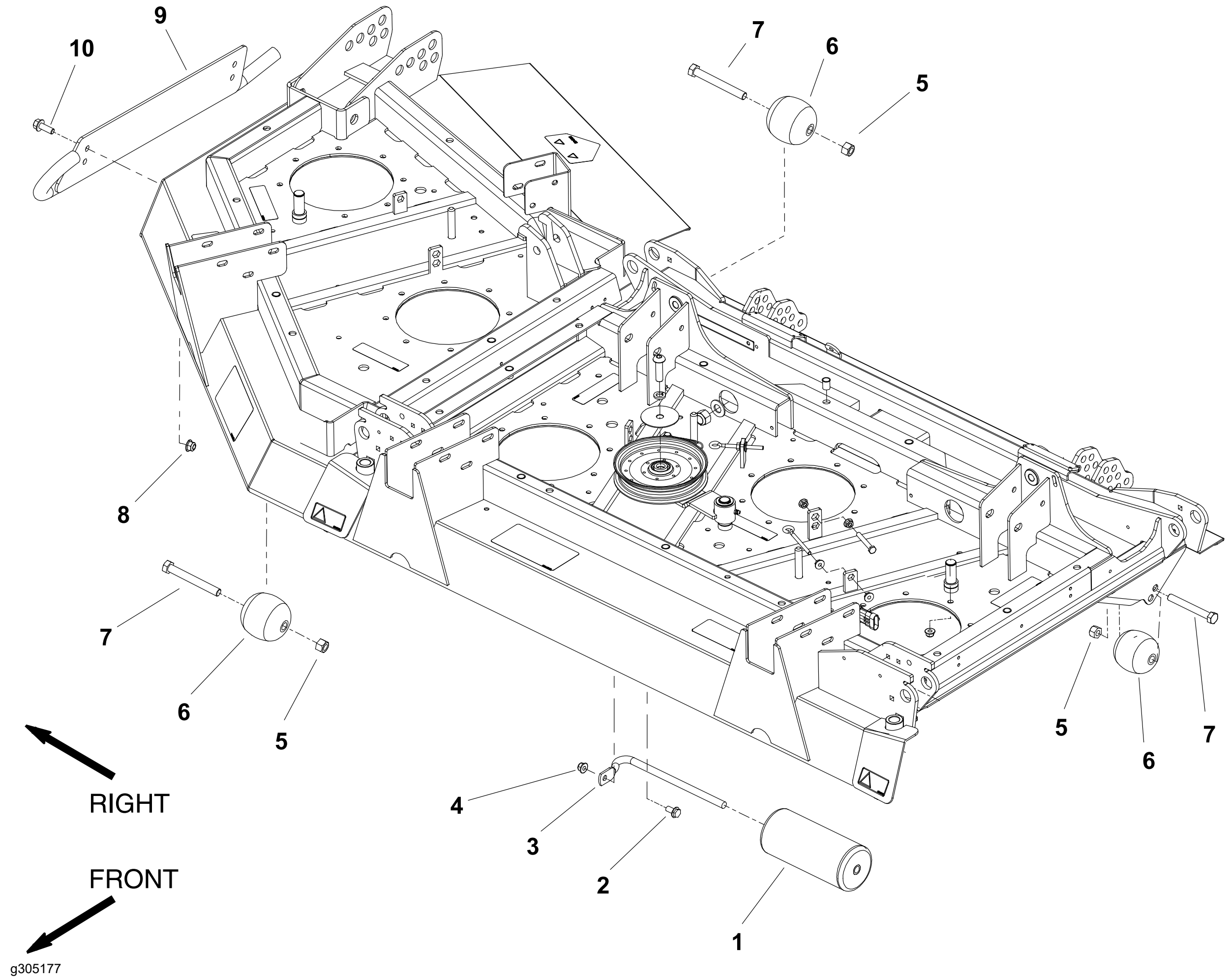

Figure 346

1. Roller
2. Flange head screw
3. Roller shaft
4. Flange nut
5. Lock nut
6. Roller
7. Cap screw
8. Flange nut
9. Skid (RH shown)
10. Flange head screw

Removal (Figure 346)

Remove skids and rollers from deck using Figure 346 as a guide.

Installation (Figure 346)

1. Install skids (item 9) to deck using Figure 346 as a guide. Make sure to install skids in the same mounting hole height position (lower or upper).
2. Install rollers (items 1 and 6) to deck using Figure 346 as a guide. When installing roller (item 6), install cap screw with the threads orientated toward the center line of the deck. Install and tighten lock nut until roller will not rotate, then loosen lock nut only enough to allow roller to rotate freely. Make sure to install all deck rollers in the same mounting hole height position (lower or upper).

Chapter 10

Operator Cab (For models 30602 and 30606)

Table of Contents

Additional Reference Materials

Sanden SD Compressor Service Guide

General Information

The information in this chapter pertains to the operator cab on the Groundsmaster 4110−D.

Operator's Manual

The *Operator's Manual* provides information regarding the operation, adjustment procedures, and general maintenance for your Greensmaster machine. Refer to the *Operator's Manual* for additional information when servicing the machine.

Electrical Components and Schematic

Information regarding Groundsmaster 4110−D electrical cab components (switches and relay) is included in Chapter 5 − Electrical System. The electrical schematic and wire harness drawings for the operator cab are included in Appendix A (page A–1).

Air Conditioning System

The air conditioning system used on the Groundsmaster 4110−D consists of the following components:

1. A compressor mounted on the engine and driven by a v−belt.
2. A condenser and condenser fan located on the top of the cab.
3. A drier−receiver, an expansion valve and an evaporator (combined with the heater core) mounted in the headliner of the cab.
4. The necessary hoses and tubes that connect the system components.
5. A fan motor that provides air movement through the evaporator and into the cab. The fan motor is located in the cab headliner and is also used for the cab heater system.
6. Operator controls to turn the air conditioning on, to adjust the fan speed and to control the cab air temperature.

Cab Heater System

The cab heater system used on the Groundsmaster 4110−D consists of the following components:

1. A heater core (combined with the A/C evaporator) located in the cab headliner.
2. Hoses to allow a circuit for engine coolant to circulate through the heater core. The heater core (combined with the A/C evaporator) is located in the headliner of the cab.
3. A fan motor that provides air movement through the heater core and into the cab. The fan motor is located in the cab headliner and is also used for the air conditioning system.
4. Operator controls to adjust the fan speed and to control the cab air temperature.

Service and Repairs

General Precautions for Removing and Installing the Air Conditioning System Components

WARNING

Do not let the refrigerant contact your skin or eyes as there is a possibility of serious injury.

Always wear safety goggles or a face shield when you work with the air conditioning system components.

CAUTION

Loosening any air conditioning system fitting or component allows the pressurized refrigerant to escape, causing possible injury.

Do not loosen any system fitting or component until a certified air conditioning service technician discharges the system completely.

CAUTION

In some conditions, the pressurized mixtures of the refrigerant and air are combustible.

Do not use compressed air for leak test or pressure test of the air conditioning system.

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1. Before you service any air conditioning system components, park the machine on a level surface, set the parking brake, lower the cutting deck or attachments, and shut off the engine. Remove the key from the key switch.
2. Clean the machine before you disconnect, remove, or disassemble any air conditioning system components. Clean the system to prevent the system contamination while you perform the service procedures.
3. Before you loosen or remove any air conditioning system hoses or other components, have a certified air conditioning service technician collect the system refrigerant and then evacuate the air conditioning system completely. It is illegal to open the refrigerant to the atmosphere.
4. Install caps or plugs on any lines, fittings, or components that are left open or exposed to prevent moisture and contaminants from entering into the system.
5. Label all the disconnected system lines and hoses for proper installation after repairs are completed.
6. If you remove the compressor from the machine, keep the compressor in the same orientation as it was in the installed position. This prevents the compressor oil from filling the compressor cylinders.
7. Air conditioning system failures that have resulted in debris found in the system will need system component flushing using appropriate solvent and procedures. Replace the damaged components along with the receiver/dryer.

General Precautions for Removing and Installing the Air Conditioning System Components (continued)

8. Air conditioning refrigerant oil capacity must be determined and replenished during reassembly/vacuum/recharge.
9. Failure to address the contamination in the closed loop system will result in early compressor failure.
10. Note the position of the fittings (especially elbow fittings) before removal.

    Note: Mark the parts, if necessary, and ensure that they are aligned correctly when installing the hoses and tubes.
11. Always use a DOT approved tank to store the used and recycled refrigerants.
12. The air conditioning system uses R134a refrigerant. Do not use other refrigerants in the system.

    Note: The capacity of the air conditioning system is approximately 0.8 kg (1.75 lb) of R134a refrigerant.
13. The refrigerant containers (either full or empty) are under pressure and the pressure increases if you heat them. Do not expose the refrigerant containers to high-heat sources or flame.
14. Ensure that the work area is properly ventilated to prevent any accumulation of the refrigerant or other fumes.
15. Ensure that the caps are always placed on the pressure hose ports. These caps prevent refrigerant leakage from the system.
16. The air conditioning drier-receiver component is used to collect moisture that reduces the air conditioning performance. If the air conditioning system is opened for the component repair or replacement, ensure that the drier-receiver ports are plugged to prevent damage to the drier-receiver. If either the compressor or air conditioning expansion valve is replaced, replace the drier-receiver.
17. After you install the air conditioning components, have a certified air conditioning service technician evacuate the air conditioning system completely, properly recharge the system with R134a refrigerant, and perform the leak test on the system.

Air Conditioning Compressor

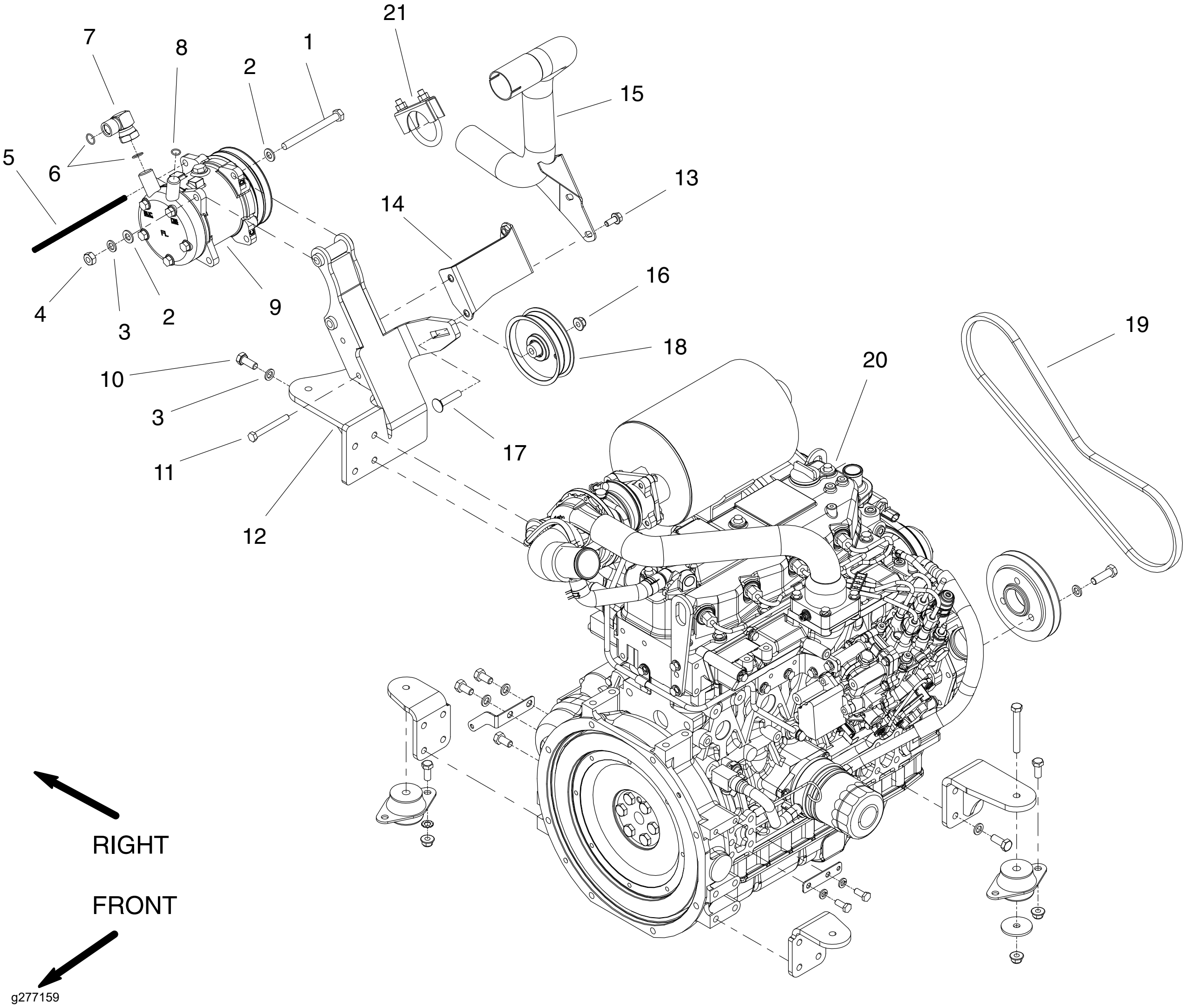


Figure 347

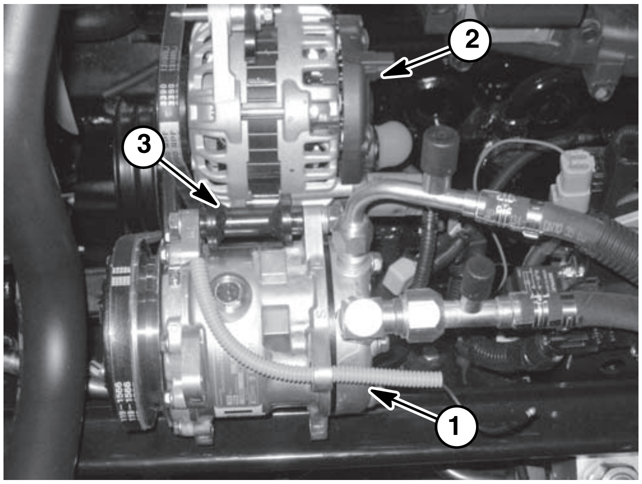
1.	Cap screw (2 used)	8.	O−ring	15.	Exhaust pipe
2.	Flat washer (4 used)	9.	A/C compressor	16.	Flange nut
3.	Lock washer (6 used)	10.	Cap screw (4 used)	17.	Carriage screw
4.	Hex nut (2 used)	11.	Cap screw (2 used)	18.	Idler pulley
5.	Conduit	12.	A/C compressor mount	19.	Compressor drive belt
6.	O−ring (2 used)	13.	Flange head screw (2 used)	20.	Engine (model 30602 shown)
7.	90º fitting	14.	Exhaust bracket	21.	Clamp assembly

Removal (Figure 347)

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the key switch.
2. Raise hood to allow access to engine.
3. Remove exhaust pipe (item 15).
4. Loosen flange nut that secures idler pulley. Move pulley to loosen A/C compressor drive belt. Remove drive belt from A/C compressor pulley.
5. Inspect compressor drive belt for glazing or damage. Replace belt if necessary.

Removal (Figure 347) (continued)

6. Disconnect compressor electrical connector from machine wire harness.



g277161

Figure 348

1. A/C compressor
2. Alternator
3. A/C compressor mount

7. Read the General Precautions for Removing and Installing the Air Conditioning System Components (page 11–4).

CAUTION

The air conditioning system is under high pressure. Do not loosen any system fitting or component until after the system has been completely discharged by a certified A/C service technician.

8. Have refrigerant evacuated from air conditioning system by a certified A/C service technician.
9. Label and remove hoses from compressor. Immediately cap hoses and fittings to prevent moisture and contaminants from entering the system.
10. Support compressor to prevent it from shifting or falling.

    Note: There may be shims mounted between compressor and compressor mount. When removing compressor, note shim location and quantity for assembly purposes.

11. Remove fasteners and washers that secure compressor to compressor mount.

IMPORTANT

To prevent compressor oil from filling the compressor cylinders, keep compressor in the same orientation as the installed position.

12. Carefully remove compressor from engine and machine.

    Note: The replacement of the drier−receiver is recommended whenever A/C compressor is removed from the system (see Heater/Evaporator Assembly (page 10–13)).

Removal (Figure 347) (continued)

Note: The air conditioning compressor used on the Groundsmaster 4110−D is a Sanden model SD5H09. For air conditioning compressor repair procedures, see the Sanden SD Compressor Service Guide.

Installation (Figure 347)

New compressor installation requires flushing of the system which also removes all air conditioning system PAG oil. New compressors should be drained of air condition PAG oil into a clean and clear graduated container. Add or subtract the oil from this measured amount to equal the system oil capacity. This oil can be added into both the compressor and dryer prior to reassembly or injected with the air conditioning charging machine if equipped.

1. Position compressor to compressor mount on engine.

   Note: The clearance between the compressor mounting flanges and compressor mount must be less than **0.10 mm (0.004 in)**. If necessary, install shims between compressor flanges and mount to adjust clearance. See Compressor Parts Catalog for shim kit.

2. Secure compressor to compressor mount with removed fasteners and spacers. Do not fully tighten fasteners.

   Note: After the compressor has been installed, make sure to rotate the compressor drive shaft several times to properly distribute oil in the compressor. Compressor damage due to oil slugging can occur if this procedure is not performed.

3. Manually rotate the compressor drive shaft at least ten (10) revolutions to make sure that no compressor oil is in the compressor cylinders.
4. Place drive belt onto compressor pulley.
5. Tension compressor drive belt with idler pulley. Make sure to tighten flange nut to secure belt adjustment.
6. Install exhaust pipe (item 15).
7. Remove caps that were placed on hoses and fittings during the removal process. Using labels placed during removal, properly secure hoses to compressor.
8. Connect compressor electrical connector to machine wire harness.
9. Have a certified air conditioning service technician evacuate the air conditioning system completely, properly recharge the system with R134a refrigerant and then leak test the system. A/C system capacity is 0.8 kg (1.75 lb) of R134a refrigerant.
10. Lower and secure hood.

Roof Assembly

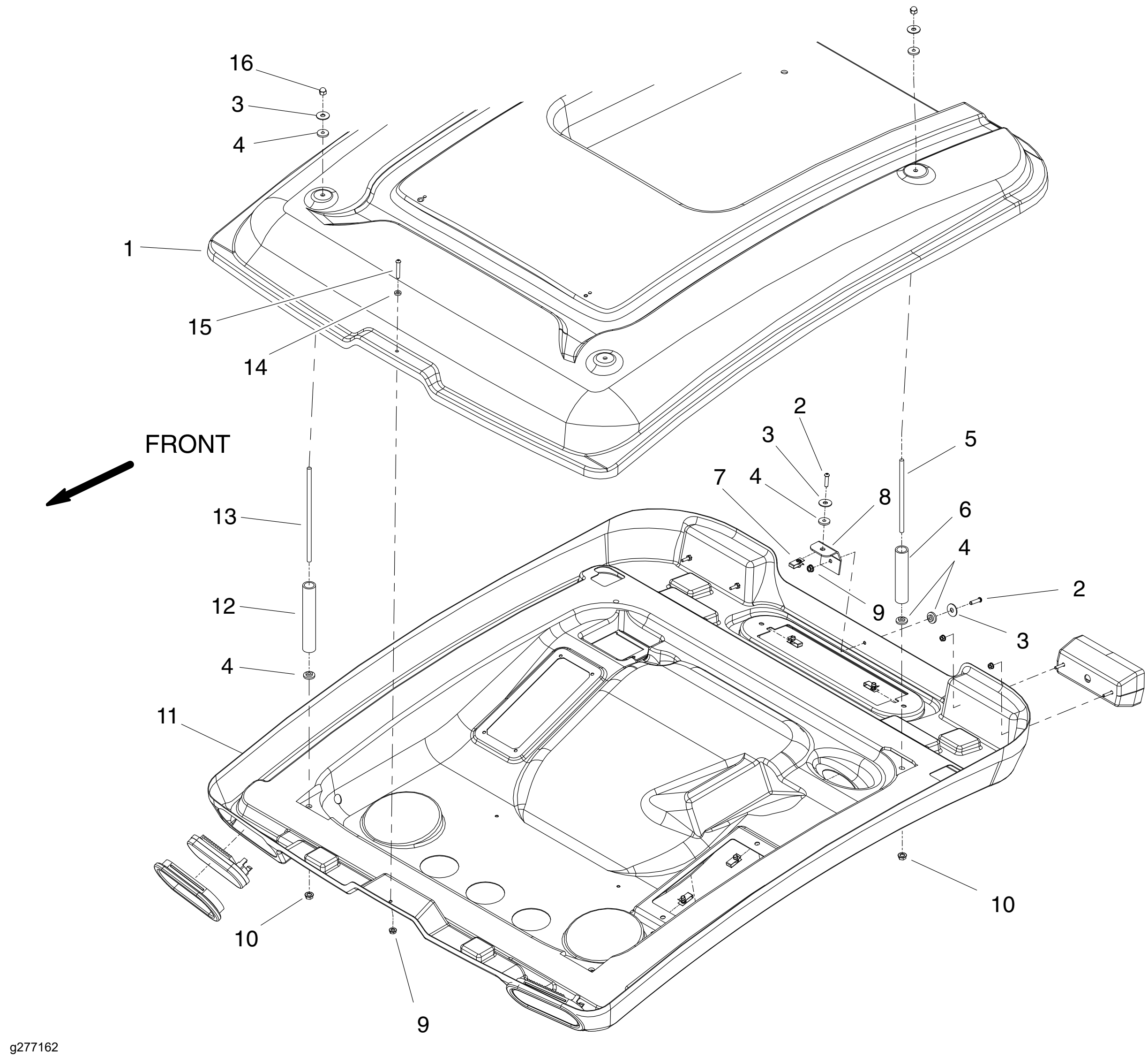


Figure 349

1. Roof
2. Screw (2 used)
3. Flat washer (6 used)
4. Bushing (10 used)
5. Rear fastener (2 used)
6. Rear spacer (2 used)
7. Panel nut
8. Roof mount
9. Flange nut (2 used)
10. Flange nut (4 used)
11. Headliner
12. Front spacer (2 used)
13. Front fastener (2 used)
14. Rubber washer
15. Cap screw
16. Hex nut (4 used)

To gain access to the heater core and air conditioning components that are located under the cab roof, the roof panel can be loosened, raised and supported.

Removal (Figure 349)

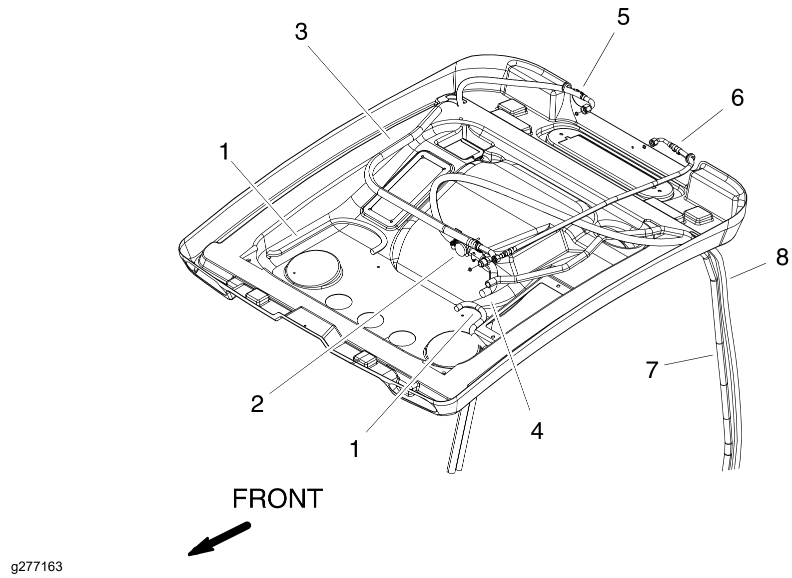


Figure 350

1.	Condensation drain hose (2 used)	5.	A/C hose: compressor to condenser
2.	Heater valve	6.	A/C hose: condenser to drier
3.	A/C hose: evaporator to compressor	7.	Heater hose: thermostat to heater valve
4.	Heater hose: heater valve to heater core	8.	Heater hose: heater core to water pump

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the key switch.
2. Remove screw (item 2), flat washer (item 3) and bushing (item 4) that secure the rear of the roof to the roof mount.
3. Remove the cap screw (item 15) and rubber washer (item 14) that secure the front of the roof.
4. Remove four (4) hex nuts (item 16), flat washers (item 3) and bushings (item 4) that secure roof to front and rear fasteners.
5. Carefully lift front of roof while leaving rear of roof against headliner. Support front of roof in the raised position to allow access to heater and air conditioning components.

Installation (Figure 349)

1. Make sure that all components in headliner and roof are installed and secure.
2. Remove support and carefully lower roof into position.
3. Secure roof to headliner with all removed fasteners.

Air Conditioning Condenser Assembly

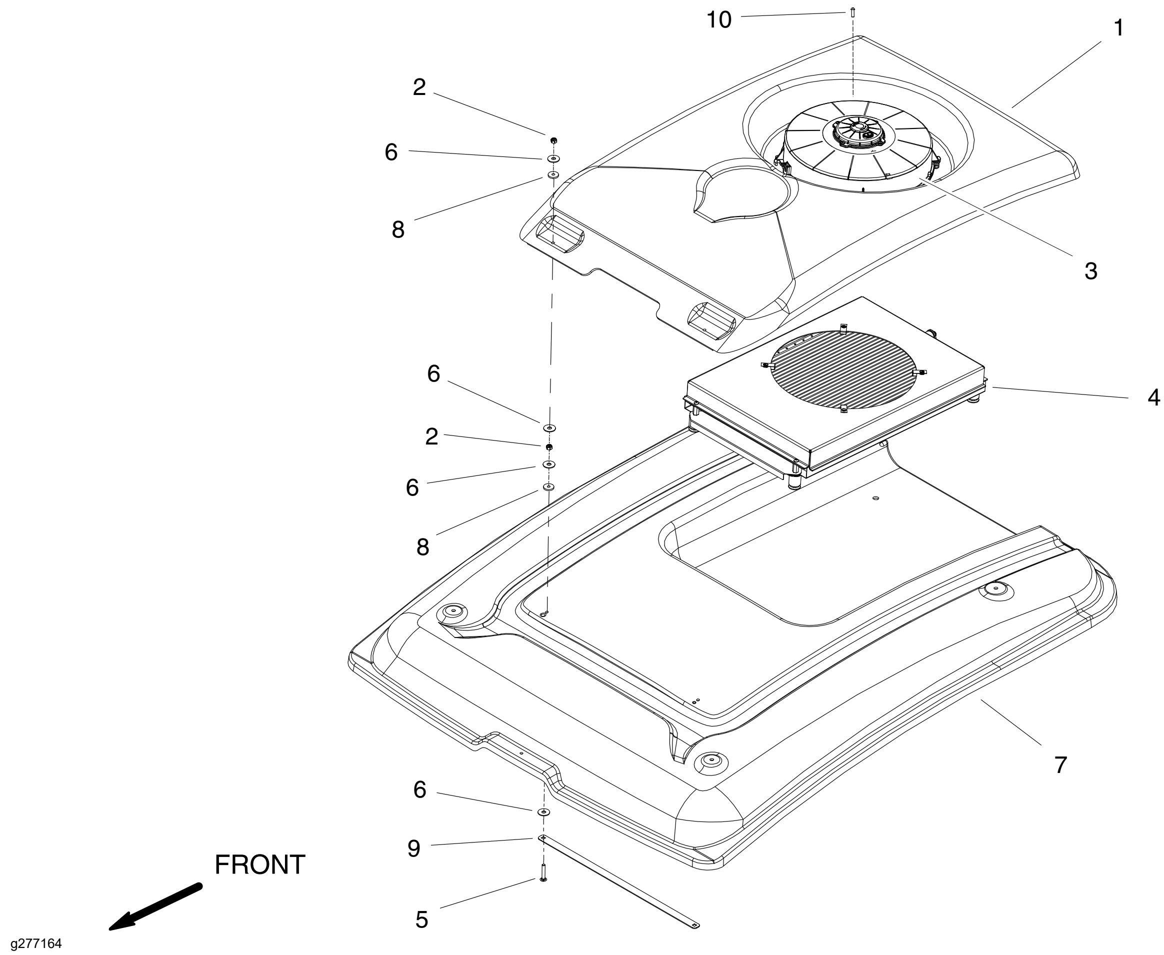


Figure 351

1. Condenser cover
2. Lock nut (4 used)
3. Condenser fan
4. Condenser coil assembly
5. Carriage screw (2 used)
6. Flat washer (8 used)
7. Roof
8. Bushing (4 used)
9. Mounting strap
10. Button head screw (4 used)

Removal (Figure 351)

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the key switch.
2. Remove fasteners that secure roof in place. Raise and support roof to allow access to condenser assembly (see Roof Assembly (page 11–9)).
3. Disconnect wire harness connector from condenser fan motor.
4. Remove button head screws (item 10) that secure condenser fan and cover to condenser coil.
5. Remove fasteners (items 2, 6 and 8) that secure front of condenser cover to roof. Lift condenser fan and cover from roof.
6. Read the General Precautions for Removing and Installing the Air Conditioning System Components (page 10–3).

Removal (Figure 351) (continued)

⚠ CAUTION ⚠

The air conditioning system is under high pressure. Do not loosen any system fitting or component until after the system has been completely discharged by a certified A/C service technician.

7. Have refrigerant evacuated from air conditioning system by a certified A/C service technician.
8. Label and remove hoses from condenser coil. Immediately cap hoses and fittings to prevent moisture and contaminants from entering the system.

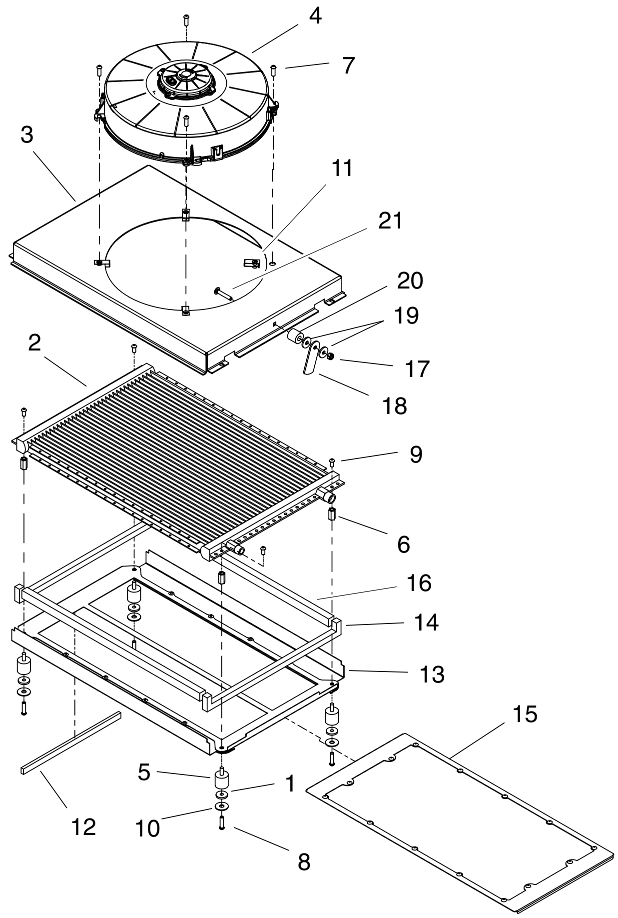


Figure 352

1. Bushing (4 used)
2. Condenser coil
3. Fan shroud
4. Condenser fan
5. Isolator mount (4 used)
6. Coupler nut (4 used)
7. Screw (4 used)
8. Screw (4 used)
9. Screw (4 used)
10. Flat washer (4 used)
11. Clip (4 used)
12. Tray foam
13. Screen frame
14. End foam (2 used)
15. Screen
16. Side foam (2 used)
17. Lock nut
18. Latch plate
19. Friction washer (2 used)
20. Latch spacer
21. Carriage screw

Removal (Figure 351) (continued)

9. Remove condenser coil from roof using Figure 352 as a guide.

   Note: The replacement of the drier−receiver is recommended whenever the air conditioning system is opened (see Heater/Evaporator Assembly (page 10–13)).

Installation (Figure 351)

1. Install condenser coil to roof using Figure 352 as a guide.
2. Remove caps that were placed on hoses and fittings during the removal process. Using labels placed during removal, properly secure hoses to condenser coil.
3. Position condenser cover and condenser fan to roof. Secure cover and fan with removed fasteners (items 2, 6 and 8).
4. Secure condenser fan to condenser coil with button head screws (item 10).
5. Connect wire harness connector to condenser fan motor.
6. Make sure that all machine air conditioning components are installed and secure.
7. Have a certified air conditioning service technician evacuate the air conditioning system completely, properly recharge the system with R134a refrigerant and then leak test the system. A/C system capacity is 0.8 kg (1.75 lb) of R134a refrigerant.
8. Lower and secure roof assembly (see Roof Assembly (page 10–8)).

Heater/Evaporator Assembly

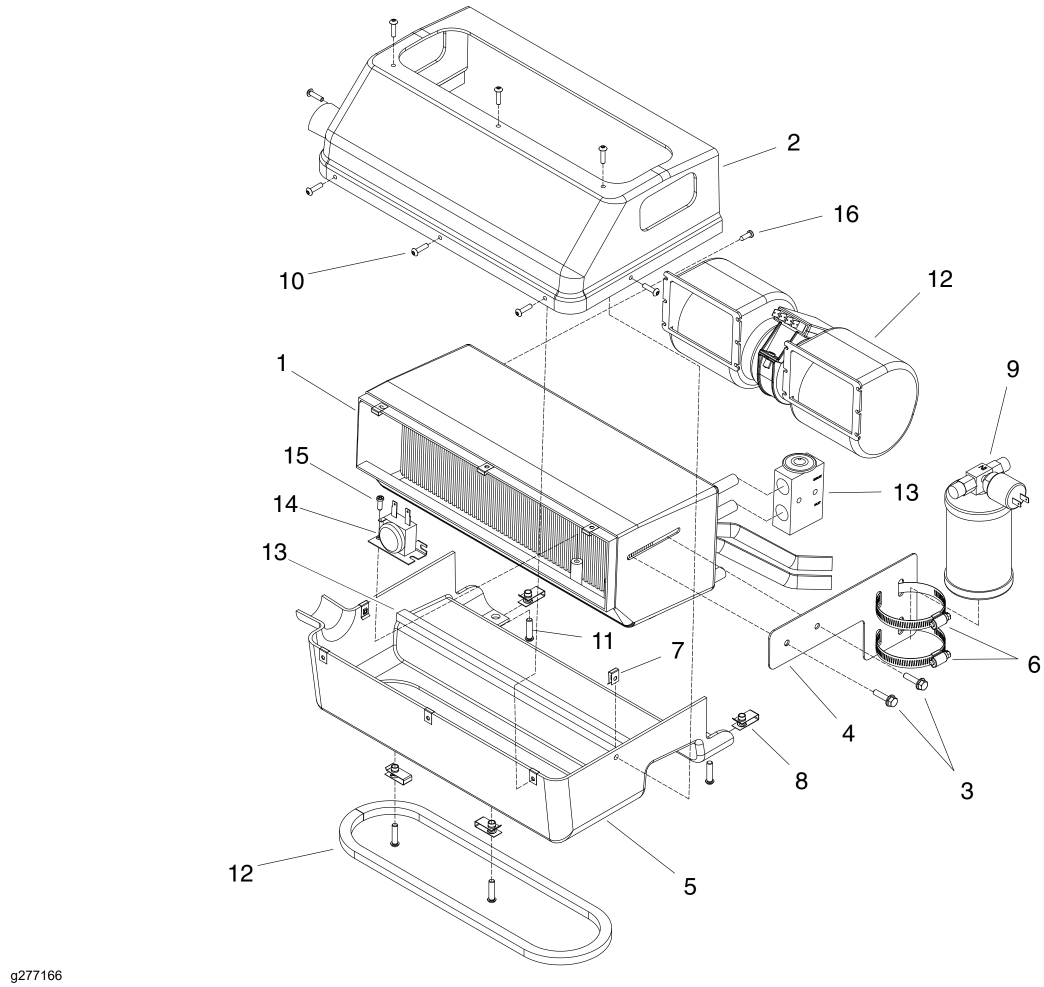


Figure 353

1. Heater/evaporator assembly
2. Top cover
3. Flange head screw (2 used)
4. Drier−receiver mount
5. Bottom cover
6. Hose clamp (2 used)
7. Speed nut (8 used)
8. Panel nut (4 used)
9. Drier−receiver assembly
10. Screw (8 used)
11. Screw (4 used)
12. Blower fan assembly
13. Expansion valve
14. Freeze switch
15. Screw (2 used)
16. Screw (12 used)

Removal (Figure 353)

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the key switch.
2. Remove fasteners that secure roof in place. Raise and support roof to allow access to heater/evaporator assembly (see Roof Assembly (page 10–8)).
3. Disconnect wire harness connectors from fan motor and binary switch on drier−receiver.

Removal (Figure 353) (continued)

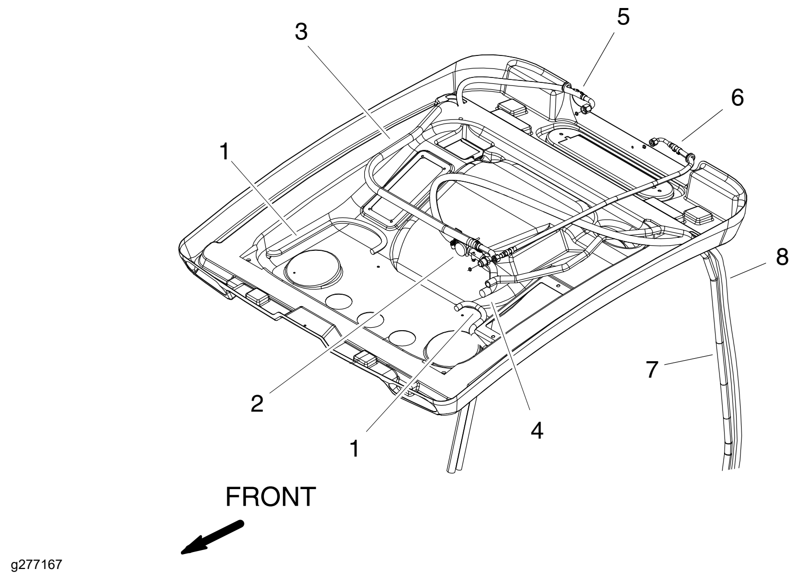


Figure 354

1. Condensation drain hose (2 used)
2. Heater valve
3. A/C hose: evaporator to compressor
4. Heater hose: heater valve to heater core
5. A/C hose: compressor to condenser
6. A/C hose: condenser to drier
7. Heater hose: thermostat to heater valve
8. Heater hose: heater core to water pump

4. Read the General Precautions for Removing and Installing the Air Conditioning System Components (page 10–3).

CAUTION

The air conditioning system is under high pressure. Do not loosen any system fitting or component until after the system has been completely discharged by a certified A/C service technician.

5. Have refrigerant evacuated from air conditioning system by a certified A/C service technician.
6. Label and remove hoses from heater core, evaporator and drier−receiver. Immediately cap hoses and fittings to prevent moisture and contaminants from entering the system.
7. Loosen hose clamp that secures air duct hose to heater/evaporator assembly covers. Slide hose from covers.
8. Remove screws that secure top cover to bottom cover. Remove top cover to access heater/evaporator assembly.
9. Disassemble heater/evaporator assembly using Figure 353 as a guide.
10. If necessary, remove fan resistor from blower fan assembly (Figure 355).

    Note: The replacement of the drier−receiver is recommended whenever the air conditioning system is opened.

Installation (Figure 353)

1. Assemble heater/evaporator assembly using Figure 353 as a guide. Make sure that expansion valve is covered with insulating tape to prevent condensation issues.

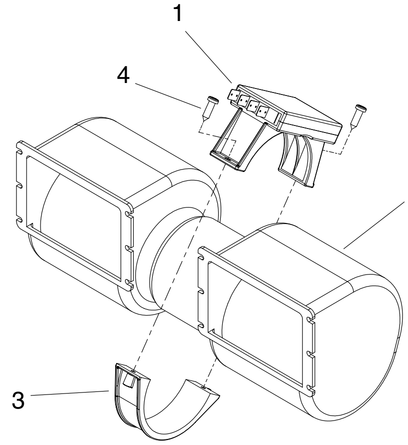


Figure 355

1.	Fan resistor	3.	Clamp
2.	Blower fan assembly	4.	Screw (2 used)

2. If removed, secure fan resistor to blower fan assembly (Figure 355).
3. Position heater/evaporator assembly into bottom cover in headliner. Secure top cover to bottom cover with removed screws.
4. Slide air duct hose onto heater/evaporator assembly covers and secure with hose clamp.
5. Remove caps that were placed on hoses and fittings during the removal process. Using labels placed during removal, properly secure hoses to heater core, evaporator and drier−receiver.
6. Make sure that condensation hoses are secured to bottom housing of heater/evaporator assembly and are routed to cab frame for proper draining of condensate.
7. Connect wire harness connectors to fan motor and binary switch on drier−receiver.
8. Make sure that all machine air conditioning components are installed and secure.
9. Have a certified air conditioning service technician evacuate the air conditioning system completely, properly recharge the system with R134a refrigerant and then leak test the system. A/C system capacity is 0.8 kg (1.75 lb) of R134a refrigerant.
10. Operate the heater system to make sure that no engine coolant leaks exist.
11. Lower and secure roof assembly (see Roof Assembly (page 10–8)).

Windshield Wiper

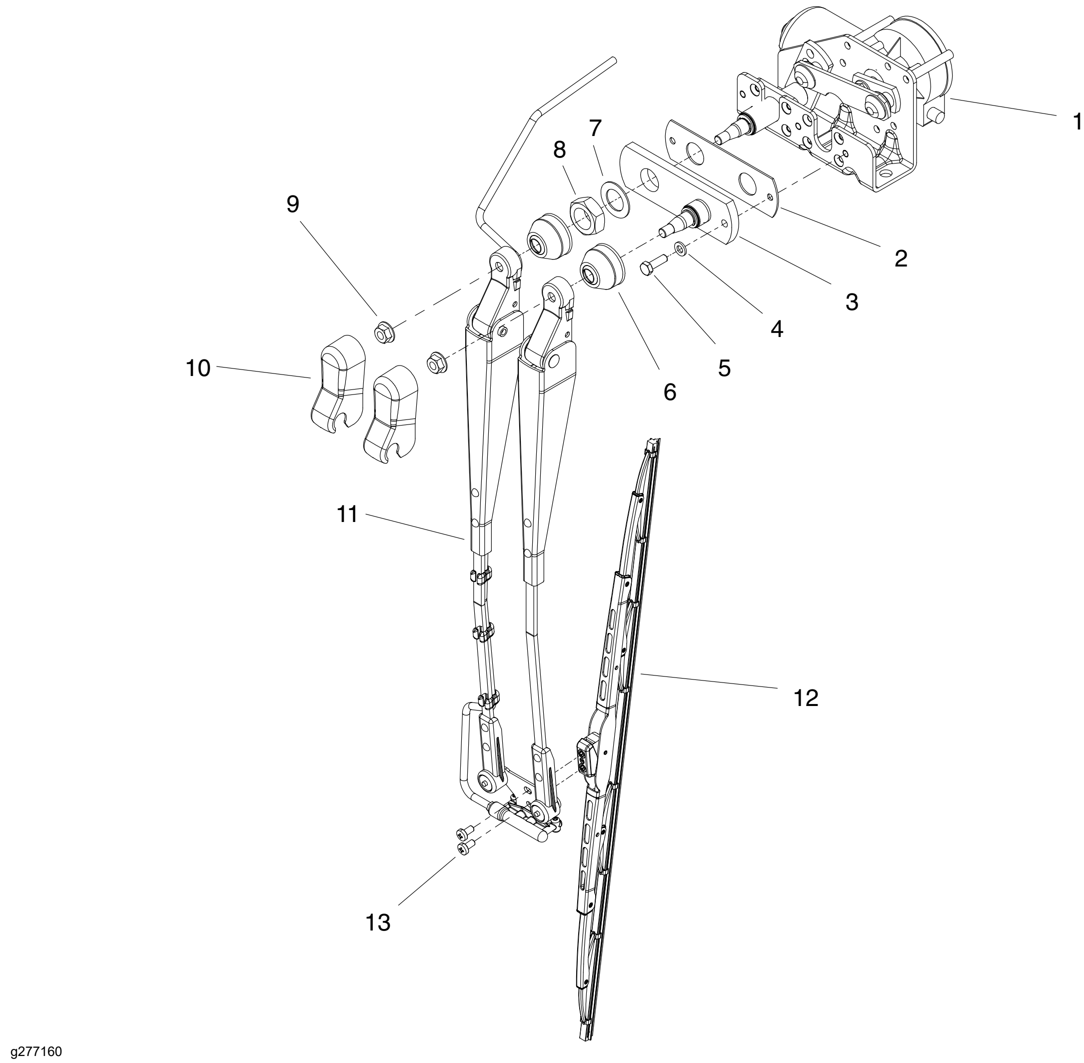


Figure 356

1. Wiper motor
2. Gasket
3. Linkage bracket
4. Lock washer
5. Cap screw
6. Cap (2 used)
7. Washer
8. Nut
9. Flange nut (2 used)
10. Cover (2 used)
11. Wiper arm assembly
12. Wiper blade
13. Screw (2 used)

Disassembly (Figure 356)

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the key switch.
2. If access to wiper motor is necessary, remove fasteners that secure roof in place. Raise and support roof to allow access to condenser assembly (see Roof Assembly (page 10–8)).
3. Remove windshield wiper components as needed using Figure 356 as a guide.

Assembly (Figure 356)

1. Assemble windshield wiper components using Figure 356 as a guide.
2. If roof was raised, lower and secure roof assembly (see Roof Assembly (page 10–8)).

Chapter 11

Operator Cab (For models 30643 and 30644)

Table of Contents

Additional Reference Materials

Badger Compressor Service Manual

General Information

Traction Unit Operator's Manual

The *Operator's Manual* provides information regarding the operation, general maintenance, and maintenance intervals for your machine. Refer to the *Operator's Manual* for additional information when servicing the machine.

Electrical Components and Schematic

Information regarding the electrical cab components (switches and relays) are included in Chapter 6: Electrical System (page 6–1). The Electrical Schematics and Wire Harness Drawings for the operator cab in Appendix A (page A–1).

Air Conditioning System

The air conditioning system used on this machine consists of the following components:

1. A compressor mounted on the right side of the engine and driven by a V-belt.
2. A condenser assembly and 2 condenser fans located at the rear of the cab roof assembly.
3. An evaporator core, a drier-receiver, and an expansion valve mounted in the headliner of the cab.
4. The necessary hoses and tubes that connect the air conditioning system components.
5. A blower fan motor that provides air movement through the evaporator and into the cab. The fan motor is a component of the mixing box located in the cab headliner and is also used for the cab heating system.
6. The operator controls to turn the air conditioning on to adjust the fan speed, and to control the cab air temperature.

Cab Heater System

The cab heater system used on your machine consists of the following components:

1. A heater core located in the headliner of the cab.
2. The hoses to allow a circuit for engine coolant to circulate through the heater core.
3. A blower fan motor that provides air movement through the heater core and into the cab. The fan motor is a component of the mixing box located in the cab headliner and is also used for the air conditioning system.
4. The operator controls to adjust the fan speed and to control the cab air temperature.

Air Conditioning System Performance

There are a number of factors that can affect the performance of the air conditioning system of your machine.

To ensure the best system operation, inspect the following components:

1. Ensure that the heater control fully closes the heater valve in the cab headliner.
2. Ensure that the condenser and evaporator fins are clean.
3. Check that the refrigerant charge quantity and system operating pressures are correct.
4. Ensure that the exposed metal surfaces inside the cab are insulated.
5. If the ambient temperatures exceeds 43 °C (110 °F), apply additional window tinting to lower solar heat load to the cab.

Service and Repairs

General Precautions for Removing and Installing the Air Conditioning System Components

WARNING

Do not let the refrigerant contact your skin or eyes as there is a possibility of serious injury.

Always wear safety goggles or a face shield when you work with the air conditioning system components.

CAUTION

Loosening any air conditioning system fitting or component allows the pressurized refrigerant to escape, causing possible injury.

Do not loosen any system fitting or component until a certified air conditioning service technician discharges the system completely.

CAUTION

In some conditions, the pressurized mixtures of the refrigerant and air are combustible.

Do not use compressed air for leak test or pressure test of the air conditioning system.

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1. Before you service any air conditioning system components, park the machine on a level surface, set the parking brake, lower the cutting deck or attachments, and shut off the engine. Remove the key from the key switch.
2. Clean the machine before you disconnect, remove, or disassemble any air conditioning system components. Clean the system to prevent the system contamination while you perform the service procedures.
3. Before you loosen or remove any air conditioning system hoses or other components, have a certified air conditioning service technician collect the system refrigerant and then evacuate the air conditioning system completely. It is illegal to open the refrigerant to the atmosphere.
4. Install caps or plugs on any lines, fittings, or components that are left open or exposed to prevent moisture and contaminants from entering into the system.
5. Label all the disconnected system lines and hoses for proper installation after repairs are completed.
6. If you remove the compressor from the machine, keep the compressor in the same orientation as it was in the installed position. This prevents the compressor oil from filling the compressor cylinders.
7. Note the position of the fittings (especially elbow fittings) before removal.

   Note: Mark the parts, if necessary, and ensure that they are aligned correctly when installing the hoses and tubes.

General Precautions for Removing and Installing the Air Conditioning System Components (continued)

8. Always use a DOT approved tank to store the used and recycled refrigerants.
9. The air conditioning system uses R134a refrigerant. Do not use other refrigerants in the system.

   Note: The capacity of the air conditioning system is 1.55 kg (3.4 lb) of R134a refrigerant. The capacity of the air conditioning system oil is 89 ml (3 oz).
10. The refrigerant containers (either full or empty) are under pressure and the pressure increases if you heat them. Do not expose the refrigerant containers to high-heat sources or flame.
11. Ensure that the work area is properly ventilated to prevent any accumulation of the refrigerant or other fumes.
12. Ensure that the caps are always placed on the pressure hose ports. These caps prevent refrigerant leakage from the system.
13. The air conditioning drier-receiver component is used to collect moisture that reduces the air conditioning performance. If the air conditioning system is opened for the component repair or replacement, ensure that the drier-receiver ports are plugged to prevent damage to the drier-receiver. If either the compressor or air conditioning expansion valve is replaced, replace the drier-receiver.
14. After you install the air conditioning components, have a certified air conditioning service technician evacuate the air conditioning system completely, properly recharge the system with R134a refrigerant, and perform the leak test on the system.

Air Conditioning Compressor

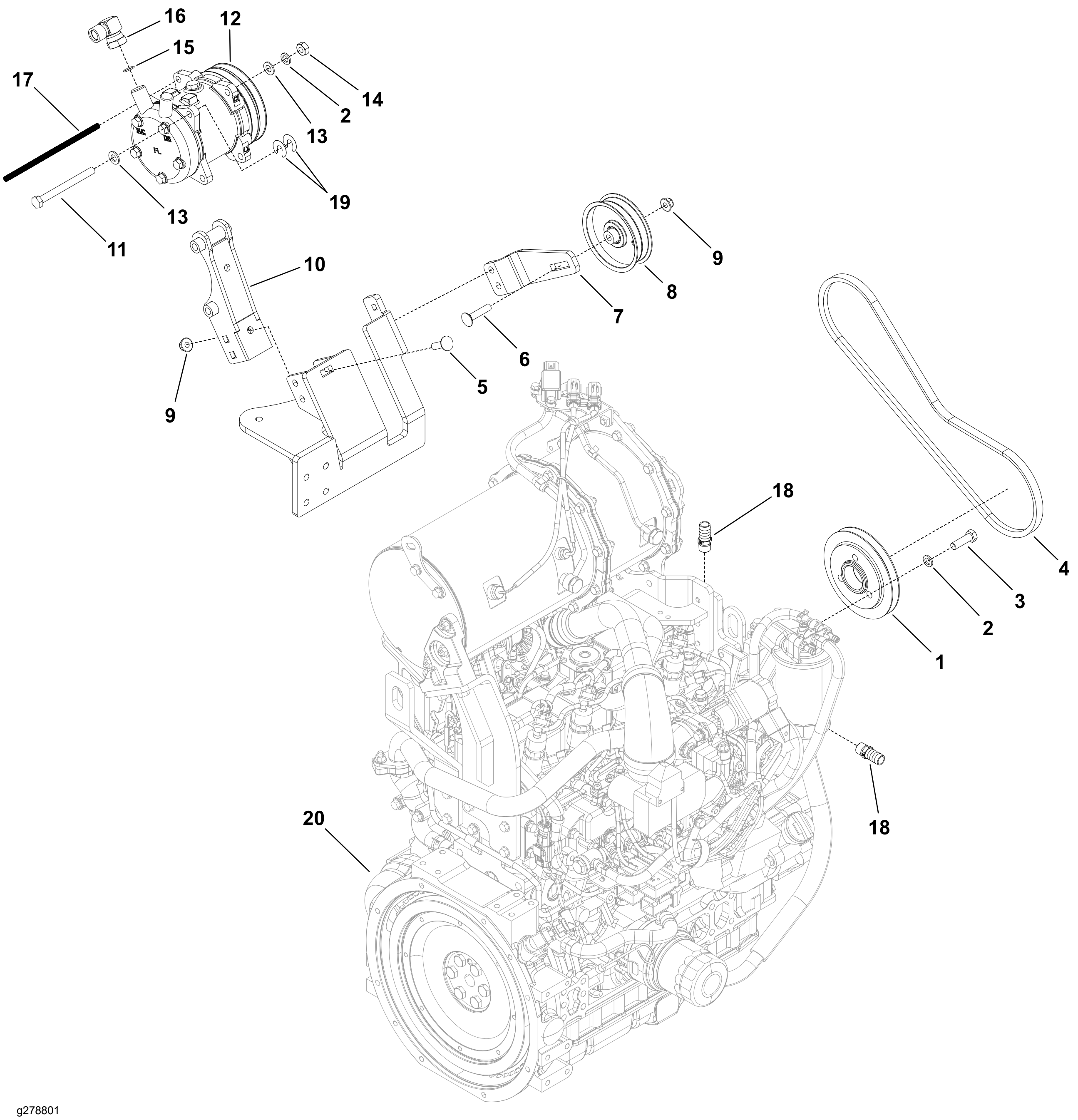

Figure 357

1. Pulley
2. Lock washer (5 each)
3. Bolt (3 each)
4. V-belt
5. Carriage bolt (5 each)
6. Carriage bolt
7. Pulley mount
8. Idler pulley
9. Nut (6 each)
10. Compressor mount
11. Bolt (2 each)
12. Compressor
13. Washer (4 each)
14. Nut (2 each)
15. O-ring
16. Elbow fitting
17. Convoluted conduit
18. Straight fitting (2 each)
19. Shim (4 each)
20. Engine

Removing the Air Conditioning Compressor (Figure 357)

1. Park the machine on a level surface, lower the cutting deck, shut off the engine, set the parking brake and remove the key from the key switch.
2. Raise the hood to get access to the engine and air conditioning compressor.
3. Remove the exhaust pipe; refer to Exhaust System (Models 30606, 30608 and 30644) (page 4–30).
4. Loosen the flange nut that secures the idler pulley. Move the pulley to loosen A/C compressor drive belt. Remove the drive belt from A/C compressor pulley.
5. Inspect the compressor drive belt for glazing or damage. Replace the belt if necessary.
6. Disconnect the compressor electrical connector from machine wire harness.
7. Read the General Precautions for Removing and Installing the Air Conditioning System Components (page 11–4).

⚠ CAUTION ⚠

The air conditioning system is under high pressure. Do not loosen any system fitting or component until after the system has been completely discharged by a certified A/C service technician.

8. Have refrigerant evacuated from air conditioning system by a certified A/C service technician.
9. Label and remove hoses from compressor. Immediately cap hoses and fittings to prevent moisture and contaminants from entering the system.
10. Support the compressor to prevent it from shifting or falling.

    Note: There may be shims mounted between compressor and compressor mount. When removing compressor, note shim location and quantity for assembly purposes.

11. Remove fasteners and washers that secure compressor to compressor mount.

IMPORTANT

To prevent compressor oil from filling the compressor cylinders, keep compressor in the same orientation as the installed position.

12. Carefully remove the compressor from engine and machine.

    Note: The replacement of the drier−receiver is recommended whenever A/C compressor is removed from the system (see Heater and Air Conditioning Evaporator Cores (page 11–23)).

    Note: The air conditioning compressor used on the Groundsmaster 4110−D is a Badger Compressor. For air conditioning compressor repair procedures, see the Badger Compressor Service Manual.

Installing the Air Conditioning Compressor (Figure 357)

1. Position compressor to compressor mount on engine.

   Note: The clearance between the compressor mounting flanges and compressor mount must be less than **0.10 mm (0.004 in)**. If necessary, install shims between compressor flanges and mount to adjust clearance. See Compressor Parts Catalog for shim kit.

2. Secure compressor to compressor mount with removed fasteners and spacers. Do not fully tighten fasteners.

IMPORTANT

After the compressor has been installed, make sure to rotate the compressor drive shaft several times to properly distribute oil in the compressor. Compressor damage due to oil slugging can occur if this procedure is not performed.

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3. Manually rotate the compressor drive shaft at least ten (10) revolutions to make sure that no compressor oil is in the compressor cylinders.
4. Place drive belt onto compressor pulley.
5. Tension compressor drive belt with idler pulley. Make sure to tighten flange nut to secure belt adjustment.
6. Install exhaust pipe; refer to Exhaust System (Models 30606, 30608 and 30644) (page 4–30).
7. Remove caps that were placed on hoses and fittings during the removal process. Using labels placed during removal, properly secure hoses to compressor.
8. Connect compressor electrical connector to machine wire harness.
9. Have a certified air conditioning service technician evacuate the air conditioning system completely, properly recharge the system with R134a refrigerant and then leak test the system. A/C system capacity is 1.55 kg (3.4 lb) of R134a refrigerant.
10. Lower and secure hood.

Roof Assembly

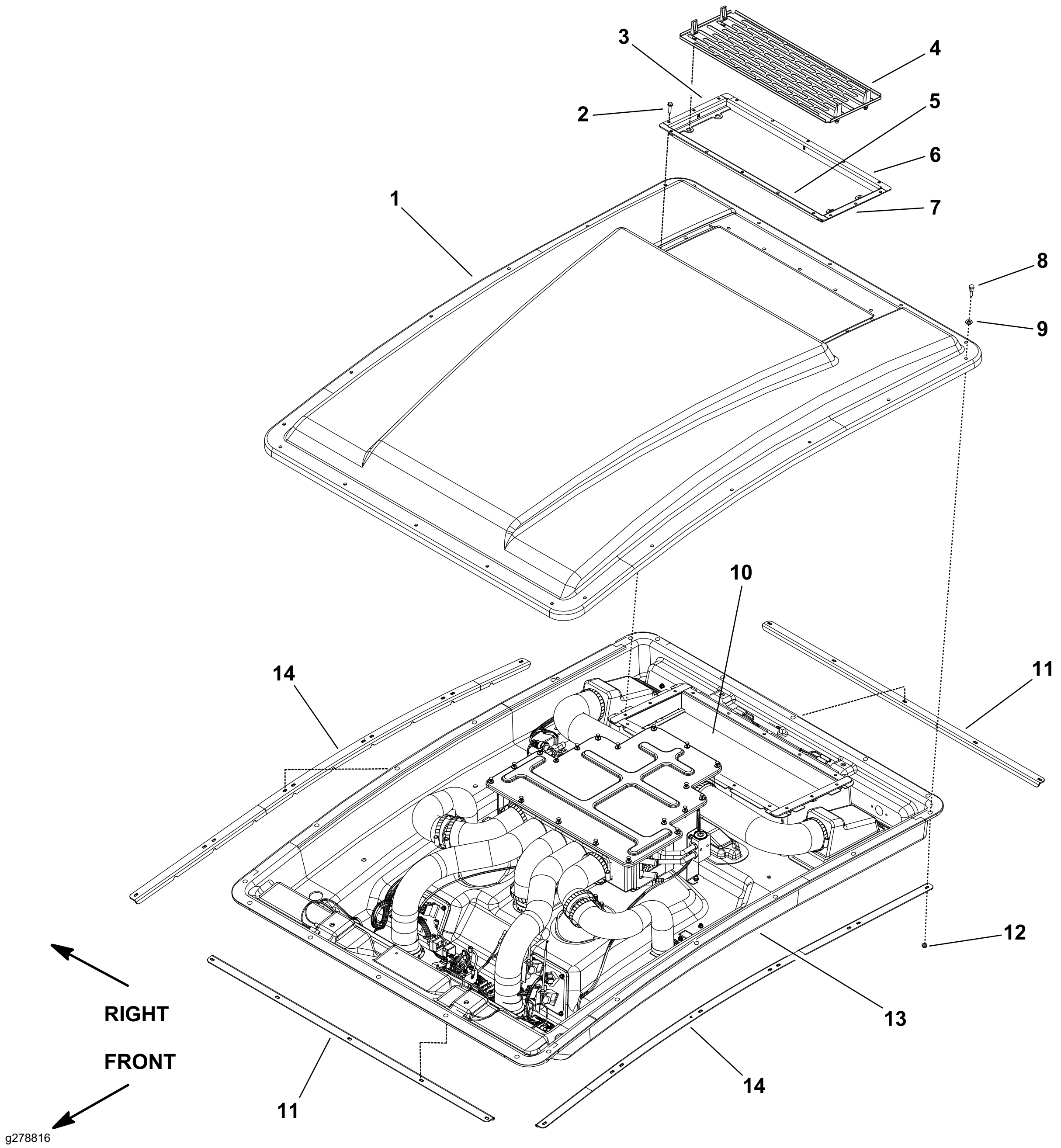


Figure 358

1. Roof panel
2. Flange-head screw (16 each)
3. Right condenser seal
4. Condenser screen
5. Front condenser seal
6. Rear condenser seal
7. Left condenser seal
8. Shoulder screw (22 each)
9. Flat washer (22 each)
10. Condenser assembly
11. Front/rear cab strap (2 each)
12. Flange nut (22 each)
13. Headliner assembly
14. Side cab strap (2 each)

Get access to the heater core and air conditioning components by removing the roof panel.

Removing the Roof Assembly (Figure 358)

1. Park the machine on a level surface, lower the cutting deck, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Release the 4 swell latches and lift the condenser screen (item 4) from the roof assembly.
3. Remove the 16 flange-head screws (item 2) that secure the condenser seals (items 3, 5, 6, and 7) to the roof and air conditioning condenser assembly.
4. Remove the 22 shoulder screws (item 8), 22 flat washers, and 22 flange nuts that secure the roof and cab straps to the headliner.
5. Carefully lift the roof from the headliner and cab.
6. Inspect all the roof seals for wear or damage. Replace the roof seals as necessary.

Installing the Roof Assembly (Figure 358)

1. Ensure that all the components in the headliner are installed and secure.
2. Position the roof onto the headliner. Ensure that all the roof mounting holes are correctly aligned with the headliner and air conditioning condenser assembly.
3. Secure the roof to the headliner with the 22 shoulder screws (item 8), 22 flat washers, cab straps, and 22 flange nuts that were removed.
4. Secure the condenser seals to the roof and air conditioning condenser assembly with the 16 flange-head screws that were removed.
5. Install and secure the condenser screen to the roof assembly with the 4 swell latches.

Heating and Air Conditioning Components

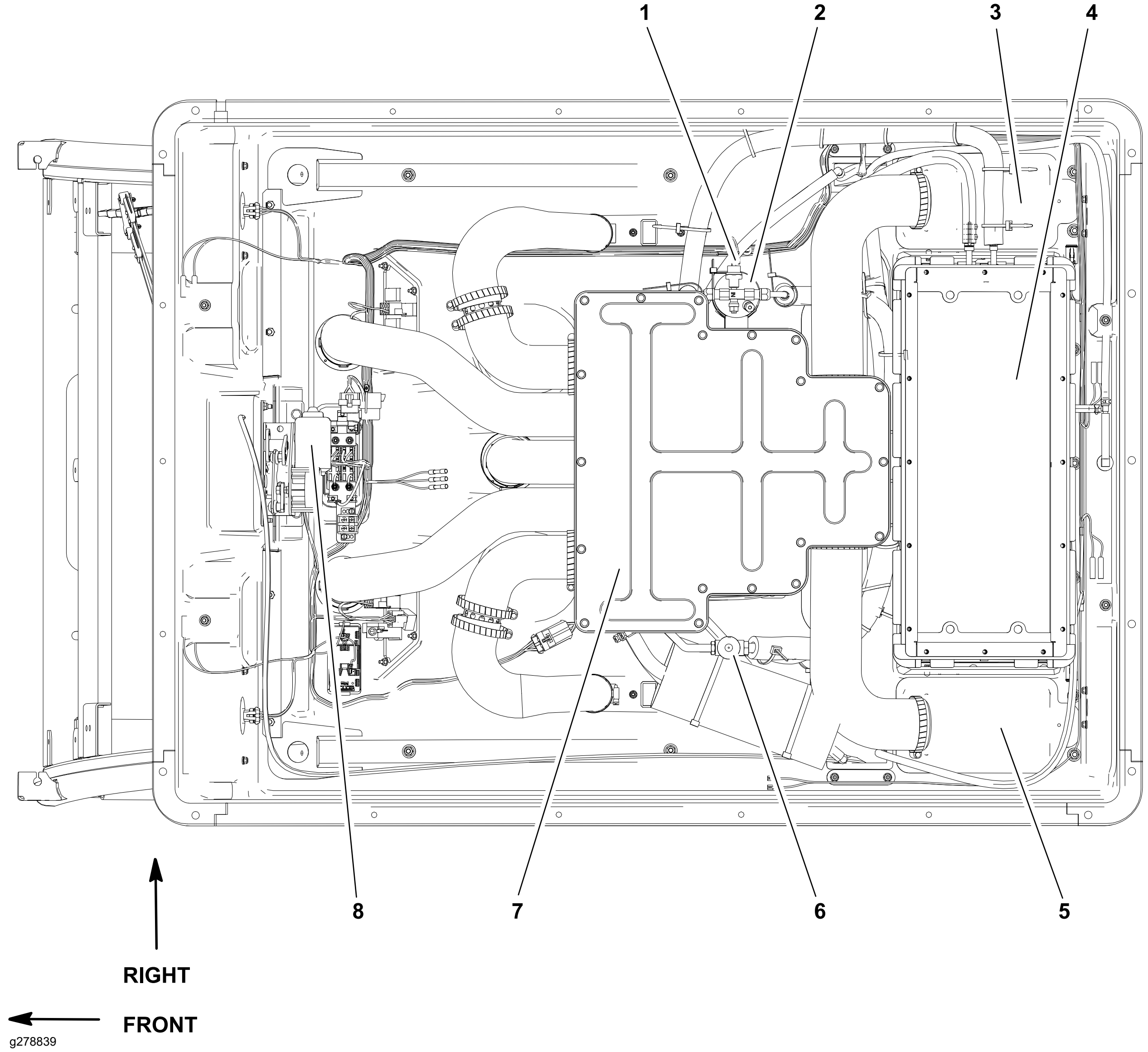


Figure 359

1. Air conditioning binary switch
2. Air conditioning drier-receiver
3. Right intake air filter
4. Air conditioning condenser assembly
5. Left intake air filter
6. Air conditioning expansion valve
7. Heat and air conditioning mixing box assembly
8. Wiper motor assembly

Heating and Air Conditioning Components (continued)

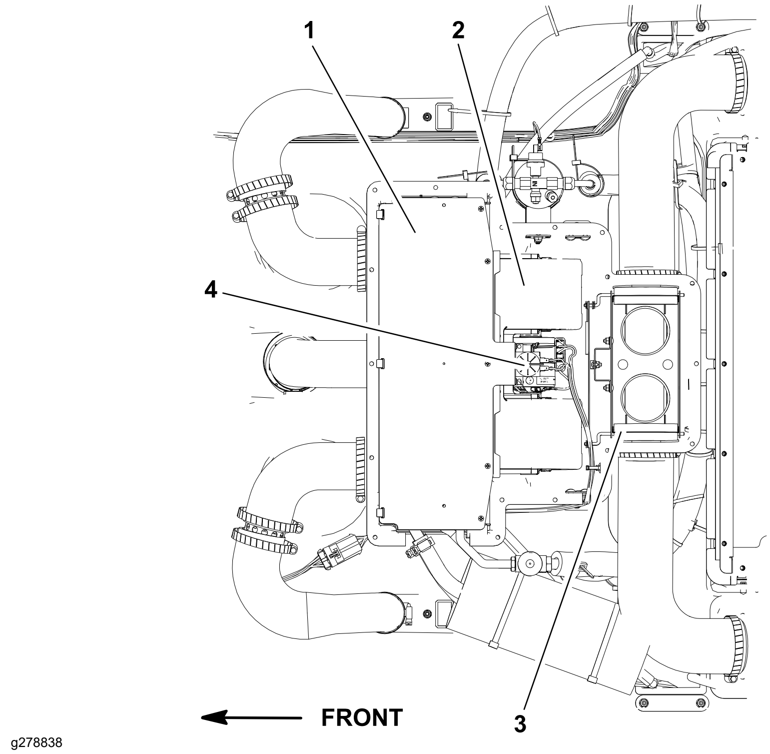


Figure 360

1. Evaporator/heater cores
2. Blower fan
3. Air diverter assembly
4. Air conditioning freeze switch

Get access to the cab heating and air conditioning components by removing the cab roof; refer to Roof Assembly (page 11–9). After you remove the cab roof, refer to Figure 359 and Figure 360 to identify the components used for heating and cooling the operator cab.

Note: Figure 360 shows the heat and air conditioning mixing box assembly with the mixing box cover removed.

Note: The capacity of the air conditioning system is **1.55 kg (3.4 lb)** of R134a refrigerant.

Air Conditioning Condenser Fan Assembly

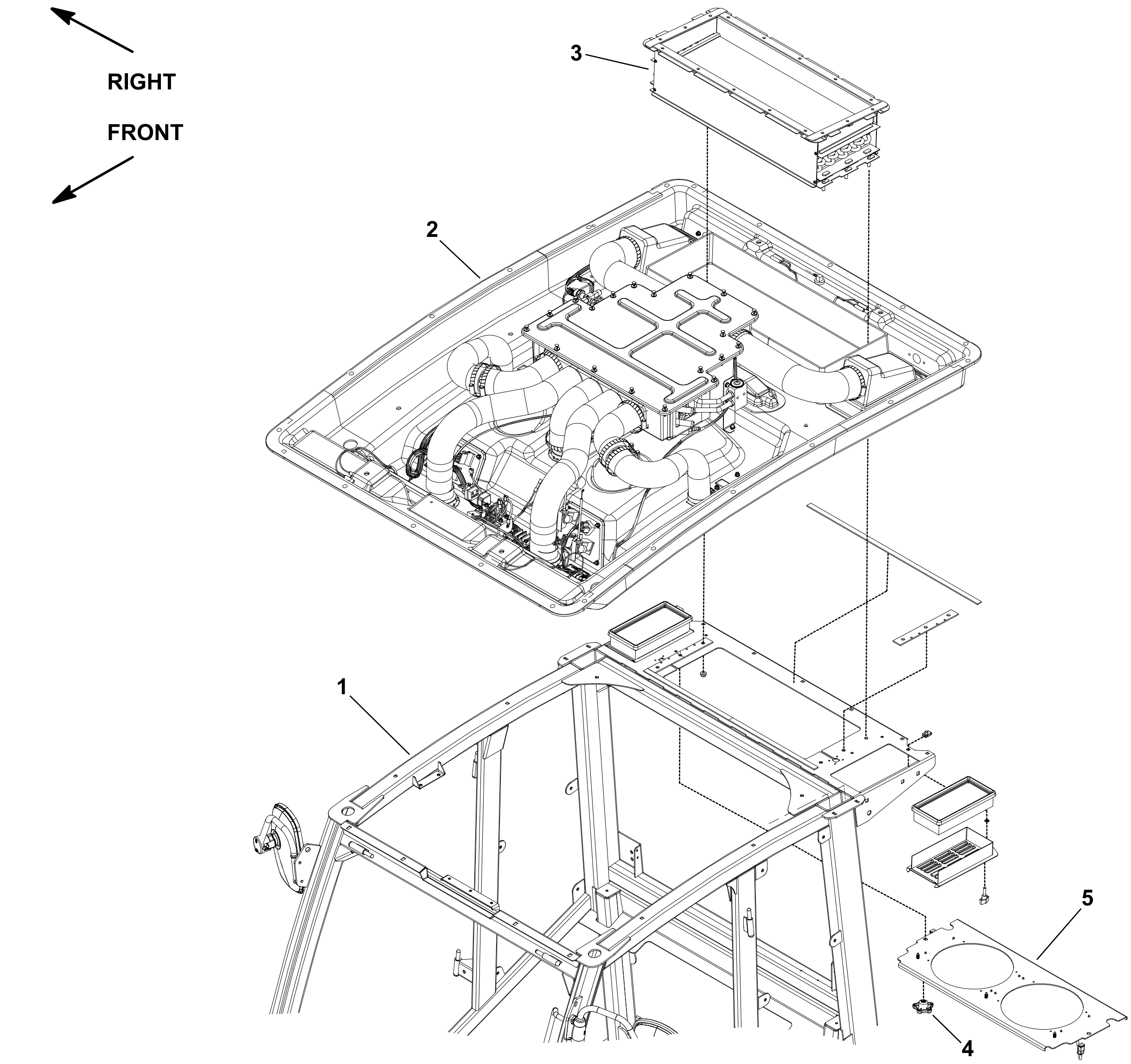


Figure 361

1. Cab frame
2. Cab headliner assembly
3. Air conditioning condenser assembly
4. Knob (2 each)
5. Condenser fan assembly

Removing the Air Conditioning Condenser Fan Assembly

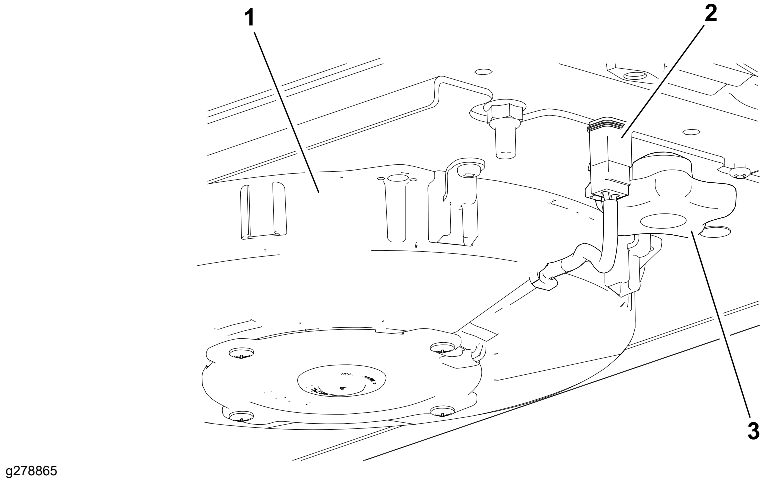


Figure 362

1. Condenser fan (2 each)
2. Fan plug (2 each)
3. Knob (2 each)

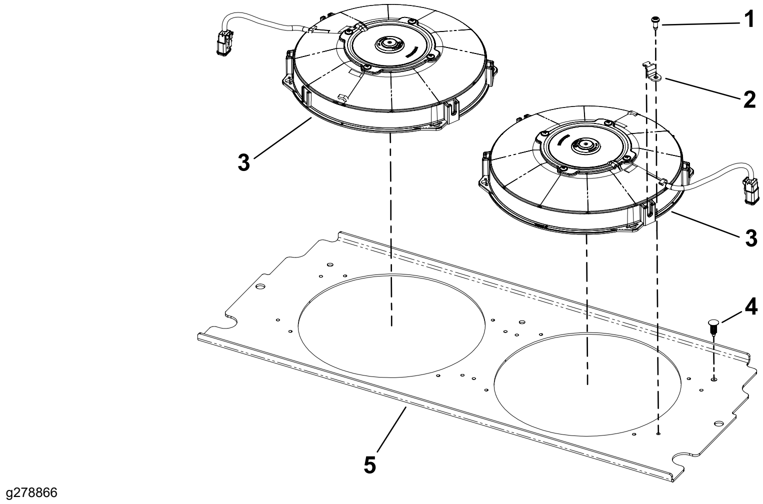


Figure 363

1. Screw (4 each per fan)
2. Fan tab (4 each per fan)
3. Condenser fan (2 each)
4. Plug (3 each)
5. Fan mount plate

---

1. Park the machine on a level surface, lower the cutting deck, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Locate the air conditioning condenser fan assembly that is secured to the frame under the rear of the cab headliner.
3. Disconnect the 2 condenser fan plugs (item 2 in Figure 362) from the wire harness connectors that are attached to the cab frame.
4. Support the condenser fan assembly to prevent it from falling.
5. Remove the 2 knobs (item 3 in Figure 362) that secure the condenser fan assembly to the machine.
6. Lower the condenser fan assembly from the machine.
7. If necessary, disassemble the condenser fan assembly (Figure 363).

Installing the Air Conditioning Condenser Fan Assembly

1. If the condenser fan assembly was disassembled, secure the fans to the fan mount plate (Figure 363).
2. Raise and support the fan assembly to the cab frame.
3. Secure the fan assembly to the machine with the 2 knobs.
4. Connect the 2 condenser fan plugs to the wire harness connectors that are attached to the cab frame.

Air Conditioning Condenser Assembly

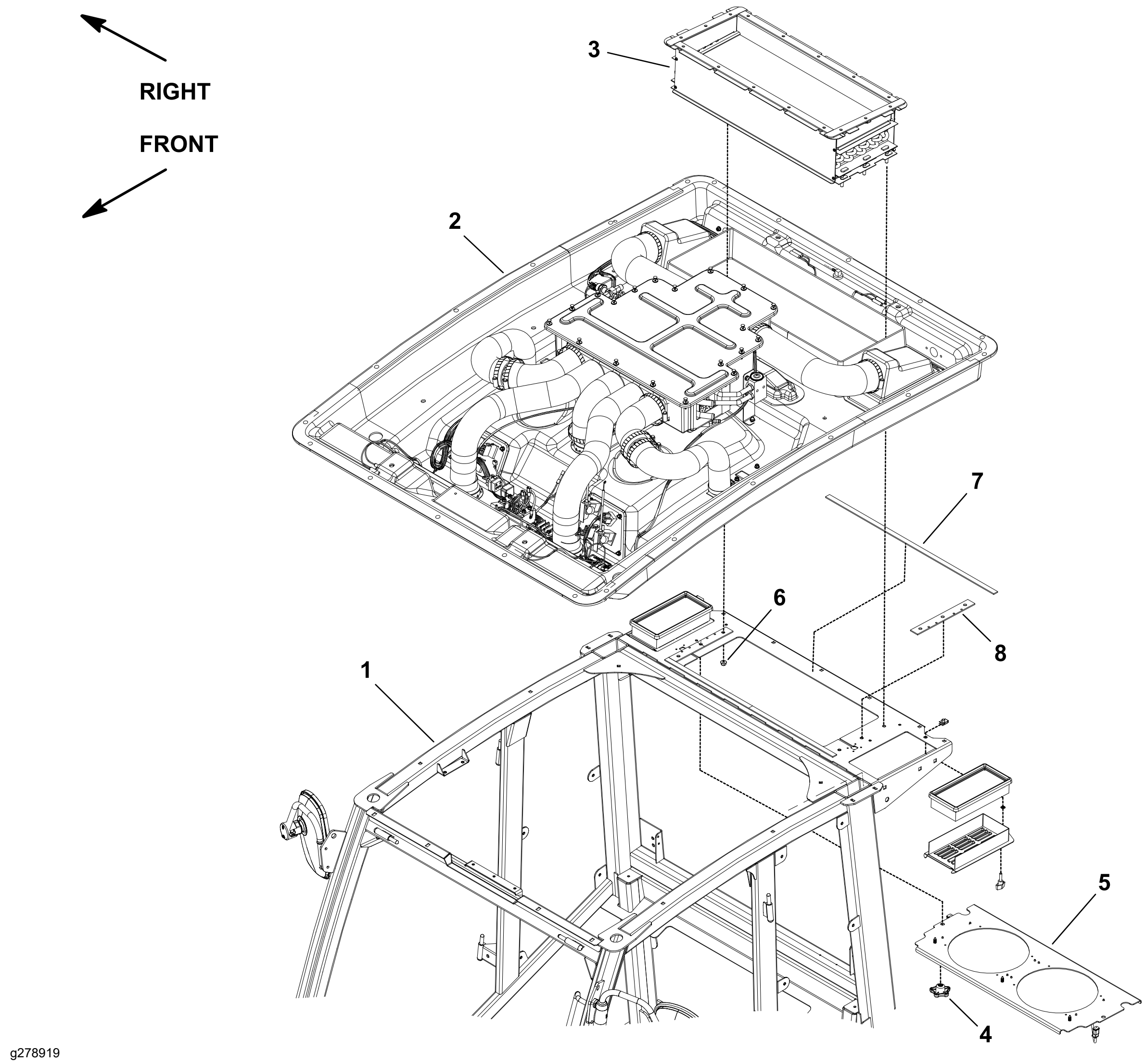


Figure 364

1. Cab frame
2. Cab headliner assembly
3. Air conditioning condenser assembly
4. Knob (2 each)
5. Condenser fan assembly
6. Flange nut (4 each)
7. Strip seal (2 each)
8. Edge seal (2 each)

Removing the Air Conditioning Condenser Assembly

1. Park the machine on a level surface, lower the cutting deck, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Remove the roof panel from the top of the cab to get access to the air conditioning condenser assembly; refer to Roof Assembly (page 11–9).
3. Remove the condenser fan assembly from the machine; refer to Air Conditioning Condenser Fan Assembly (page 11–13).
4. Read the General Precautions for Removing and Installing the Air Conditioning System Components (page 11–4).

CAUTION

Loosening any air conditioning system fitting or component allows the pressurized refrigerant to escape, causing possible injury.

Do not loosen any system fitting or component until a certified air conditioning service technician discharges the system completely.

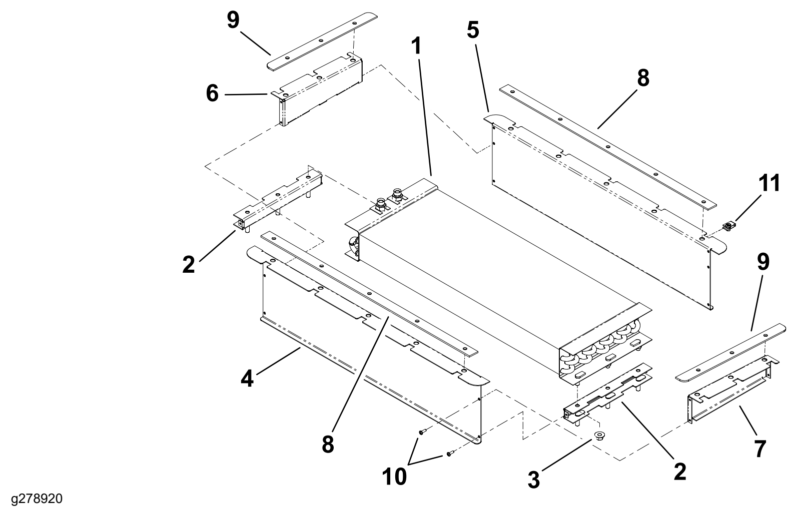


Figure 365

1. Condenser core
2. Lower leg (2 each)
3. Hex nut (6 each)
4. Front wall
5. Back wall
6. Right side wall
7. Left side wall
8. Strip seal (2 each)
9. Edge seal (2 each)
10. Screw (12 each)
11. Clip (16 each)

5. Have a certified air conditioning service technician evacuate the refrigerant from the air conditioning system.
6. Label and remove the hoses from the condenser core. Immediately install the caps on the hoses and fittings to prevent moisture and contaminants from entering into the system.
7. Remove the 4 flange nuts (item 6 in Figure 364) that secure the air conditioning condenser assembly to the cab frame.
8. Carefully raise the condenser assembly from the headliner and remove the assembly from the machine.
9. Inspect the seals (items 7 and 8 in Figure 364) on the top of the cab frame for wear or damage and replace the seals if necessary.
10. If necessary, disassemble the condenser assembly (Figure 365).
11. Inspect the seals (items 8 and 9 in Figure 365) on the top of the condenser assembly walls for wear or damage and replace the seals if necessary.

Installing the Air Conditioning Condenser Assembly

1. If the condenser assembly was disassembled, do as follows:
   A. To properly seal the condenser core, apply RTV sealant to all mating surfaces of walls, lower legs, and condenser core before assembly.
   B. Assemble all the condenser assembly components as shown in Figure 365.

   Note: Ensure that the strip and edge seals are in good condition after assembly.
2. Carefully lower the air conditioning condenser assembly through the headliner and onto the cab frame.
3. Secure the air conditioning condenser assembly to the cab frame with the 4 flange nuts.
4. Remove the caps that were placed on the hoses and fittings during the removal process. Use the labels that you attached during removal to correctly connect the hoses to the condenser core.
5. Secure the condenser fan assembly to the machine; refer to Air Conditioning Condenser Fan Assembly (page 11–13).
6. Ensure that all the machine air conditioning components are installed and secure.
7. Have a certified air conditioning service technician evacuate the air conditioning system completely, properly recharge the system with R134a refrigerant, and perform the leak test on the system.

   Note: The capacity of the air conditioning system is 1.55 kg (3.4 lb) of R134a refrigerant.
8. When you complete the service in the cab headliner, secure the roof panel to the top of the cab; refer to Roof Assembly (page 11–9).

Mixing Box Assembly

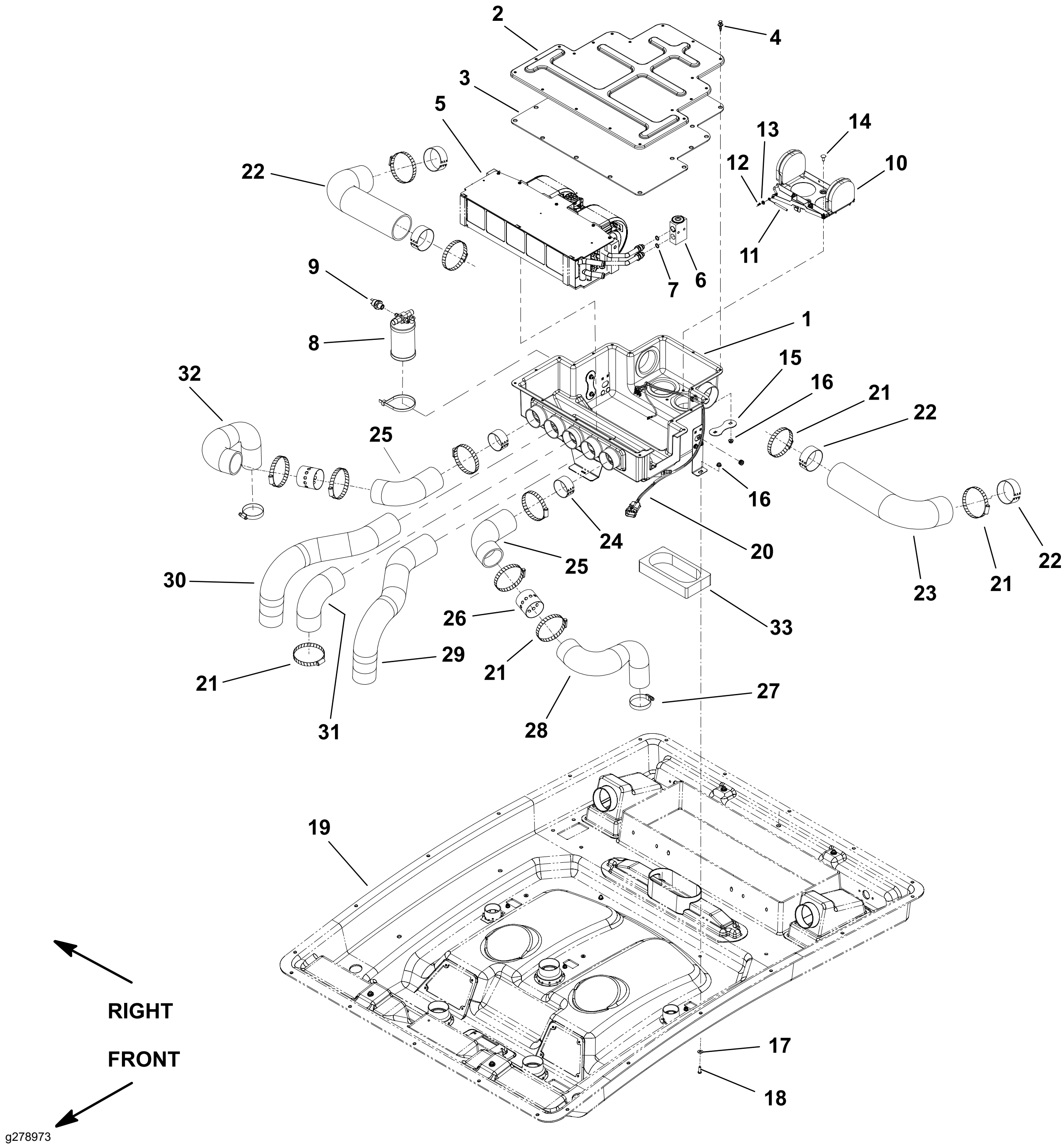


Figure 366

1. Mixing box
2. Mixing box cover
3. Cover insulation
4. Rivet (19 each)
5. Heater core/ air conditioning evaporator/fan assembly
6. Expansion valve
7. O-ring (2 each)
8. Air conditioning drier-receiver
9. Binary switch
10. Air diverter assembly
11. Control cable
12. Hairpin
13. Flat washer
14. Carriage screw (2 each)
15. Support plate
16. Flange nut (4 each)
17. Flat washer (2 each)
18. Button-head screw (2 each)
19. Cab headliner
20. Mixing box wire harness
21. Hose clamp (11 each)
22. Tube support (4 each)
23. Vent hose (2 each)
24. Tube support (2 each)
25. Vent hose (2 each)
26. Adapter (2 each)
27. Hose clamp (2 each)
28. Vent hose
29. Vent hose
30. Vent hose
31. Vent hose
32. Vent hose
33. Mixing box inlet foam

Removing the Mixing Box Assembly

1. Park the machine on a level surface, lower the cutting deck, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Remove the roof panel from the top of the cab to get access to the mixing box assembly; refer to Roof Assembly (page 11–9).
3. Remove the cover from the mixing box assembly as follows:
   A. Carefully use a small prybar to raise the head of the pin in the center of each rivet that secures the mixing box cover.
   B. Lift the rivets from the cover and mixing box.
   C. Remove the mixing box cover.

   Note: If the heater core, air conditioning evaporator core, or blower fan need to be removed from the mixing box, the box does not have to be removed from the cab headliner. Refer to Heater and Air Conditioning Evaporator Cores (page 11–23) for information on removing and installing these components.
4. Disconnect the electrical connectors from the mixing box wire harness and binary switch on the drier-receiver.
5. Read the General Precautions for Removing and Installing the Air Conditioning System Components (page 10–3). Ensure that these instructions are followed if any air conditioning hoses are loosened or if any air conditioning components are to be removed from the cab headliner.

CAUTION

Loosening any air conditioning system fitting or component allows the pressurized refrigerant to escape, causing possible injury.

Do not loosen any system fitting or component until a certified air conditioning service technician discharges the system completely.

6. Remove the mixing box components as shown in Figure 366 and Figure 367.

   Note: Replace the air conditioning drier-receiver whenever you replace the expansion valve.

Installing the Mixing Box Assembly

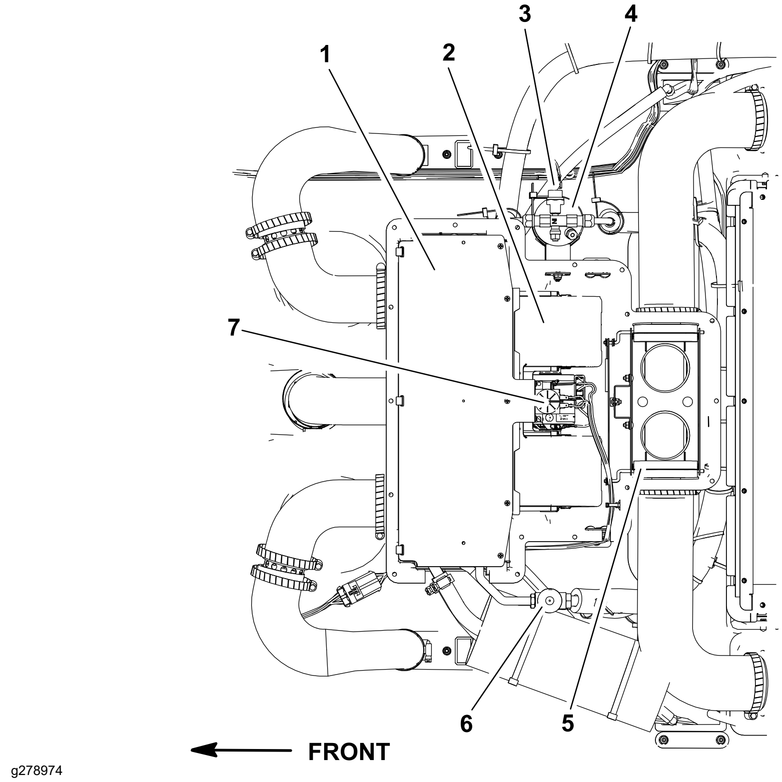


Figure 367

1. Evaporator and heater core
2. Blower fan
3. Air conditioning binary switch
4. Air conditioning drier-receiver
5. Air diverter assembly
6. Air conditioning expansion valve
7. Air conditioning freeze switch

---

1. Install all the mixing box components that were removed (Figure 366 and Figure 367).

   Note: Ensure that the expansion valve is covered with insulating tape to prevent condensation issues.

2. Ensure that the condensation hoses are secured to the drain fittings on the bottom of the mixing box assembly. Also, route the hoses to the cab frame for proper draining of the condensate.
3. Ensure to connect the electrical connectors from the mixing box wire harness and binary switch on the air conditioning drier-receiver.
4. If any air conditioning system components were removed from the cab headliner, ensure that all the machine air conditioning components are installed and secure.
5. Have a certified air conditioning service technician evacuate the air conditioning system completely, properly recharge the system with R134a refrigerant, and perform the leak test on the system.

   Note: The capacity of the air conditioning system is 1.55 kg (3.4 lb) of R134a refrigerant.

Installing the Mixing Box Assembly (continued)

6. Secure the cover to the mixing box assembly as follows:
   A. Position the mixing box cover to the mixing box. Ensure that the wire harness is routed through recess in side of the mixing box.
   B. With the rivet pin in a raised position, insert the rivets through the cover and into the hole in the mixing box. Press the pin into the rivet to secure the rivet in place.
7. Operate the heater system to ensure that there are no coolant leaks in the cab headliner.
8. When you complete all the service in the cab headliner, secure the roof panel to the top of the cab; refer to Roof Assembly (page 11–9).

Heater and Air Conditioning Evaporator Cores

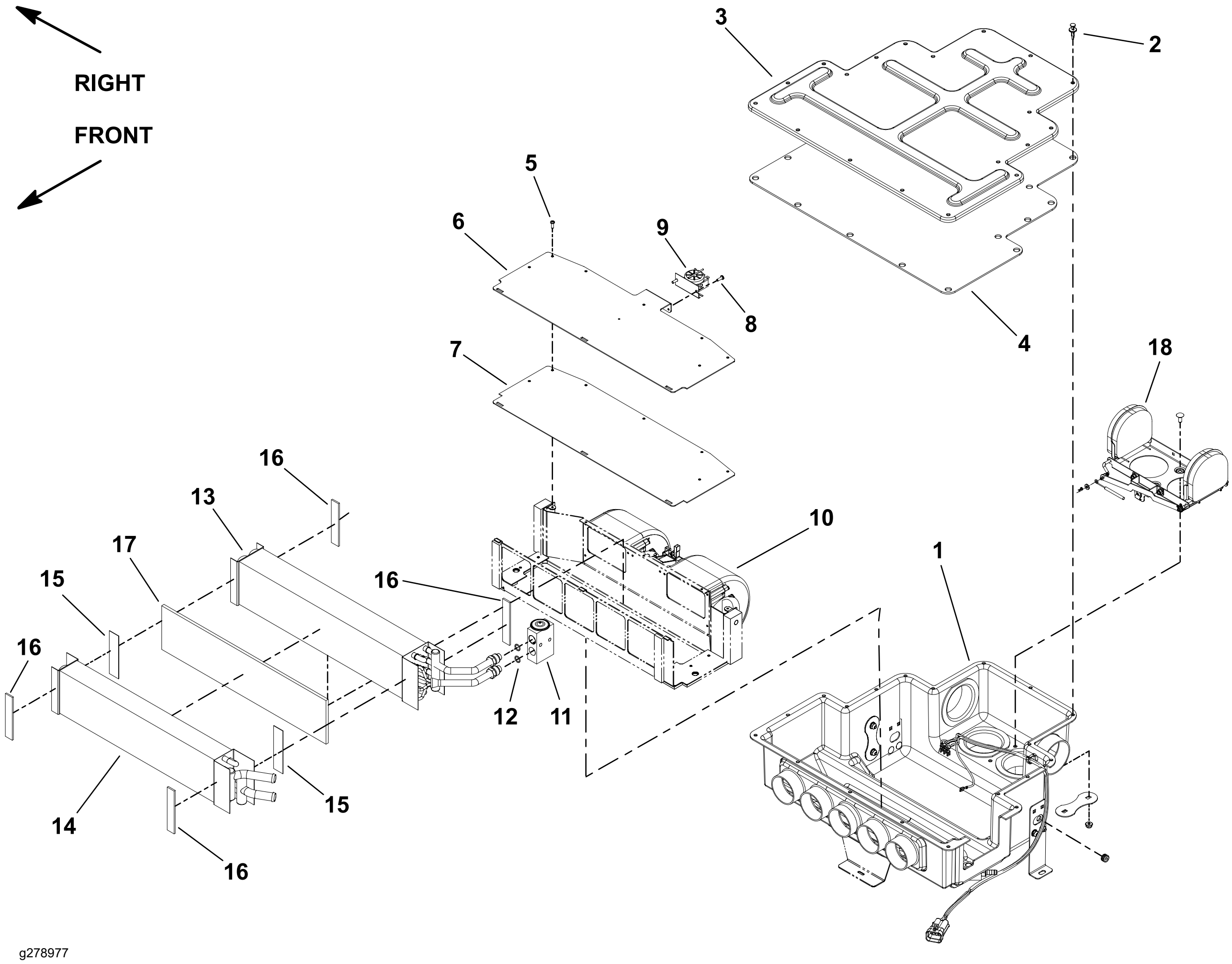


Figure 368

1. Mixing box
2. Rivet (19 each)
3. Mixing box cover
4. Cover insulation
5. Screw (5 each)
6. Mount bracket cover
7. Cover gasket
8. Screw (2 each)
9. Freeze switch
10. Mount bracket (shown with fan)
11. Expansion valve
12. O-ring (2 each)
13. Air conditioning evaporator core
14. Heater core
15. Double sided tape (2 each)
16. Gasket (4 each)
17. Condensation catch foam
18. Air diverter assembly

Note: The heater and evaporator cores can be removed and installed with the mixing box (item 1 in Figure 368) attached to the cab headliner.

Removing the Heater and Air Conditioning Evaporator Cores

1. Park the machine on a level surface, lower the cutting deck, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Remove the roof panel from the top of the cab to get access to the heater and air conditioning evaporator cores; refer to Roof Assembly (page 11–9).
3. Read the General Precautions for Removing and Installing the Air Conditioning System Components (page 11–4).

Removing the Heater and Air Conditioning Evaporator Cores (continued)

CAUTION

Loosening any air conditioning system fitting or component allows the pressurized refrigerant to escape, causing possible injury.

Do not loosen any system fitting or component until a certified air conditioning service technician discharges the system completely.

4. Have a certified air conditioning service technician evacuate the air conditioning system.
5. Disconnect both the evaporator core swivel fittings from the front ports of the expansion valve. Immediately install the caps on the tubes and expansion valve ports to prevent moisture and contaminants from entering into the system. Position the expansion valve with attached hoses away from the mixing box.
6. For assembly purposes, label the heater hoses. Loosen the hose clamps and disconnect both the heater hoses from the tubes on the heater core.
7. Remove the mixing box cover as follows:
   A. Carefully use a small prybar to raise the head of the pin in the center of each rivet that secures the mixing box cover.
   B. Lift the rivets from the cover and mixing box.
   C. Remove the mixing box cover.
8. Locate the wire from the freeze switch that is inserted into the air conditioning evaporator core through the mount bracket cover. Carefully pull the wire from the cover and position it away from the cover.
9. Remove the 5 screws (item 5 in Figure 368) that secure the mount bracket cover to the mount bracket. Lift the cover and position it away from the mount bracket to ensure that you do not damage the freeze switch or wires connected to the switch.
10. Carefully lift the heater and air conditioning evaporator core assembly from the frame.
11. Separate the heater and air conditioning evaporator cores (Figure 368). The cores are secured to each other with double sided tape (item 15 in Figure 368).
12. Inspect the seals, gaskets, and insulation in the mixing box assembly for tears or other damage. Replace all the sealing components that were damaged.

Installing the Heater and Air Conditioning Evaporator Cores

1. Assemble the heater and air conditioning evaporator cores (Figure 368).
2. Carefully install the heater and air conditioning evaporator core assembly into the frame in the mixing box.

   Note: Do not damage the freeze switch or wires connected to the switch during assembly of the mount bracket cover.
3. Position the mount bracket cover to the mount bracket. Secure the cover to the mount bracket with the 5 screws (item 5 in Figure 368).
4. Insert the wire from the freeze switch into the air conditioning evaporator core through the mount bracket cover.

   Note: The wire should be inserted **51 mm (2 in)** through the cover.

Installing the Heater and Air Conditioning Evaporator Cores (continued)

5. Secure the cover to the mixing box assembly as follows:

   A. Position the mixing box cover to the mixing box. Ensure that the wire harness is routed through recess in side of the mixing box.

   B. With the rivet pin in a raised position, insert the rivets through cover and into the hole in the mixing box. Press the pin into the rivet to secure the rivet in place.

6. Use the labels that you attached during removal, connect both the heater hoses to the tubes on the heater core, and secure the heater hoses with the hose clamps.

7. Remove the caps that were placed on the evaporator core tubes and expansion valve ports during the removal process. Position the expansion valve with attached hoses to the evaporator core tubes. Properly secure the evaporator core swivel fittings to the front ports of the expansion valve.

8. Ensure that all the machine air conditioning components are installed and secure.

9. Ensure that the expansion valve is covered with insulating tape to prevent condensation issues.

10. Have a certified air conditioning service technician evacuate the air conditioning system completely, properly recharge the system with R134a refrigerant, perform the leak test on the system.

    Note: The capacity of the air conditioning system is **1.55 kg (3.4 lb)** of R134a refrigerant.

11. Operate the heater system to ensure that there are no coolant leaks in the headliner.

12. Secure the roof panel to the top of the cab; refer to Roof Assembly (page 11–9).

Blower Fan

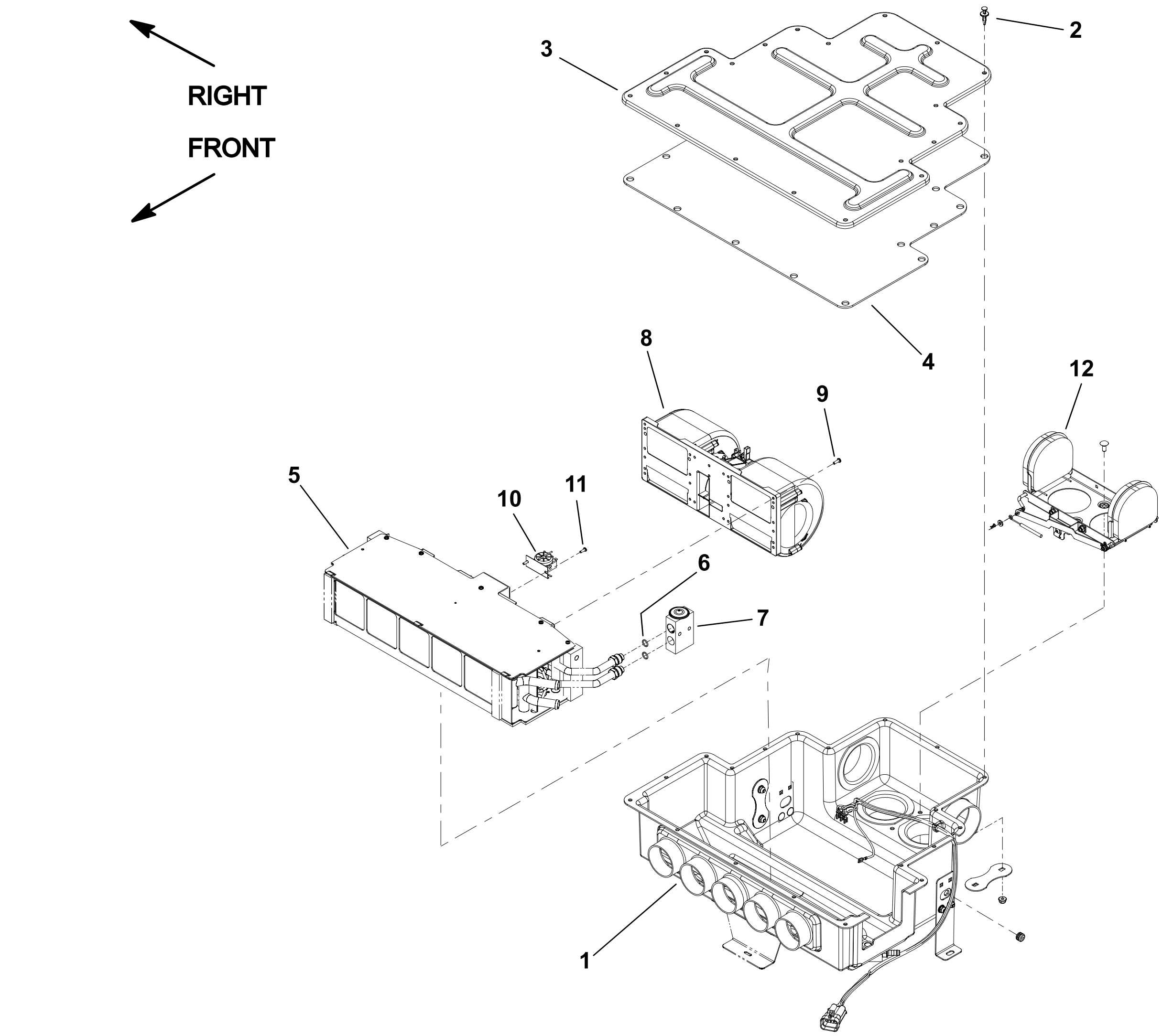


Figure 369

1.	Mixing box	5.	Heater core/air conditioning evaporator assembly	9.	Screw (6 each)
2.	Rivet (19 each)	6.	O-ring (2 each)	10.	Freeze switch
3.	Mixing box cover	7.	Expansion valve	11.	Screw (2 each)
4.	Cover insulation	8.	Blower fan	12.	Air diverter assembly

Note: The blower fan can be removed and installed with the mixing box (item 1 in Figure 369) attached to the cab headliner.

Removing the Blower Fan

1. Park the machine on a level surface, lower the cutting deck, shut of the engine, set the parking brake, and remove the key from the key switch.
2. Remove the roof panel from the top of the cab to get access to the blower fan; refer to Roof Assembly (page 11–9).
3. Read the General Precautions for Removing and Installing the Air Conditioning System Components (page 11–4).

Removing the Blower Fan (continued)

CAUTION

Loosening any air conditioning system fitting or component allows the pressurized refrigerant to escape, causing possible injury.

Do not loosen any system fitting or component until a certified air conditioning service technician discharges the system completely.

4. Have a certified air conditioning service technician evacuate the refrigerant from the air conditioning system.
5. Disconnect both evaporator core swivel fittings from front ports of expansion valve. Immediately cap tubes and expansion valve ports to prevent moisture and contaminants from entering the system. Position expansion valve with attached hoses away from the mixing box.

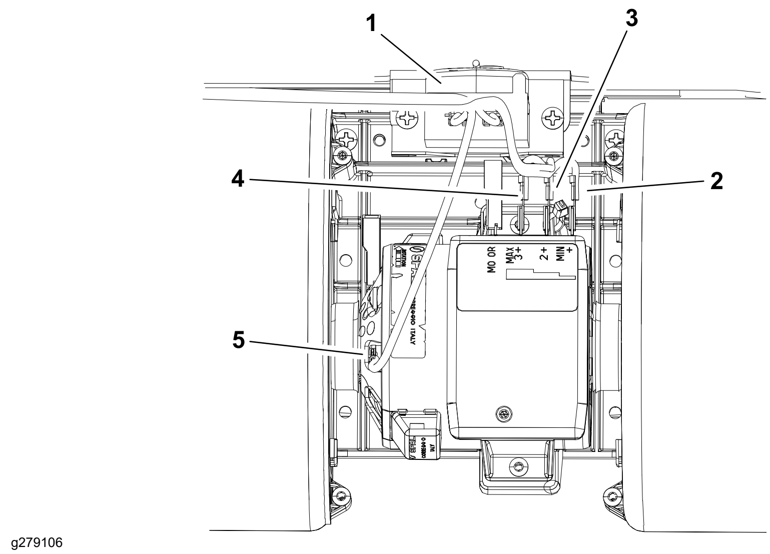


Figure 370

1. Freeze switch
2. MIN terminal (violet)
3. Terminal 2 (brown)
4. Terminal 3 (orange)
5. Ground terminal (black)

6. Label heater hoses for assembly purposes. Loosen hose clamps and disconnect both heater hoses from tubes on heater core.
7. Remove the mixing box cover as follows:
   A. Carefully use a small prybar to raise the head of the pin in the center of each rivet that secures the mixing box cover.
   B. Lift the rivets from the cover and mixing box.
   C. Remove the mixing box cover.
8. Note the location of the wire harness connectors on the freeze switch and blower fan assembly (Figure 370), disconnect the wire harness connectors from the switch and fan.
9. Carefully raise the heater core/air conditioning evaporator assembly with attached blower fan from the mixing box.
10. Remove the 6 screws (item 9 in Figure 369) that secure the blower fan to the heater core/air conditioning evaporator assembly, and remove the blower fan.

Installing the Blower Fan

1. Position the blower fan to the heater core/air conditioning evaporator assembly and secure the fan with the 6 screws.
2. Carefully lower the heater core/air conditioning evaporator assembly with attached blower fan into the mixing box.
3. Connect the wire harness connectors to the freeze switch and blower fan assembly (Figure 370).
4. Secure the mixing box cover as follows:
   A. Position the mixing box cover to the mixing box. Ensure that the wire harness is routed through recess in side of the mixing box.

   B. With the rivet pin in a raised position, insert the rivets through cover and into the hole in the mixing box. Press the pin into the rivet to secure the rivet in place.
5. Use the labels that you attached during removal, connect both the heater hoses to the tubes on the heater core, and secure the heater hose with the hose clamps.
6. Remove the caps that were placed on the evaporator core tubes and expansion valve ports during the removal process. Position the expansion valve with attached hoses to the evaporator core tubes. Properly secure the evaporator core swivel fittings to the front ports of the expansion valve.
7. Ensure that all the machine air conditioning components are installed and secure.
8. Have a certified air conditioning service technician evacuate the air conditioning system completely, properly recharge the system with R134a refrigerant, perform the leak test on the system.

   Note: The capacity of the air conditioning system is 1.55 kg (3.4 lb) of R134a refrigerant.
9. Operate the heater system to ensure that there are no coolant leaks in the headliner.
10. Secure the roof panel to the top of the cab; refer to Roof Assembly (page 11–9).

Windshield Wiper Assembly

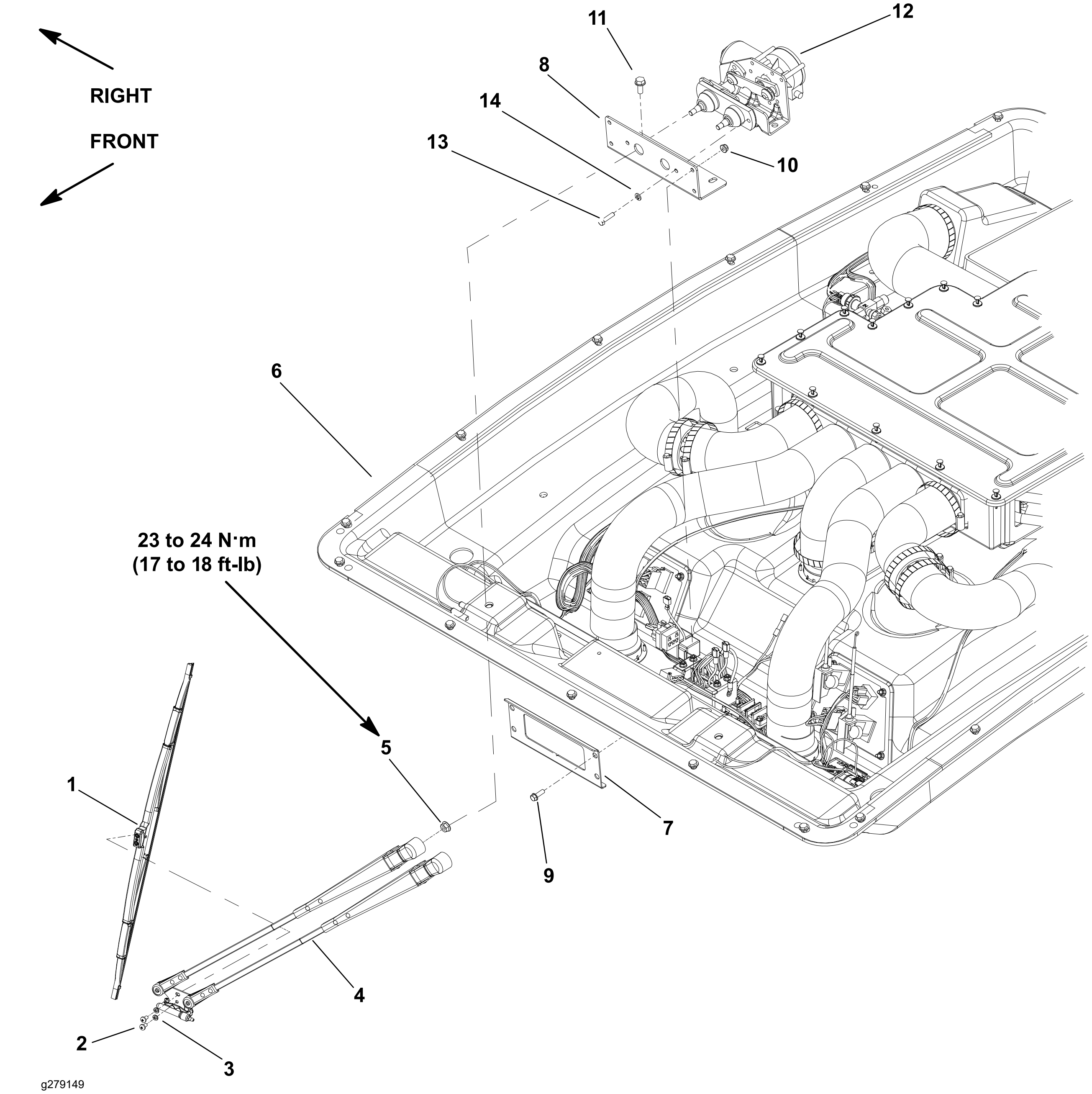


Figure 371

1. Wiper blade
2. Bolt (2 each)
3. Lock washer (2 each)
4. Wiper arm assembly
5. Flange nut (2 each)
6. Cab headliner
7. Washer plate
8. Wiper bracket
9. Washer-head screw (4 each)
10. Flange nut (4 each)
11. Washer-head screw (2 each)
12. Wiper motor
13. Bolt
14. Lock washer

Disassembling the Windshield Wiper Assembly

1. Park the machine on a level surface, lower the cutting deck, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Remove the 2 bolts (item 2 in Figure 371) and 2 lock washers that secure the wiper blade to the wiper arm assembly, and remove the wiper blade.

Disassembling the Windshield Wiper Assembly (continued)

3. If necessary, remove the wiper arm assembly as follows:
   A. Disconnect the washer hose from the wiper assembly.
   B. Lift the caps at the top of the wiper arms and remove the flange nuts that secure the wiper arms to the wiper motor.
   C. Use a suitable puller to remove the tapered wiper arm sockets from the wiper motor shafts.
4. If access to the wiper motor is necessary, remove the roof panel from the top of the cab to get access to the wiper motor assembly; refer to Roof Assembly (page 11–9).
5. Remove the wiper motor components as shown in Figure 371.

Assembling the Windshield Wiper Assembly

1. If required, install the wiper motor components that were removed (Figure 371) and do the following:
   A. If the wiper bracket (item 8 in Figure 371) was removed, apply bead of RTV sealant around the wiper opening on inside of the headliner before you install the bracket.
   B. Ensure that the wiper motor electrical connector is secured to the cab wire harness.
   C. Secure the roof panel to the top of the cab; refer to Roof Assembly (page 11–9).
2. If the wiper arm assembly was removed, do the following:
   A. Clean the tapered wiper arm sockets and wiper motor shafts.
   B. Slide the wiper arm sockets onto the wiper motor shafts and secure the wiper arm sockets with the flange nuts. Install the wiper arm caps over the flange nuts.
   C. Connect the washer hose to the wiper assembly.
3. If the wiper blade was removed, secure the blade to the wiper arm assembly with the 2 bolts and 2 lock washers.

Appendix A

Foldout Drawings

Table of Contents

Electrical Drawing Designations

Note: A splice used in a wire harness will be identified on the wire harness diagram by SP. The manufacturing number of the splice is also identified on the wire harness diagram (e.g., SP01 is splice number 1).

Wire Color

The following abbreviations are used for wire harness colors on the electrical schematics and wire harness drawings in this chapter.

ABBREVIATION	COLOR
BK	BLACK
BR or BN	BROWN
BU	BLUE
GN	GREEN
GY	GRAY
OR	ORANGE
PK	PINK
R or RD	RED
T	TAN
VIO	VIOLET
W or WH	WHITE
Y or YE	YELLOW

Numerous harness wires used on the Toro machines include a line with an alternate color. These wires are identified with the wire color and line color with either a / or _ separating the color abbreviations listed above (e.g., R/BK is a red wire with a black line, OR_BK is an orange wire with a black line).

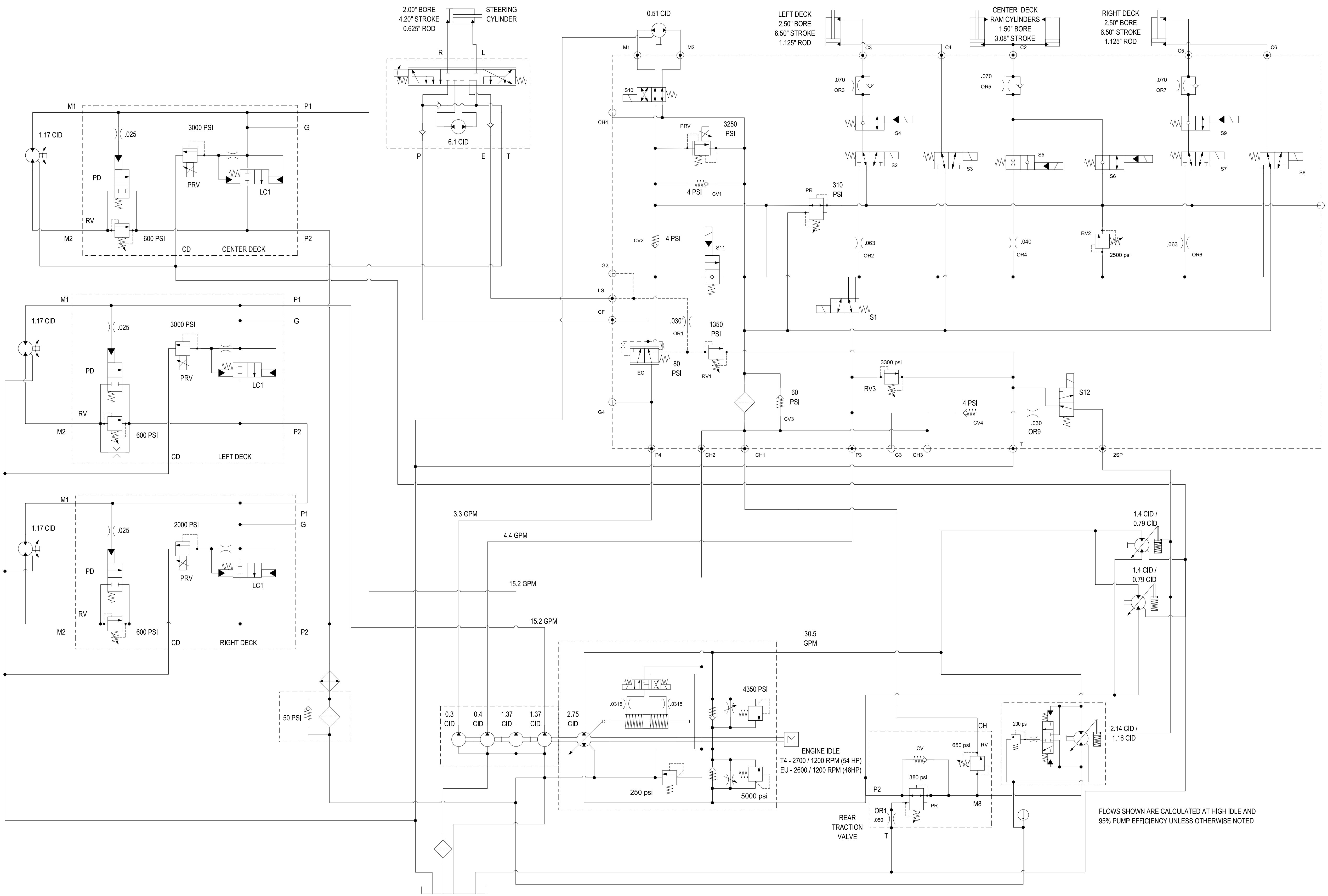
Wire Size

The individual wires of the electrical harness diagrams in this chapter identify both the wire color and the wire size.

Examples:

- 16 BK = 16 AWG (American Wire Gauge) wire that has a black insulator
- 050 R = 0.5 mm metric wire that has a red insulator (AWG equivalents for metric wire appear in the following table)

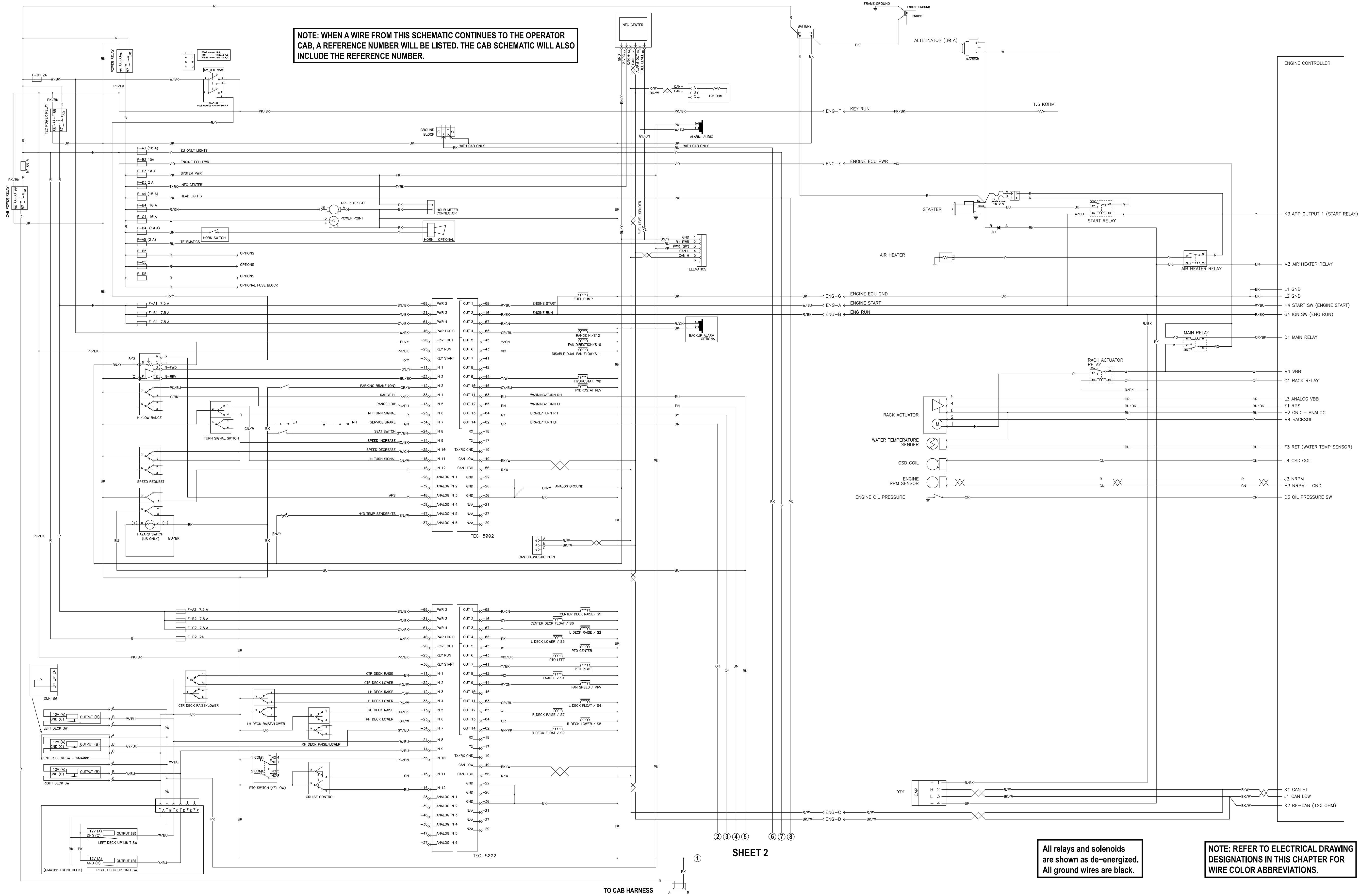
AWG Equivalents for Metric Wire		
Diagram Label	**Metric Size**	**AWG Equivalent**
050	0.5 mm	20 GA
175	0.75 mm	18 GA
100	1.0 mm	16 GA
150	1.5 mm	14 GA



2.00" BORE
4.20" STROKE
0.625" ROD
STEERING
CYLINDER
6.1 CID
0.51 CID
LEFT DECK
2.50" BORE
6.50" STROKE
1.125" ROD
CENTER DECK
RAM CYLINDERS
1.50" BORE
3.08" STROKE
RIGHT DECK
2.50" BORE
6.50" STROKE
1.125" ROD
1.17 CID
3000 PSI
600 PSI
CENTER DECK
LEFT DECK
2000 PSI
RIGHT DECK
3250 PSI
4 PSI
310 PSI
2500 psi
1350 PSI
80 PSI
60 PSI
3300 psi
S12
3.3 GPM
4.4 GPM
15.2 GPM
15.2 GPM
30.5 GPM
1.4 CID / 0.79 CID
2.14 CID / 1.16 CID
50 PSI
4350 PSI
250 psi
5000 psi
ENGINE IDLE
T4 - 2700 / 1200 RPM (54 HP)
EU - 2600 / 1200 RPM (48HP)
REAR TRACTION VALVE
650 psi
380 psi
200 psi
FLOWS SHOWN ARE CALCULATED AT HIGH IDLE AND
95% PUMP EFFICIENCY UNLESS OTHERWISE NOTED

g305649

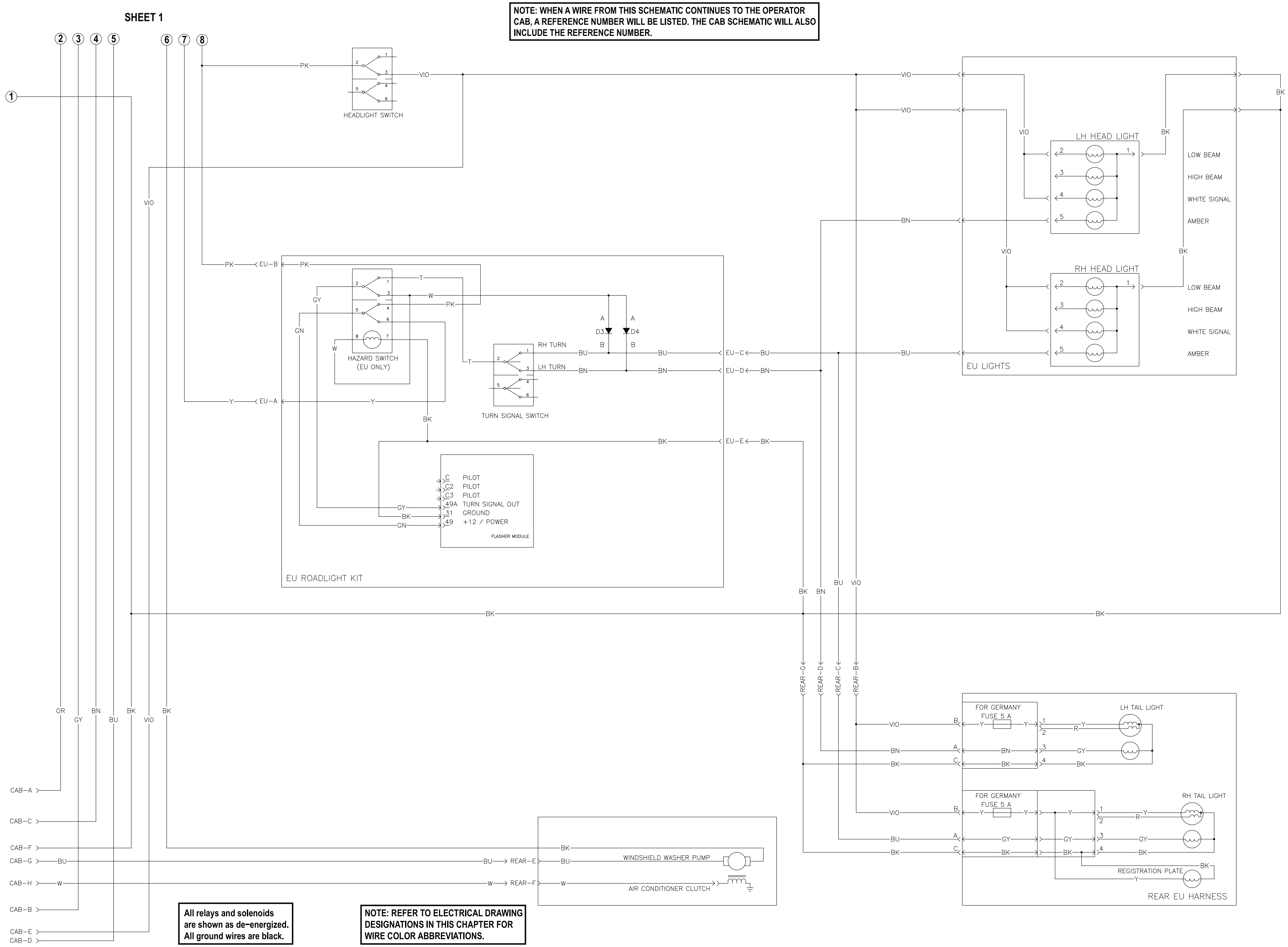
Electrical Schematic for Models 30604 and 30602/30643 (For machines serial number below 400000000)



g327930

Electrical Schematic for Models 30604 and 30602/30643 (For machines serial number below 400000000)

NOTE: WHEN A WIRE FROM THIS SCHEMATIC CONTINUES TO THE OPERATOR CAB, A REFERENCE NUMBER WILL BE LISTED. THE CAB SCHEMATIC WILL ALSO INCLUDE THE REFERENCE NUMBER.

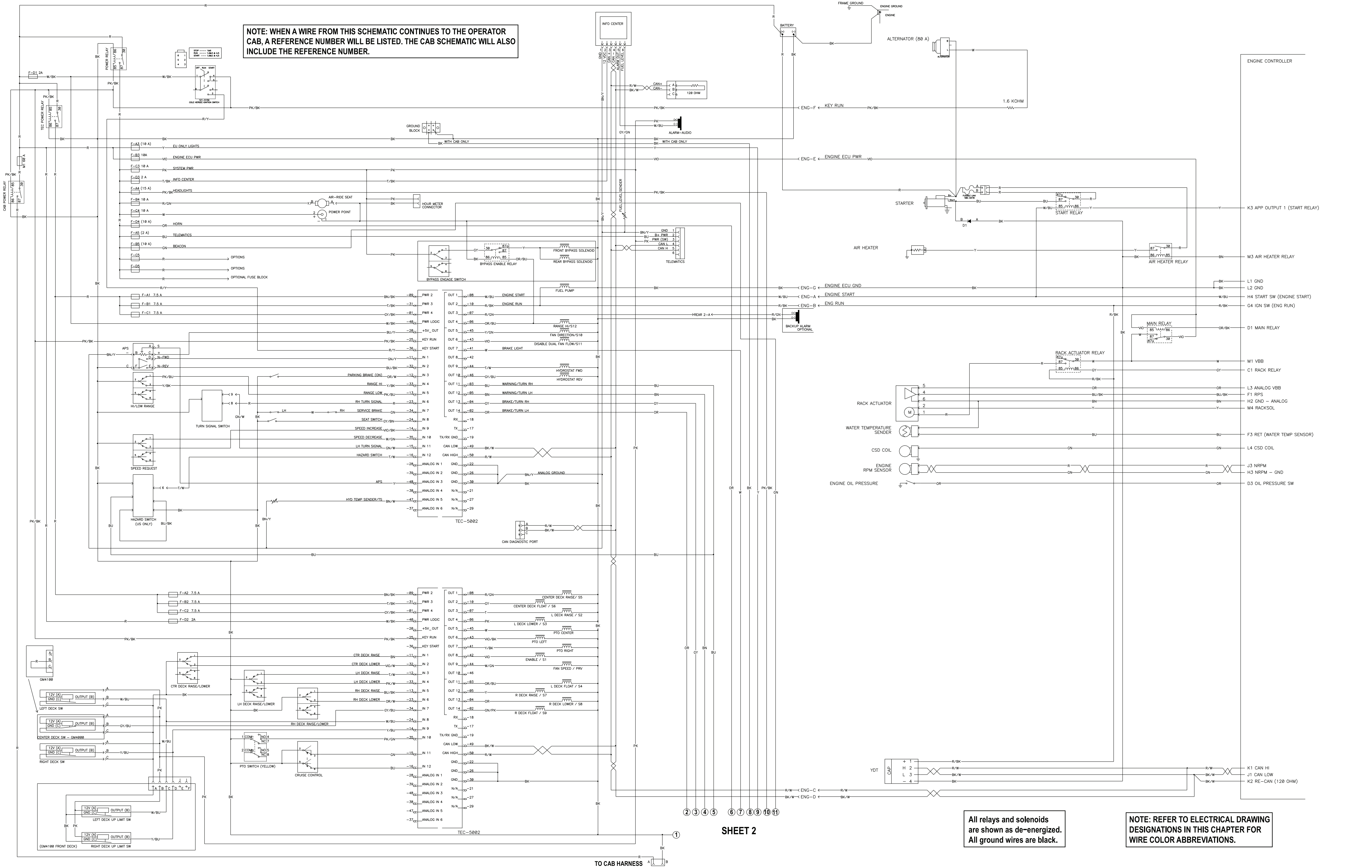


All relays and solenoids are shown as de-energized. All ground wires are black.

NOTE: REFER TO ELECTRICAL DRAWING DESIGNATIONS IN THIS CHAPTER FOR WIRE COLOR ABBREVIATIONS.

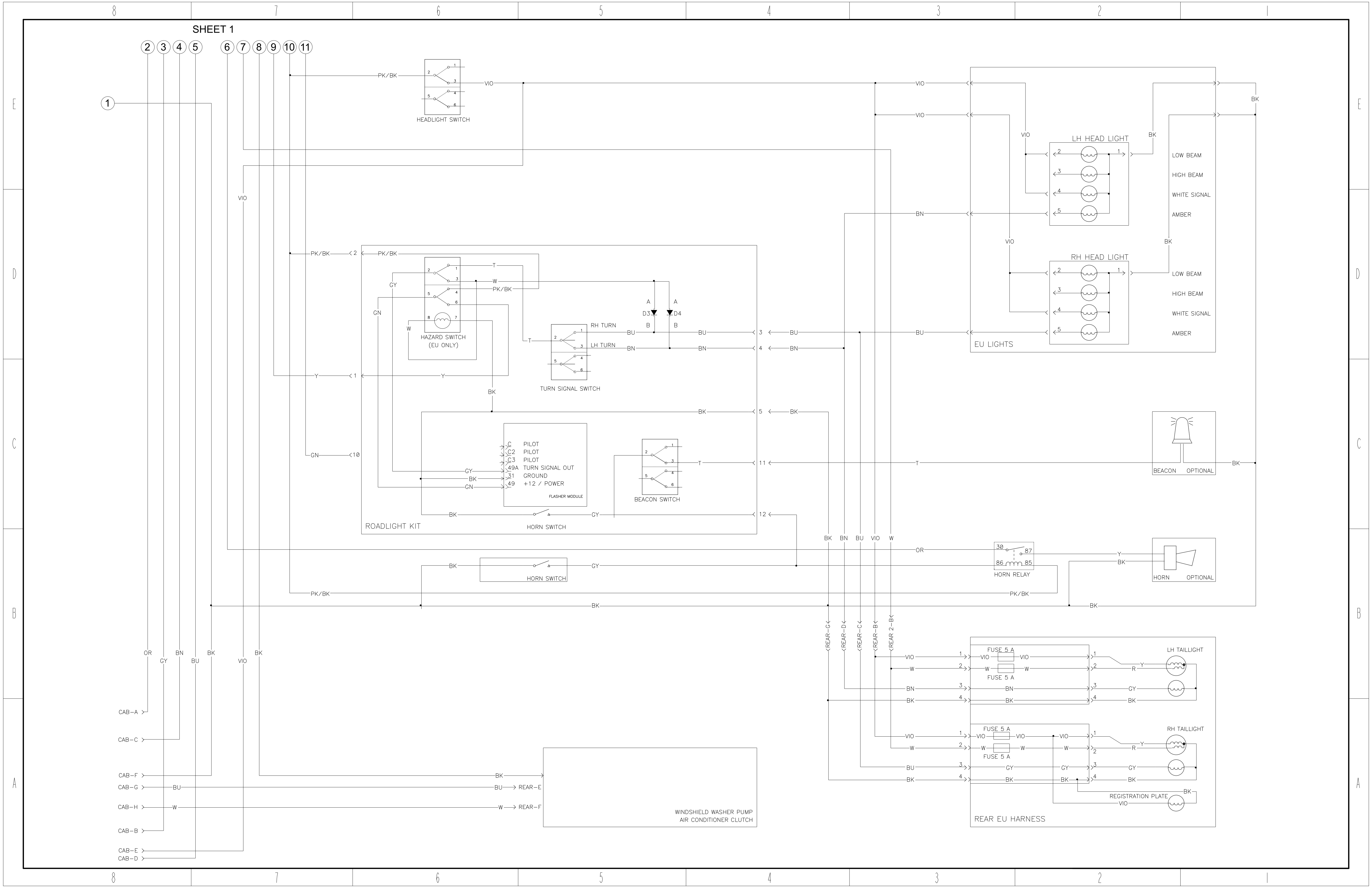
g327931

Electrical Schematic for Models 30604 and 30602/30643 (For machines serial number 400000001 to 403450000)



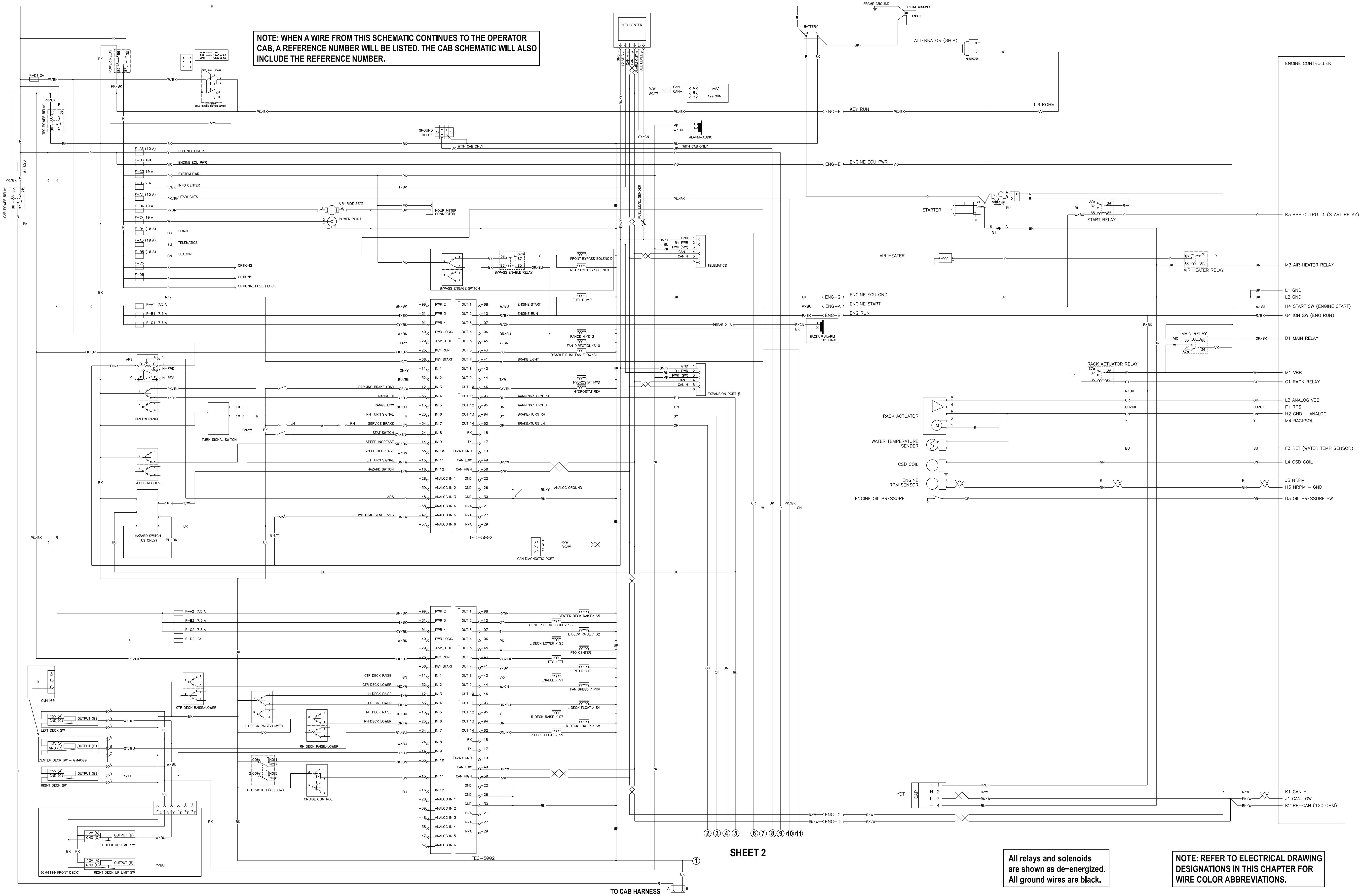
g327933

Electrical Schematic for Models 30604 and 30602/30643 (For machines serial number 400000001 to 403450000)



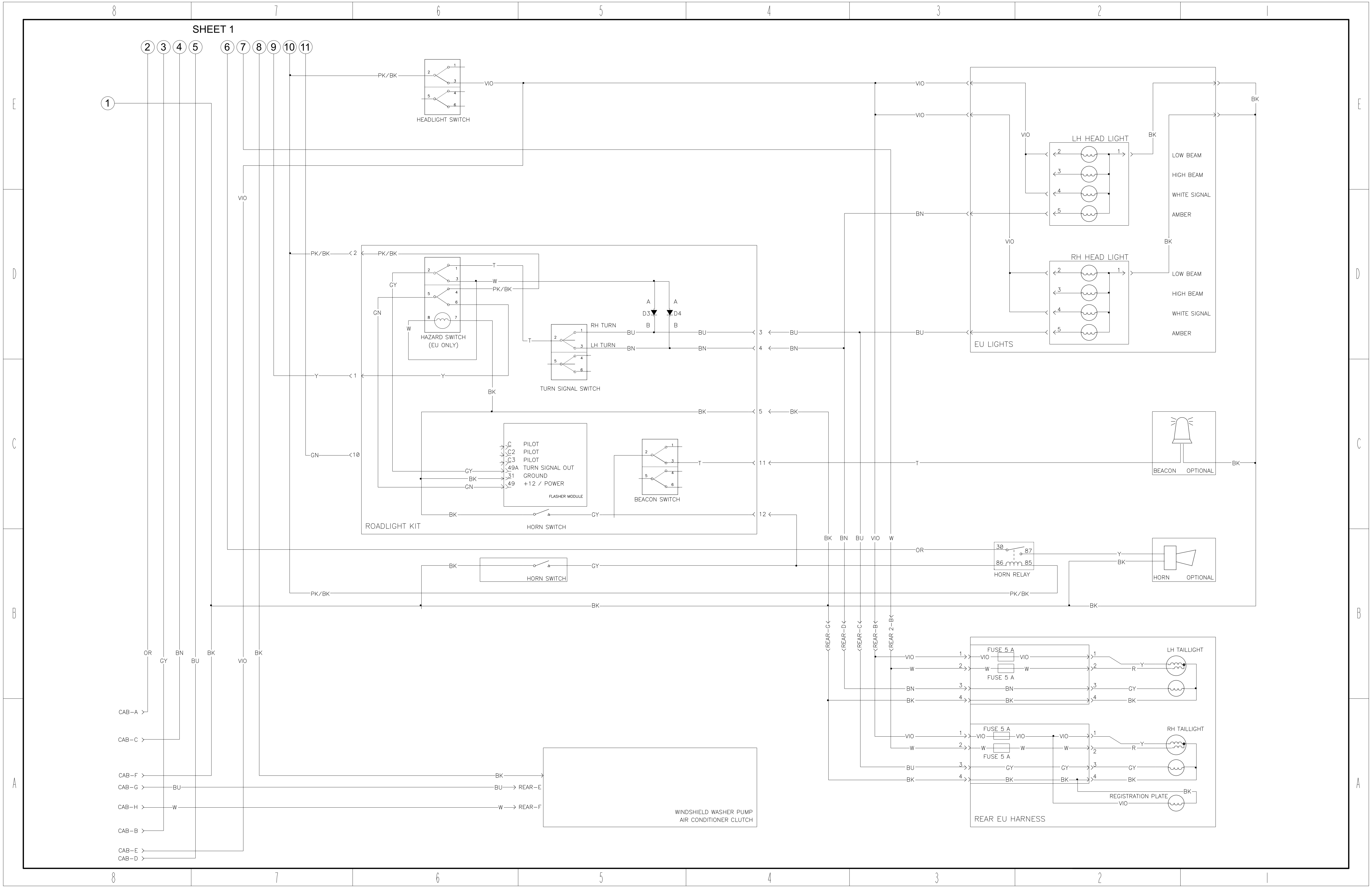
g279724

Electrical Schematic for Models 30604 and 30602/30643 (For machines serial number 403450001 to 408000000)



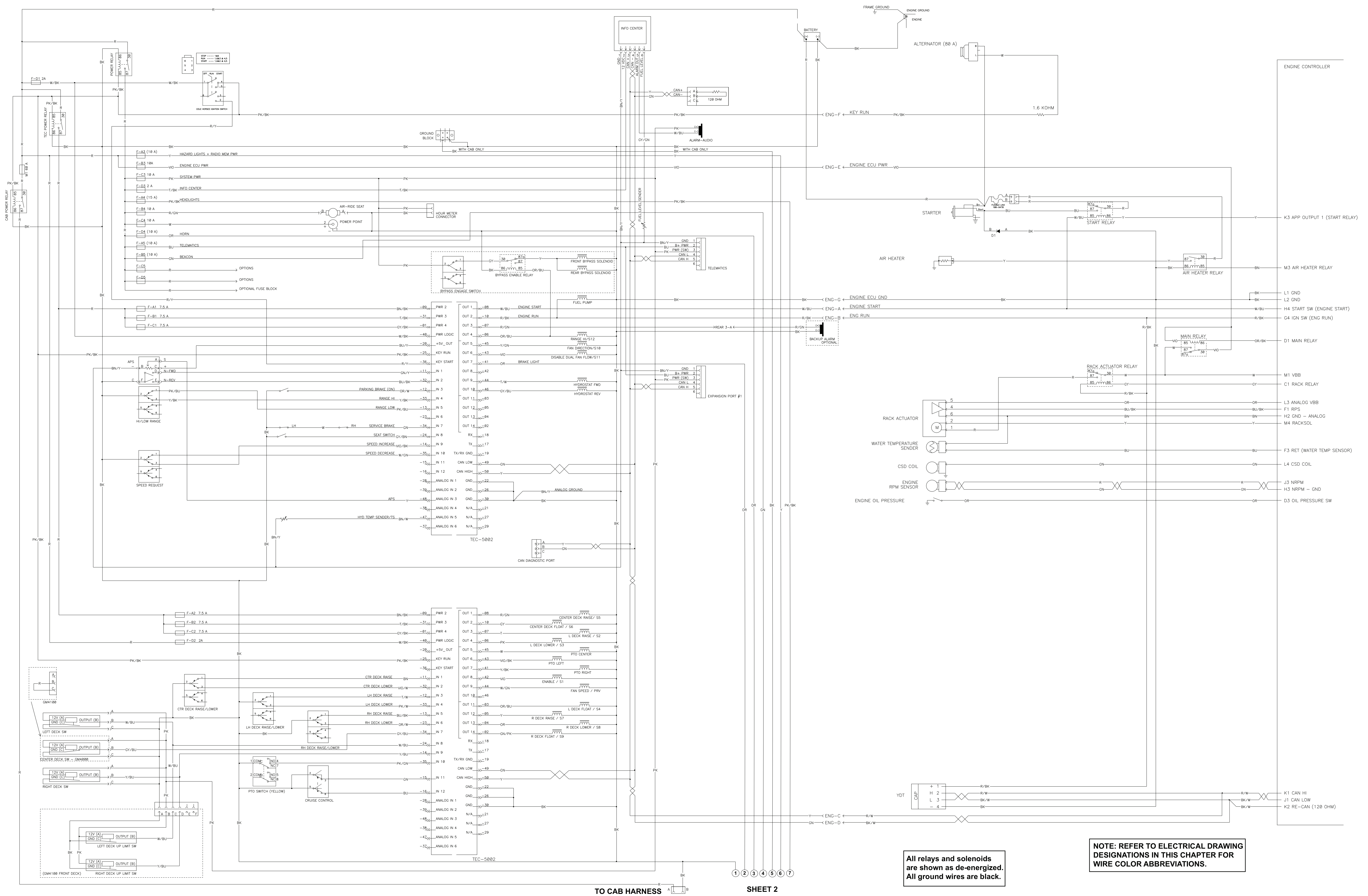
g327935

Electrical Schematic for Models 30604 and 30602/30643 (For machines serial number 403450001 to 408000000)

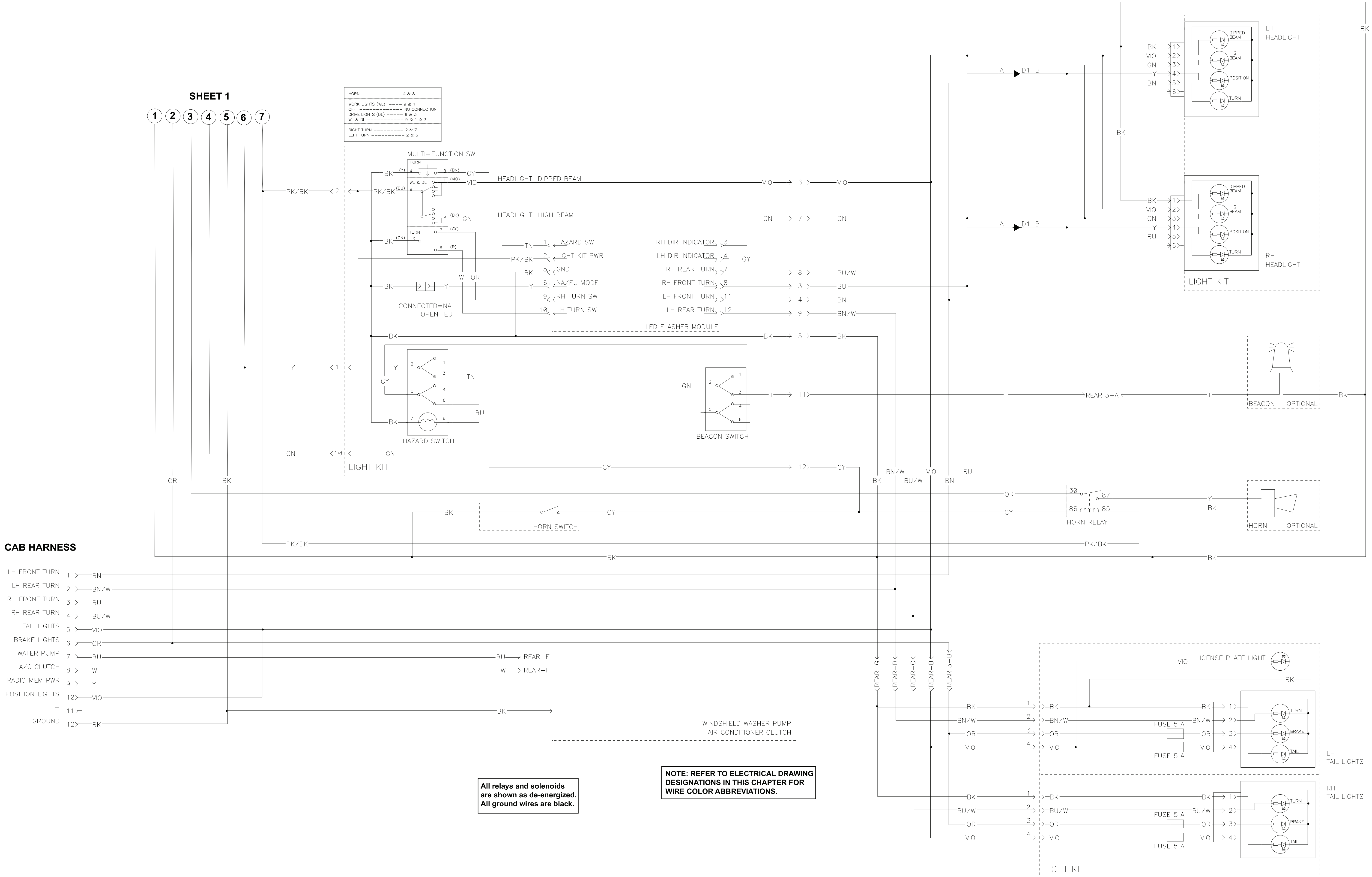


g279724

Electrical Schematic for Models 30604 and 30602/30643 (For machines serial number above 408000000)

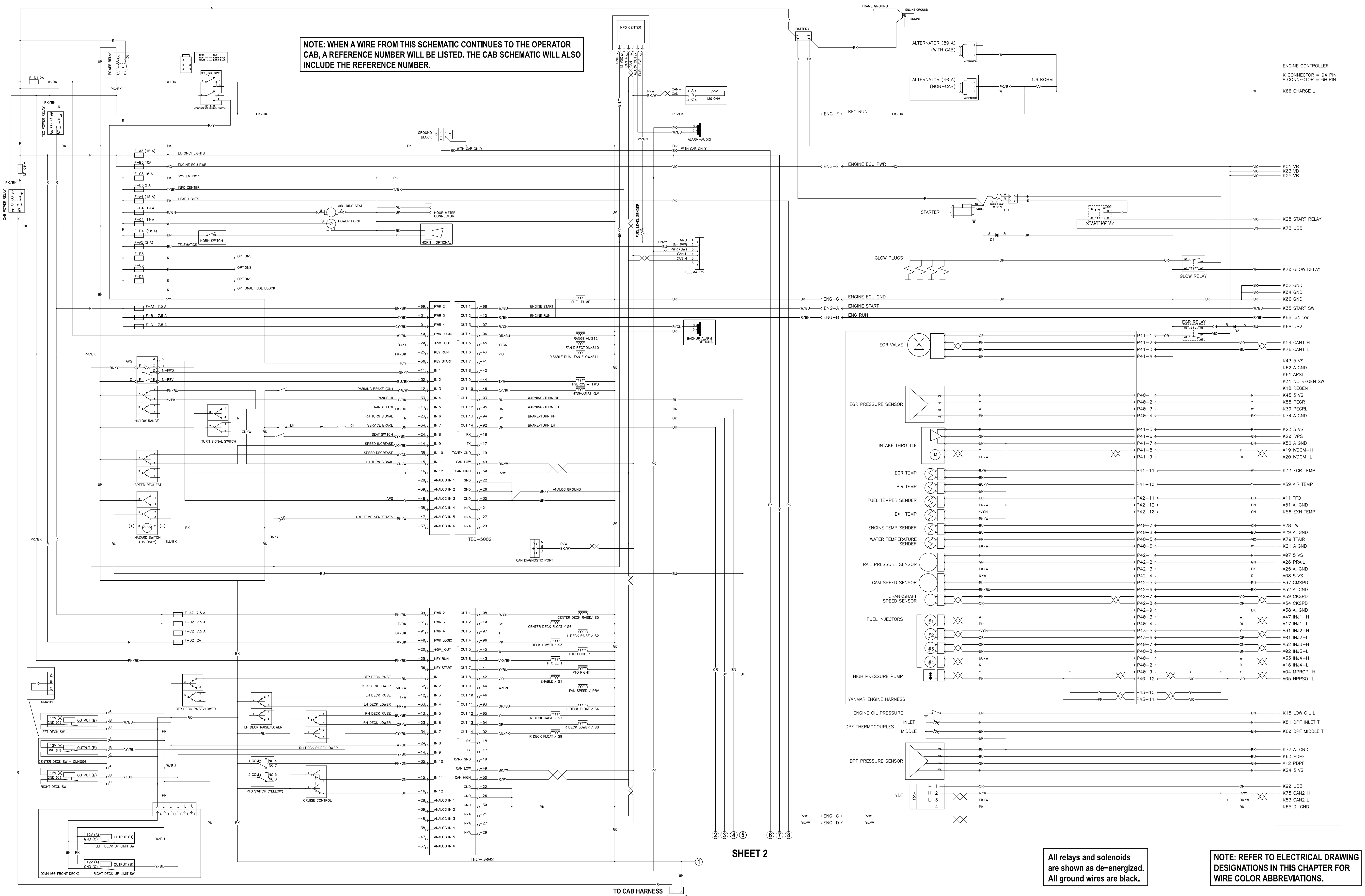


Electrical Schematic for Models 30604 and 30602/30643 (For machines serial number above 408000000)



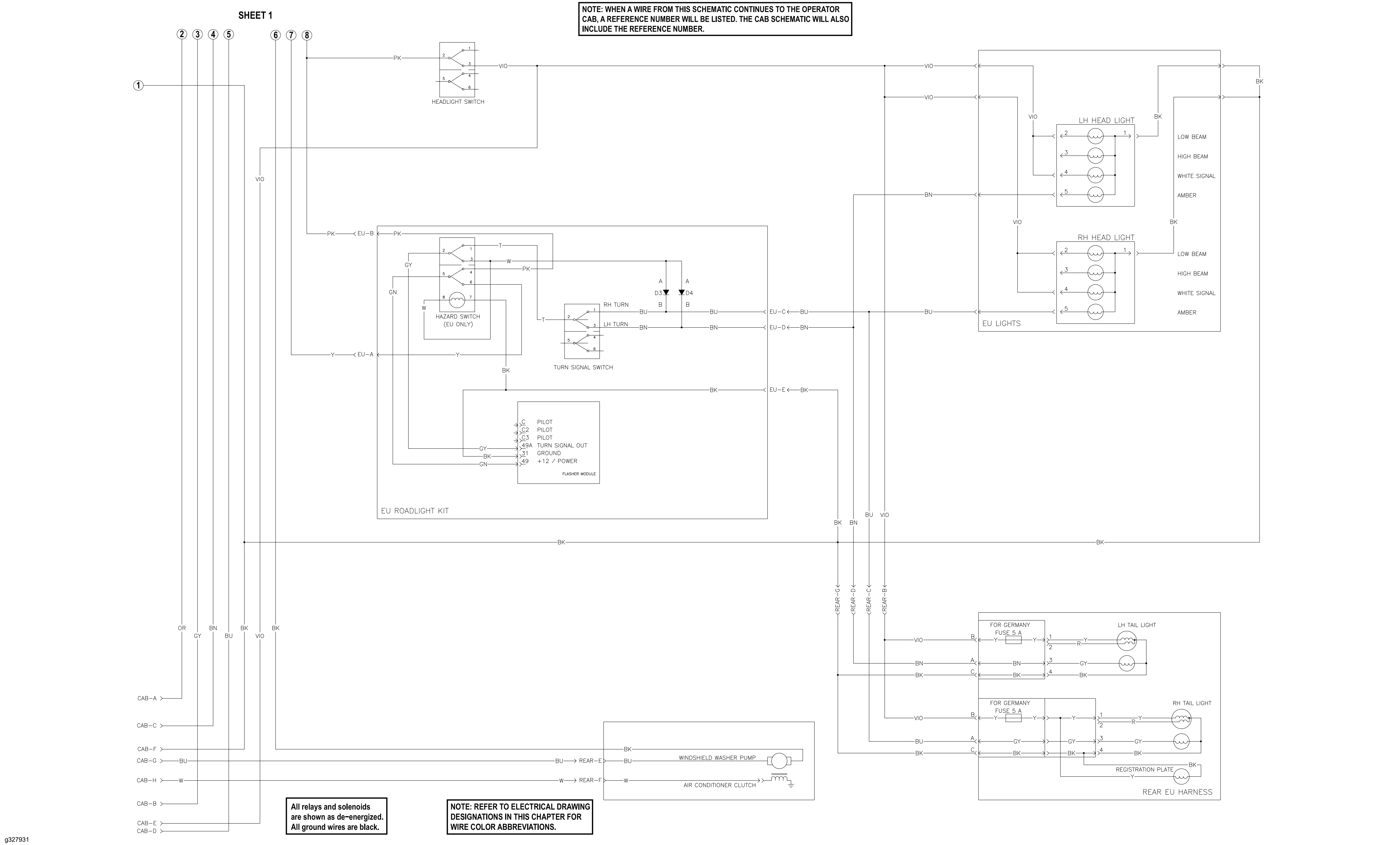
g362029

Electrical Schematic for Models 30608 and 30606/30644 (For machines serial number below 400000000)

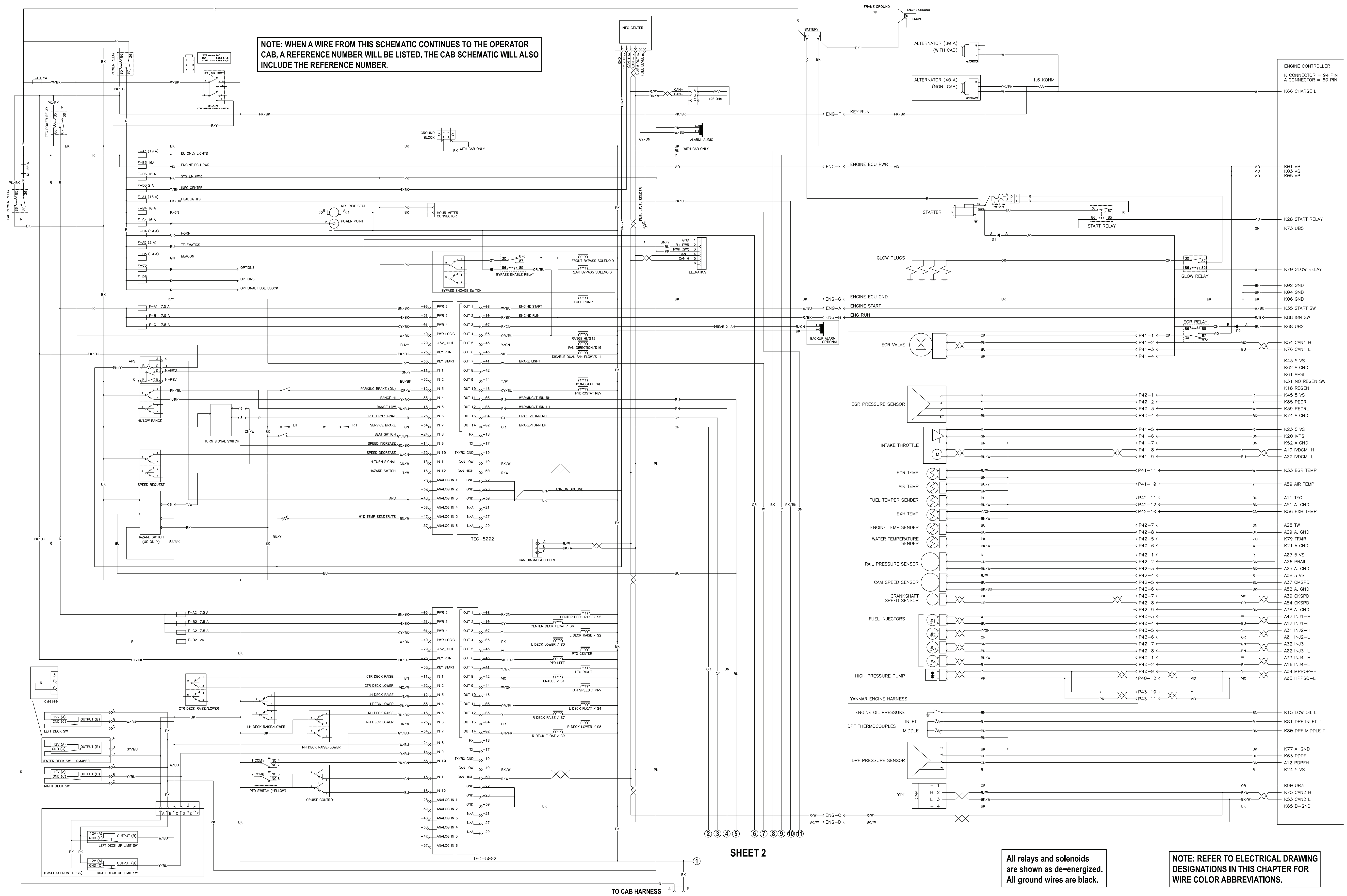


g327932

Electrical Schematic for Models 30608 and 30606/30644 (For machines serial number below 400000000)

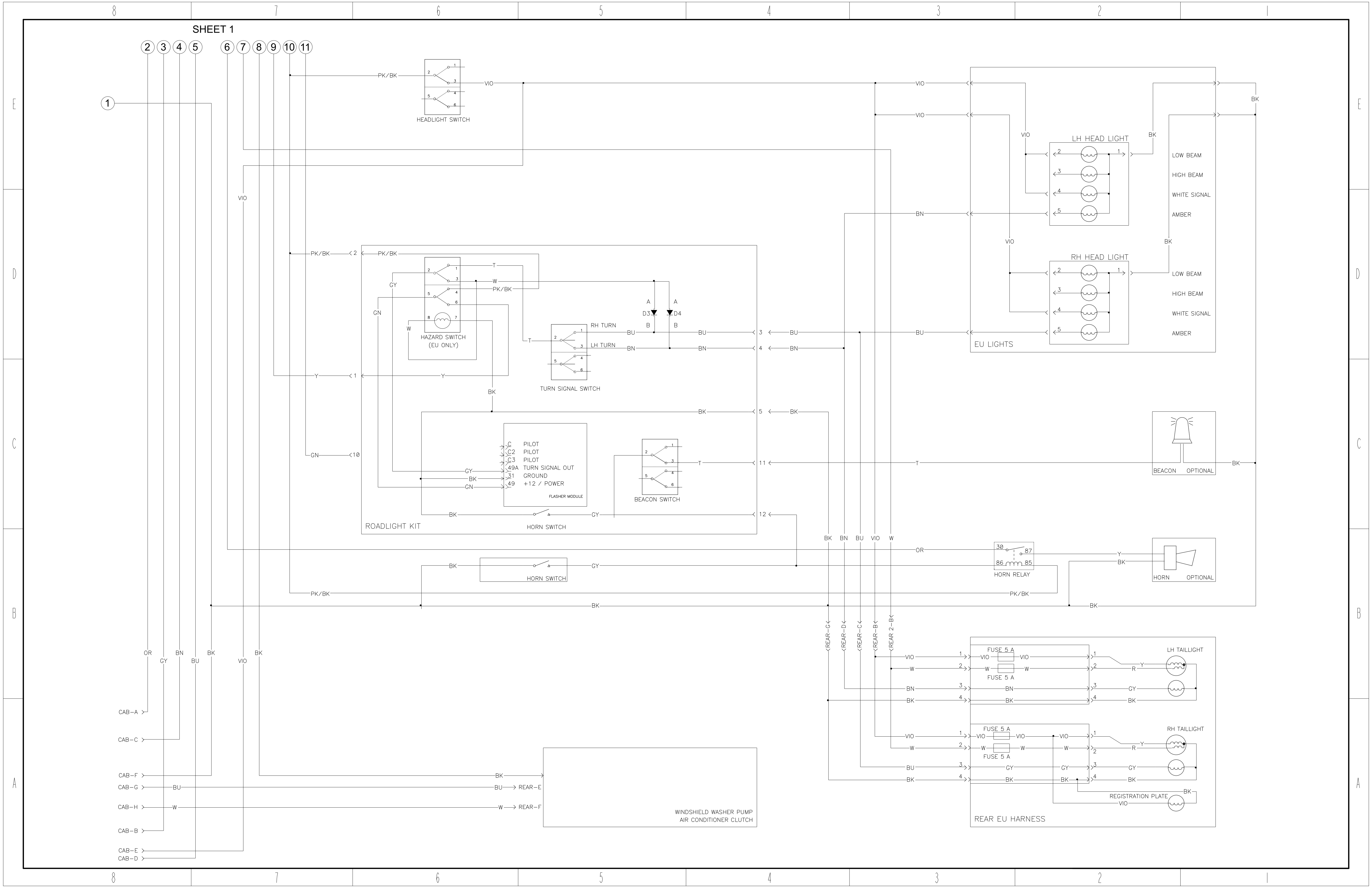


Electrical Schematic for Models 30608 and 30606/30644 (For machines serial numbers 400000001 to 403450000)

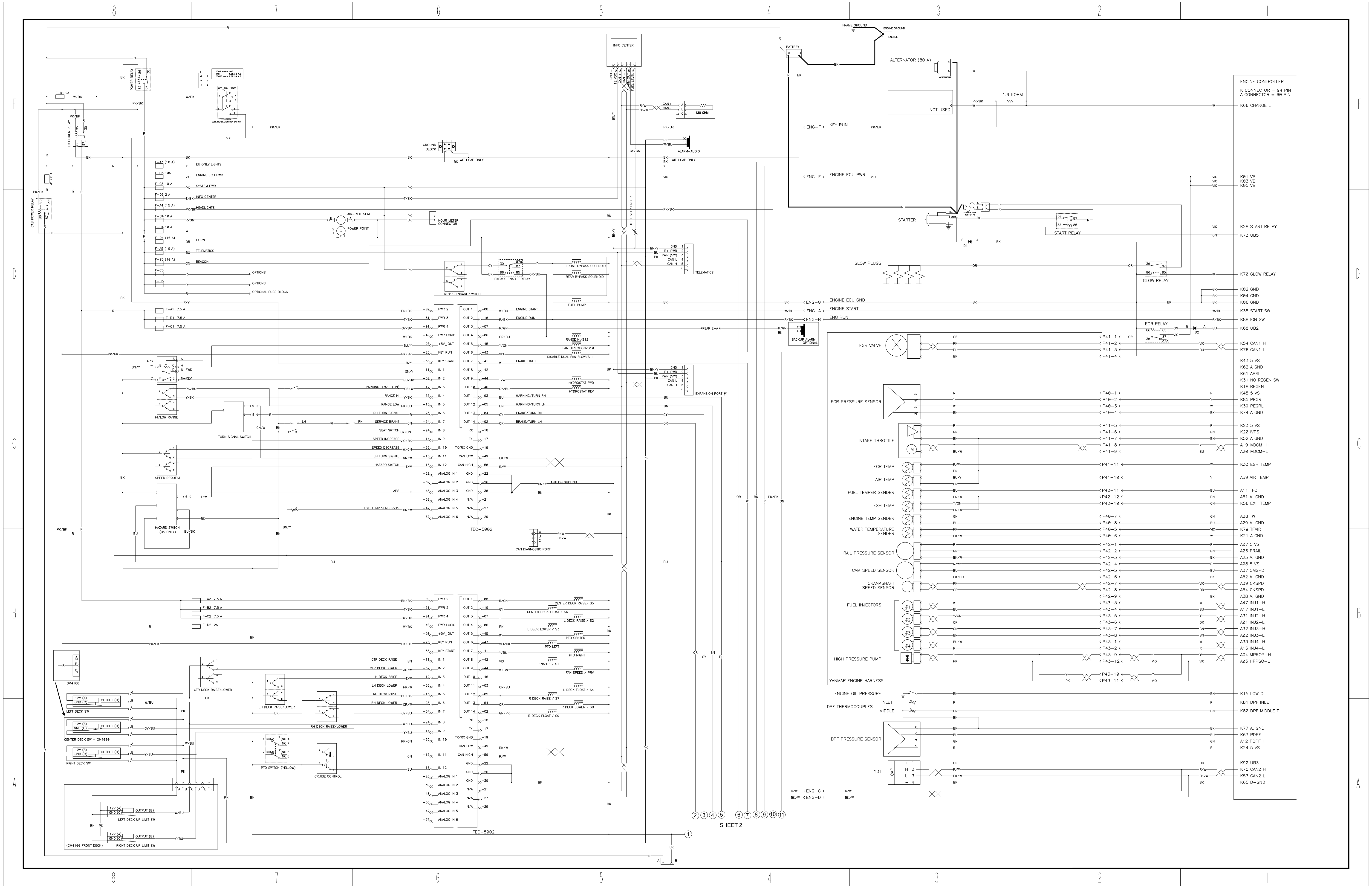


g327934

Electrical Schematic for Models 30608 and 30606/30644 (For machines serial numbers 400000001 to 403450000)

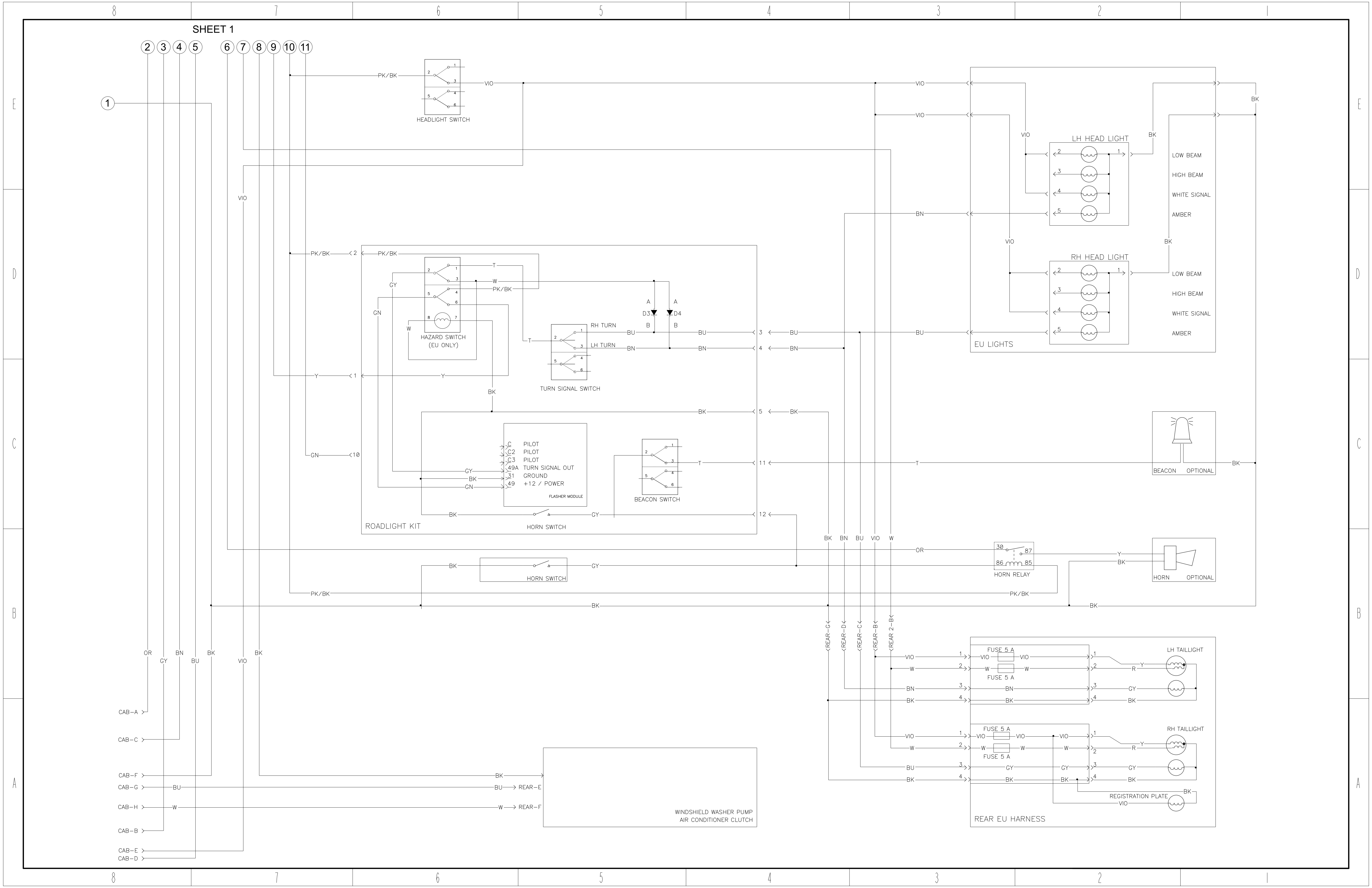


Electrical Schematic for Models 30608 and 30606/30644 (For machines serial numbers 403450001 to 408000000)



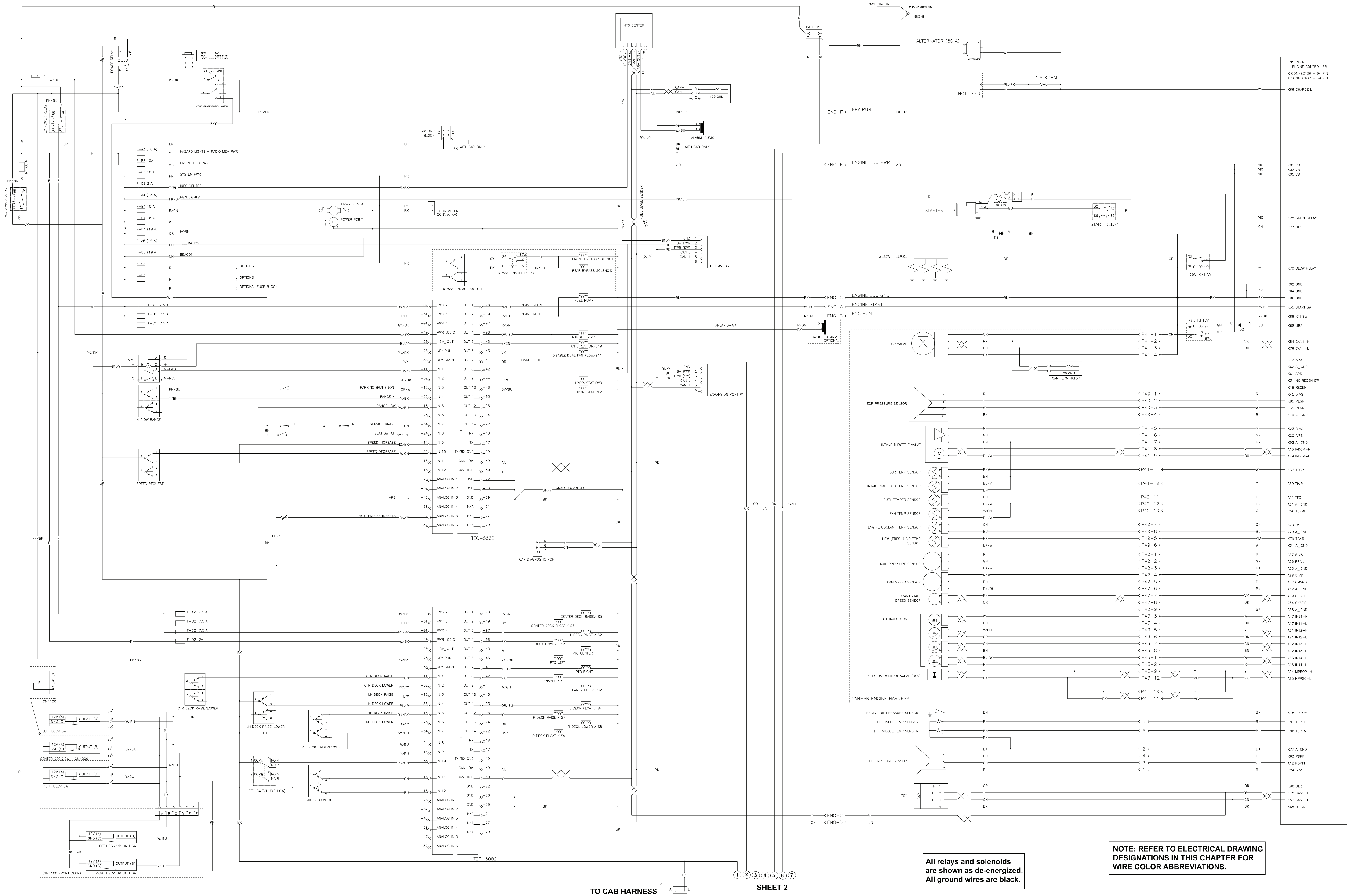
g317194

Electrical Schematic for Models 30608 and 30606/30644 (For machines serial numbers 403450001 to 408000000)



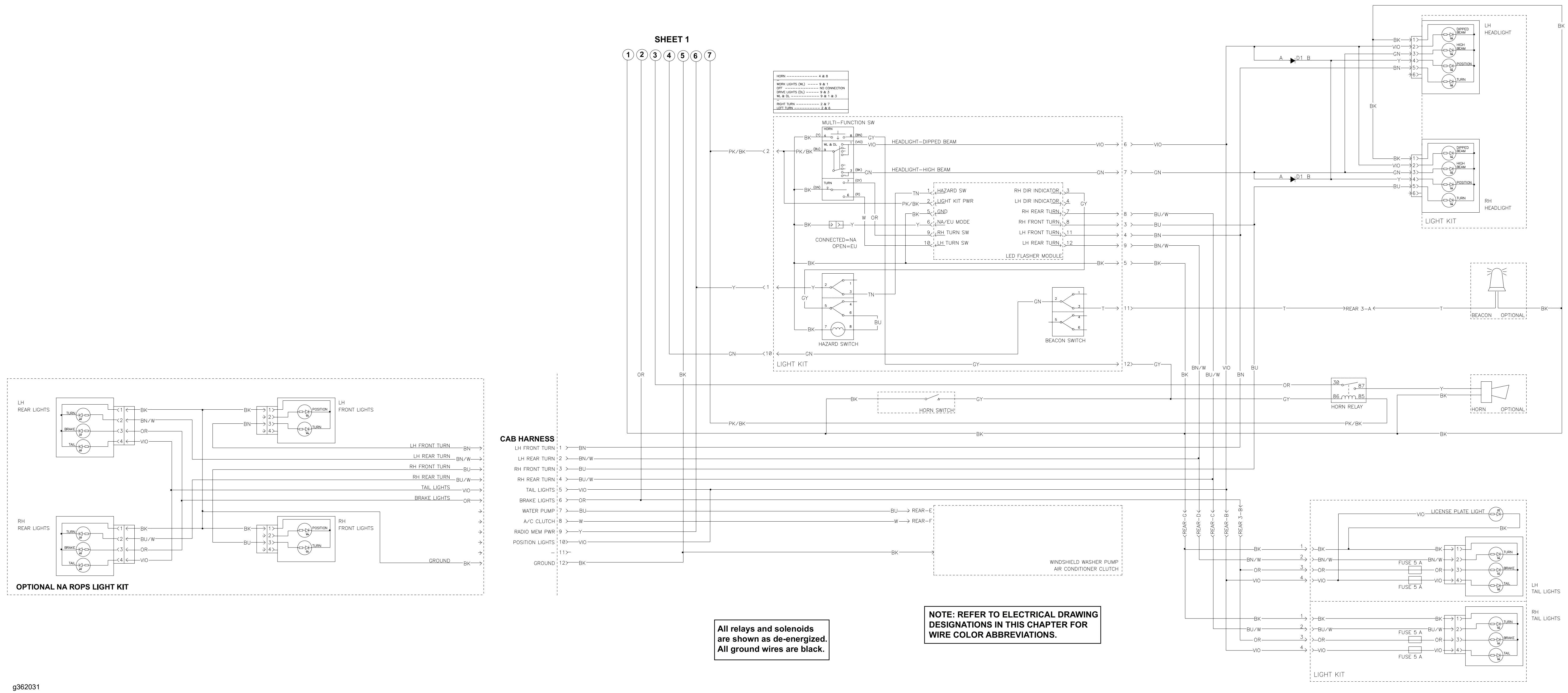
g279724

Electrical Schematic for Models 30608 and 30606/30644 (For machines serial numbers above 408000000)

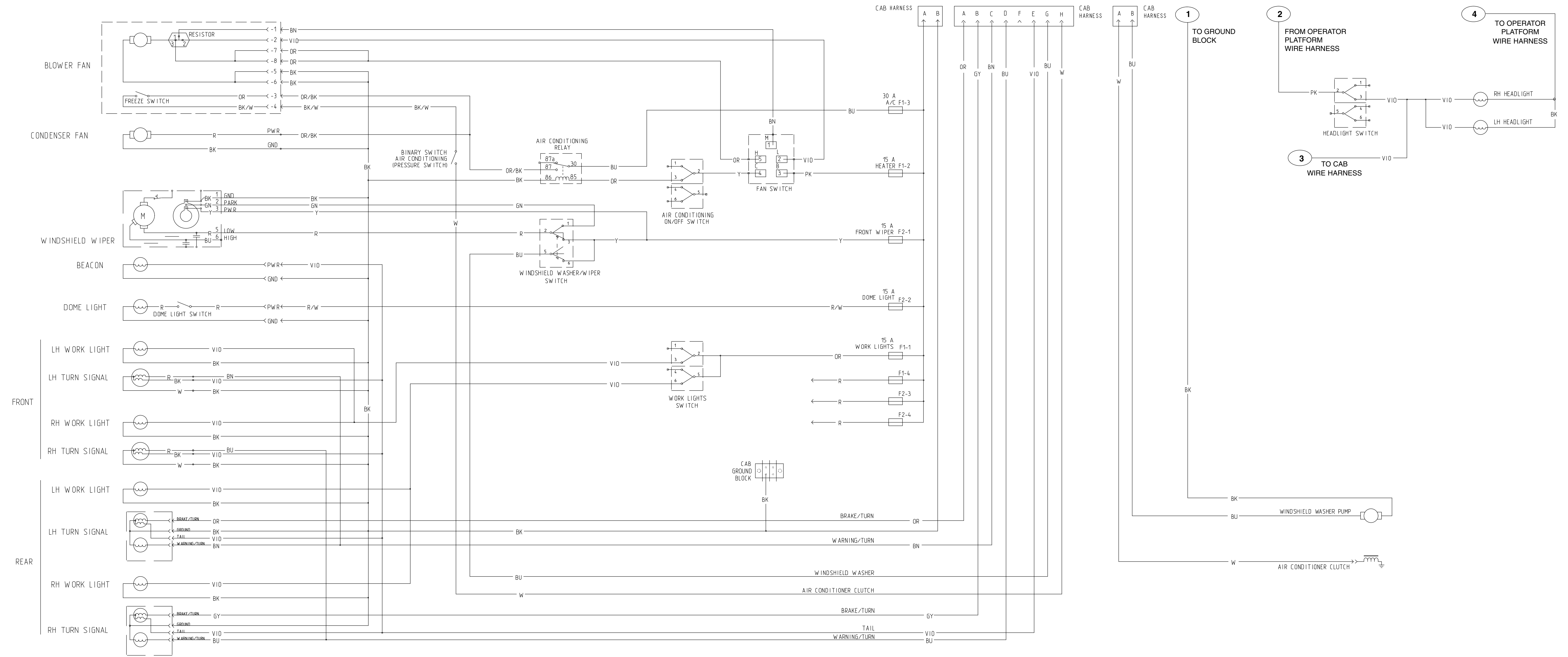


g362030

Electrical Schematic for Models 30608 and 30606/30644 (For machines serial numbers above 408000000)



NOTE: REFER TO ELECTRICAL DRAWING DESIGNATIONS IN THIS CHAPTER FOR WIRE COLOR ABBREVIATIONS.



All relays and solenoids are shown as de–energized.

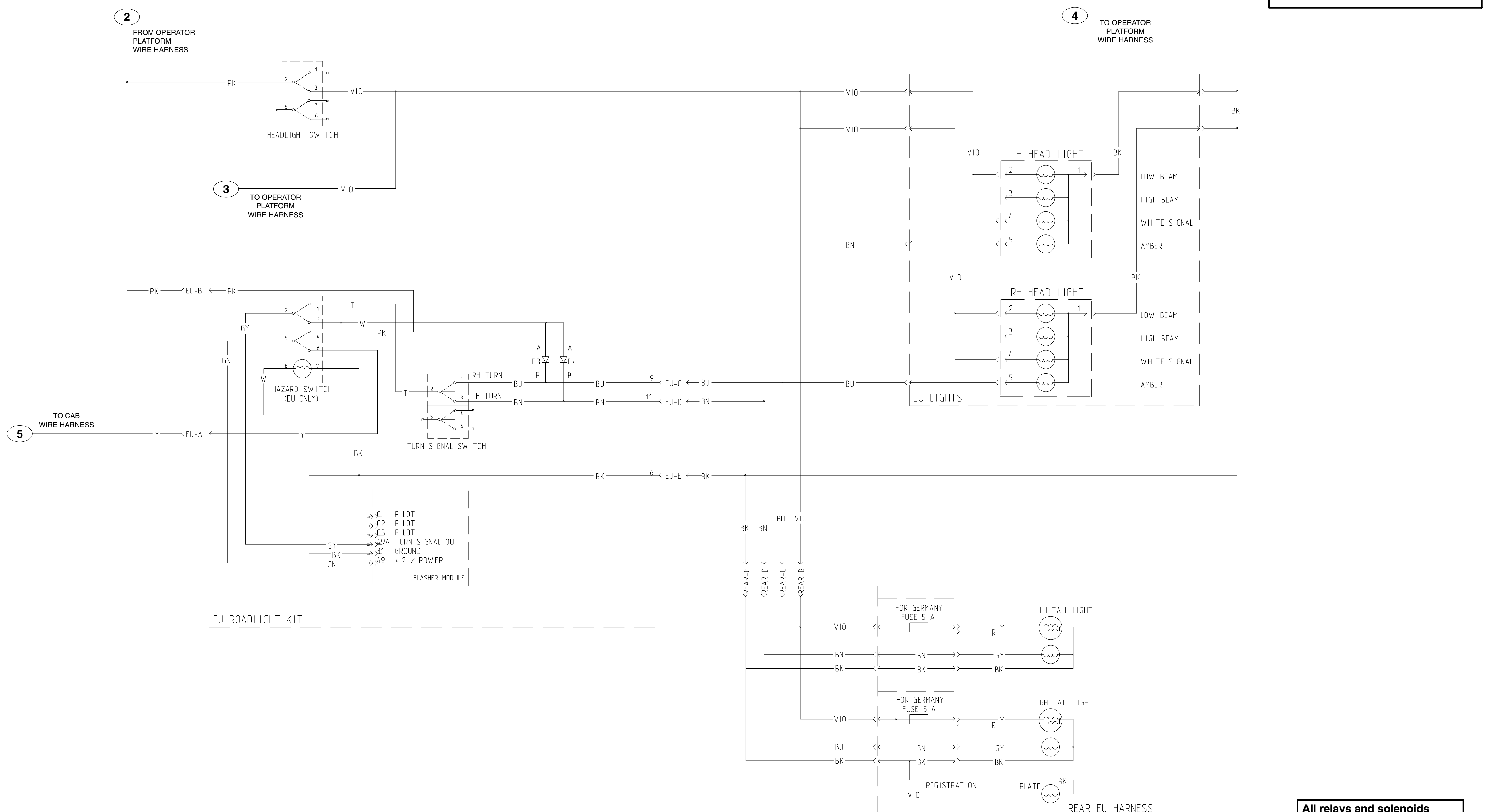
All ground wires are black.

NOTE: THE OPERATOR CAB SCHEMATIC SHOULD BE USED WITH THE ELECTRICAL SCHEMATIC FOR THE APPROPRIATE MODEL NUMBER WHICH IS ON A SEPARATE PAGE. WHEN A WIRE FROM THIS CAB SCHEMATIC CONTINUES TO THE MACHINE SCHEMATIC, A REFERENCE NUMBER WILL BE LISTED.

g277235

Electrical Schematic - International Light Kits

NOTE: REFER TO ELECTRICAL DRAWING DESIGNATIONS IN THIS CHAPTER FOR WIRE COLOR ABBREVIATIONS.



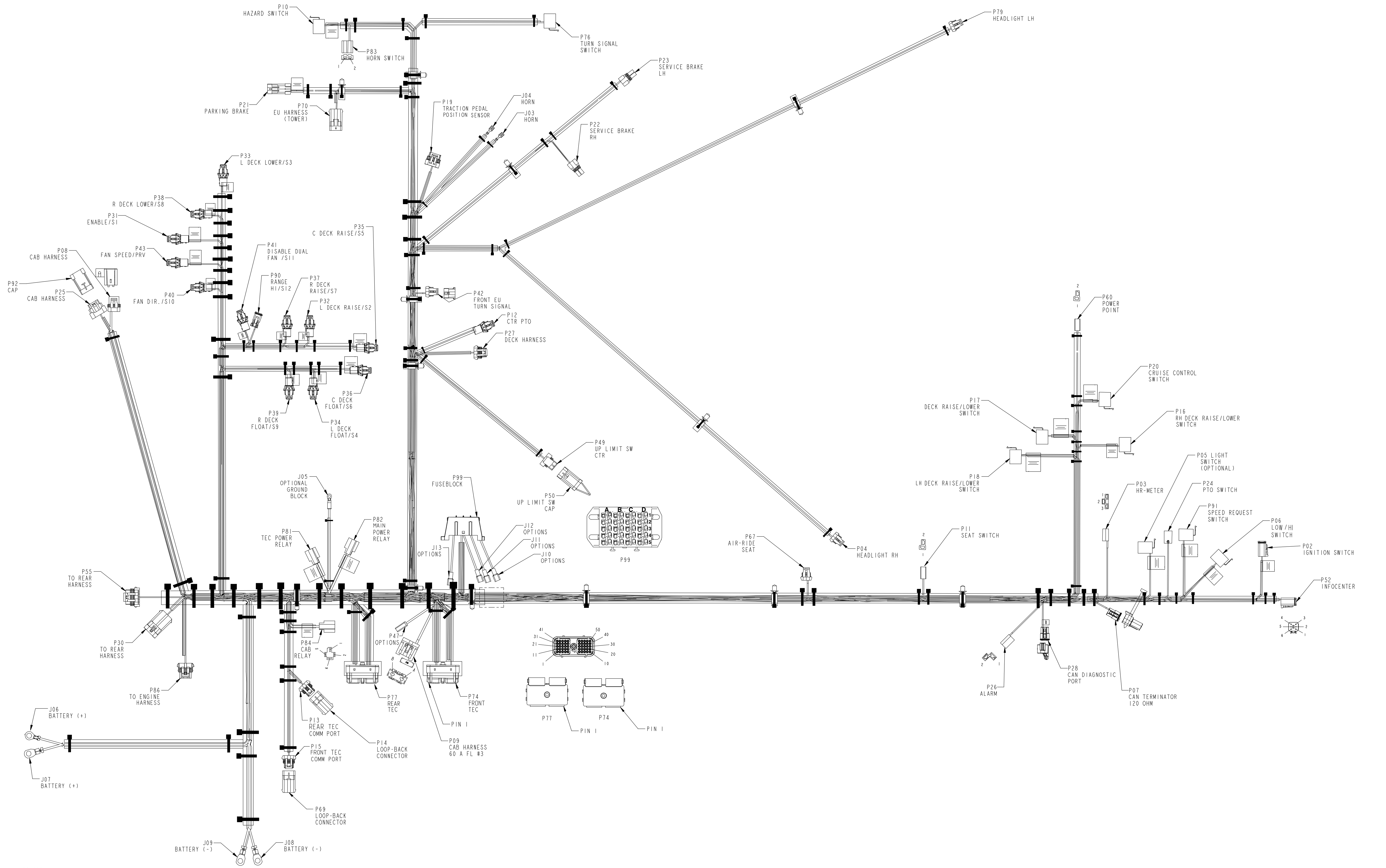
All relays and solenoids are shown as de–energized.

All ground wires are black.

NOTE: THE OPERATOR CAB SCHEMATIC SHOULD BE USED WITH THE ELECTRICAL SCHEMATIC FOR THE APPROPRIATE MODEL NUMBER WHICH IS ON A SEPARATE PAGE. WHEN A WIRE FROM THIS CAB SCHEMATIC CONTINUES TO THE MACHINE SCHEMATIC, A REFERENCE NUMBER WILL BE LISTED.

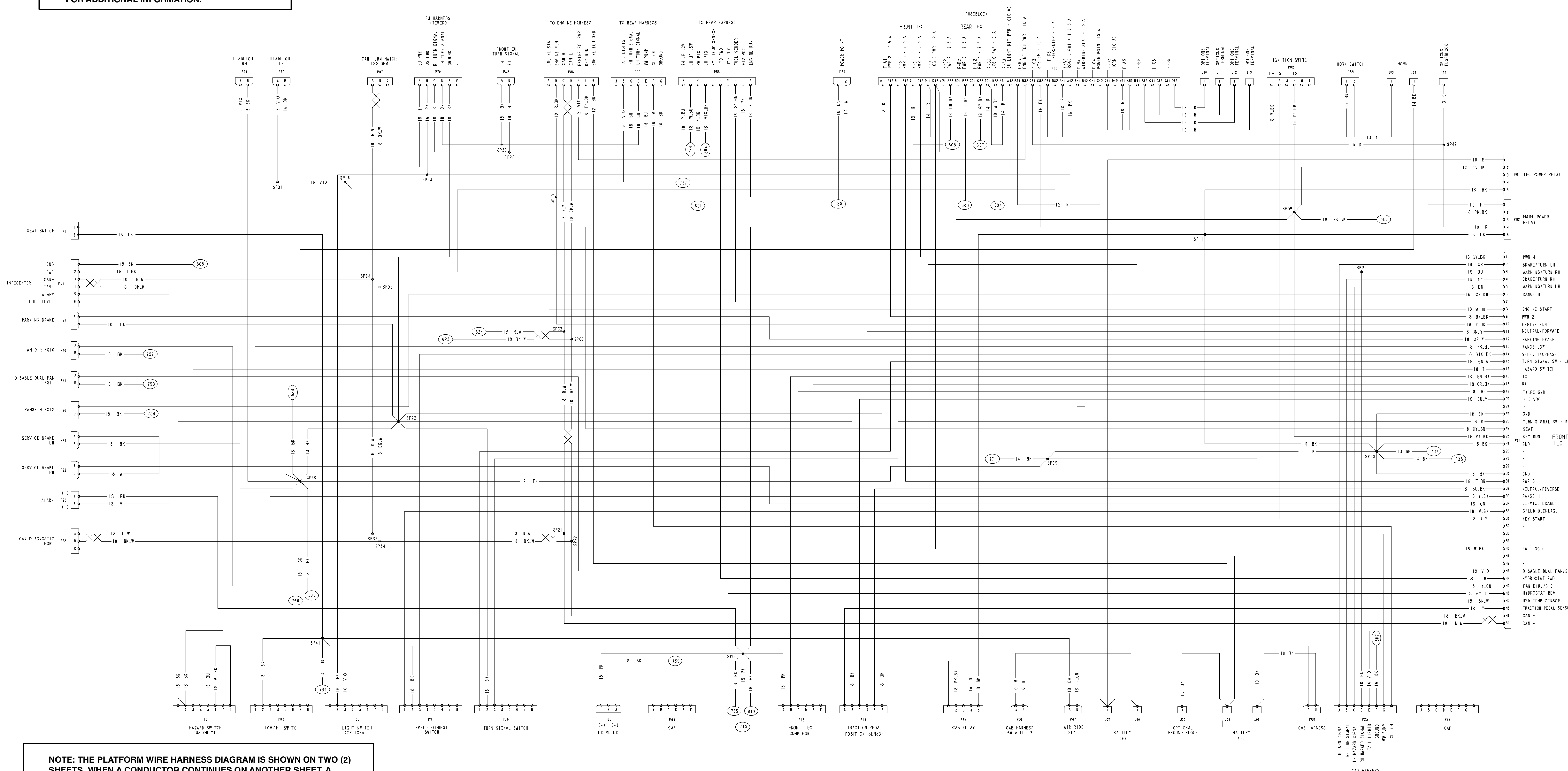
g277236

Platform Wire Harness Diagram (For machines serial number below 400000000)



Platform Wire Harness Diagram (For machines serial number below 400000000)

NOTE: THIS DRAWING IDENTIFIES WIRE GAUGE SIZE AND WIRE COLOR. REFER TO ELECTRICAL DRAWING DESIGNATIONS IN THIS CHAPTER FOR ADDITIONAL INFORMATION.

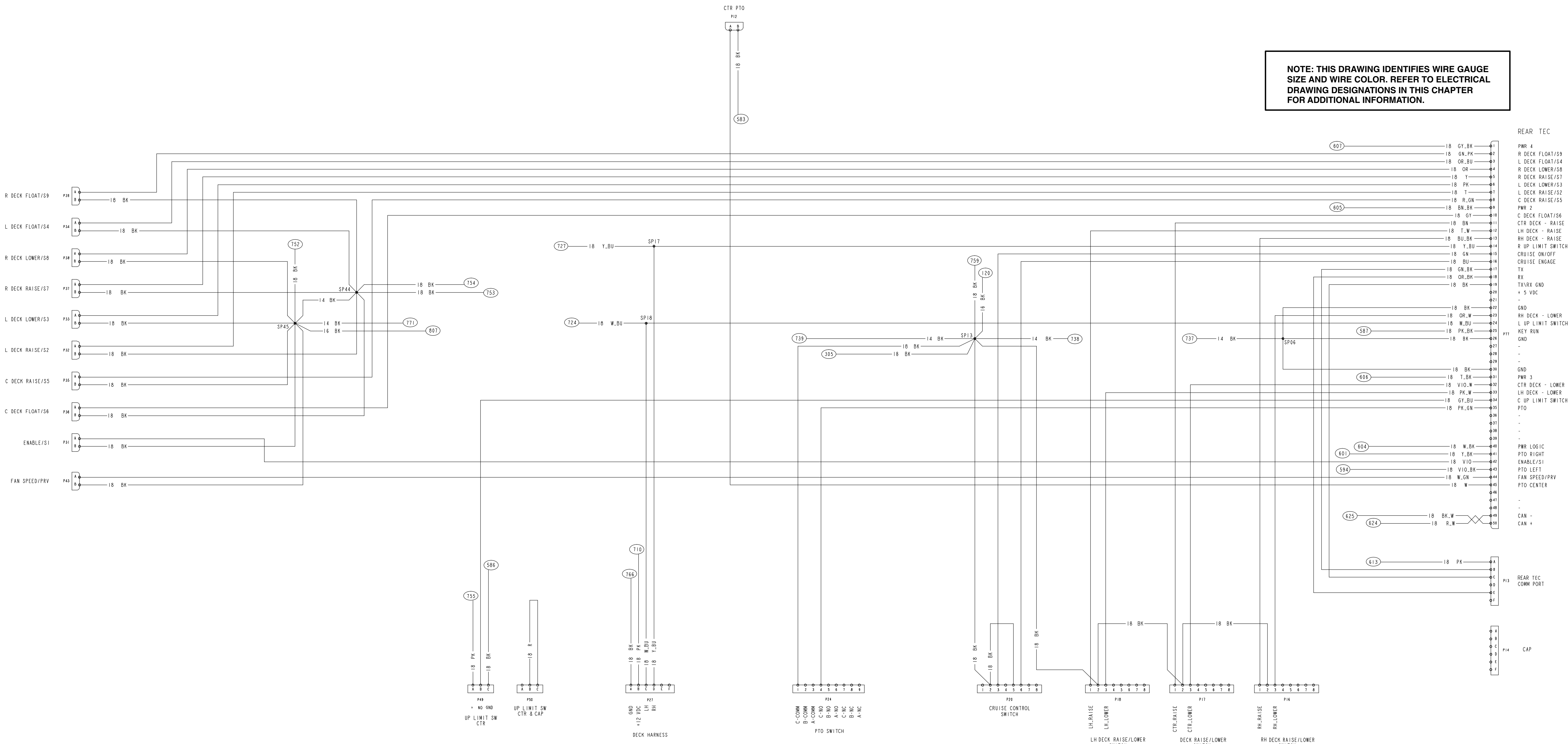


NOTE: THE PLATFORM WIRE HARNESS DIAGRAM IS SHOWN ON TWO (2) SHEETS. WHEN A CONDUCTOR CONTINUES ON ANOTHER SHEET, A REFERENCE NUMBER WILL BE IDENTIFIED.

g305688

Platform Wire Harness Diagram (For machines serial number below 400000000)

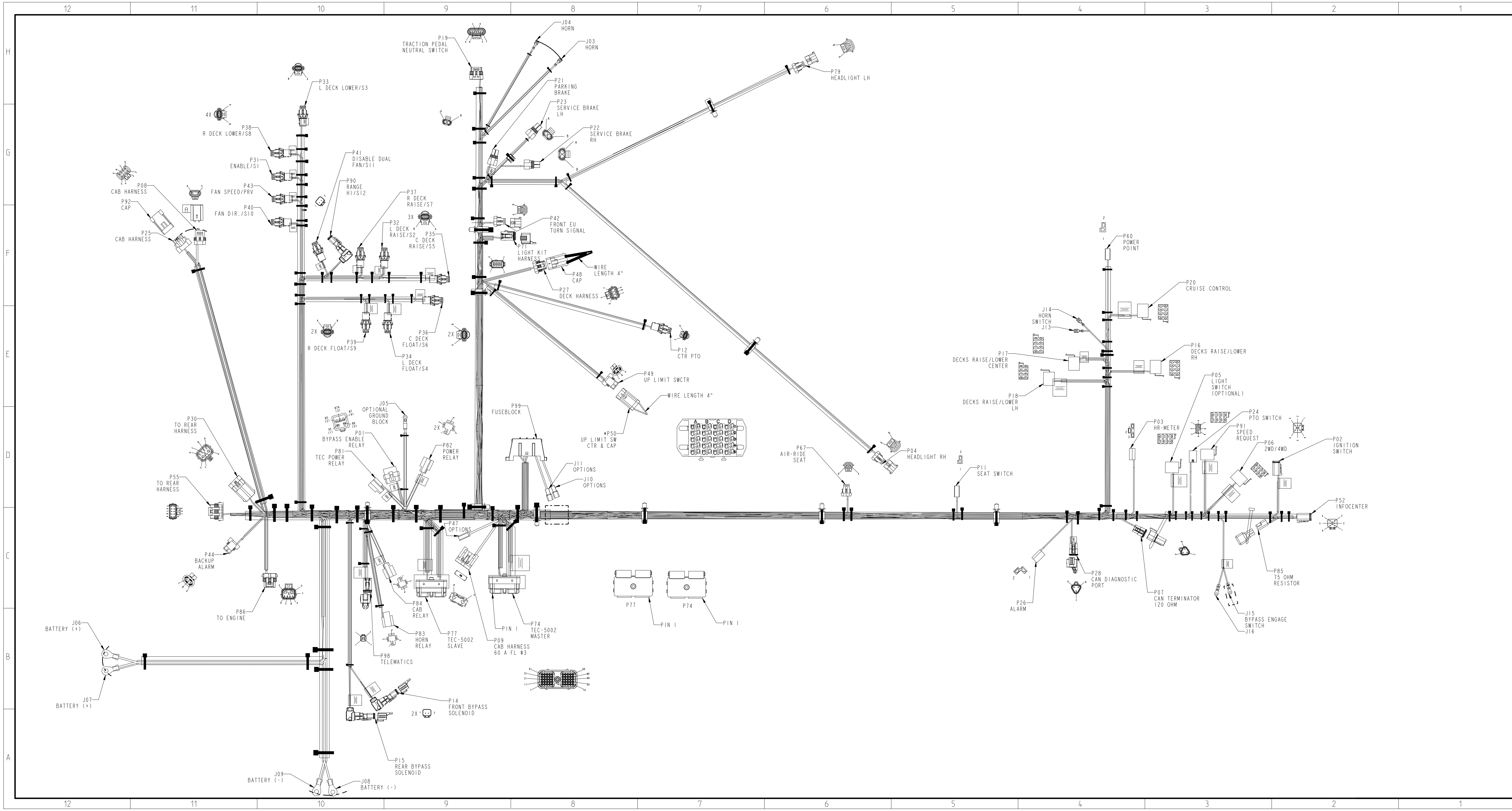
NOTE: THIS DRAWING IDENTIFIES WIRE GAUGE SIZE AND WIRE COLOR. REFER TO ELECTRICAL DRAWING DESIGNATIONS IN THIS CHAPTER FOR ADDITIONAL INFORMATION.



NOTE: THE PLATFORM WIRE HARNESS DIAGRAM IS SHOWN ON TWO (2) SHEETS. WHEN A CONDUCTOR CONTINUES ON ANOTHER SHEET, A REFERENCE NUMBER WILL BE IDENTIFIED.

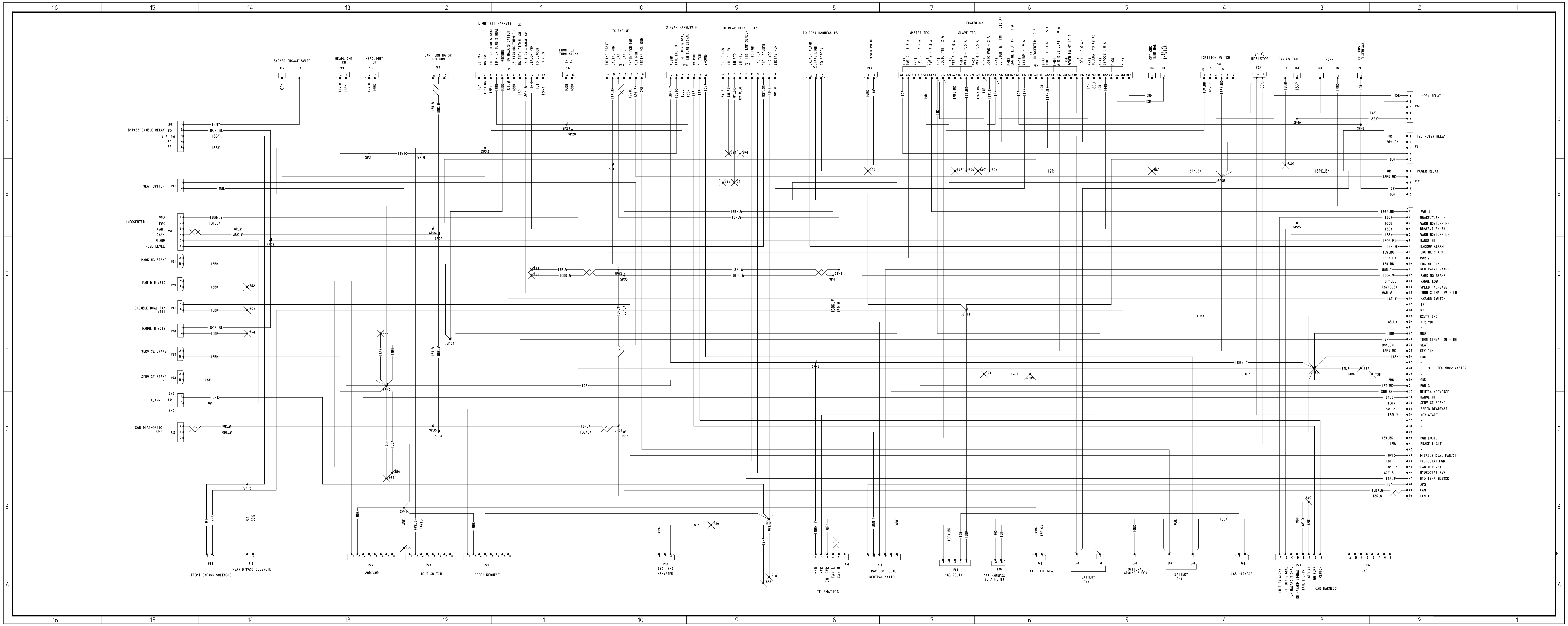
g305689

Platform Wire Harness Diagram (For machines serial numbers 400000001 to 403450000)



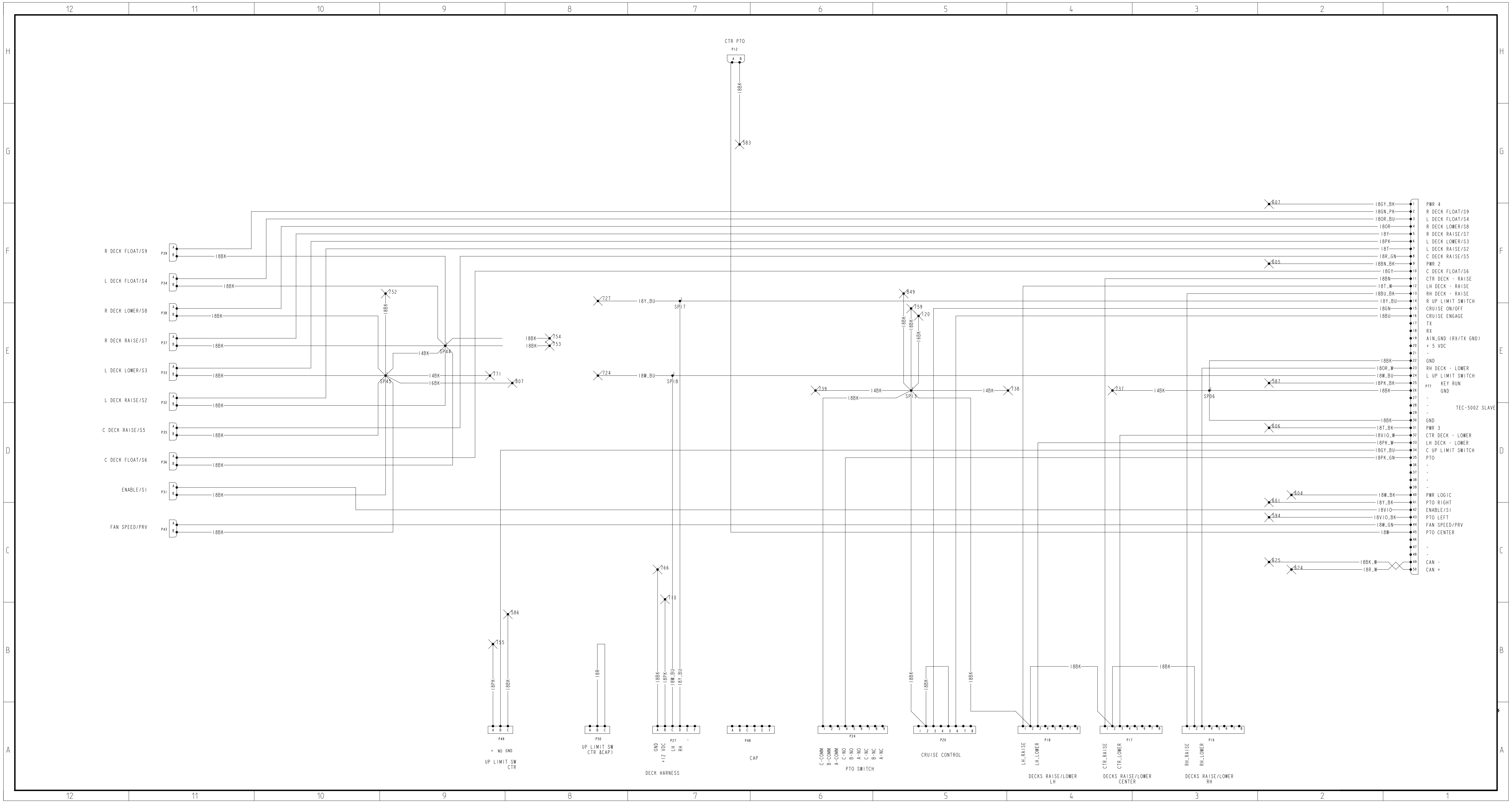
g279263

Platform Wire Harness Diagram (For machines serial numbers 400000001 to 403450000)



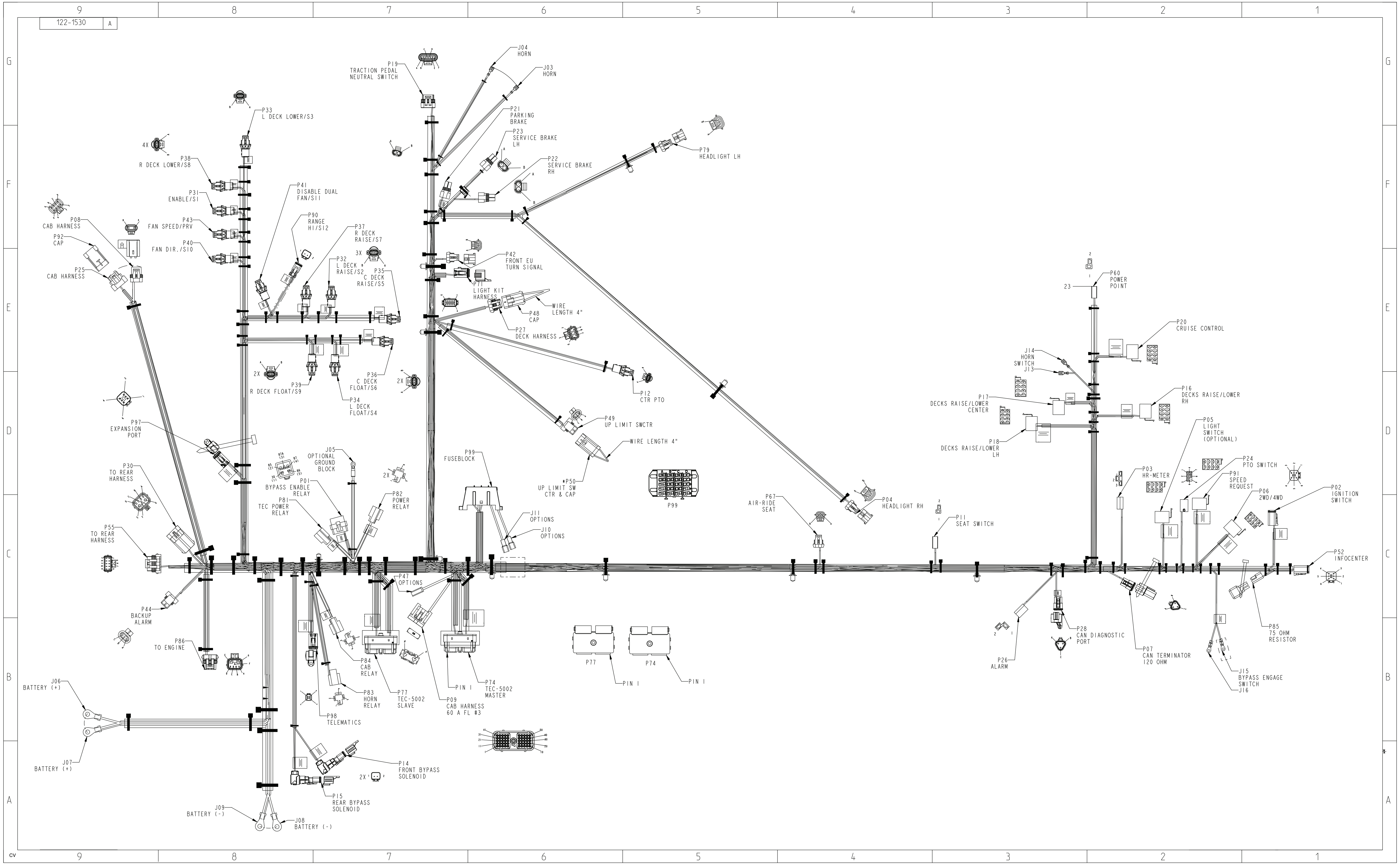
g279264

Platform Wire Harness Diagram (For machines serial numbers 400000001 to 403450000)



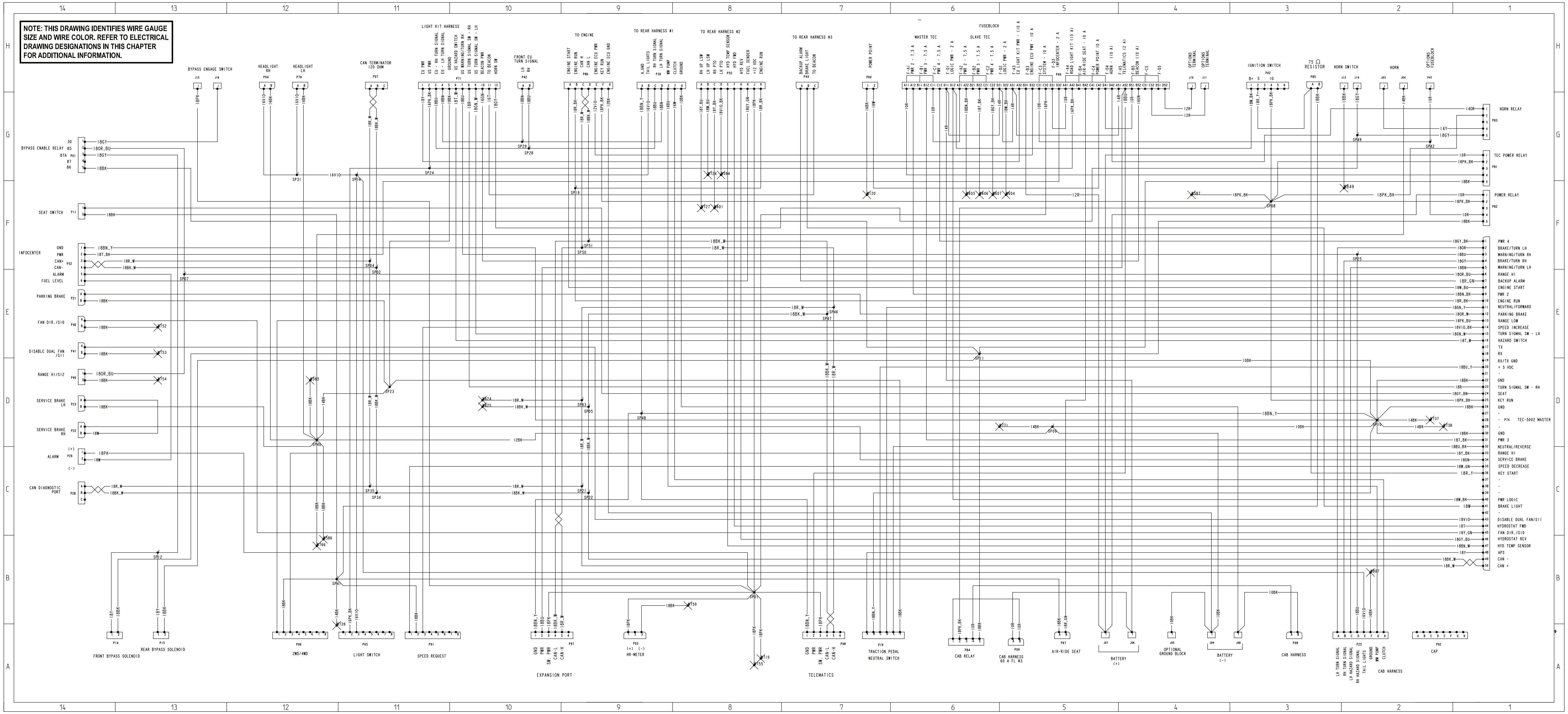
g279265

Platform Wire Harness Diagram (For machines serial number 403450001 to 408000000)



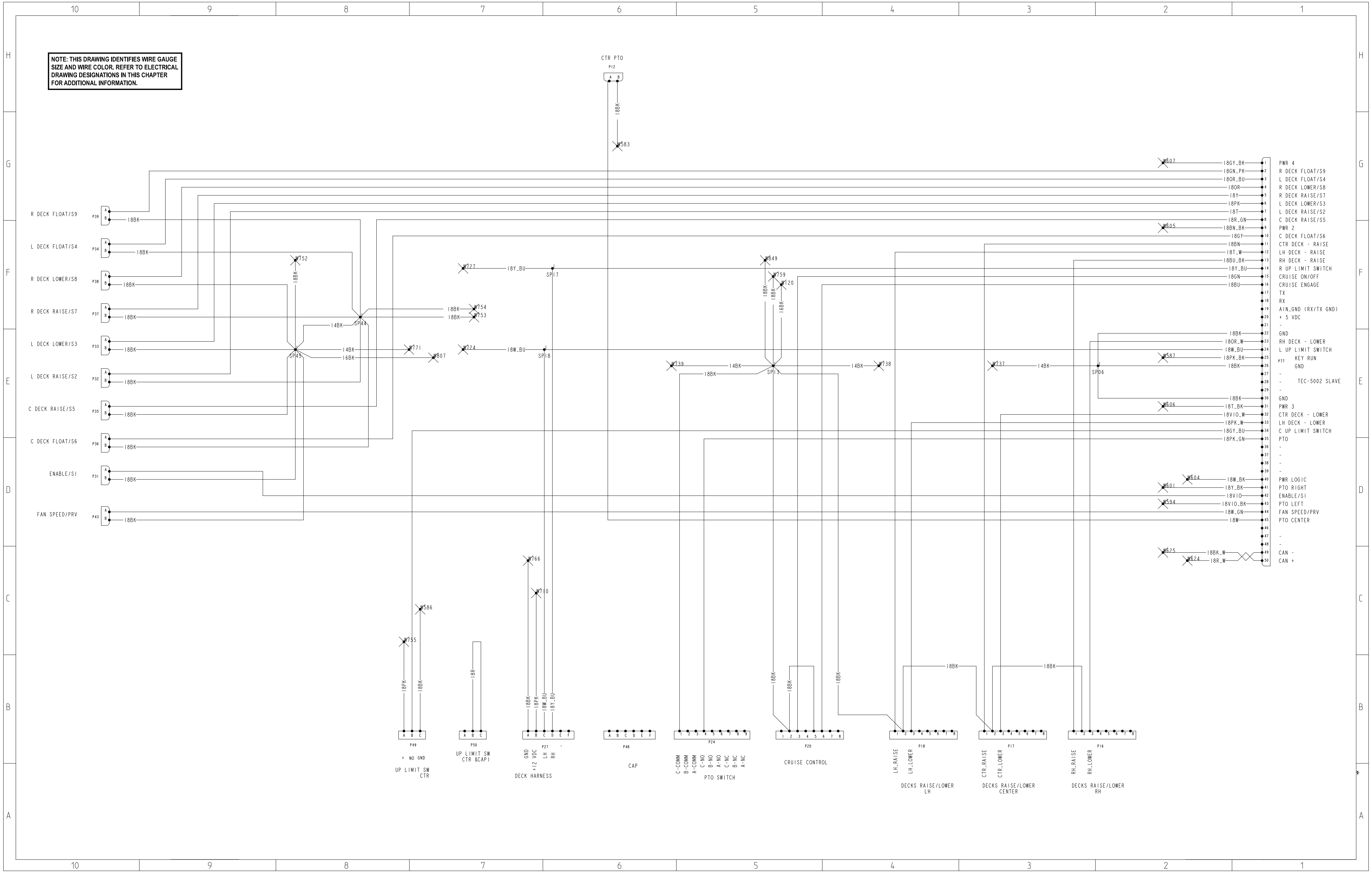
g327816

Platform Wire Harness Diagram (For machines serial number 403450001 to 408000000)



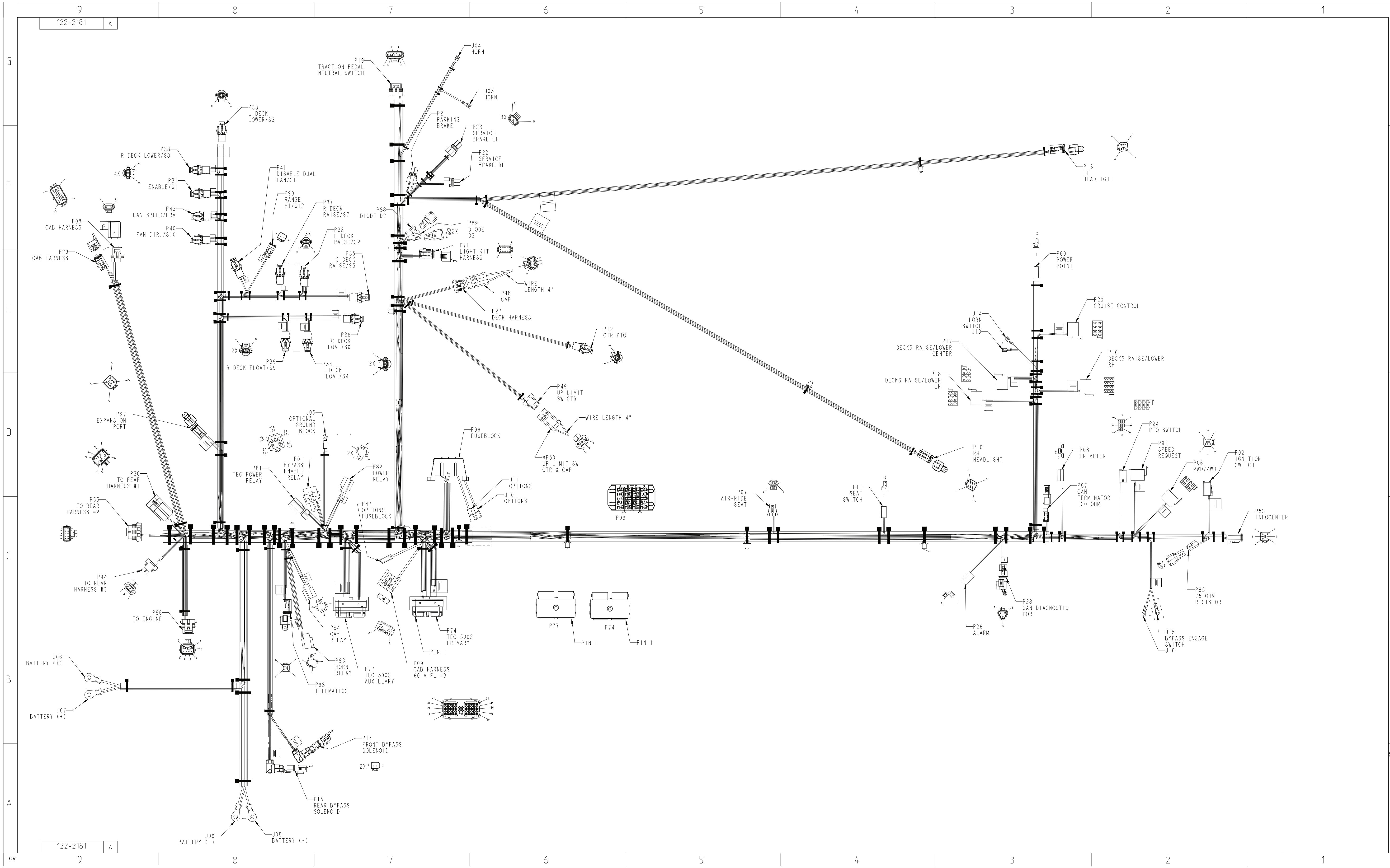
g327817

Platform Wire Harness Diagram (For machines serial number 403450001 to 408000000)



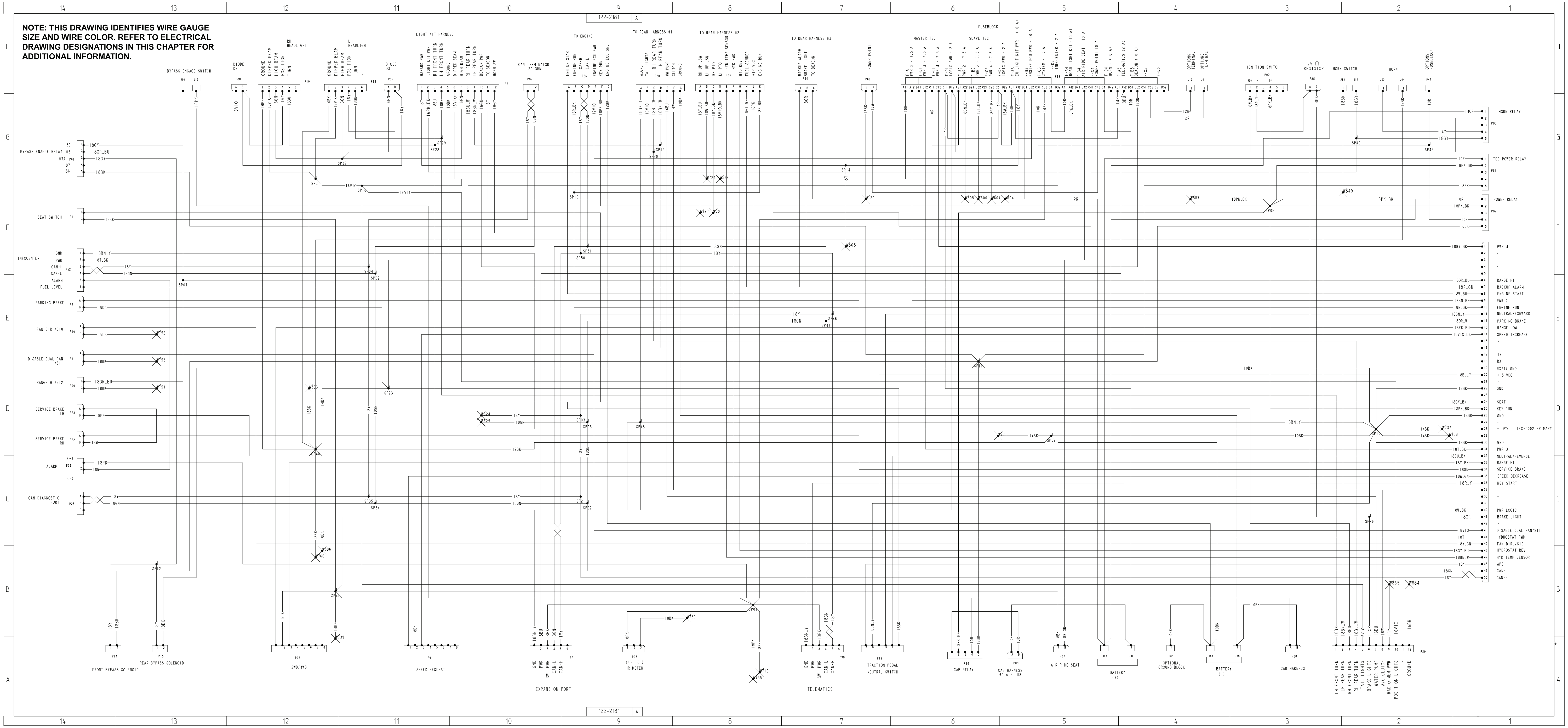
g327818

Platform Wire Harness Diagram (For machines serial number above 408000000)



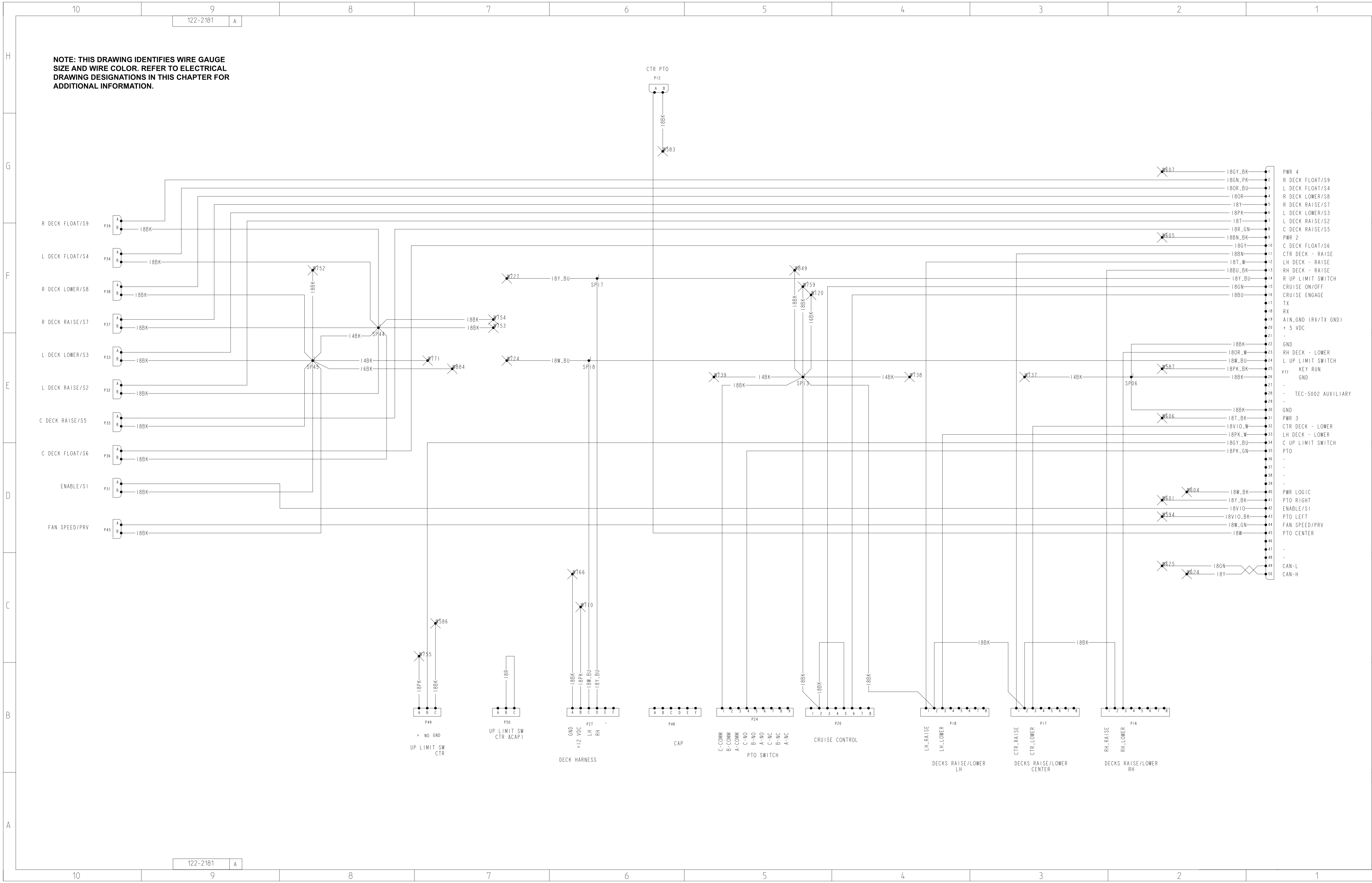
g362032

Platform Wire Harness Diagram (For machines serial number above 408000000)



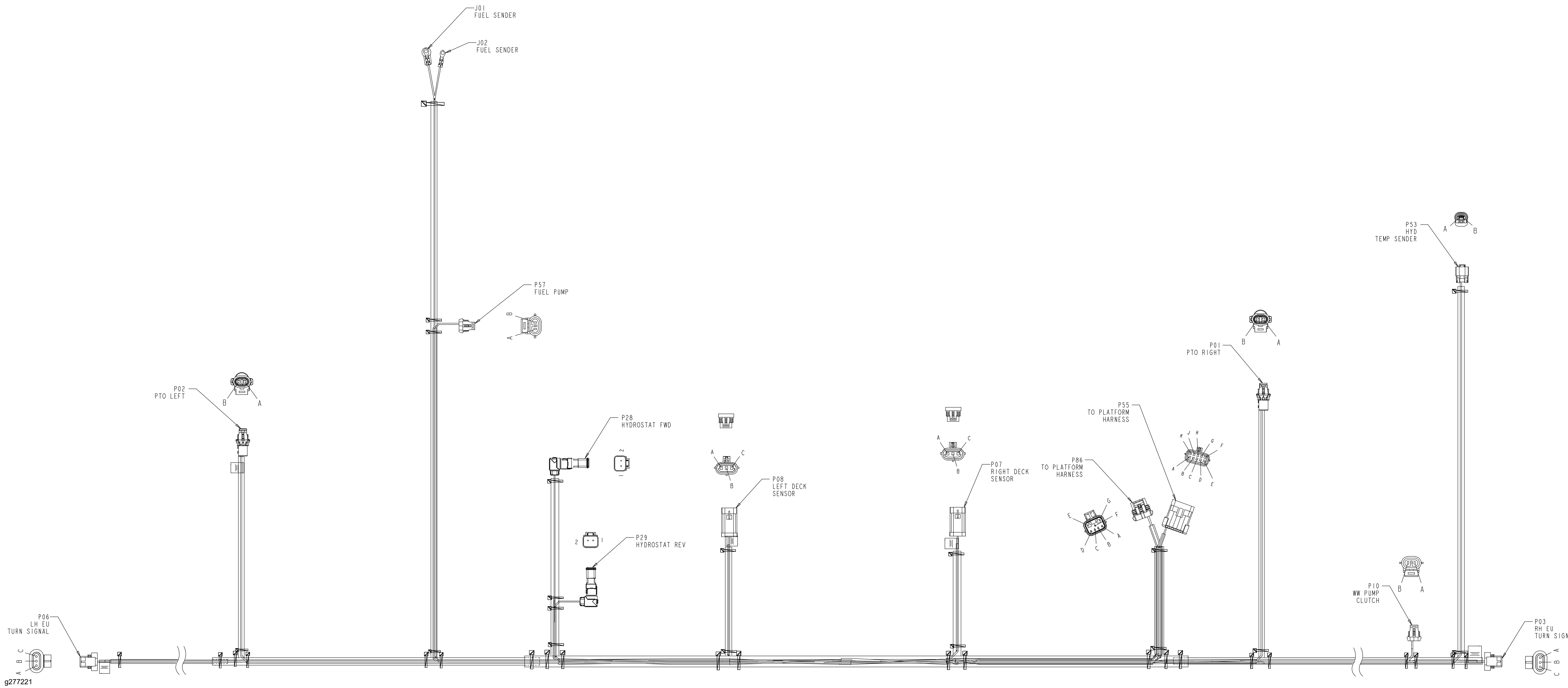
g362033

Platform Wire Harness Diagram (For machines serial number above 408000000)

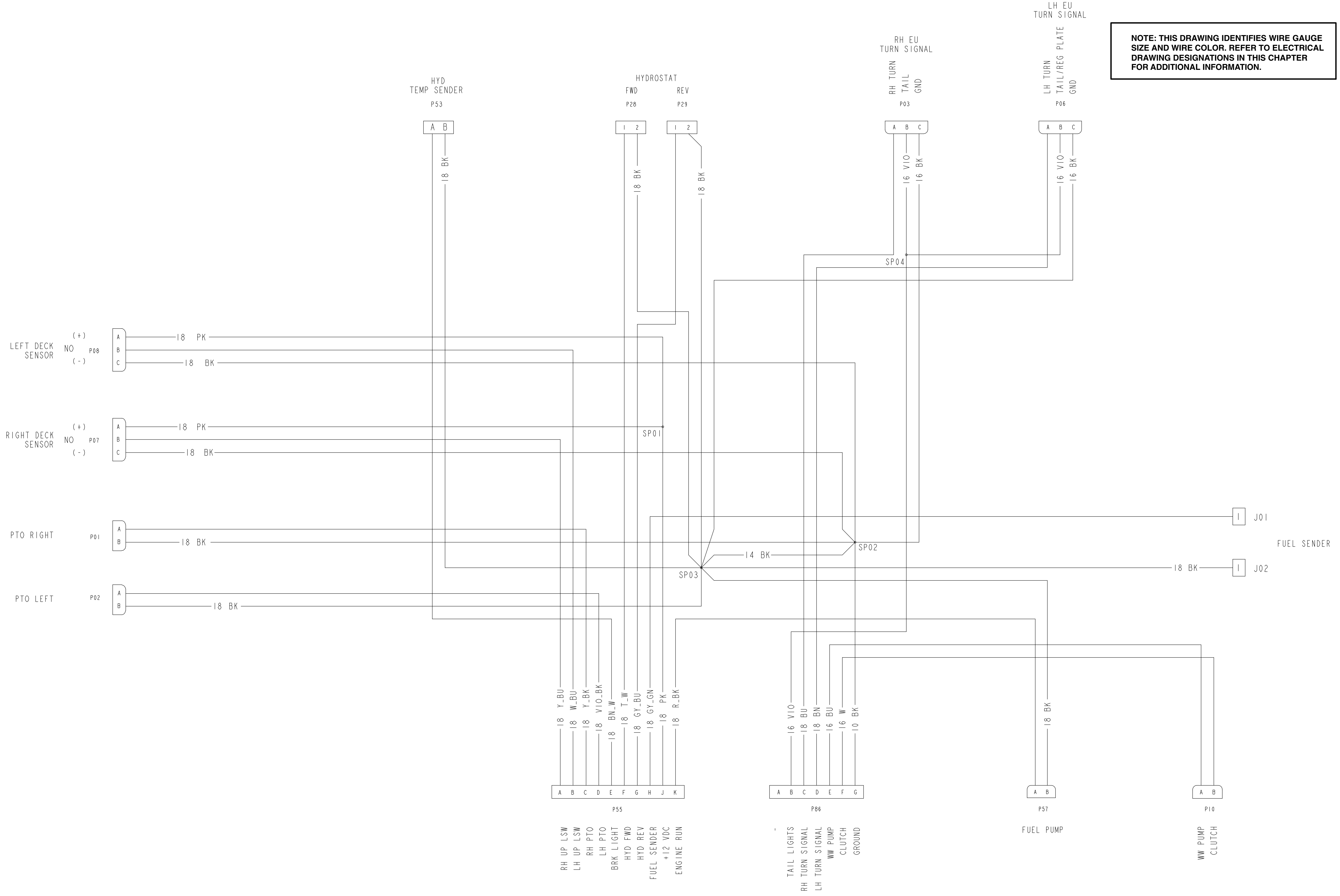


g362034

Rear Wire Harness Diagram (For machines serial number below 400000000)

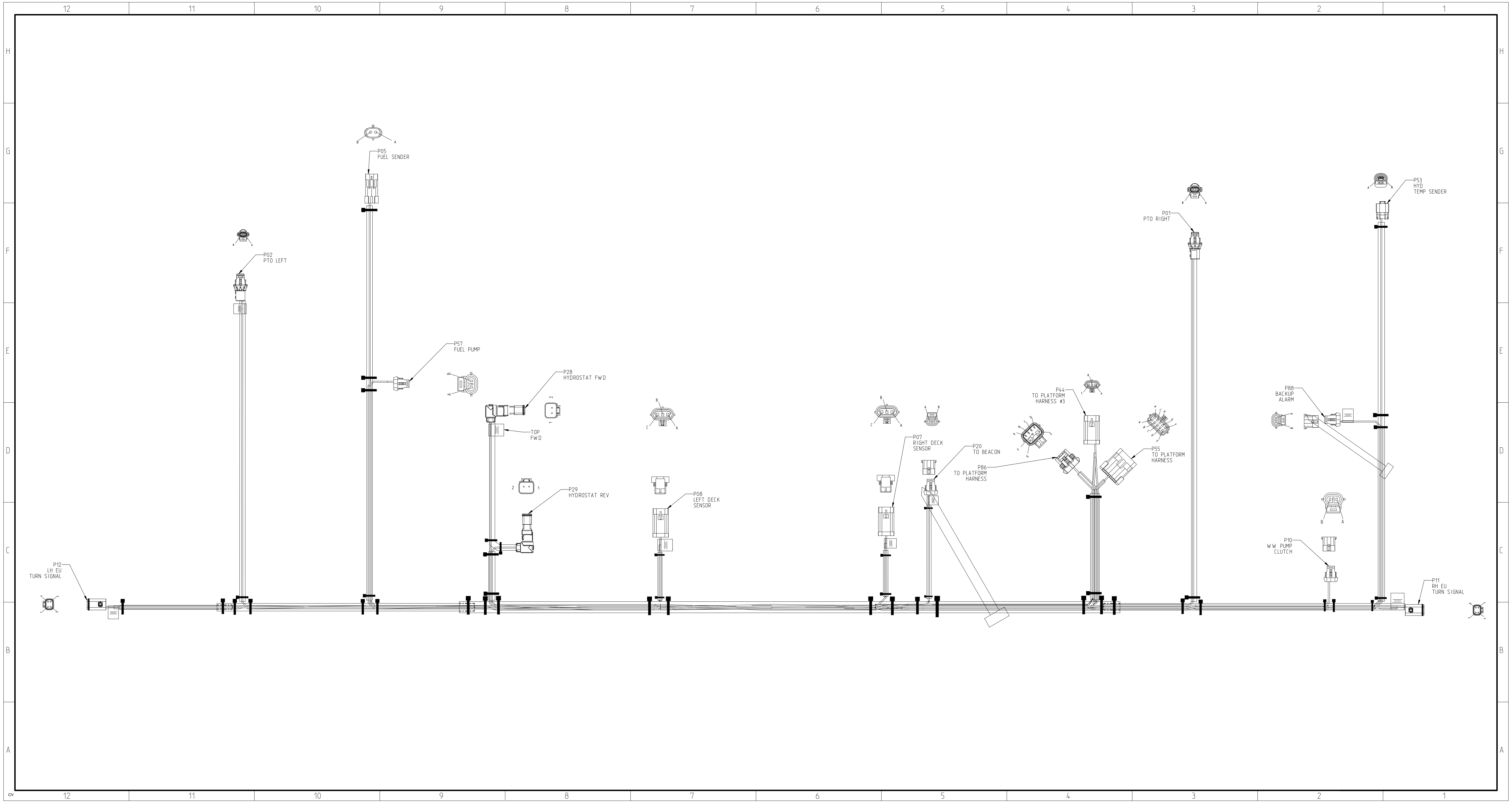


Rear Wire Harness Diagram (For machines serial number below 400000000)



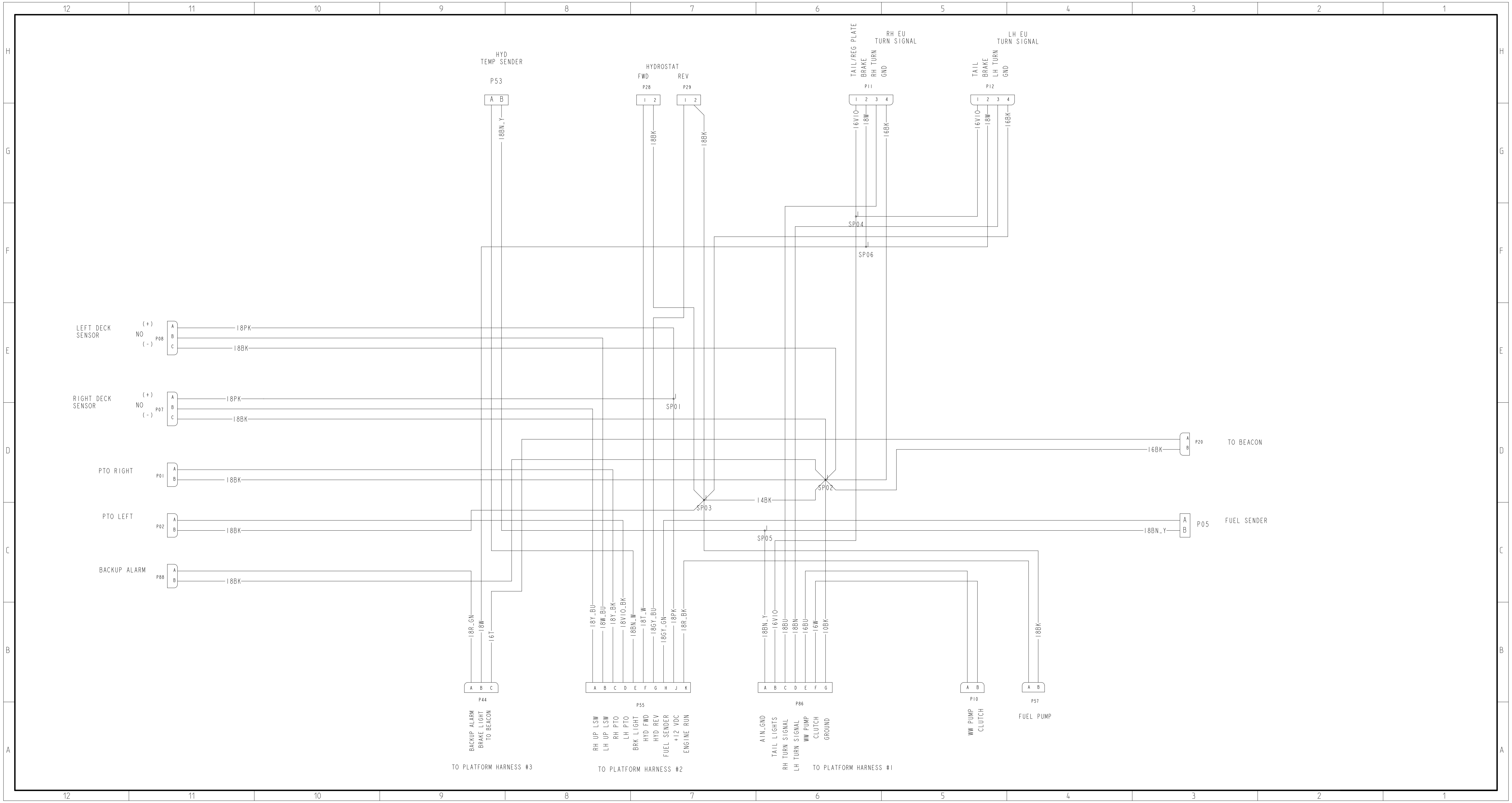
g277222

Rear Wire Harness Diagram (For machines serial number 400000000 to 408000000)



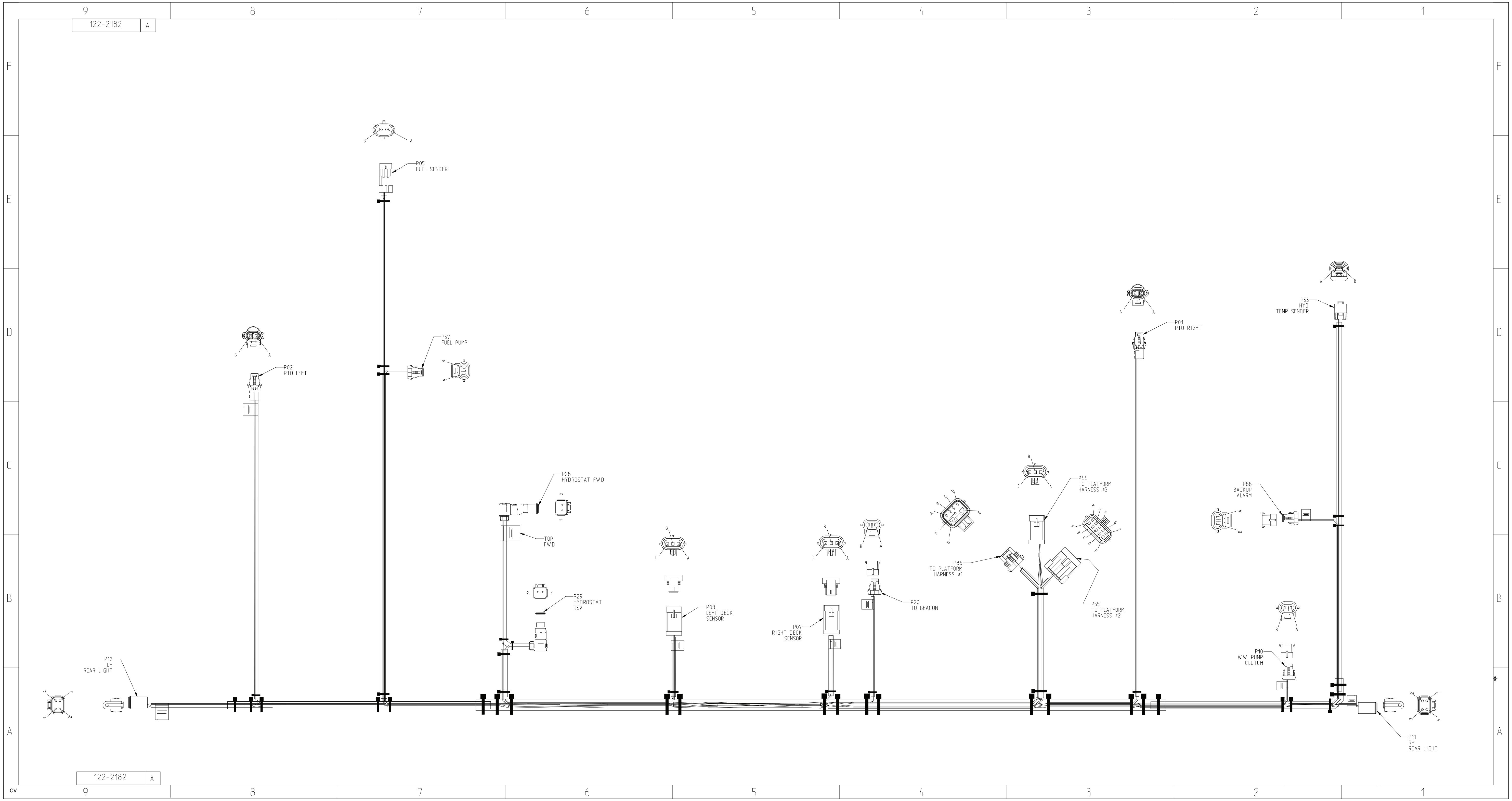
g279590

Rear Wire Harness Diagram (For machines serial number 400000000 to 408000000)



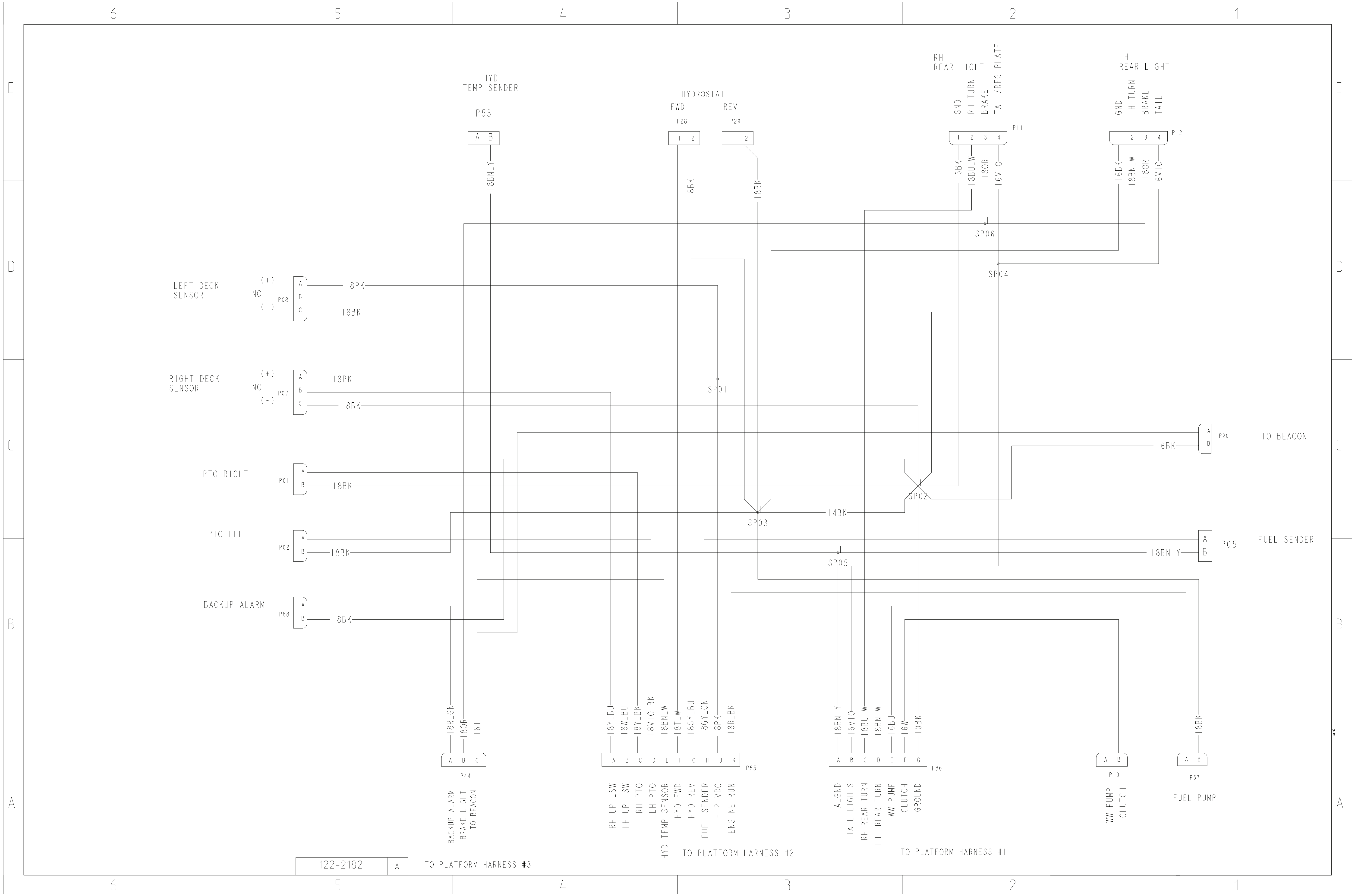
g279591

Rear Wire Harness Diagram (For machines serial numbers above 408000000)



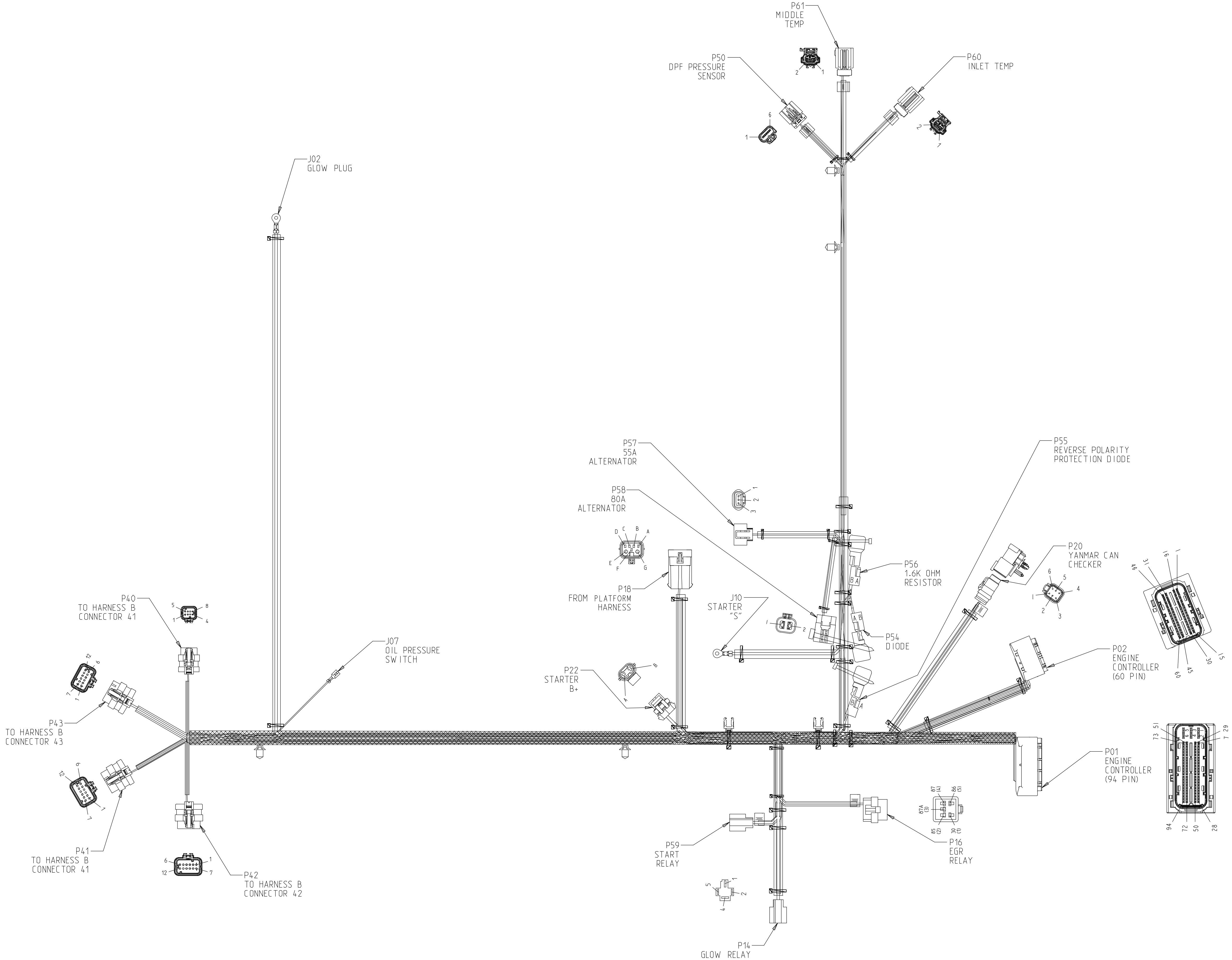
g362035

Rear Wire Harness Diagram (For machines serial numbers above 408000000)



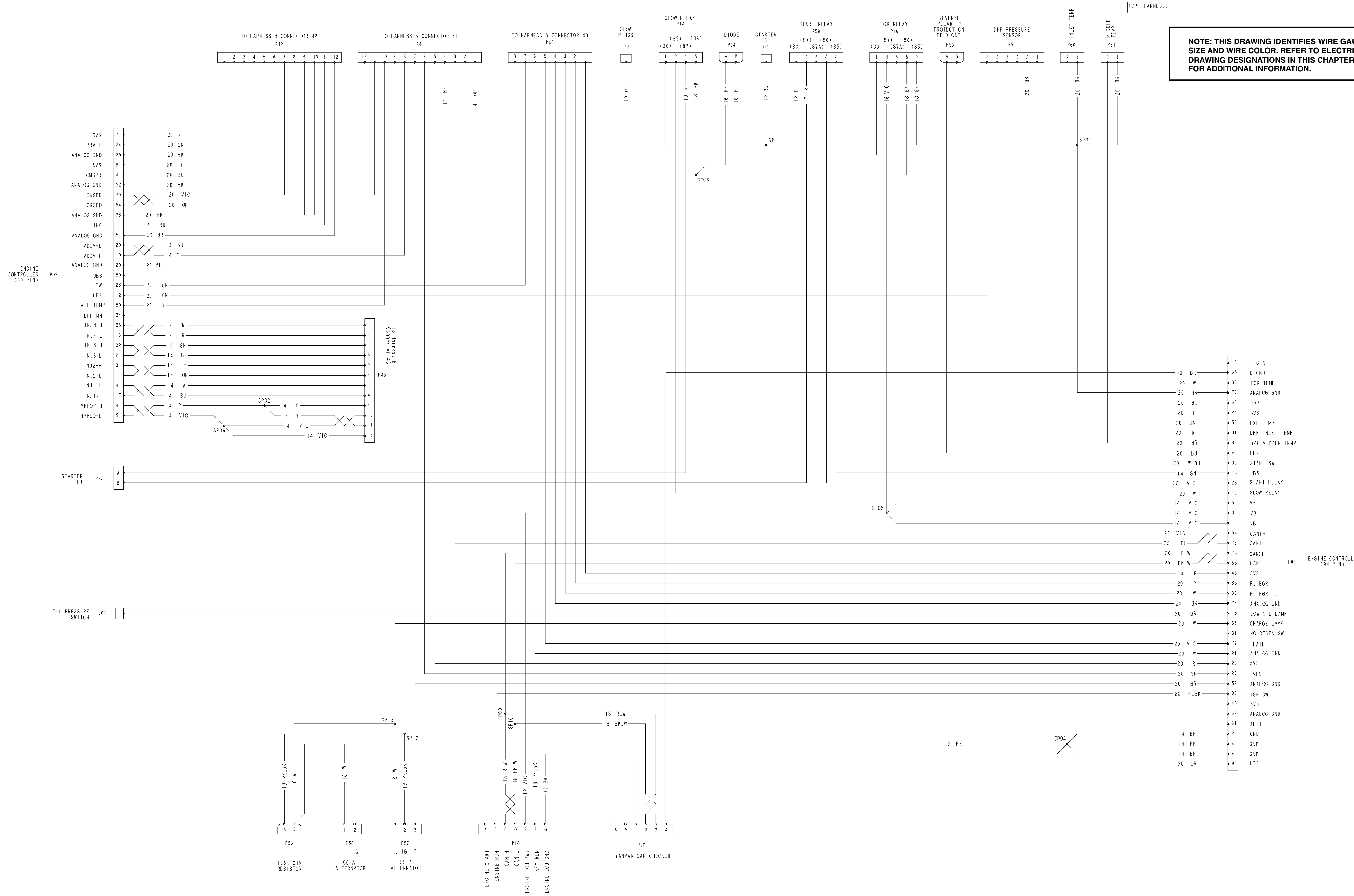
g362036

Engine Wire Harness Drawing for Models 30606, 30608, 30644 (For machines serial number below 400000000)



g277223

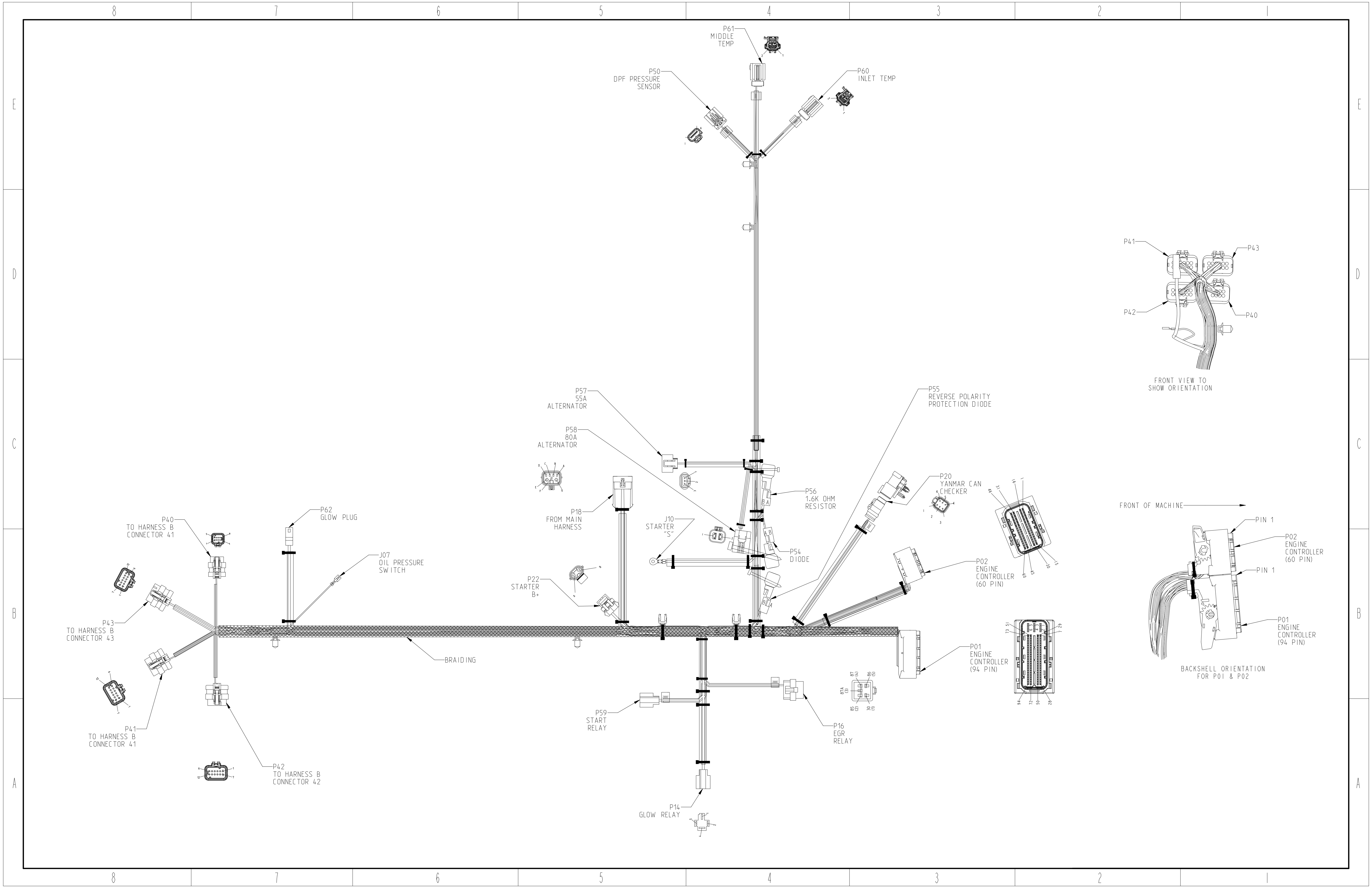
Engine Wire Harness Diagram for Models 30606, 30608, 30644 (For machines serial number below 400000000)



NOTE: THIS DRAWING IDENTIFIES WIRE GAUGE SIZE AND WIRE COLOR. REFER TO ELECTRICAL DRAWING DESIGNATIONS IN THIS CHAPTER FOR ADDITIONAL INFORMATION.

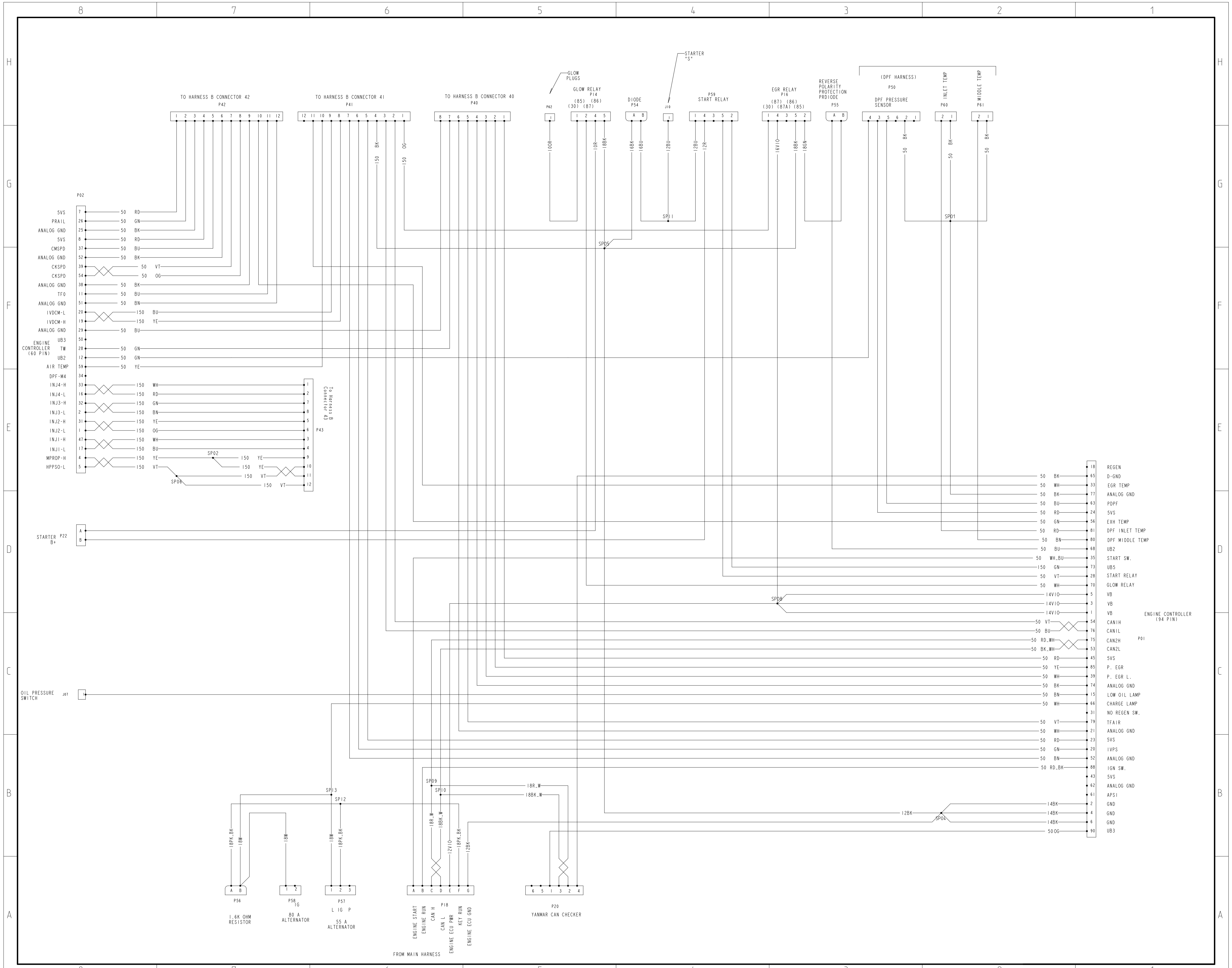
g277224

Engine Wire Harness Diagram for Models 30606, 30608, 30644 (For machines serial numbers 400000001 to 403450000)



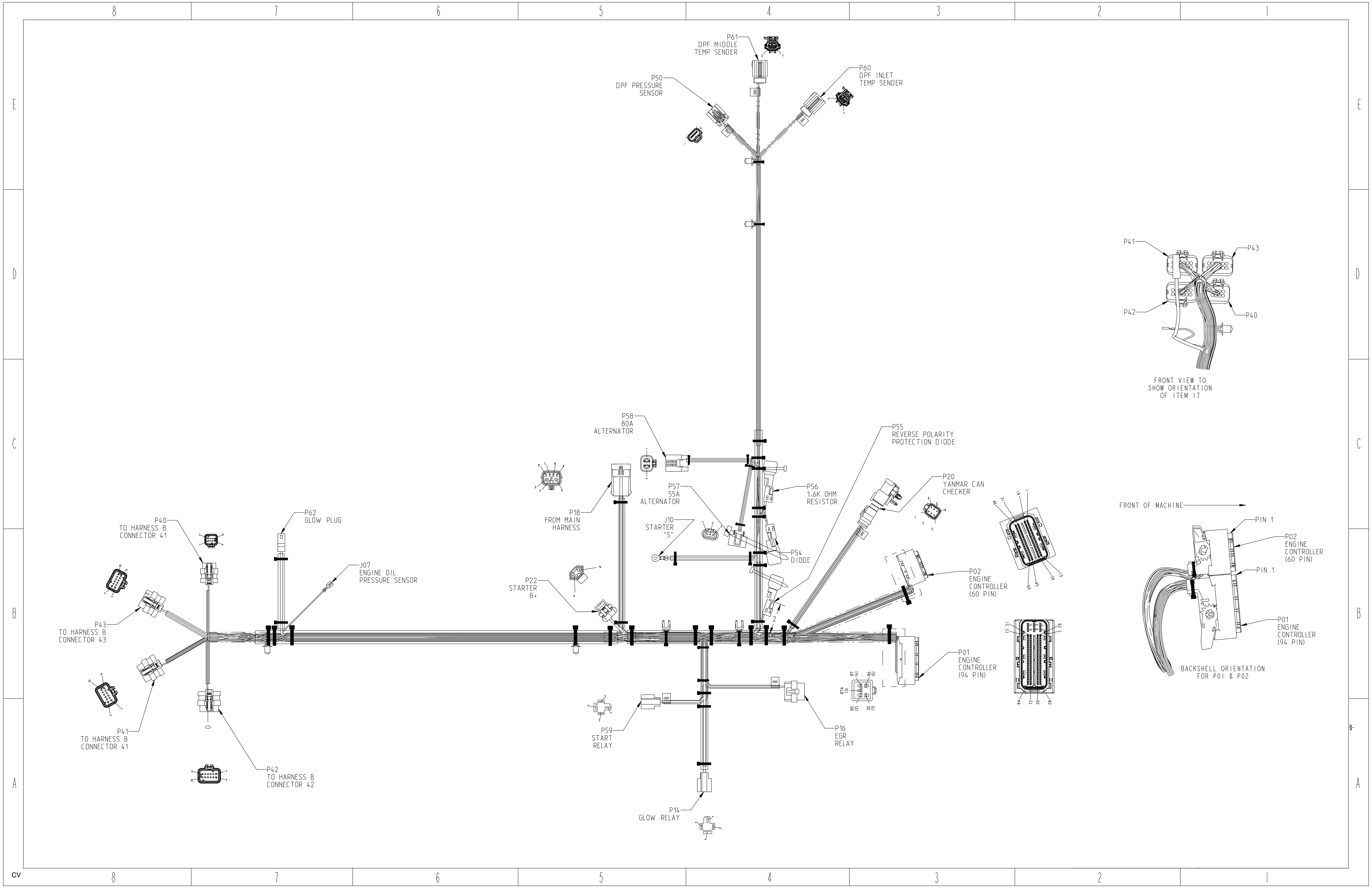
g279588

Engine Wire Harness Diagram for Models 30606, 30608, 30644 (For machines serial numbers 400000001 to 403450000)



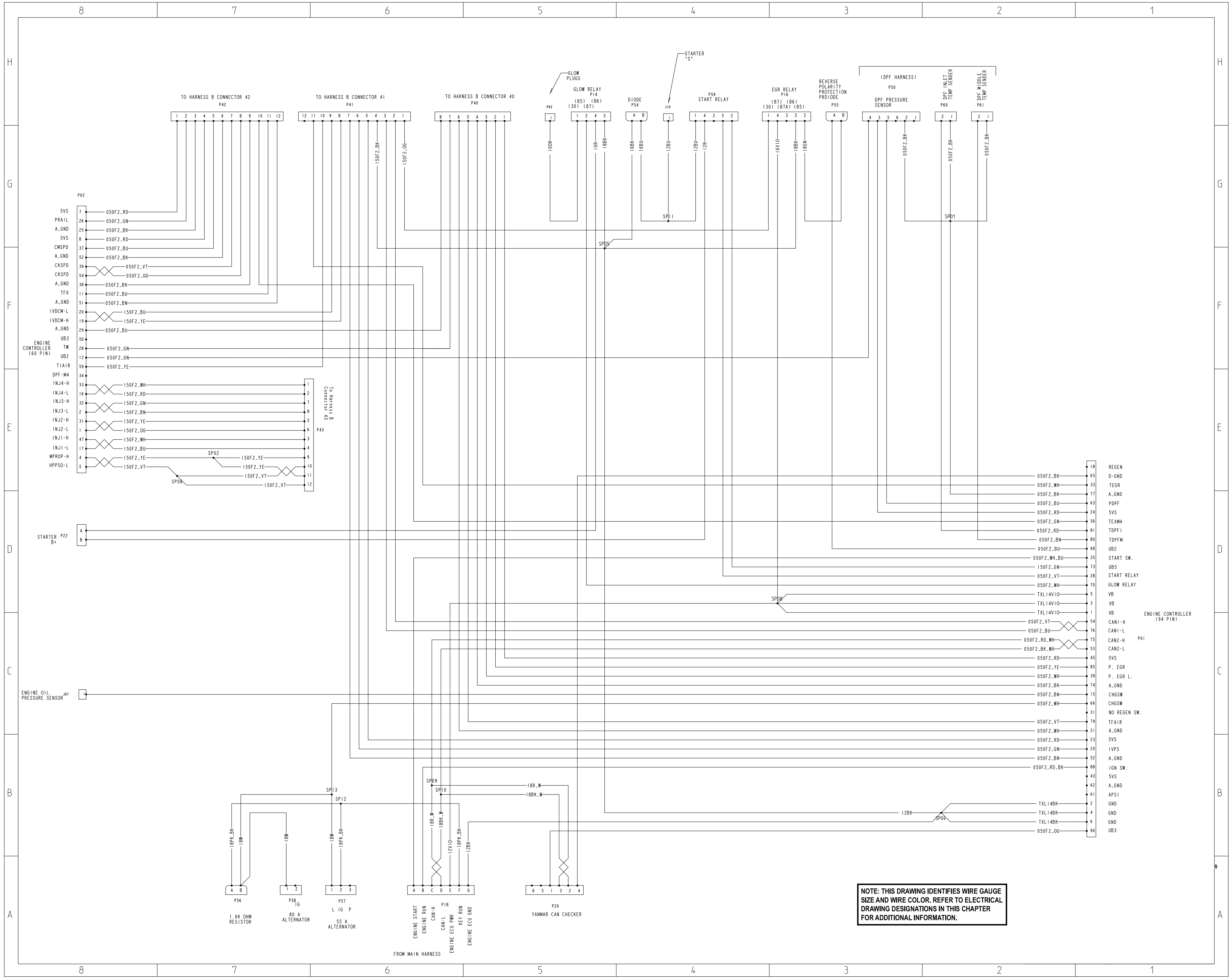
g279589

Engine Wire Harness Diagram for Models 30606, 30608, 30644 (For machines serial number 403450001 to 408000000)



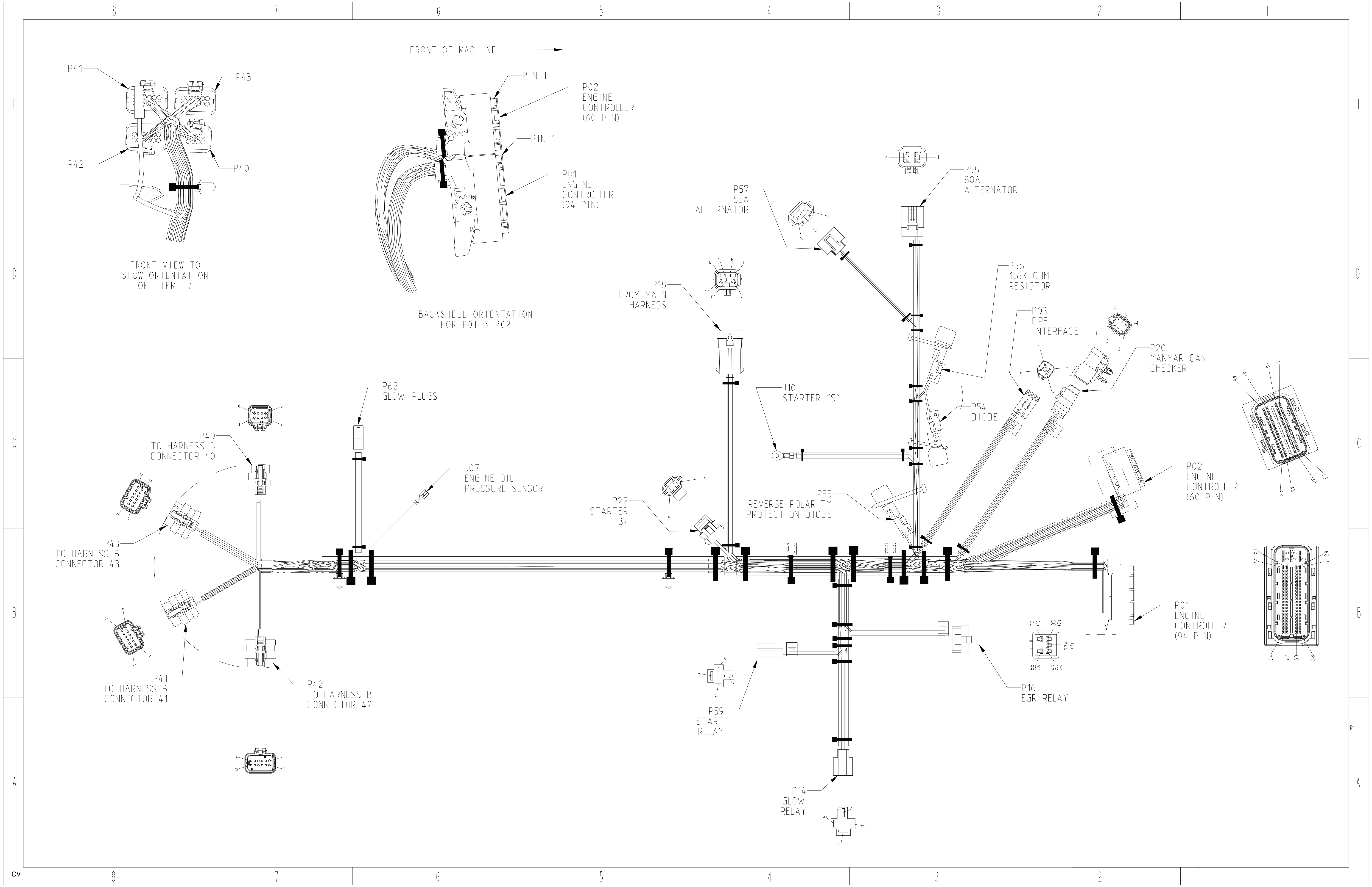
g327819

Engine Wire Harness Diagram for Models 30606, 30608, 30644 (For machines serial number 403450001 to 408000000)



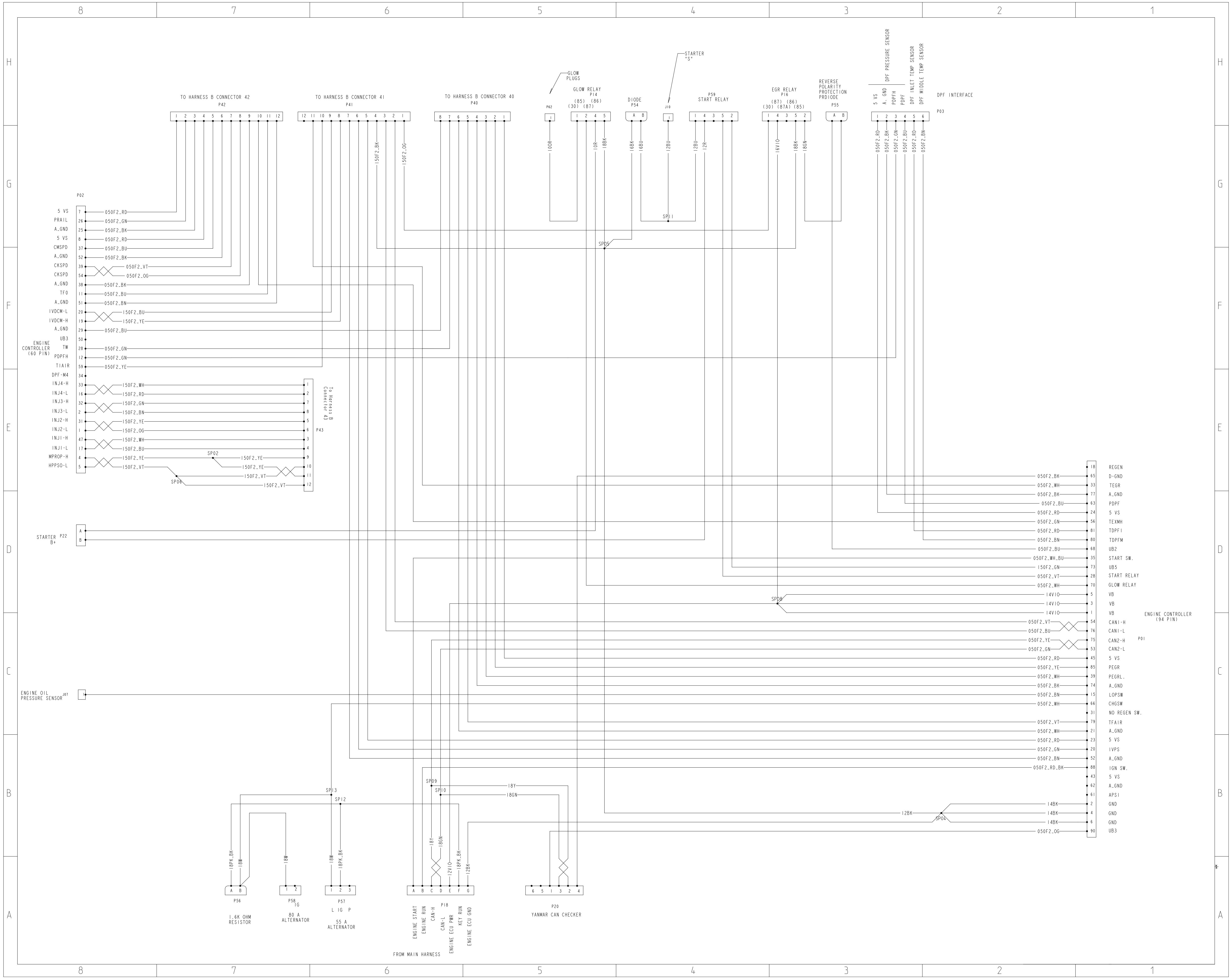
g327820

Engine Wire Harness Diagram for Models 30606, 30608, 30644 (For machines serial number above 408000000)

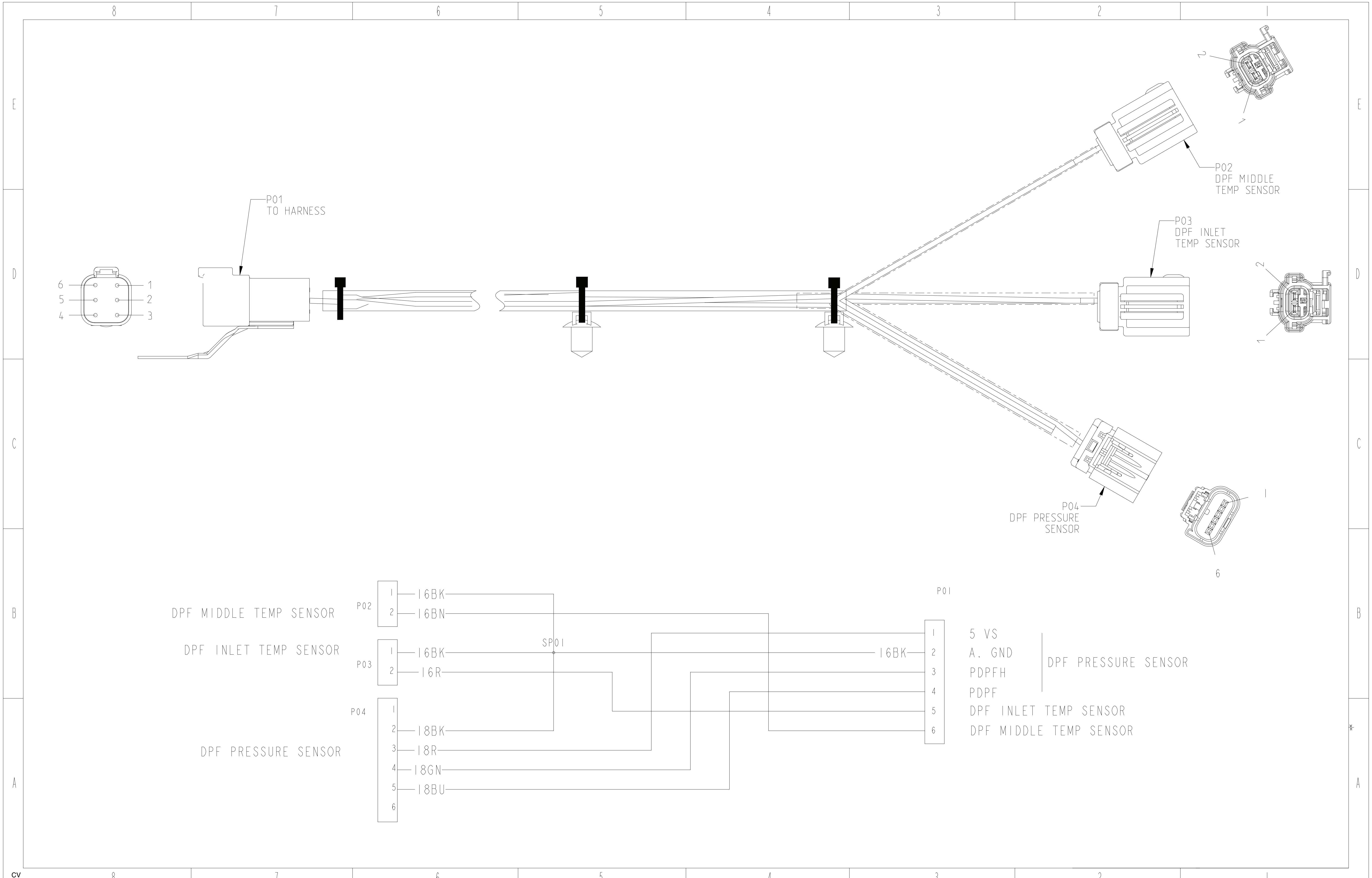


g362037

Engine Wire Harness Diagram for Models 30606, 30608, 30644 (For machines serial number above 408000000)



Engine DPF Wire Harness Diagram for Models 30606, 30608, 30644 (For machines serial number above 408000000)



g362042

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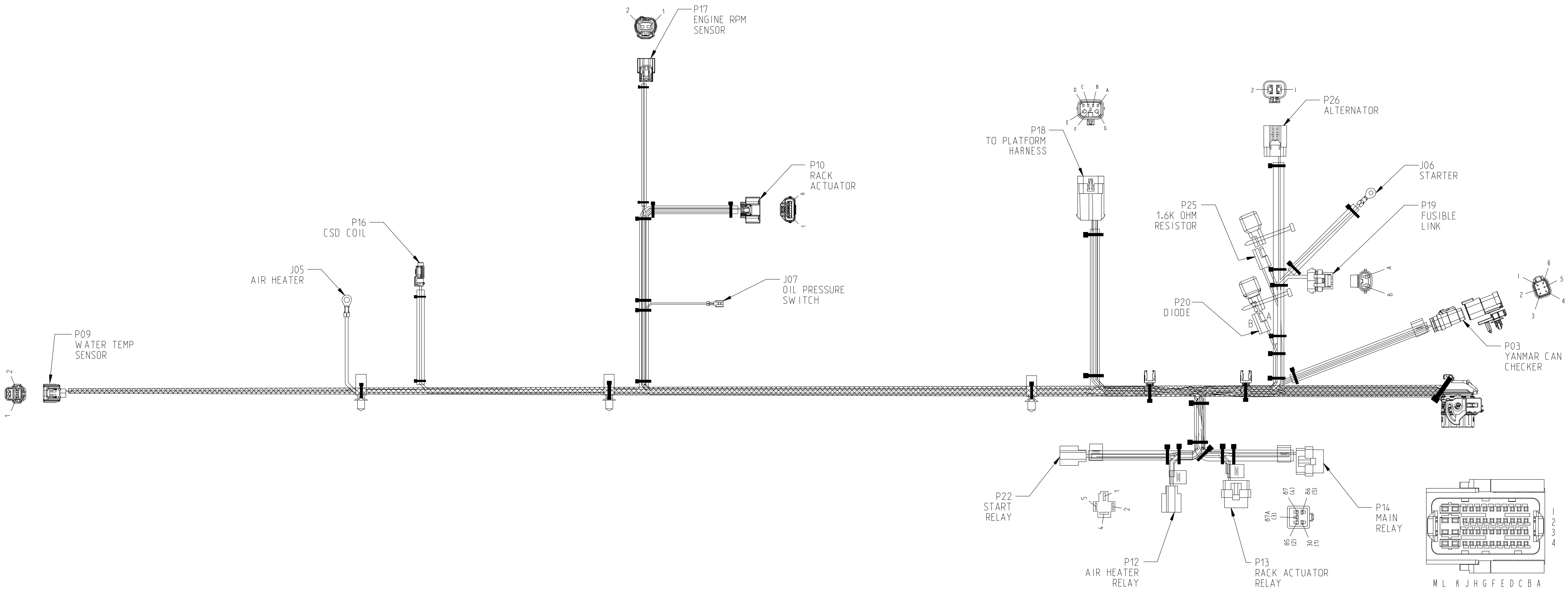
g326106

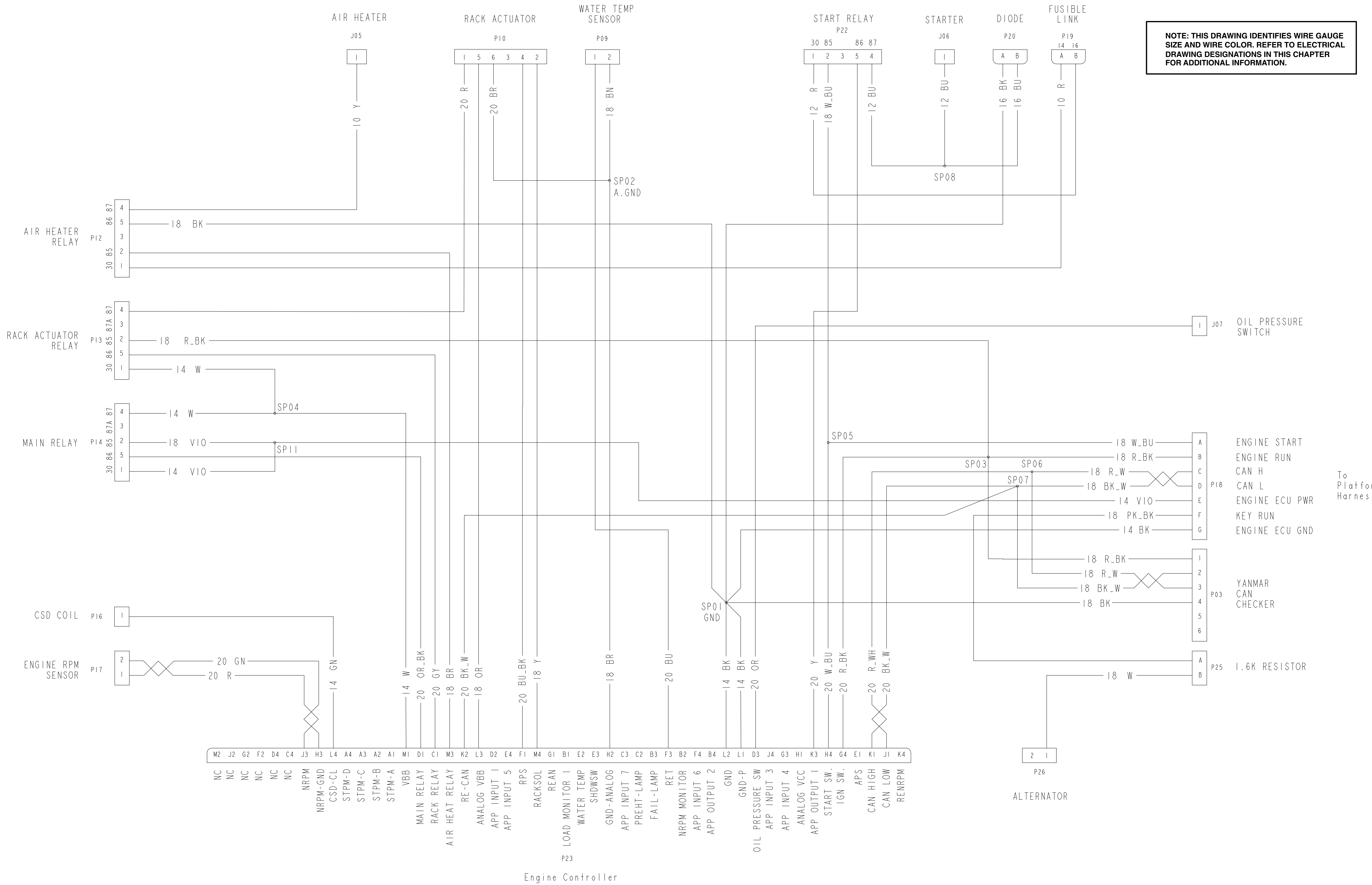
Engine Wire Harness Drawing for Models 30602, 30604, 30643



g277225

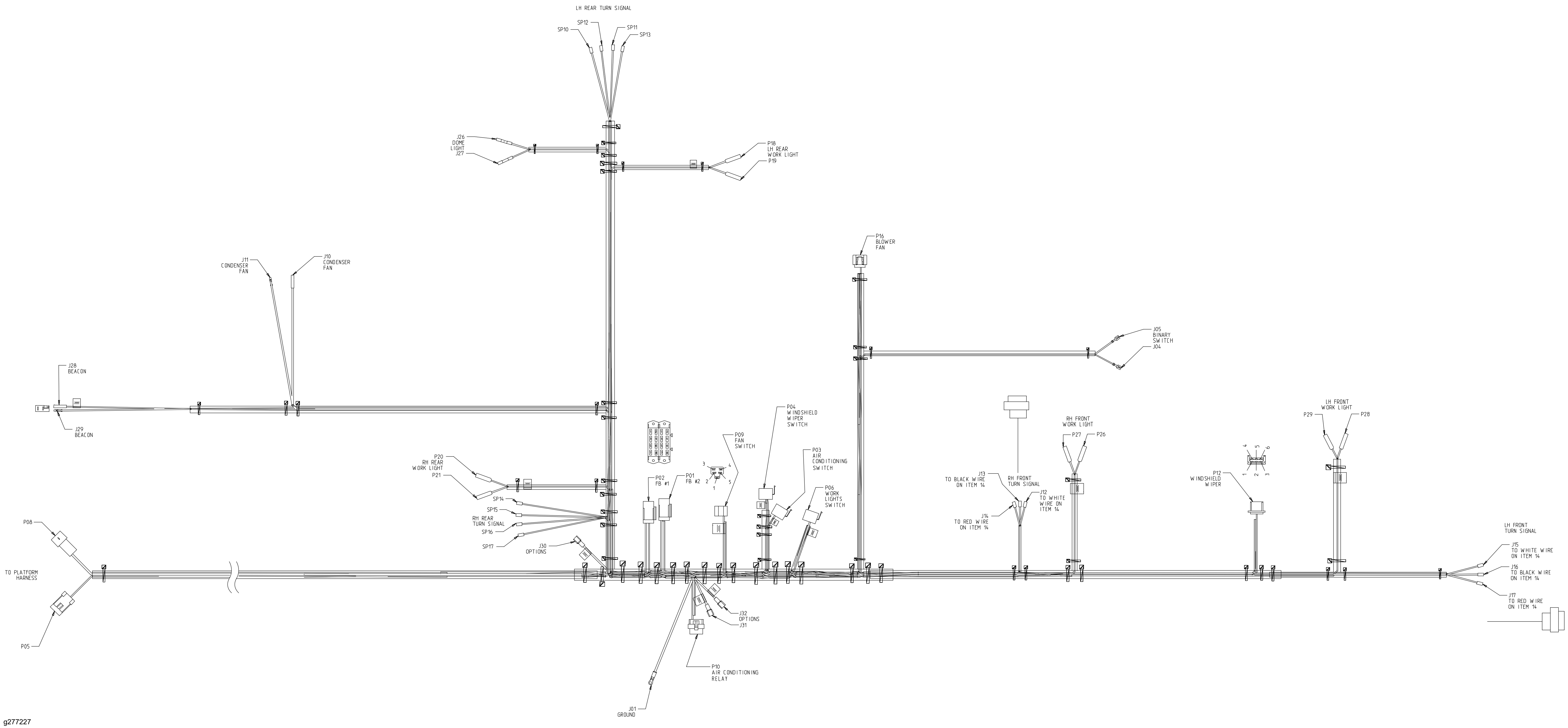
Engine Wire Harness Drawing for Models 30602, 30604, 30643

NOTE: THIS DRAWING IDENTIFIES WIRE GAUGE SIZE AND WIRE COLOR. REFER TO ELECTRICAL DRAWING DESIGNATIONS IN THIS CHAPTER FOR ADDITIONAL INFORMATION.



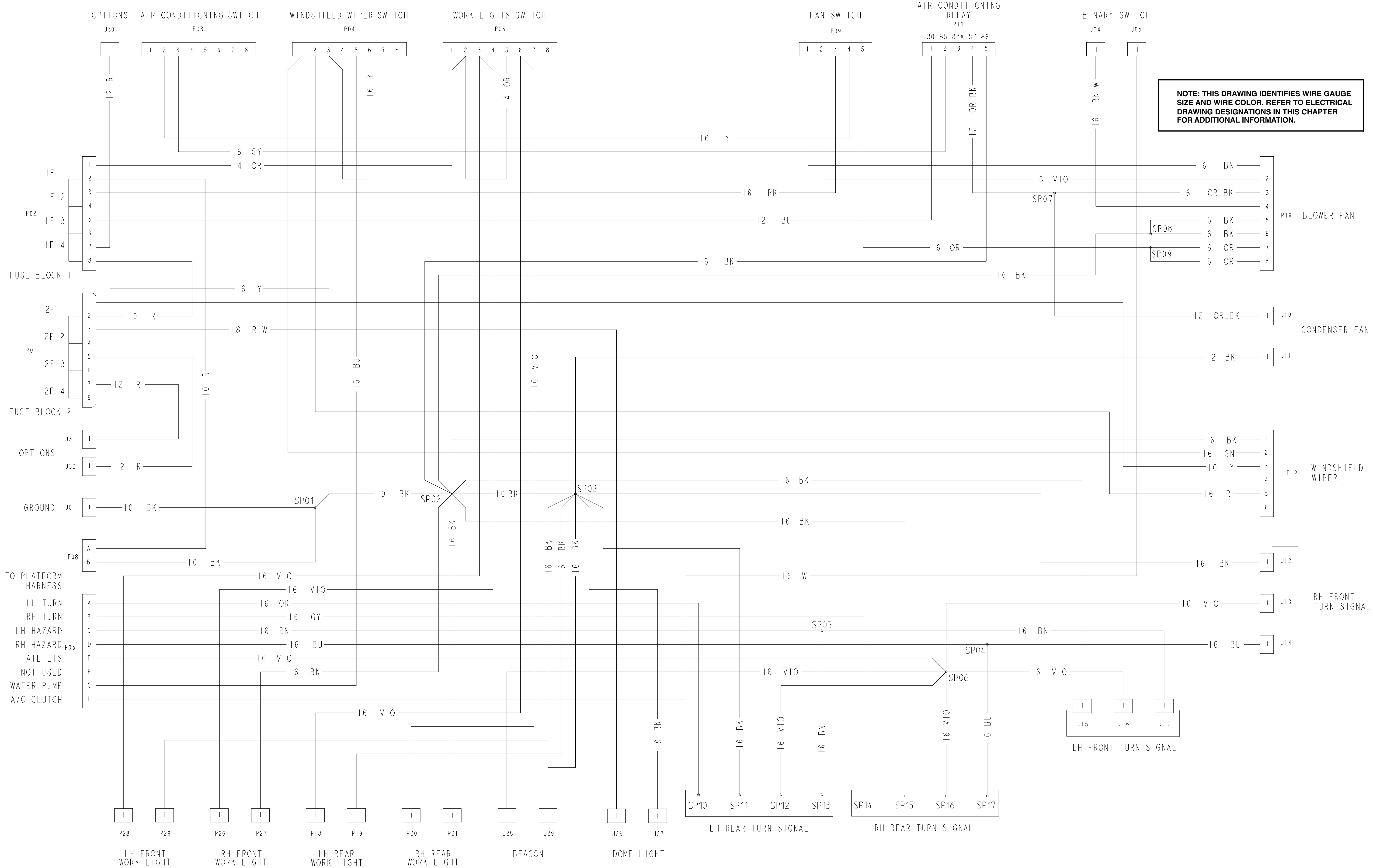
g277226

Operator Cab Wire Harness Diagram (For machines serial number below 400000000)

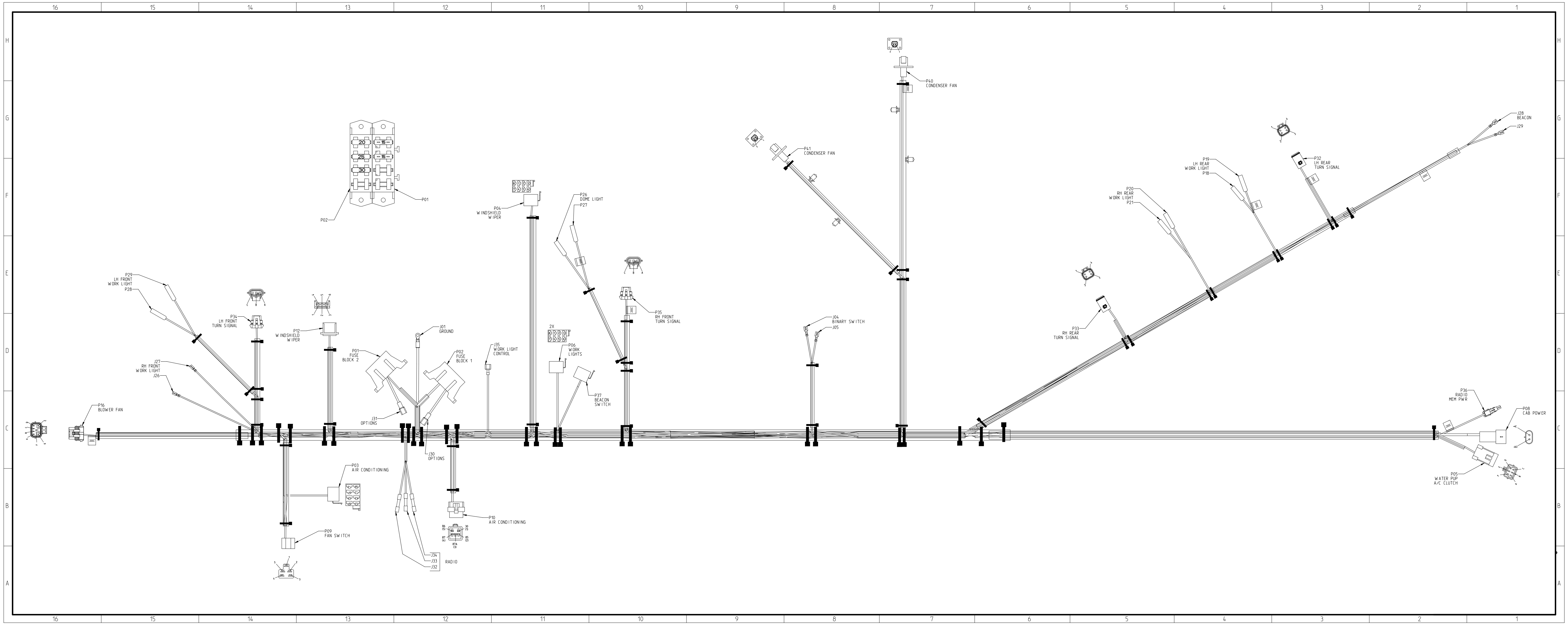


g277227

Operator Cab Wire Harness Diagram (For machines serial number below 400000000)

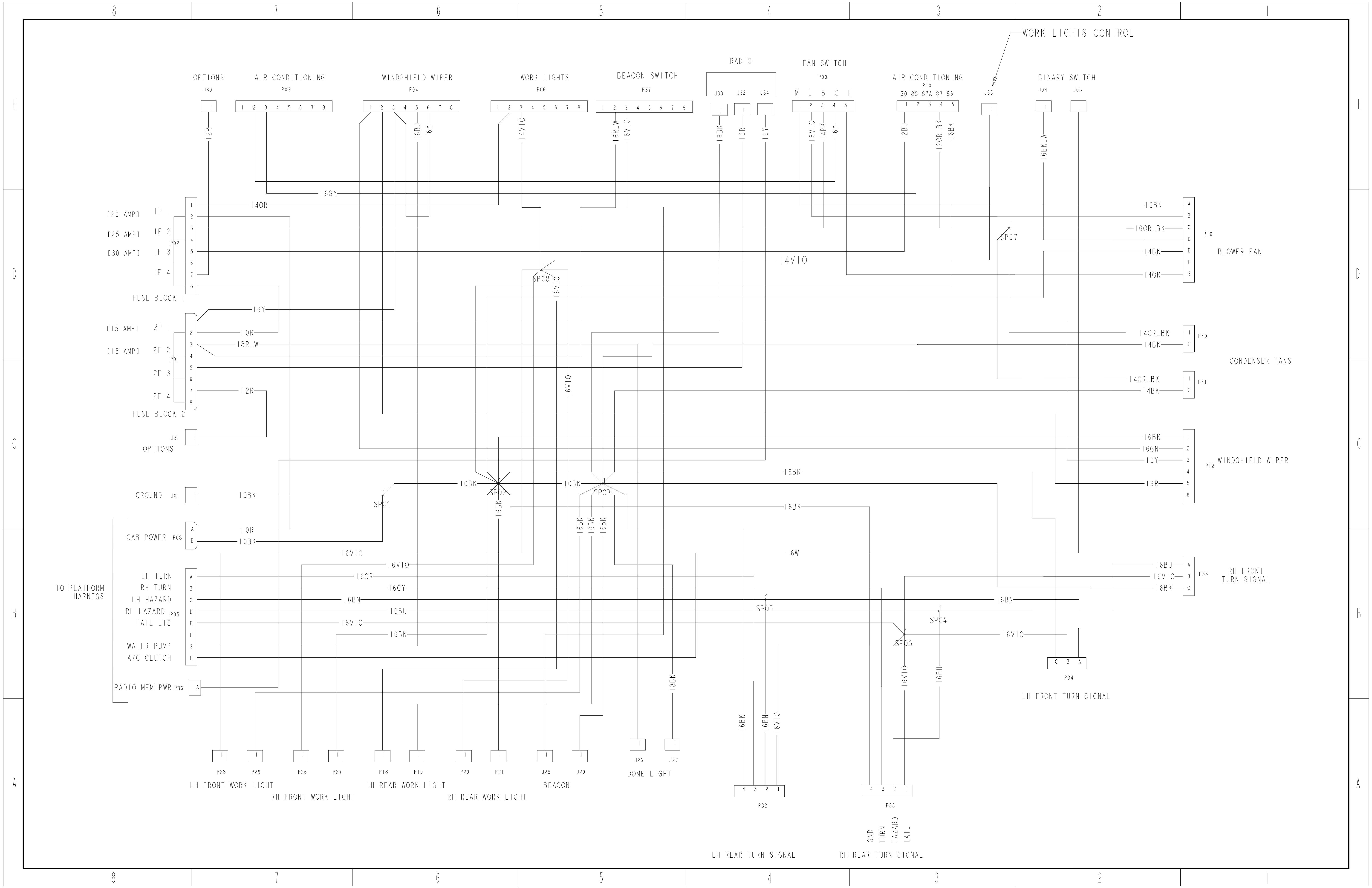


Operator Cab Wire Harness Diagram (For machines serial number above 400000000)



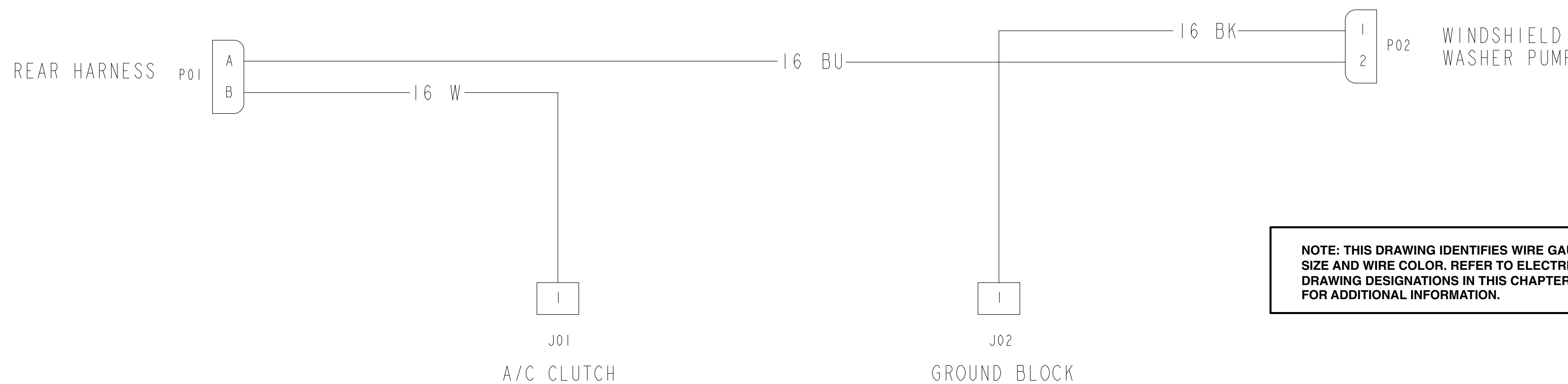
g279586

Operator Cab Wire Harness Diagram (For machines serial number above 400000000)



g279587

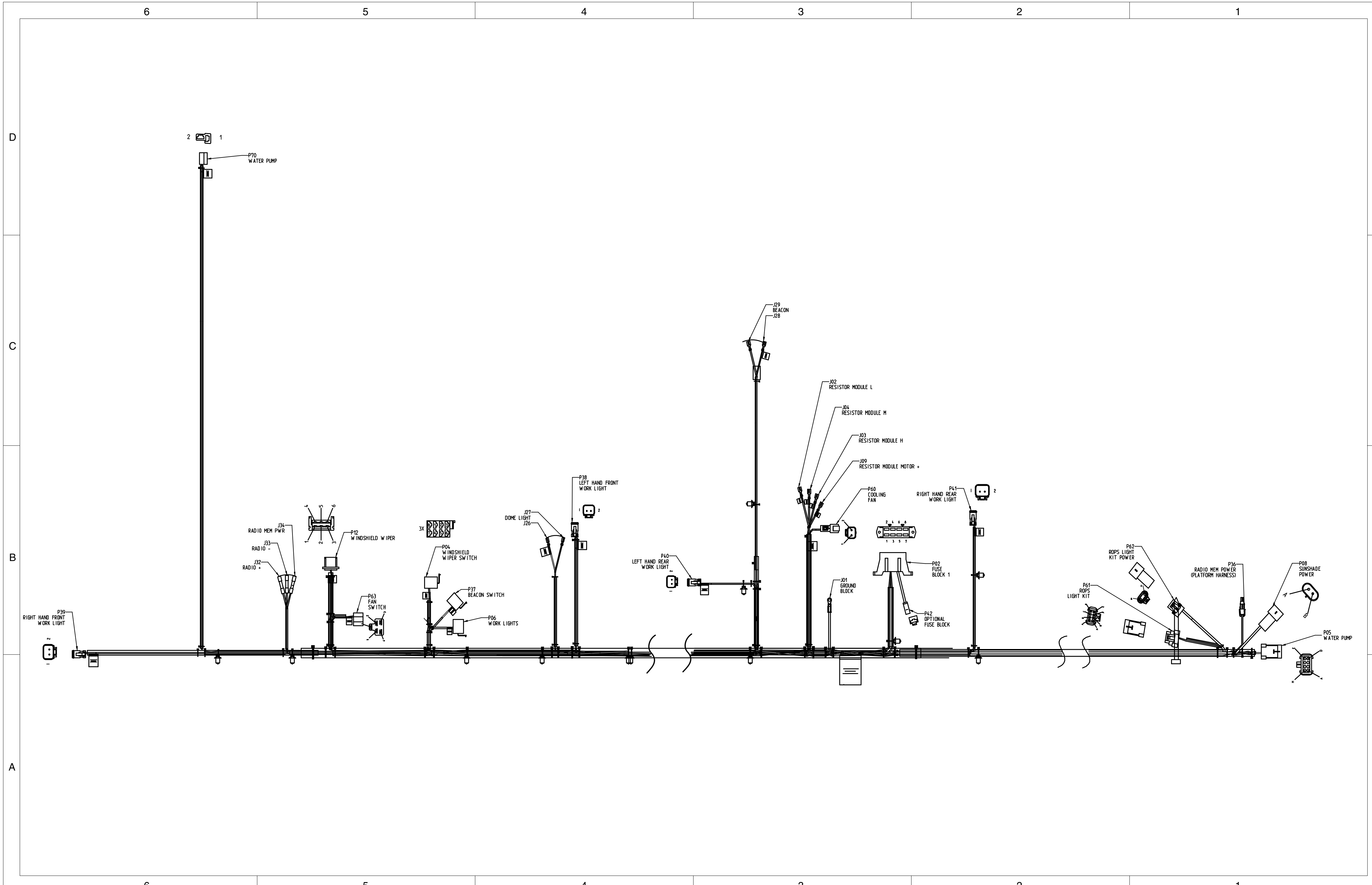
Operator Cab Interconnect Wire Harness



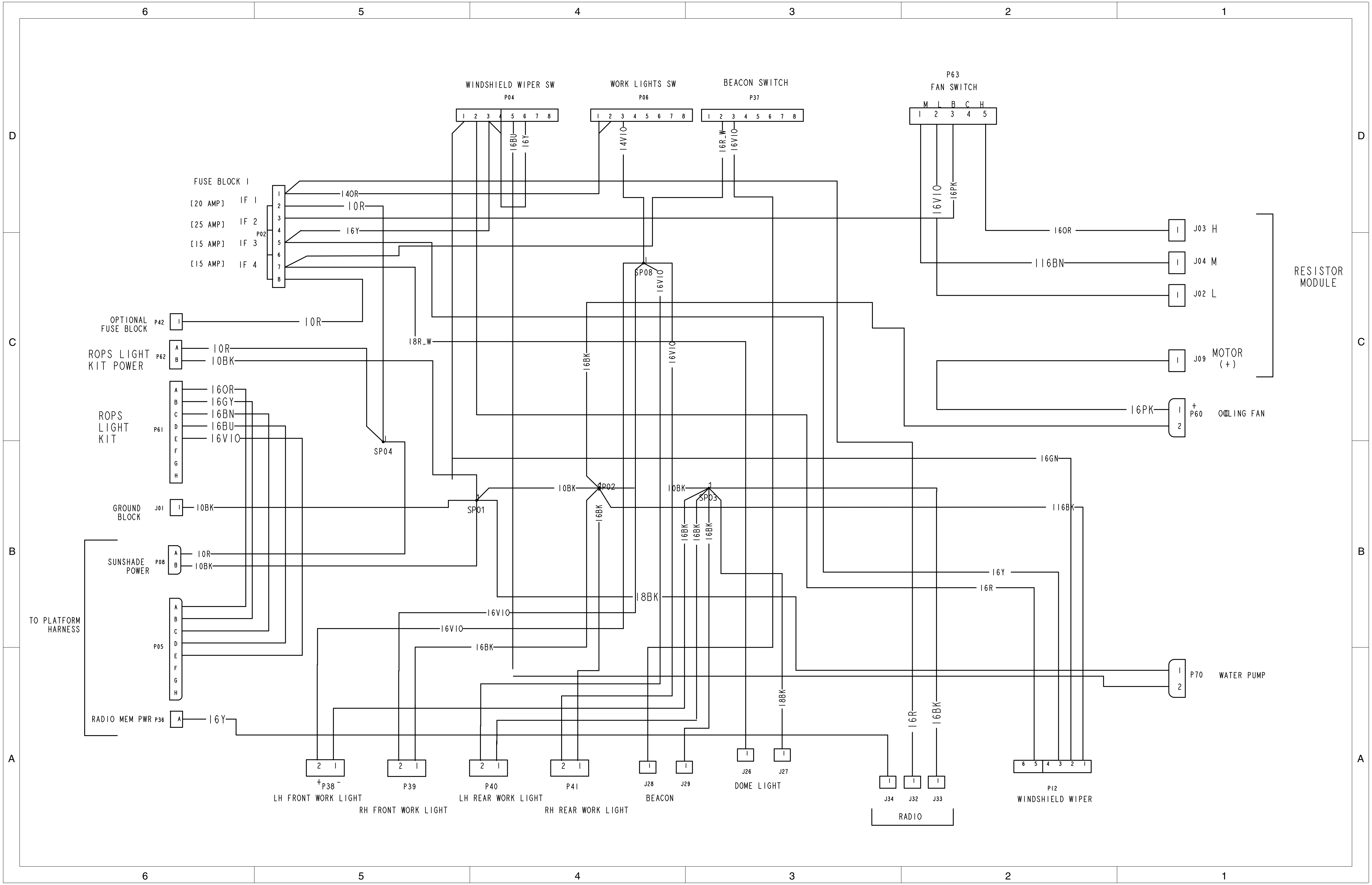
NOTE: THIS DRAWING IDENTIFIES WIRE GAUGE SIZE AND WIRE COLOR. REFER TO ELECTRICAL DRAWING DESIGNATIONS IN THIS CHAPTER FOR ADDITIONAL INFORMATION.

g277229

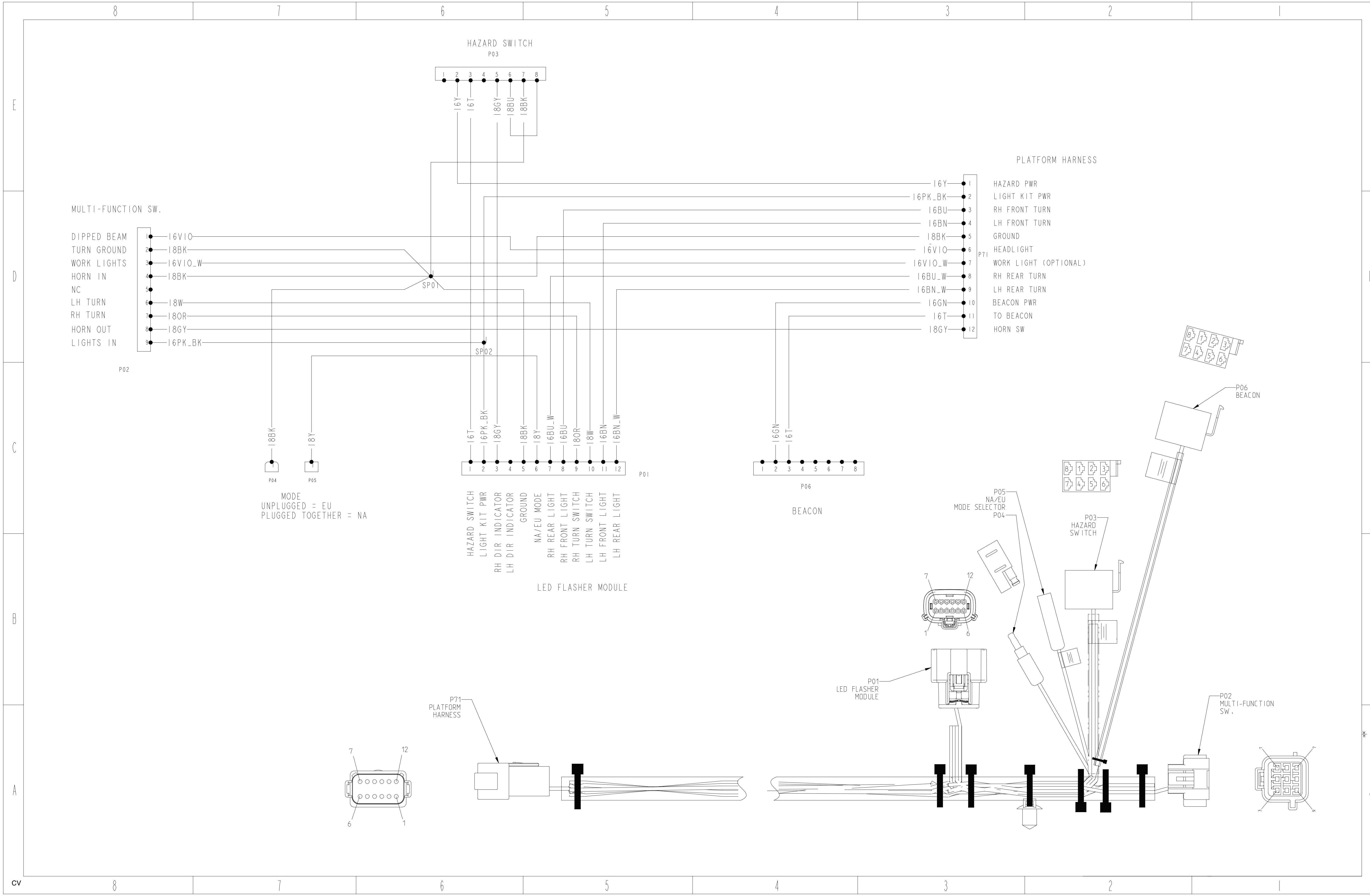
Wire Harness Diagram – Two–Post ROPS Extension (Models 30604 and 30608)

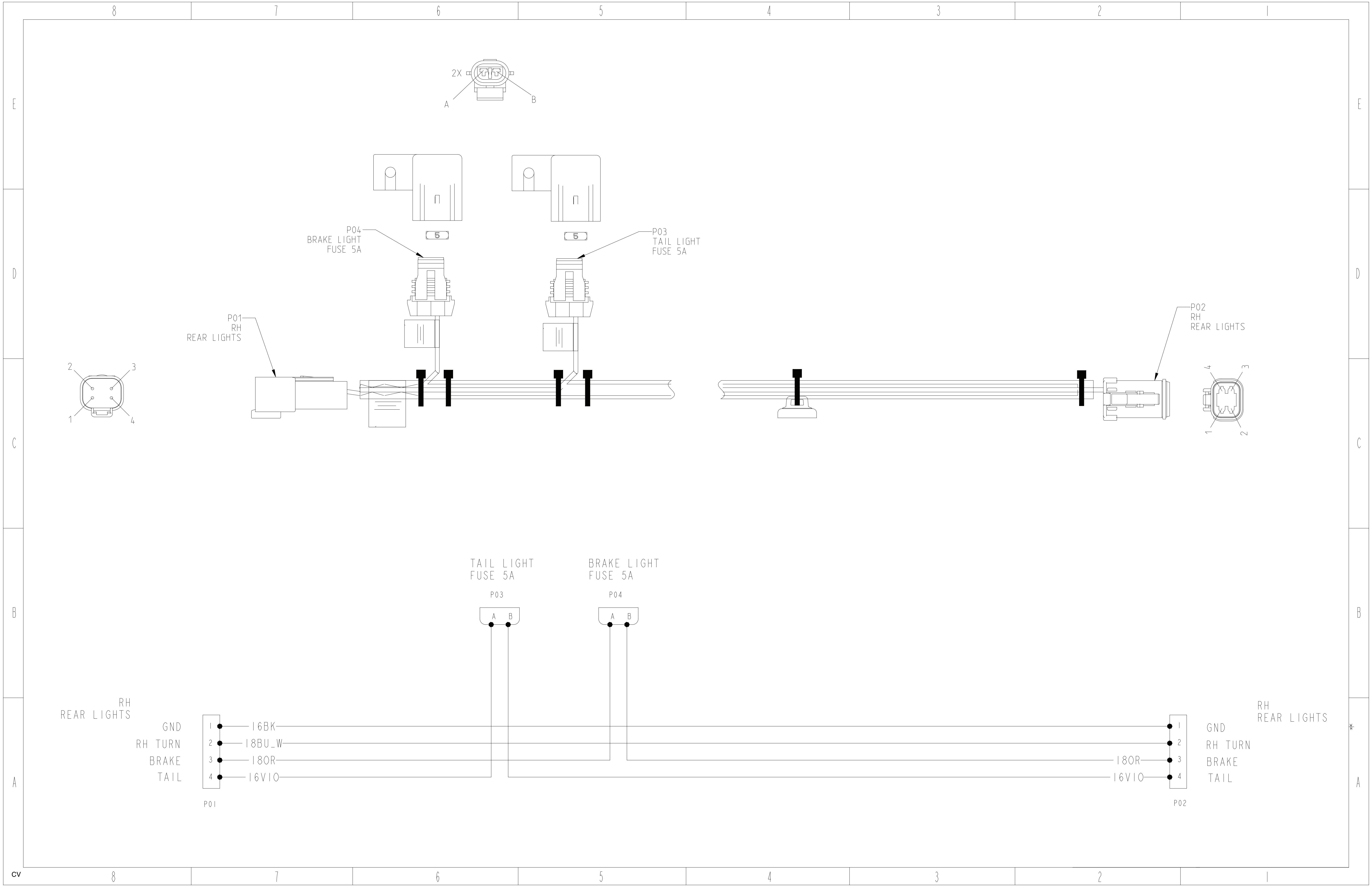


g277230

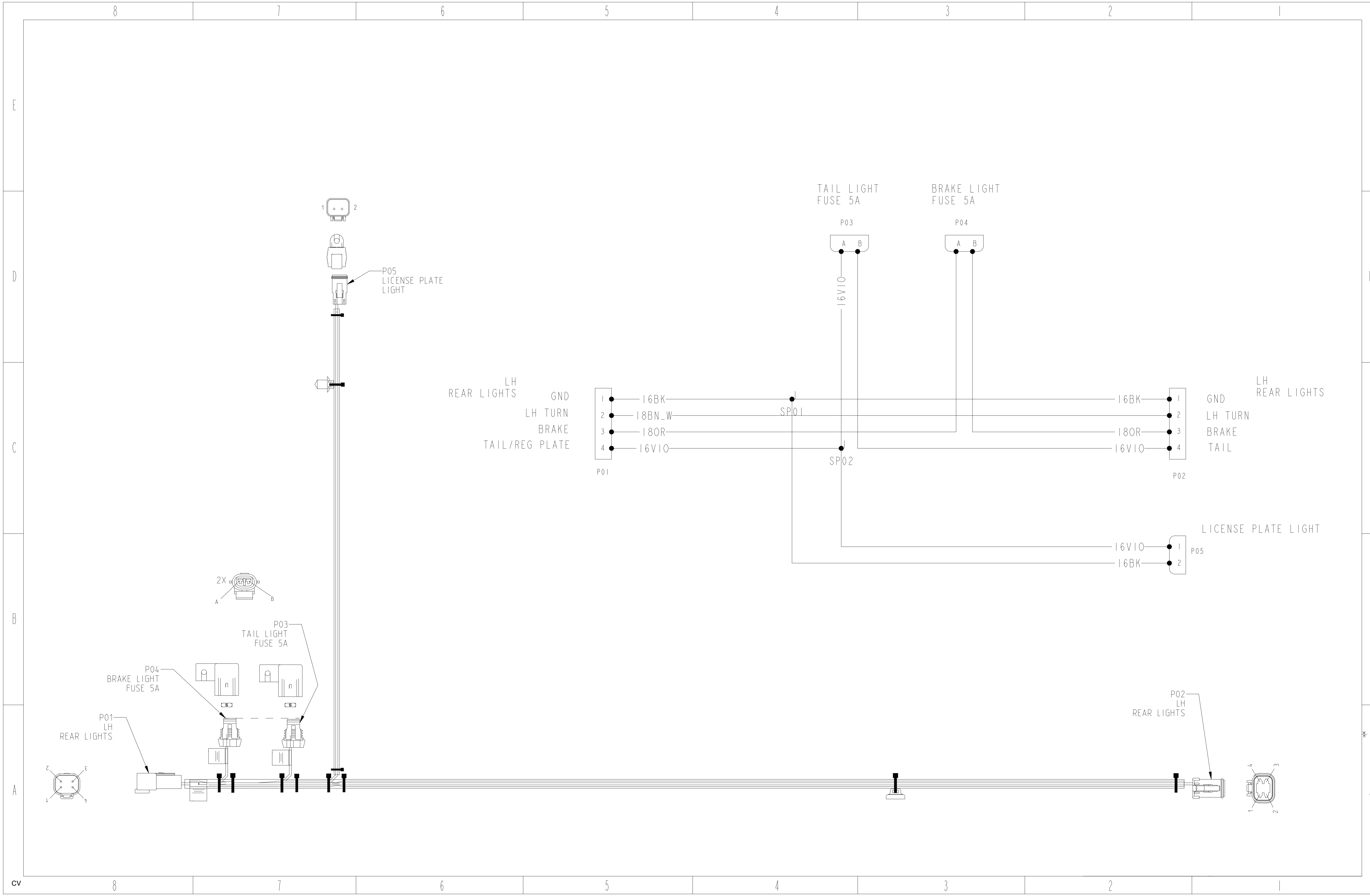

WINDSHIELD WIPER SW
P04
WORK LIGHTS SW
P06
BEACON SWITCH
P37
P63
FAN SWITCH
M L B C H
FUSE BLOCK 1
[20 AMP] 1F 1
[25 AMP] 1F 2
[15 AMP] 1F 3
[15 AMP] 1F 4
P02
OPTIONAL FUSE BLOCK
P42
ROPS LIGHT KIT POWER
P62
ROPS LIGHT KIT
P61
GROUND BLOCK
J01
SUNSHADE POWER
P08
TO PLATFORM HARNESS
P05
RADIO MEM PWR
P36
SP01
SP02
SP03
SP04
SP08
J03 H
J04 M
J02 L
J09 MOTOR (+)
RESISTOR MODULE
P60 COOLING FAN
P70 WATER PUMP
P38
LH FRONT WORK LIGHT
P39
RH FRONT WORK LIGHT
P40
LH REAR WORK LIGHT
P41
RH REAR WORK LIGHT
J28
J29
BEACON
J26
J27
DOME LIGHT
J34
J32
J33
RADIO
P12
WINDSHIELD WIPER
g277231

Light Kit Wire Harness




2X
A
B
P04
BRAKE LIGHT
FUSE 5A
5
5
P03
TAIL LIGHT
FUSE 5A
P01
RH
REAR LIGHTS
P02
RH
REAR LIGHTS
2
3
1
4
TAIL LIGHT
FUSE 5A
P03
A B
BRAKE LIGHT
FUSE 5A
P04
A B
RH
REAR LIGHTS
GND
RH TURN
BRAKE
TAIL
16BK
18BU_W
18OR
16VIO
P01
18OR
16VIO
RH
REAR LIGHTS
GND
RH TURN
BRAKE
TAIL
P02
CV
g362040

LH Rear Lights Wire Harness



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Count on it.