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Service Manual

Groundsmaster® 4000-D & 4010-D (Models 30603, 30605, 30607, 30609, 30635 and 30636)

Revision History

[illegible]

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 4000-D (Models 30605 and 30609) and Groundsmaster 4010-D (Models 30603, 30607, 30635 and 30636).

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](#)



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Safety Instructions

The Groundsmaster 4000-D and 4010-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 ignition 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

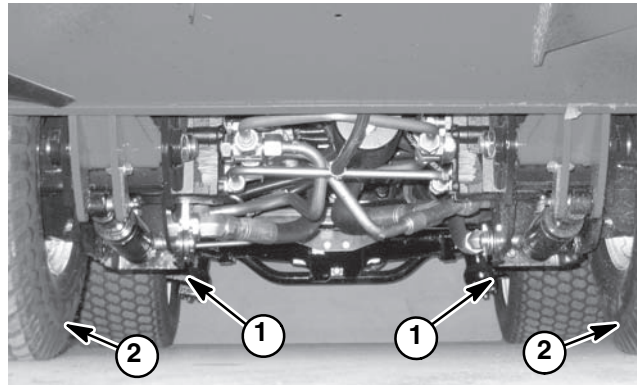


CAUTION



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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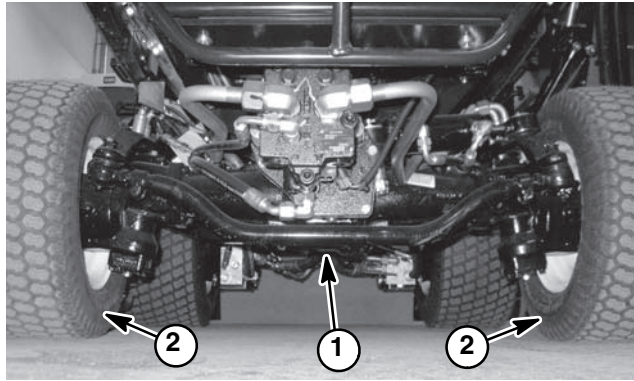
Figure 1

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 |
|----------------------------|--------------|

-
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.



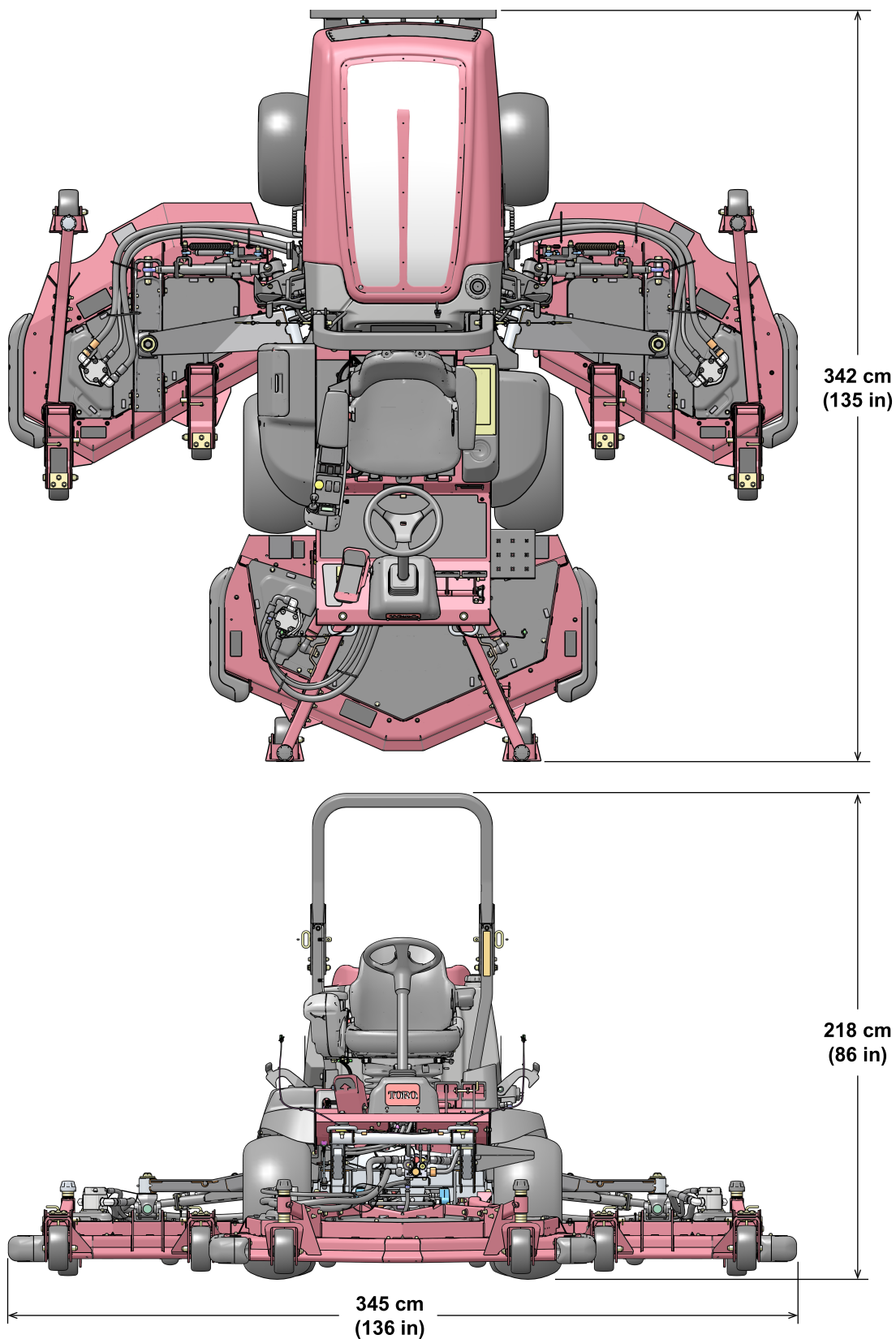
Specifications and Maintenance

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Specifications

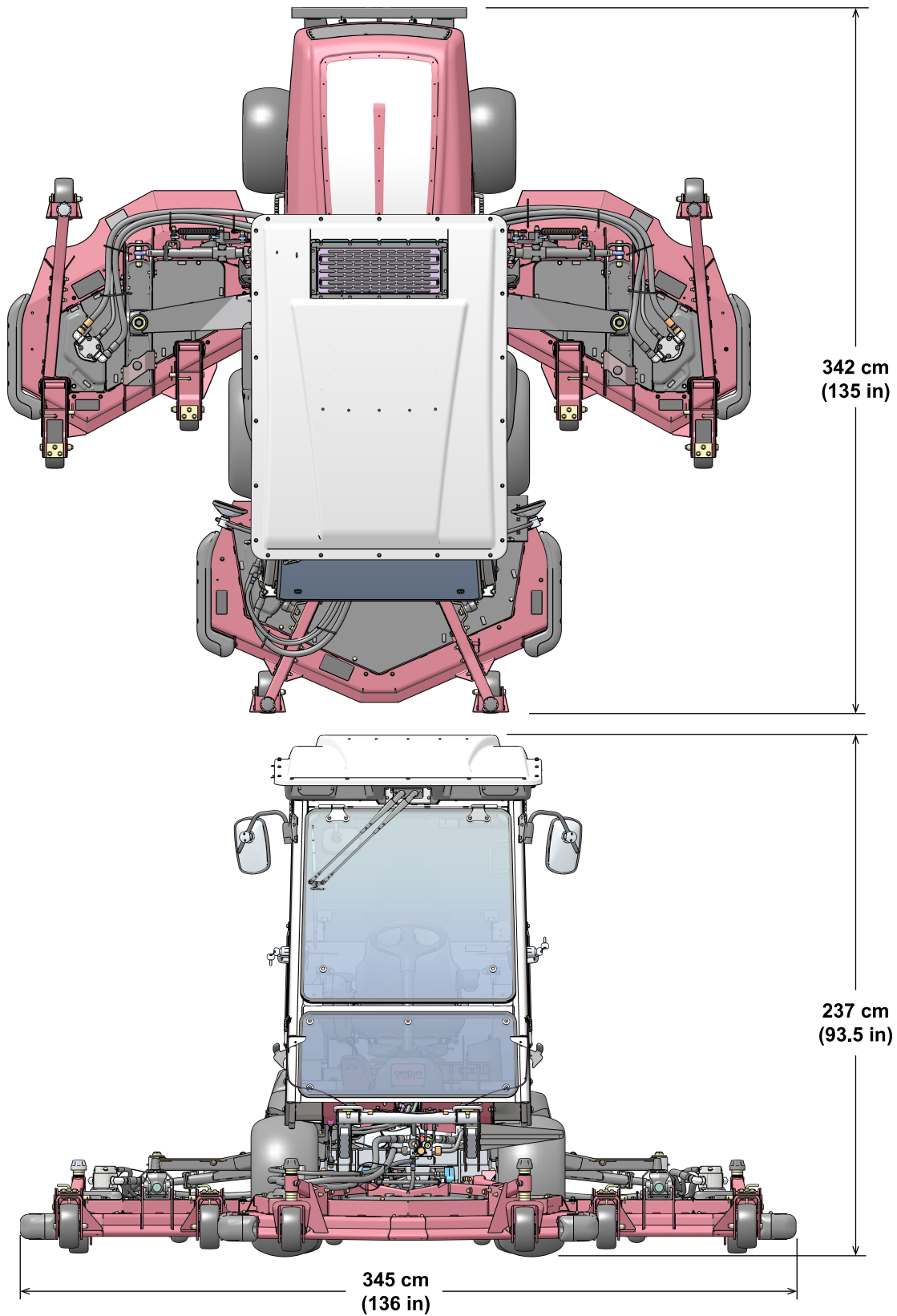
Overall Dimensions



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Figure 3
Groundsmaster 4000

Overall Dimensions (continued)



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Figure 4
Groundsmaster 4010

Engine (Models 30603, 30605 and 30635)

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 <i>Operator's Manual</i>
Crankcase Oil Capacity	5.7 liters (6 U.S. quarts) with Filter
Oil Pump	Trochoid Type
Coolant Capacity	
Groundsmaster 4000-D (Model 30605)	8.5 liters (9 U.S. quarts)
Groundsmaster 4010-D (Model 30635)	8.5 liters (9 U.S. quarts)
Groundsmaster 4010-D (Model 30603)	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 30607, 30609 and 30636)

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 <i>Operator's Manual</i>
Crankcase Oil Capacity	5.7 liters (6 U.S. quarts) with Filter
Oil Pump	Trochoid Type
Coolant Capacity	
Groundsmaster 4000-D (Model 30609)	8.5 liters (9 U.S. quarts)
Groundsmaster 4010-D (Model 30636)	8.5 liters (9 U.S. quarts)
Groundsmaster 4010-D (Model 30607)	13.7 liters (14.5 U.S. quarts)
Alternator/Regulator	12 VDC, 80 Amp
Engine Weight (Dry)	225 kg (496 U.S. pounds)

Note: Groundsmaster 4000-D (Model 30609) machines with serial numbers below 314000000 are equipped with a 40 amp alternator.

Hydraulic System

Item	Description
Piston (Traction) Maximum Displacement (per revolution) System Relief Pressure: Forward System Relief Pressure: Reverse Charge Pressure	Sauer-Danfoss Variable Displacement Axial Piston Pump 45 cc (2.75 in ³) 300 bar (4350 PSI) 345 bar (5000 PSI) 17 bar (250 PSI)
Front Wheel Motors Displacement (per revolution)	Sauer-Danfoss 2-Position Axial Piston Motors 19.55 cc (1.19 in ³) Maximum / 10.55 cc (0.64 in ³) Minimum
Rear Axle Motor Displacement (per revolution)	Sauer-Danfoss 2-Position Axial Piston Motor with Loop Flushing Valve 35.00 cc (2.14 in ³) Maximum / 18.99 cc (1.16 in ³) Minimum
Gear Pump Section P1/P2 Displacement (per revolution) Section P3 Displacement (per revolution) Section P4 Displacement (per revolution)	Casappa 4 Section, Positive Displacement Gear pump 21.14 cc (1.29 in ³) 6.6 cc (0.40 in ³) 4.96 cc (0.30 in ³)
Steering Control Valve Displacement (per revolution)	Eaton Steering Unit, Series 5 100 cc (6.1 in ³)
Steering Circuit Relief Pressure	93 bar (1350 PSI)
Lift/Lower Circuit Relief Pressure	110 bar (1600 PSI)
Cutting Deck Motors Displacement (per revolution)	Gear Motor 19.2 cc (1.17 in ³)
PTO Circuit Relief Pressure Front and Left Side Right Side	207 bar (3000 PSI) 138 bar (2000 PSI)
Engine Cooling Fan Motor Displacement (per revolution)	Casappa Gear Motor 8.4 cc (0.51 in ³)
Engine Cooling Fan Circuit Relief Pressure	224 bar (3250 PSI)
Hydraulic Filters In-line Suction Strainer	Spin-on Cartridge Type 100 Mesh (In Reservoir)
Hydraulic Reservoir	29.3 Liters (7.75 U.S. Gallons)
Hydraulic Oil	See <i>Operator's Manual</i>

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	SAE 85W-140 wt. Gear Lube
Capacity (each wheel)	0.47 to 0.59 liters(16 to 20 fl. oz.)
Rear axle lubricant	SAE 85W-140 wt. gear lube
System gear lube capacity	2.4 liters (80 fl. oz.)
Rear axle gear box lubricant	SAE 85W-140 wt. gear lube
System gear lube capacity	0.5 liters (16 fl. oz.)
Wheel lug nut torque	115 to 136 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)
Front wheel motor mounting screw torque	101 to 115 N·m (75 to 85 ft-lb)

Cutting Decks

MOUNTING:	Cutting decks are supported by lift arms controlled with individual lift switches.
CONSTRUCTION:	Deck chamber is welded 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. Side deck adjustment requires adding or removing spacers from the castor forks, re-positioning the castor wheel axles in the castor forks and securing the pivot arms to the correct height-of-cut bracket holes.
DECK DRIVE:	Closed loop hydraulic system operates hydraulic motor on each cutting deck. The motor drives one spindle directly with remaining deck 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 552 mm (21.750 in) long, 64 mm (2.500 in) wide and 6.4 mm (0.250 in) thick. Anti-scalp cup installed on each cutting blade. Three (3) blades on front deck and two (2) blades on each side deck.
WIDTH OF CUT:	Center deck provides 1575 mm (62 in) width of cut. Each side deck has 1067 mm (42 in) width of cut. Total width of cut is 3353 mm (132 in) with 128 mm (7 in) overlap.
DISCHARGE:	Clippings are discharged from the rear of the cutting decks. Provided mounting holes allow attachment of optional Guardian Recycler Kit.
SUSPENSION SYSTEM:	A fully floating suspension with hydraulic counterbalance. Center deck suspended at rear from lift arms and has two (2) castor wheels, two (2) adjustable skids and two (2) anti-scalp rollers. Each side deck supported by three (3) castor wheels and a spring damper system which connects the fourth deck corner to the traction unit. There is a main lift arm that provides counterbalance to the side decks along with a rear anti-rotation link which also provides bi-directional impact protection. Optional Guardian Recycler Kit includes one anti-scalp roller on each cutting deck.

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

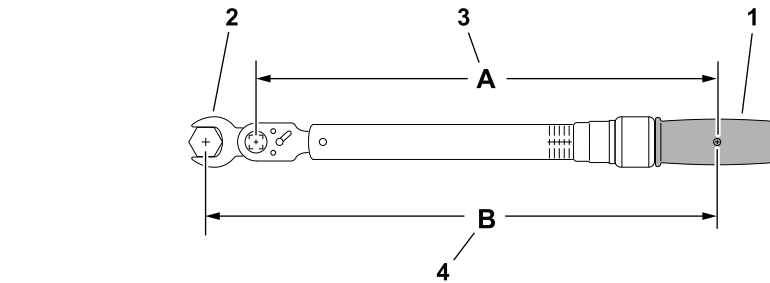


Figure 5

Torque Conversion Factor = A / B

- | | |
|-------------------------------------|---|
| 1. Torque wrench | 3. A (effective length of torque wrench) |
| 2. Drive-adapter wrench (crowsfoot) | 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

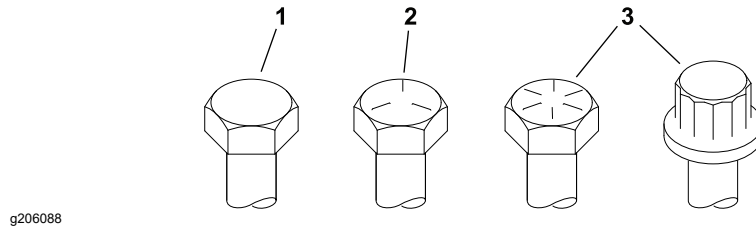


Figure 6

Inch Series Bolts and Screws

- | | | |
|------------|------------|------------|
| 1. Grade 1 | 2. Grade 5 | 3. Grade 8 |
|------------|------------|------------|
-

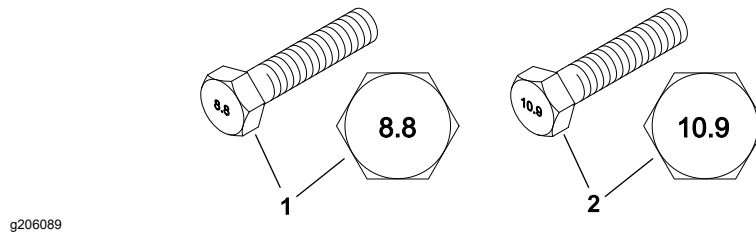


Figure 7

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

$$\text{in-lb} \times 11.2985 = \text{N·cm}$$

$$\text{ft-lb} \times 1.3558 = \text{N·m}$$

$$\text{N·cm} \times 0.08851 = \text{in-lb}$$

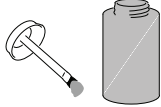
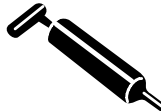
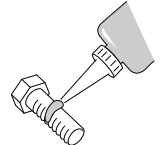
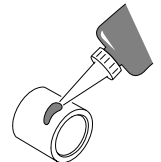

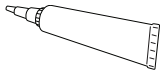
$$\text{N·m} \times 0.7376 = \text{ft-lb}$$

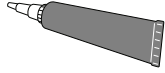

Shop Supplies

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.

<p>ANTI-SEIZE LUBRICANT</p> <p>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.</p>	
<p>GREASE</p> <p>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 <i>Operator's Manual</i> or <i>Installation Instructions</i> for grease specifications.</p>	
<p>THREAD LOCKING COMPOUND (Thread Locker)</p> <p>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.</p> <p>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.</p>	
<p>RETAINING COMPOUND (bearings and sleeves)</p> <p>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.</p>	
<p>ADHESIVE</p> <p>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.</p>	
<p>THREAD SEALANT</p> <p>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 form 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.</p>	

<p>GASKET COMPOUND</p> <p>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.</p>	
<p>SILICONE SEALANT</p> <p>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 -51F to 232C (-60F to 400F), while high temperature variants can preform in temperatures up to 343C (650F).</p>	

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

Toro 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.



57 LPM (15 GPM) Hydraulic Tester Kit

Toro 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.



150 LPM (40 GPM) Hydraulic Tester

Toro 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 Toro Part No. TOR6007 and Hydraulic Test Fitting Kit Tor 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

Toro Part No. TOR6007

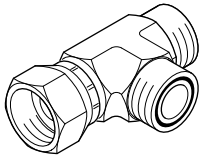
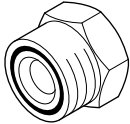
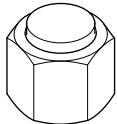
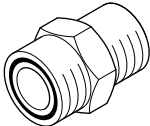
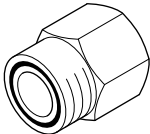
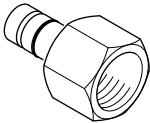
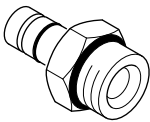
This kit includes the fittings and hoses that are used to connect high flow hydraulic filter kit (TOR6011) to the machine hydraulic traction system components.



Hydraulic Test Fitting Kit

Toro 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	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

Toro 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 Toro Part No. TOR6012. The filter element canister tightening torque is **34 N·m (25 ft-lb)**.



Measuring Container

Toro 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.

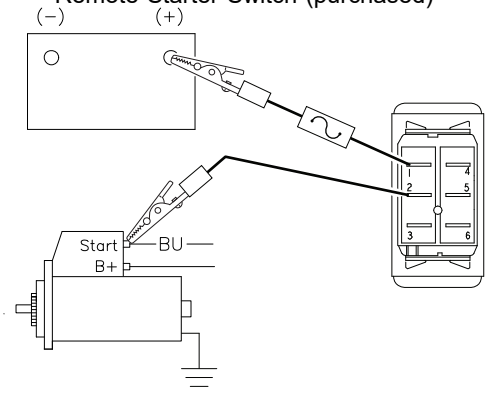
IMPORTANT: When using a remote starter switch, it is highly recommended to include a 20 amp in-line fuse between the battery and switch connector for circuit protection.

A remote starter 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)



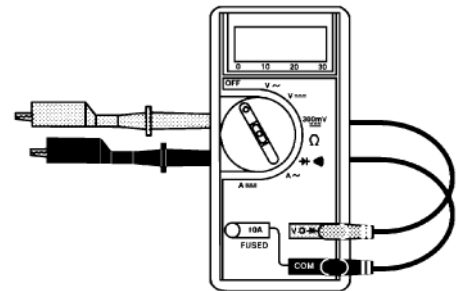
Remote Starter Switch (fabricated)

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.





Troubleshooting

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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.	<p>Piston (traction) pump by-pass valve is open or damaged.</p> <p>Traction relief valve is leaking or faulty.</p> <p>Piston (traction) pump servo control valve orifices or screens are plugged or damaged.</p> <p>Problem with TEC output to piston (traction) pump servo control exists (see Chapter 6: Electrical System (page 6–1)).</p>
Traction pedal response is sluggish.	<p>Traction pedal components are stuck or binding.</p> <p>Traction charge pressure is low.</p> <p>Piston (traction) pump servo control valve orifices are plugged or damaged.</p>
Machine travels too far before stopping when the traction pedal is released.	<p>Traction pedal components are stuck or binding.</p> <p>Traction charge pressure is low.</p> <p>Adjustment of relief valve (RV) in rear traction manifold is incorrect.</p> <p>Piston (traction) pump servo control valve orifices are plugged or damaged.</p>
Traction power is lost or machine will not operate in either direction	<p>Hydraulic reservoir oil level is low (Other hydraulic systems are affected as well).</p> <p>Piston (traction) pump by-pass valve is open or damaged.</p> <p>Traction charge pressure is low.</p> <p>Traction circuit pressure is low.</p> <p>Traction pedal position sensor is not plugged in or is faulty (see Chapter 5 – Electrical System).</p> <p>Problem with TEC output to piston (traction) pump servo control exists (see Chapter 6: Electrical System (page 6–1)).</p>
<p>LOW traction speed (mow) will not engage.</p> <p>Note: LOW (mow) will not engage when the cutting decks are lowered.</p>	<p>Electrical problem exists that prevents solenoid valve S12 from being de-energized (see Chapter 6: Electrical System (page 6–1))</p> <p>Solenoid valve (S12) in combination manifold is faulty.</p>
LOW traction speed (mow) will not disengage.	<p>Electrical problem exists that prevents solenoid valve S12 from being energized (see Chapter 6: Electrical System (page 6–1)).</p> <p>Solenoid valve (S12) in combination manifold is faulty.</p>

Mow Circuit Problems

Problem	Possible Cause
<p>None of the cutting decks will operate.</p> <p>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.</p>	<p>Electrical problem exists that prevents PRV solenoid valve in PTO manifolds from being energized (see Chapter 6: Electrical System (page 6-1)).</p> <p>Front two (2) gear pump sections for mow circuits are worn or damaged.</p>
<p>One cutting deck will not operate.</p>	<p>Electrical problem (e.g. solenoid coil in PTO manifold, cutting deck position switch) exists (see Chapter 6: Electrical System (page 6-1)).</p> <p>Cutting deck problem exists (e.g. drive belt, deck spindle).</p> <p>System pressure to the affected cutting deck is low.</p> <p>Woodruff key on affected deck motor is damaged.</p> <p>Proportional relief valve (PRV) in PTO manifold for affected deck is faulty.</p> <p>Cartridge valve in PTO manifold for affected deck is damaged or sticking.</p> <p>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).</p> <p>Gear pump section for affected deck is worn or damaged.</p>
<p>All cutting decks operate slowly.</p>	<p>Engine RPM is low.</p> <p>All deck motors are worn or damaged.</p> <p>Front two (2) gear pumps sections for mow circuits are worn or damaged.</p>
<p>Cutting deck stops under load.</p>	<p>Proportional relief valve in PTO manifold for affected deck is by- passing.</p> <p>Deck motor has internal leakage (by-passing oil).</p> <p>Gear pump section for affected deck is worn or damaged.</p>

Lift Circuit Problems

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

Steering Circuit Problems

Problem	Possible Cause
Steering inoperative or sluggish	<p>Steering components (e.g. tie rods, steering cylinder ends) are worn or binding.</p> <p>Steering cylinder is binding.</p> <p>Oil level in hydraulic reservoir is low (Note: Other hydraulic systems are affected as well).</p> <p>Steering relief valve (RV1) in combination manifold is stuck or damaged.</p> <p>The pressure compensator valve (EC) in combination manifold is stuck or damaged.</p> <p>Steering cylinder leaks internally.</p> <p>Steering control valve is worn or damaged.</p> <p>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).</p>

Engine Cooling Fan Circuit Problems

Problem	Possible Cause
Cooling fan runs only in forward direction (fan does not run in reverse direction)	<p>Solenoid cartridge valve (S10) in combination control manifold is faulty.</p> <p>Electrical problem exists that prevents combination control manifold solenoid valve (S10) operation (see Chapter 6: Electrical System (page 6-1)).</p>
Cooling fan does not rotate.	<p>Cooling fan motor is worn or damaged.</p> <p>Proportional relief valve (PRV) in combination manifold is stuck or damaged.</p> <p>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).</p>
Cooling fan always rotates at slow speed.	<p>Combination manifold cartridge valve seals are leaking.</p> <p>Check valve in combination manifold is not seating.</p> <p>Proportional relief valve (PRV) in combination manifold is stuck or damaged.</p> <p>Hydraulic fan motor is worn or damaged.</p>
Cooling fan always rotates at fast speed.	<p>Proportional relief valve (PRV) in combination manifold is faulty.</p> <p>Electrical problems exists that prevents correct operation of combination manifold proportional relief valve (PRV) (see Chapter 6: Electrical System (page 6-1)).</p>

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 keyswitch (ignition 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 inhibited
186	Regen set full throttle
188	Parked regen required
189	Parked regen required with no PTO
190	Recovery regen required with no PTO

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	Ignition switch was held in the START position for more than 30 seconds or the ignition 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	Ignition switch is faulty (check ignition 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

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 4.75V or lower than 0.25V (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 overcurrent 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 internal board 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 internal board 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.

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.	<p>The battery is discharged.</p> <p>The battery cables are loose or corroded.</p> <p>Fuse F-D1 (2 Amp) is faulty.</p> <p>A faulty ground connection exists on machine.</p> <p>The ignition switch or circuit wiring is faulty.</p>
<p>Starter solenoid clicks, but starter will not crank.</p> <p>Note: If the solenoid clicks, the problem is not in the interlock circuit.</p>	<p>The battery is discharged.</p> <p>The battery cables are loose or corroded.</p> <p>The fusible links at starter motor are loose or corroded.</p> <p>A ground wire or cable is loose or corroded.</p> <p>The wiring at the starter motor is faulty.</p> <p>The starter solenoid is faulty.</p> <p>The starter motor is faulty.</p> <p>The engine crankshaft seized.</p>
<p>No "click", no "crank", no "start" happens when start attempt is made. InfoCenter display operates with the ignition switch in the RUN position.</p> <p>Note: Use InfoCenter Display to assist with identifying problem.</p>	<p>Traction pedal position sensor is out of adjustment.</p> <p>Traction pedal position sensor or circuit wiring is faulty.</p> <p>The seat switch or circuit wiring is faulty.</p> <p>The parking brake switch or circuit wiring is faulty.</p> <p>The start relay or circuit wiring is faulty.</p> <p>The starter solenoid or starter motor is faulty.</p> <p>The engine or fuel system is malfunctioning (see <i>Yanmar Service Manual</i>).</p> <p>The wiring harness is faulty (see Appendix A (page A-1))</p>
Starter cranks, but should not, when the traction pedal is depressed.	<p>Traction pedal position sensor is out of adjustment.</p> <p>Traction pedal position sensor or circuit wiring is faulty.</p>
Engine cranks, but does not start.	<p>The fuel tank is empty.</p> <p>The battery charge is low, voltage drop in start circuit cables.</p> <p>The fuel pump or circuit wiring is faulty.</p> <p>The engine or fuel system is malfunctioning (see <i>Yanmar Service Manual</i>).</p>

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 ignition switch is turned off.	<p>The ignition switch or circuit wiring is faulty.</p> <p>The engine or fuel system is malfunctioning (see <i>Yanmar Service Manual</i>).</p>
Machine continues to move without an InfoCenter Advisory, but should not, when the traction pedal is depressed with no operator in the seat.	<p>The seat switch or circuit wiring is faulty.</p> <p>Traction pedal position sensor is out of adjustment.</p> <p>Traction pedal position sensor or circuit wiring is faulty.</p>
<p>Engine stops during operation, but is able to restart.</p> <p>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.</p>	<p>The operator is lifting off the seat switch while mowing.</p> <p>The seat switch or circuit wiring is faulty.</p> <p>The ignition switch or circuit wiring is faulty.</p> <p>The engine coolant temperature is excessive.</p> <p>Machine is being operated on a slope with a low fuel level.</p> <p>The engine or fuel system is malfunctioning (see <i>Yanmar Service Manual</i>).</p>
<p>Battery does not charge.</p> <p>Note: Charging system faults will be actively displayed if the charging system voltage is not detected by the Yanmar ECU.</p>	<p>Loose, corroded or broken wire(s) exist in charging circuit.</p> <p>The engine alternator belt is out of adjustment.</p> <p>The battery is faulty.</p> <p>The alternator is faulty.</p>

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.	<p>The seat switch or circuit wiring is faulty.</p> <p>A hydraulic problem in the mow circuit exists (see Mow Circuit Problems (page 3–5)).</p> <p>The TEC controller is faulty.</p>
Cutting deck runs, but should not, when raised. Decks shut off with PTO switch.	<p>The deck position switch or circuit wiring is faulty.</p> <p>A hydraulic problem in the mow circuit exists (see Mow Circuit Problems (page 3–5)).</p> <p>The TEC controller is faulty.</p>
Cutting decks run, but should not, when raised. Decks do not shut off with the PTO switch.	<p>Both the deck position switch or circuit wiring and PTO switch or circuit wiring are faulty.</p> <p>A hydraulic problem in the mow circuit exists (see Mow Circuit Problems (page 3–5)).</p>
Cutting decks run, but should not, when lowered with PTO switch in the OFF (disengage) position.	<p>The PTO switch or circuit wiring is faulty.</p> <p>The TEC controller is faulty.</p>
Cutting deck(s) do not operate.	<p>The operator is lifting off the seat switch.</p> <p>The cutting decks are not fully lowered.</p> <p>Traction circuit is not in LOW speed (mow) mode.</p> <p>High temperature of engine coolant or hydraulic oil has disabled the cutting decks.</p> <p>Fuse is faulty preventing PTO manifold solenoids from being energized.</p> <p>The seat switch or circuit wiring is faulty.</p> <p>The PTO switch or circuit wiring is faulty.</p> <p>The deck position switch or circuit wiring is faulty.</p> <p>The HI/LOW speed switch or circuit wiring is faulty.</p> <p>The TEC controller is faulty.</p> <p>Hydraulic valve solenoid(s) or circuit wiring to the affected deck(s) is faulty.</p> <p>A hydraulic problem in the mow circuit exists (see Mow Circuit Problems (page 3–5)).</p> <p>The engine is due for stationary regeneration.</p>

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

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 <i>Operator's Manual</i> .
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 <i>Operator's Manual</i> .
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 the cutting deck rake or blade plane. Refer to <i>Operator's Manual</i> 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

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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](#)

General Information

This Chapter gives information about specifications and repair of the diesel engine used in Groundsmaster 4000-D and 4010-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

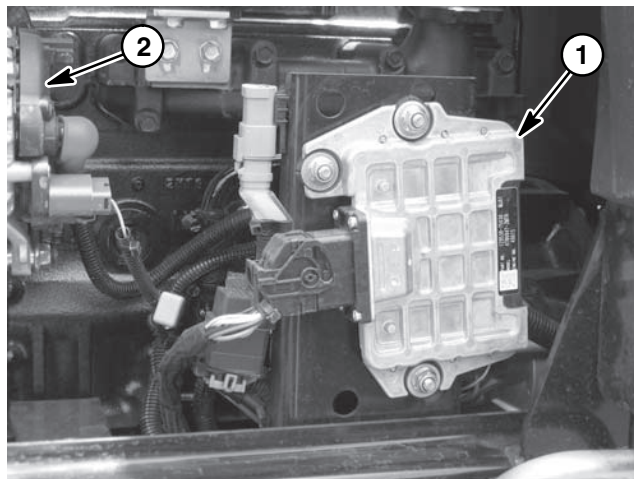
The engine that powers your Groundsmaster machine is either a Yanmar model 4TNV84T-Z (used on Groundsmaster models 30603, 30605 and 30635) (Tier 4i) or a Yanmar model 4TNV86CT (used on Groundsmaster models 30607, 30609 and 30636) (Tier 4). Both the Yanmar Service Manual and Yanmar Troubleshooting Manual 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. Failure to do so may lead to turbo-charger trouble.

Engine Electronic Control Unit (ECU)



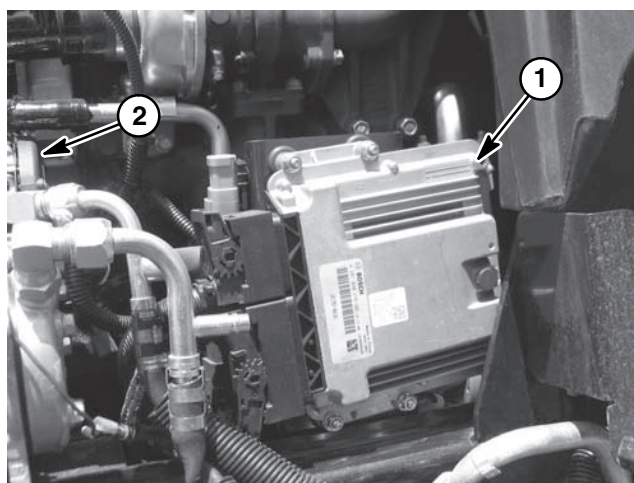
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Figure 8

1. Electronic control unit (30603 / 30605 / 30635)
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 Info Center display on the machine. All wire harness electrical connectors should be plugged into the engine ECU before the machine ignition switch is moved from the OFF position to either the ON or START position.

Note: On models 30607, 30609 and 30636 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.



g274713

Figure 9

1. Electronic control unit (30607 / 30609 / 30636)
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.

Engine Electronic Control Unit (ECU) (continued)

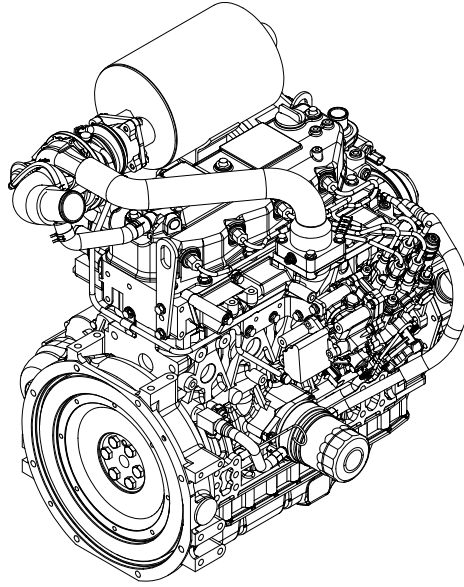
If the engine ECU identifies that an engine problem exists, the engine speed may be reduced or the engine might stop. The Yanmar electronic tool and troubleshooting manual should be used to provide assistance in identifying the cause of the problem and the repairs that are necessary. Contact your Toro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

IMPORTANT

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

If the engine ECU is to be disconnected for any reason, make sure that the ignition 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 30603, 30605 and 30635



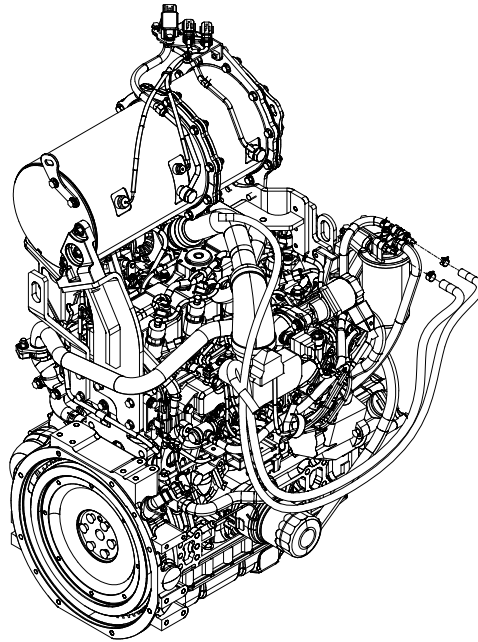
g274714

Figure 10

The engine used on Groundsmaster models 30603, 30605 and 30635 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 30607, 30609 and 30636



g274715

Figure 11

The engine used on Groundsmaster models 30607, 30609 and 30636 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 fuel injection system with direct injection, water-cooled exhaust gas recirculation (EGR), an electronic governor, 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 unburnt 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 increased pressure differential signal will result in the ECU commanding engine operation 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	<p>The DPF processes high heat exhaust gasses, oxidizing harmful emissions and incinerating soot to ash.</p> <p>The InfoCenter does not display an icon during passive regeneration.</p>




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.	<p>The engine ECU adjusts the intake throttle to raise the exhaust temperature.</p>  <p>For software 120-6372A thru O only: the InfoCenter displays the assist regeneration icon.</p>
Reset	<p>Occurs every 100 hours of engine operation</p> <p>Occurs after an assist regeneration if the engine ECU determines the assist regeneration did not sufficiently reduce the soot level</p> <p>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 <i>Operators Manual</i> for additional information.</p>	<p>The engine ECU adjusts the engine setting to raise the exhaust temperature.</p>  <p>For all software revisions: the InfoCenter displays the high exhaust temperature icon.</p>

Regeneration (continued)

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

Type	Conditions	Description
Parked	<p>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.</p> <p>May occur if the InfoCenter is set to inhibit regen (preventing a Reset Regeneration) and machine operation is continued.</p> <p>Can be initiated when prompted by the engine ECU or after a minimum of 50 hours of engine operation.</p> <p>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.</p>	<p>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.</p> <p>The engine ECU adjusts the exhaust intake throttle to raise the exhaust temperature.</p> <p> For all software revisions: the InfoCenter displays advisory #188 and/or the stationary regeneration icon .</p>
Recovery	<p>Occurs when exhaust back pressure in the DPF increases due to soot buildup reaching a critical level.</p> <p>Can only be initiated when prompted by the engine ECU.</p> <p>For software 120-6372P and up: the machine mow function (PTO) will be disabled at first notification.</p>	<p>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.</p> <p>Use the InfoCenter About screen to verify the software installed on the machine.</p> <ul style="list-style-type: none"> • 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. <p> For software 120-6372A thru O only: the InfoCenter displays the recovery regeneration icon.</p> <p> For software 120-6372P and up: the InfoCenter displays advisory #190 and/or the stationary regeneration icon.</p> <p>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.</p>

Soot Accumulation

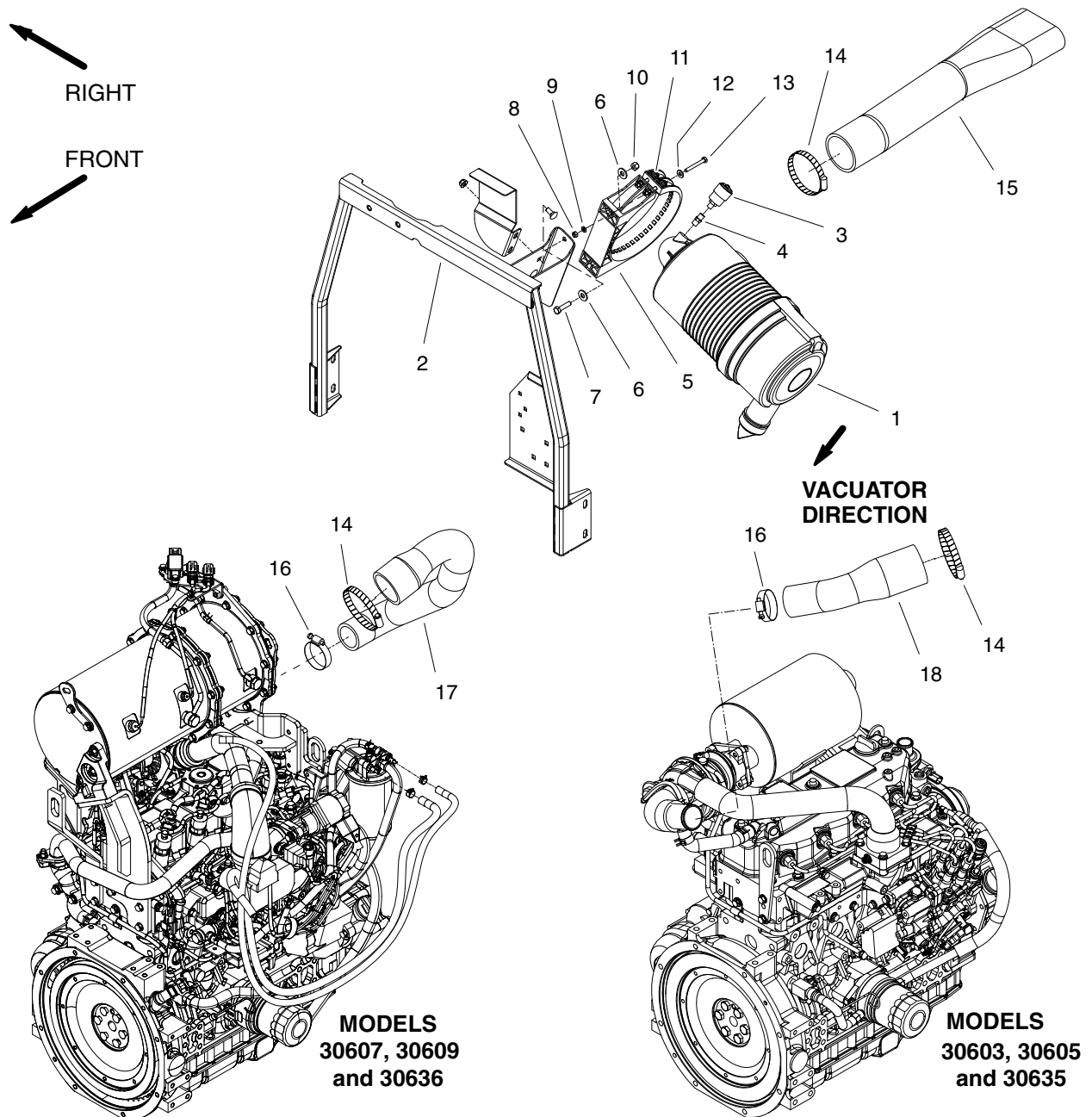
If the types of regeneration that are performed automatically (while the machine is operating) are bypassed or not allowed to complete before shutting off the engine, soot will continue to accumulate in the soot filter. When enough soot accumulates, the engine ECU will generate an engine fault to prompt 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 an engine fault to prompt servicing 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



g274776

Figure 12

- | | | |
|-------------------------|--------------------------|---------------------------------------|
| 1. Air cleaner assembly | 7. Cap screw (2 used) | 13. Socket head screw (2 used) |
| 2. Tank support | 8. Lock nut (2 used) | 14. Hose clamp |
| 3. Indicator | 9. Flat washer (2 used) | 15. Air cleaner inlet hose |
| 4. Adapter | 10. Lock nut (2 used) | 16. Hose clamp |
| 5. Air cleaner strap | 11. Spring (2 used) | 17. Air cleaner outlet hose (tier 4) |
| 6. Flat washer (4 used) | 12. Flat washer (2 used) | 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 ignition switch.
2. Raise and support hood.
3. Remove air cleaner components as needed using Figure 12 as a guide.

Installation (Figure 12)

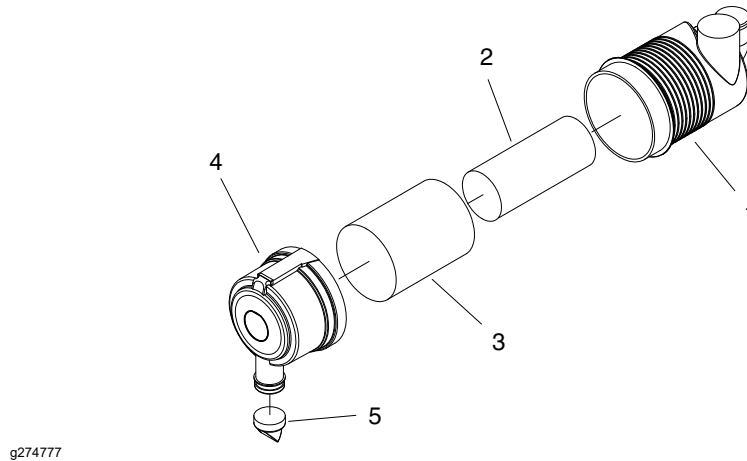


Figure 13

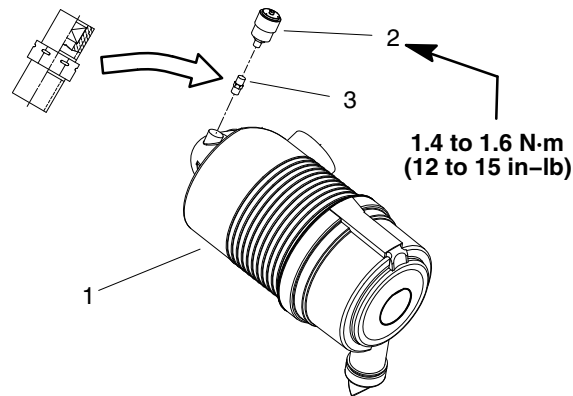
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|--------------------------|----------------------|
| 1. Air cleaner housing | 4. Air cleaner cover |
| 2. Safety filter element | 5. Vacuator valve |
| 3. Air filter element | |

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)



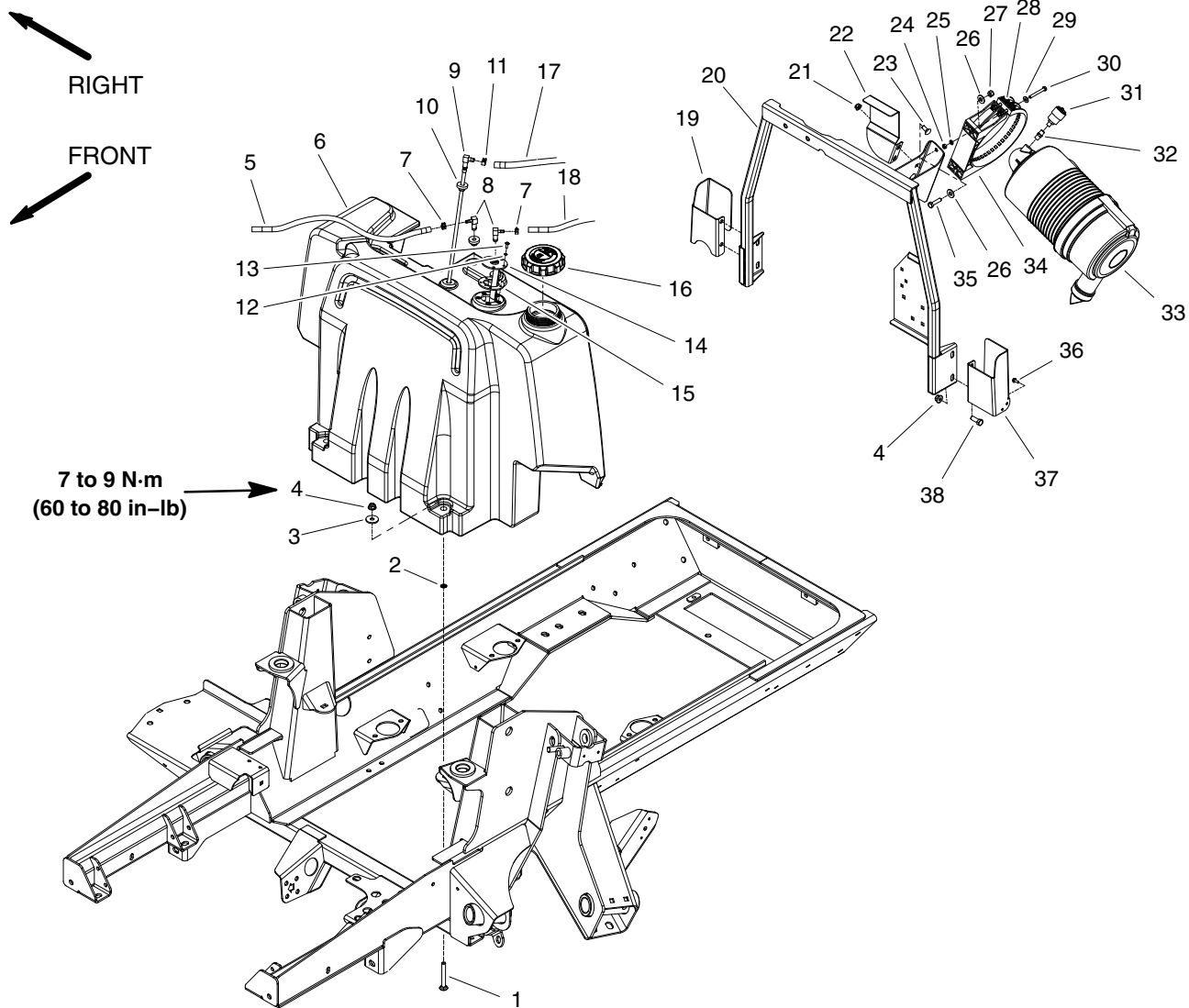
g274778

Figure 14

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

-
- 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



g274779

Figure 15

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

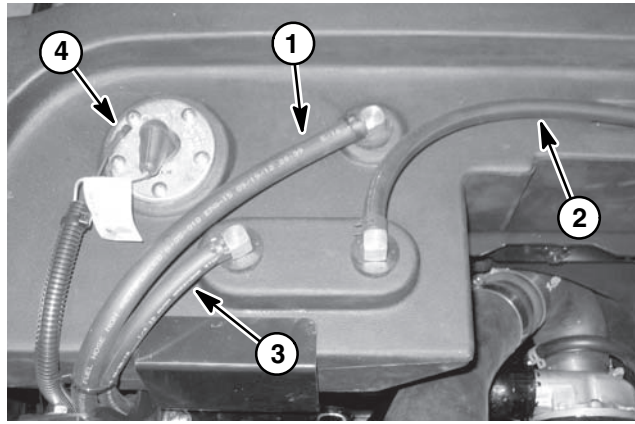
Priming the Fuel System

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 ignition key 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 ignition 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 | 3. Return hose |
| 2. Vent hose | 4. Fuel sender |

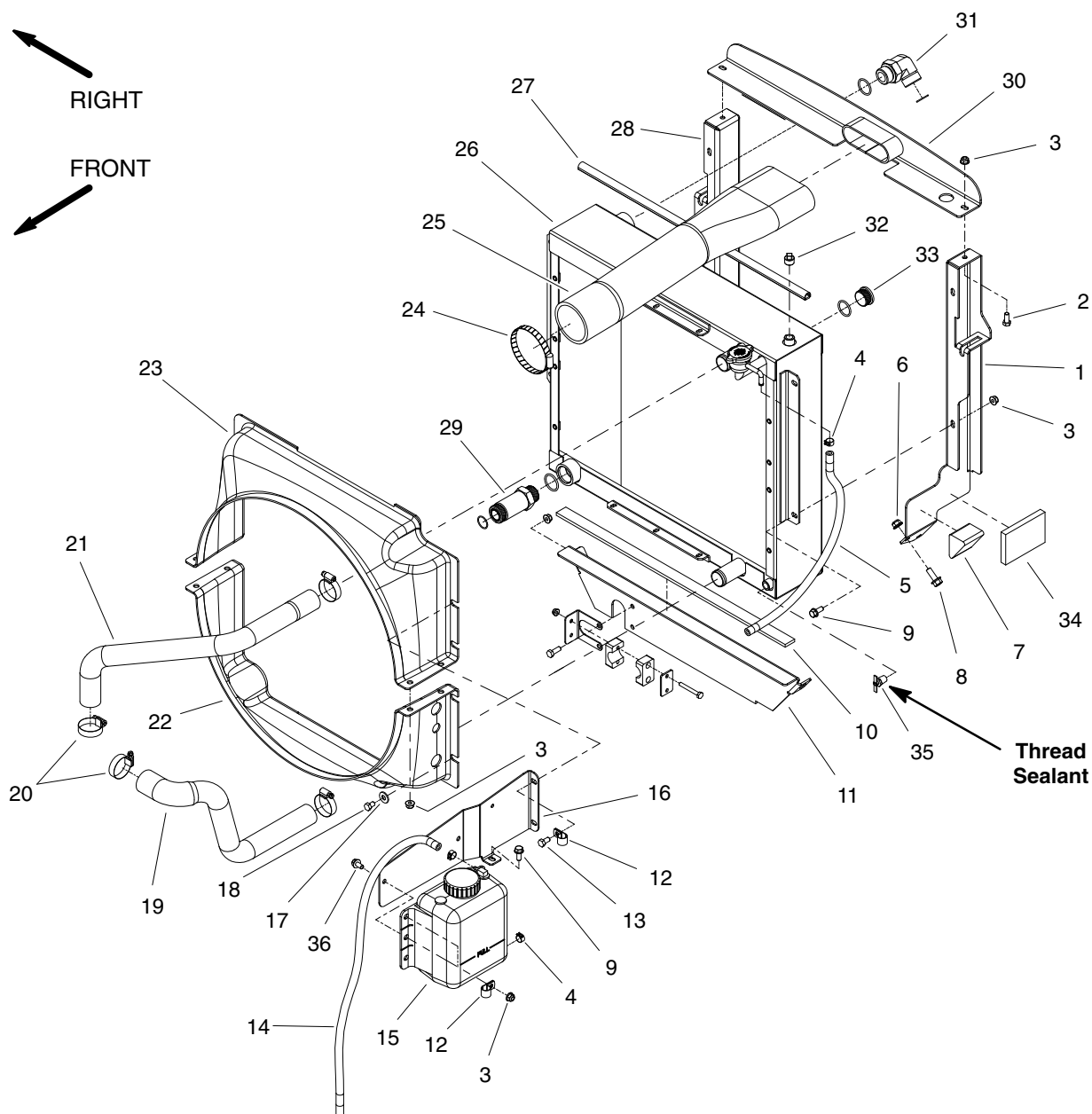
Note: Fuel sender may have two (2) wire harness terminals (shown in [Figure 16](#)) or a single harness connector.

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



g274762

Figure 17

- | | | |
|-------------------------------|---------------------------|-----------------------------------|
| 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. 90° 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) |

Removal (Figure 17)

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

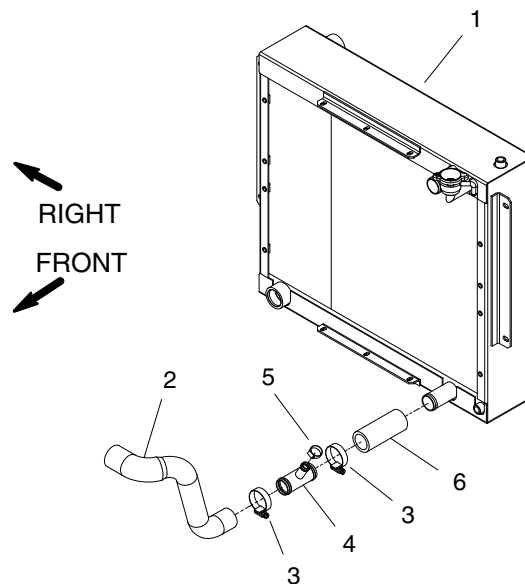
Ethylene-glycol antifreeze is poisonous. Dispose of coolant properly or store it in a properly labeled container away from children and pets.

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 30607 (WITH TIER 4 ENGINE)

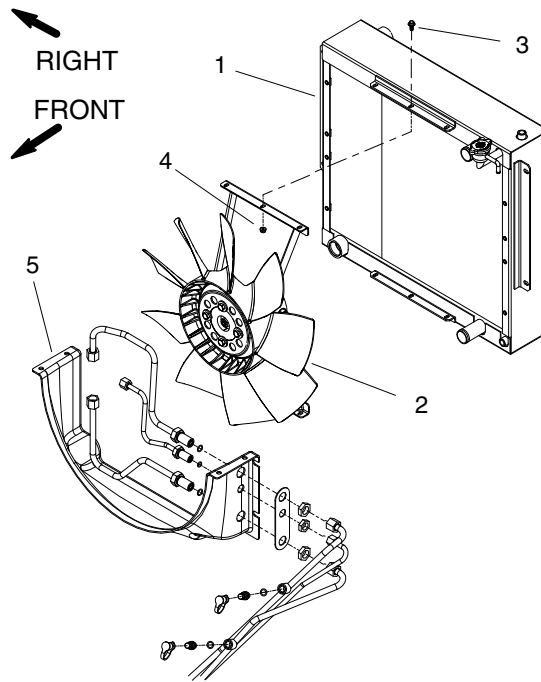


g274763

Figure 18

- | | |
|------------------------|---------------------|
| 1. Radiator/oil cooler | 4. Radiator fitting |
| 2. Lower radiator hose | 5. Hose clamp |
| 3. Hose clamp | 6. Radiator hose |
3. Disconnect radiator hoses from the radiator. Groundsmaster 4010-D machines with a Tier 4 compliant engine (model 30607 and 30636) 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).

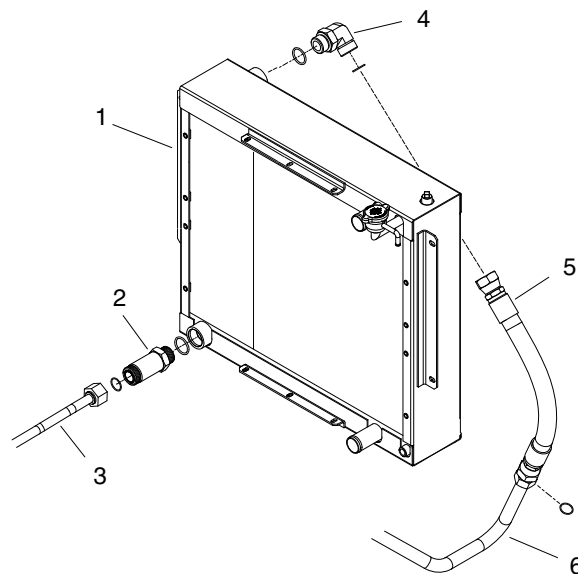
Removal (Figure 17) (continued)



g274764

Figure 19

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



g274765

Figure 20

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

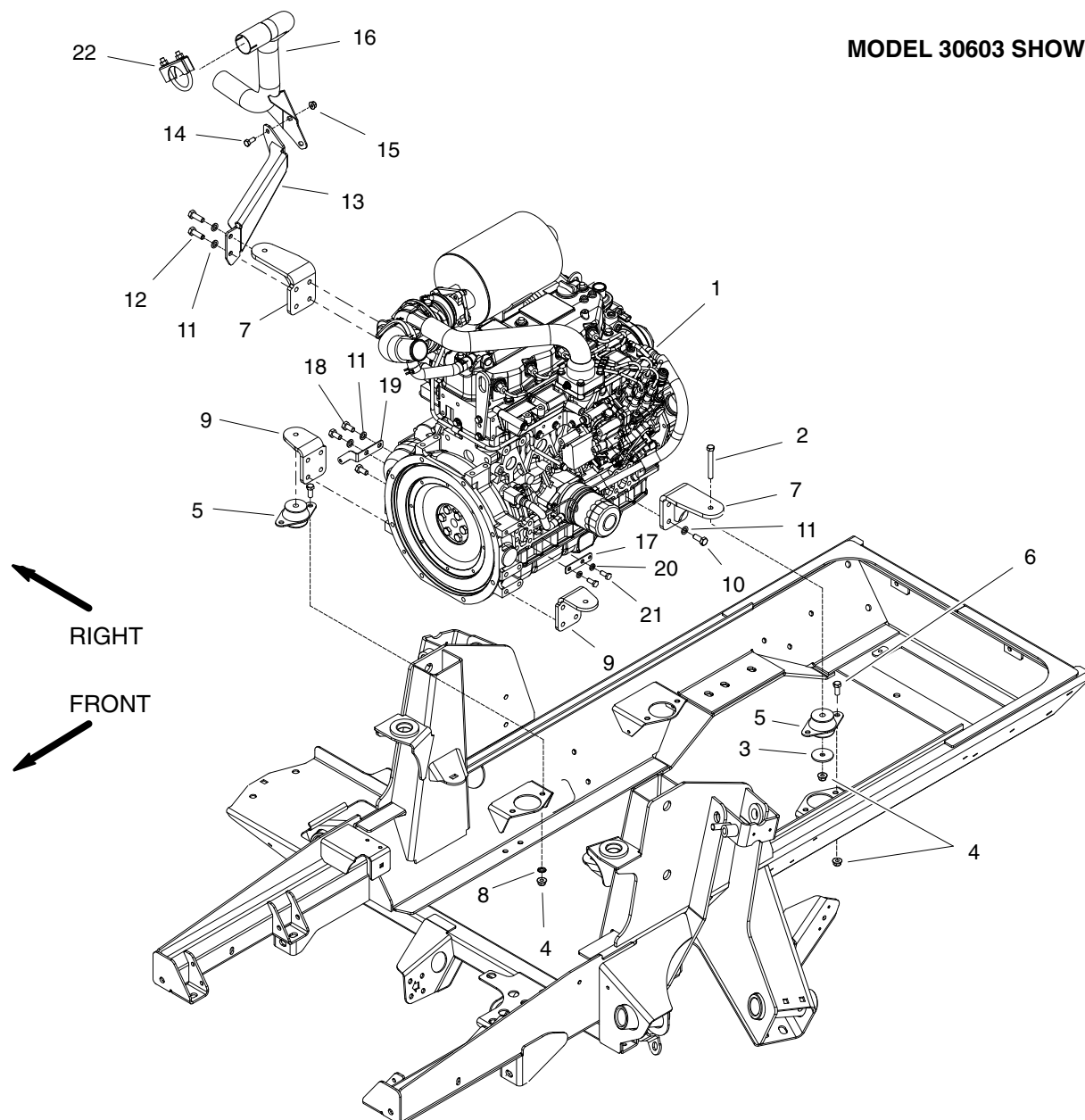
7. Disconnect hood rods from hood and radiator supports (see [Hood \(page 8–41\)](#)).
8. Remove flange head screws (item 8) and flange nuts (item 6) that secure the radiator supports (items 1 and 28) to the frame.
9. Carefully raise radiator assembly with shrouds, fan motor assembly and supports from 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 \(page 8–41\)](#)).
12. Close and secure hood.

Engine

MODEL 30603 SHOWN



g274766

Figure 21

- | | | |
|----------------------------------|----------------------------------|--------------------------|
| 1. Engine (model 30603 shown) | 9. Engine mount bracket (2 used) | 17. Wire harness bracket |
| 2. Cap screw (4 used) | 10. Cap screw (14 used) | 18. Cap screw (3 used) |
| 3. Rebound washer (4 used) | 11. Lock washer (18 used) | 19. Wire harness bracket |
| 4. Flange nut (12 used) | 12. Cap screw (2 used) | 20. Lock washer (2 used) |
| 5. Engine mount (4 used) | 13. Exhaust bracket | 21. Cap screw (2 used) |
| 6. Cap screw (2 used per mount) | 14. Cap screw (2 used) | 22. Clamp assembly |
| 7. Engine mount bracket (2 used) | 15. Flange nut (2 used) | |
| 8. Lock washer | 16. Exhaust pipe | |

Engine Removal (Figure 21)

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



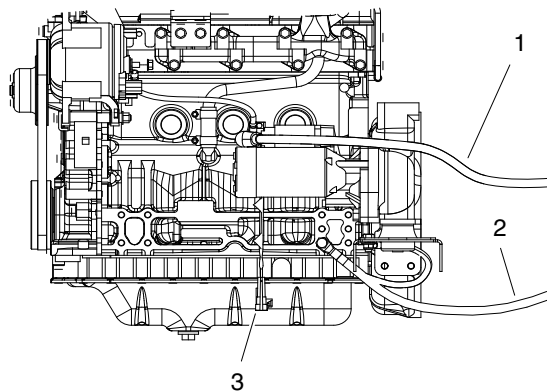
CAUTION



Do not open radiator cap or drain coolant if the radiator or engine is hot. 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.

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.



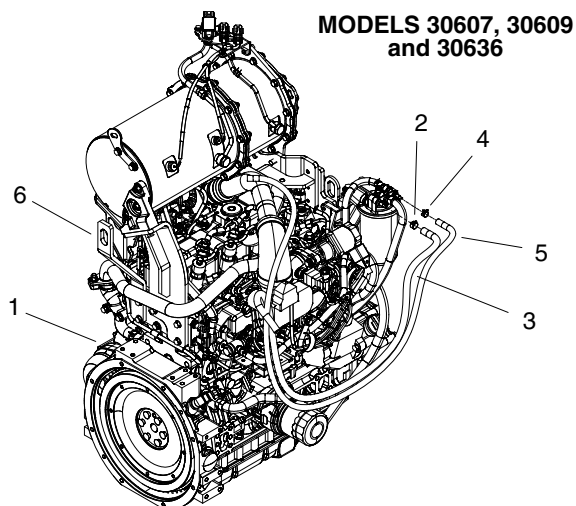
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Figure 22

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

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.

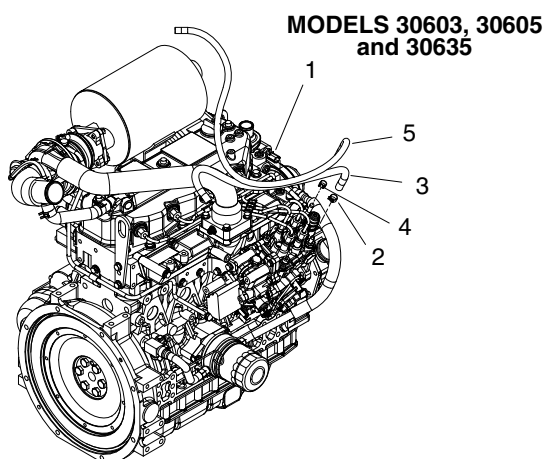
Engine Removal ([Figure 21](#)) (continued)



g274768

Figure 23

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



g274769

Figure 24

- | | |
|---------------------|---------------------|
| 1. Tier 4i engine | 4. Hose clamp |
| 2. Hose clamp | 5. Fuel return hose |
| 3. Fuel supply 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 30607, 30609 and 30636):
 - A. Remove fuel tank to allow engine to be raised from machine (see [Fuel System \(page 4–14\)](#)).
 - 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).

Engine Removal (Figure 21) (continued)

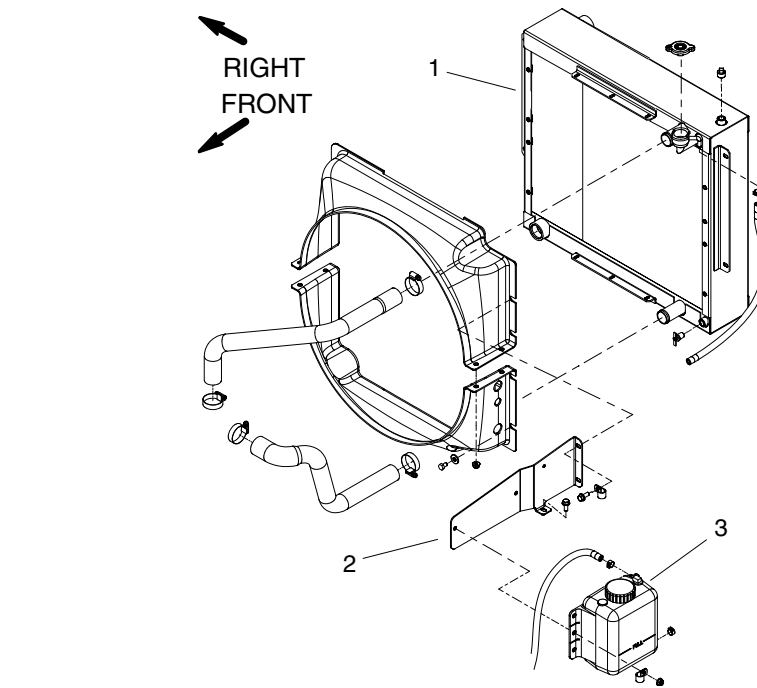


Figure 25

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

12. On Groundsmaster 4010-D machines:

- A. Remove air conditioning compressor from compressor mount (see [Air Conditioning Compressor \(page 10–5\)](#)). 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 4010-D machines with a Tier 4 compliant engine (model 30607 and 30636), 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.
- 16. Remove flange nuts, rebound washers and cap screws that secure the engine mount brackets to the engine mounts.

Engine Removal (Figure 21) (continued)

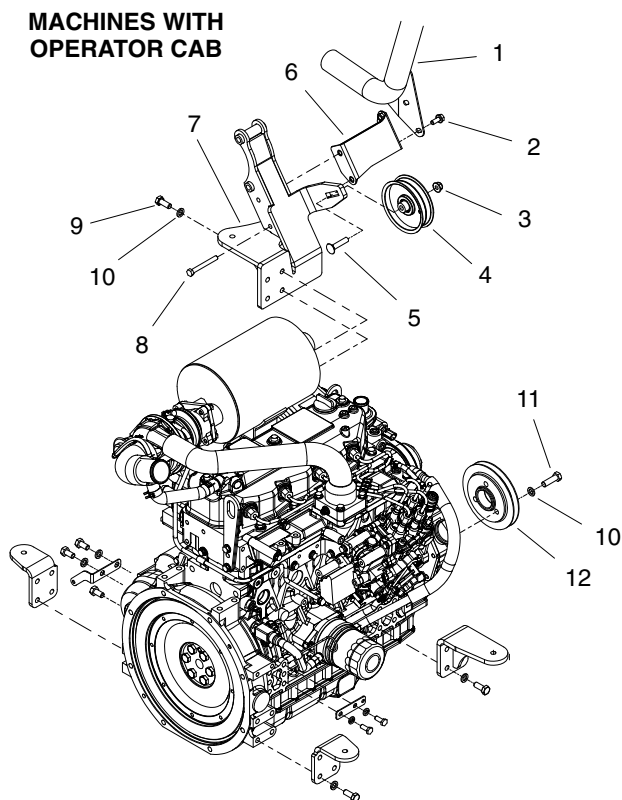


Figure 26

- | | |
|--------------------------|------------------------|
| 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.
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 30607, 30609 and 30636):
 - 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 4010–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](#)).
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.

Engine Installation ([Figure 21](#)) (continued)

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. Check and adjust oil level in hydraulic reservoir as needed.
21. Prime the fuel system (see [Fuel System \(page 4–14\)](#)).
22. Start engine and operate hydraulic controls to properly fill hydraulic system (see [Charge Hydraulic System \(page 5–91\)](#)).
23. Close and secure hood.

Spring Coupler

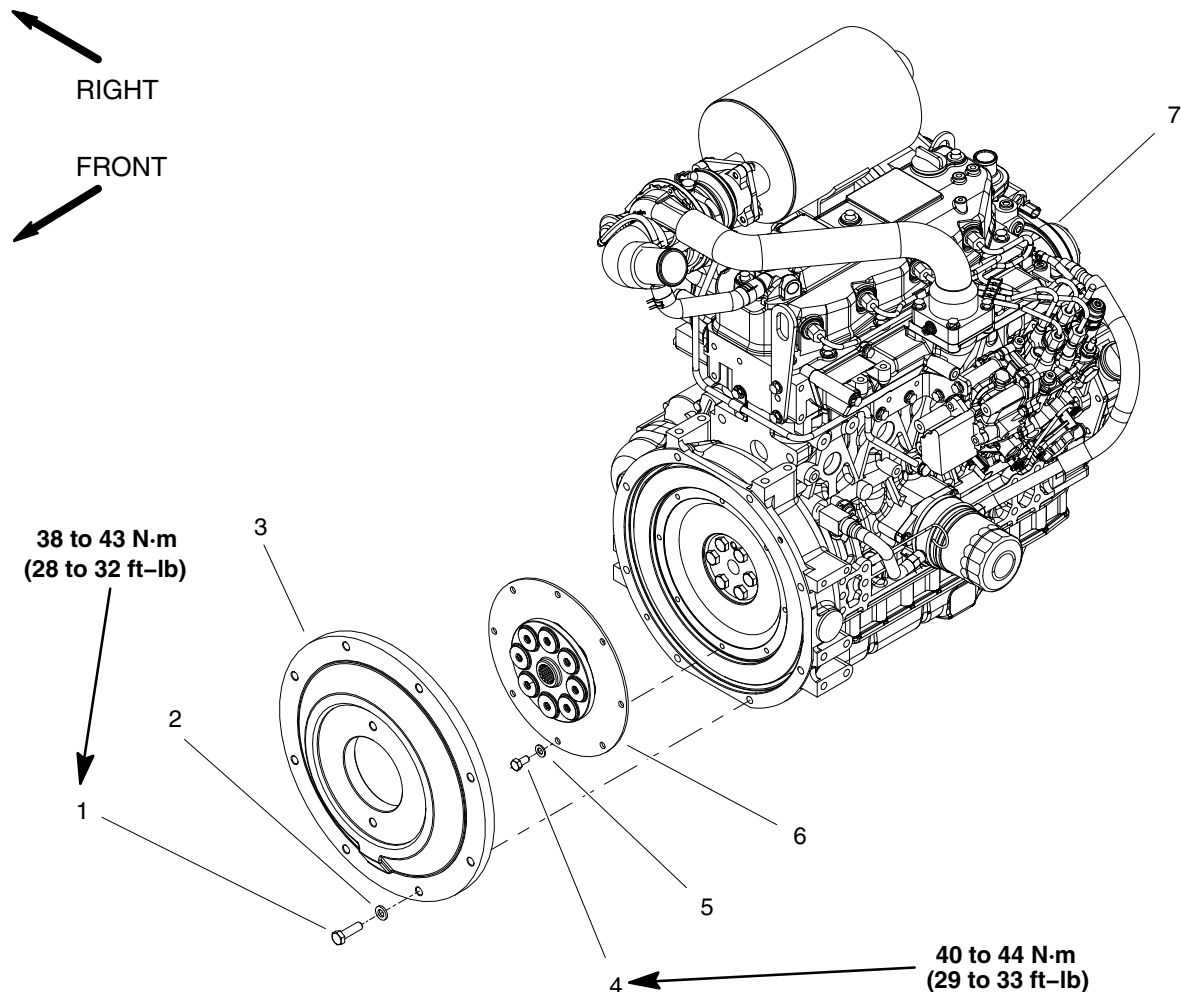


Figure 27

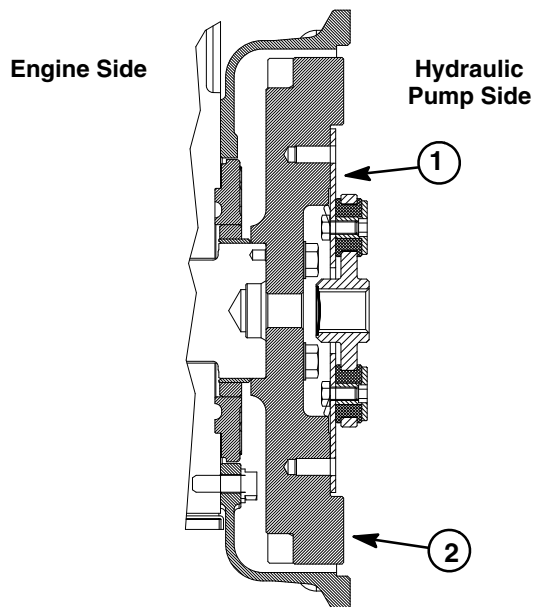
- | | | |
|-----------------------|-----------------------|-------------------------------------|
| 1. Cap screw (8 used) | 4. Cap screw (8 used) | 7. Engine (model 30603/30605 shown) |
| 2. Washer (8 used) | 5. Washer (8 used) | |
| 3. Flywheel plate | 6. Spring coupler | |

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](#))



g274773

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 30607, 30609 and 30636)

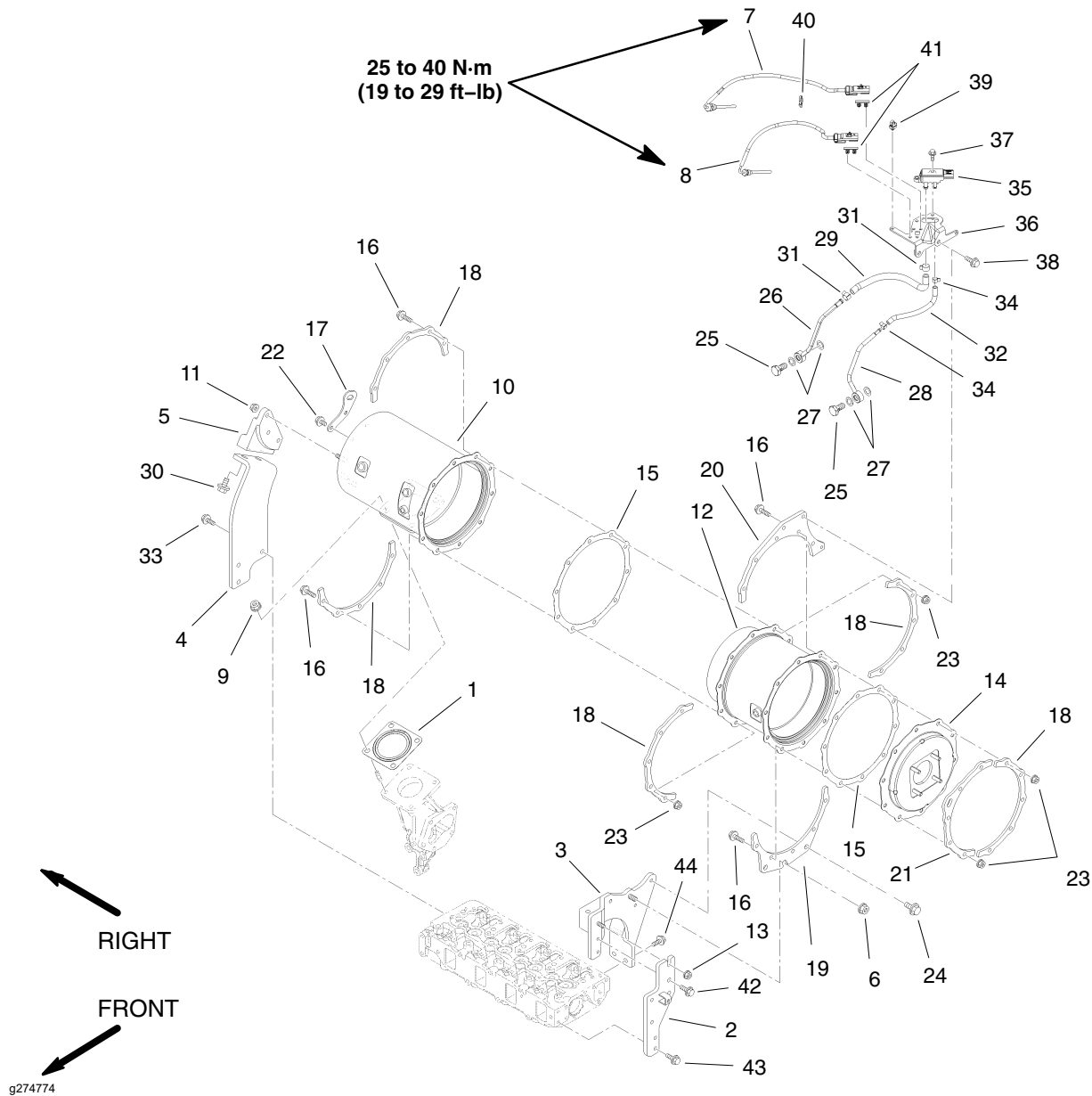


Figure 29

- | | | |
|-----------------------------|--|-----------------------------|
| 1. Gasket | 16. Bolt (20 used) | 31. Hose clip (2 used) |
| 2. Exhaust assembly stay | 17. DPF lifter | 32. Hose |
| 3. Exhaust assembly stay | 18. DPF stiffener (5 used) | 33. Bolt (3 used) |
| 4. Exhaust assembly stay | 19. DPF stiffener | 34. Hose clip (2 used) |
| 5. Exhaust assembly stay | 20. DPF stiffener | 35. Pressure sensor |
| 6. Nut | 21. DPF stiffener | 36. Sensor bracket |
| 7. DOC temp sensor (inlet) | 22. Bolt (2 used) | 37. Bolt (2 used) |
| 8. DOC temp sensor (outlet) | 23. Nut (20 used) | 38. Bolt (2 used) |
| 9. Nut (4 used) | 24. Bolt (2 used) | 39. Clip band |
| 10. DOC assembly | 25. Pipe joint bolt (2 used) | 40. Band |
| 11. Nut (3 used) | 26. Exhaust pressure pipe (DPF inlet) | 41. Connector clip (2 used) |
| 12. DPF assembly | 27. Sensor gasket (4 used) | 42. Bolt (2 used) |
| 13. Nut | 28. Exhaust pressure pipe (DPF outlet) | 43. Bolt (2 used) |
| 14. Outlet flange | 29. Exhaust hose | 44. Bolt (2 used) |
| 15. DPF gasket (2 used) | 30. 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 30607, 30609 and 30636 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.

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

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.

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)

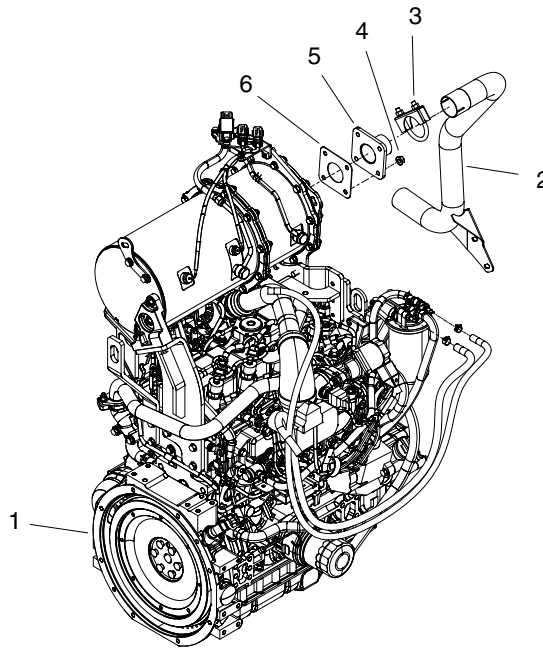


Figure 30

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



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Additional Reference Materials

[Danfoss H1 Closed Circuit Axial Piston Pumps Service Manual](#)

[Danfoss H1 Closed Circuit Axial Piston pumps 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](#)

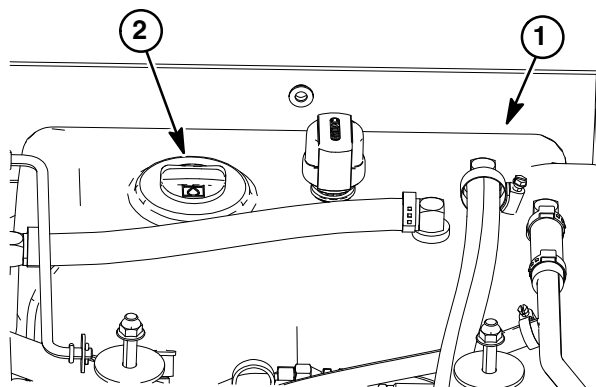
[Eaton Parts And Repair Information: 5 Series Steering Control Units](#)

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



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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.

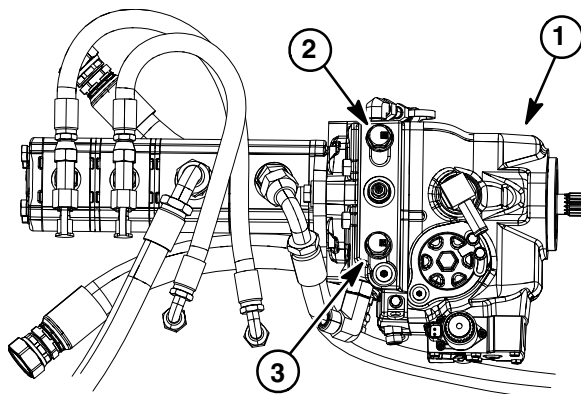
System pressure in mow circuit is relieved when the PTO switch is disengaged.

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

Towing Traction Unit

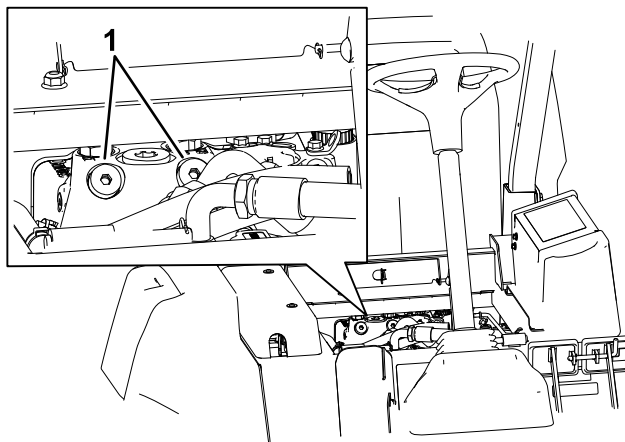


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Figure 32

(For machines serial number below 400000000)

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



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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 4000-D and 4010-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 contaminants 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:

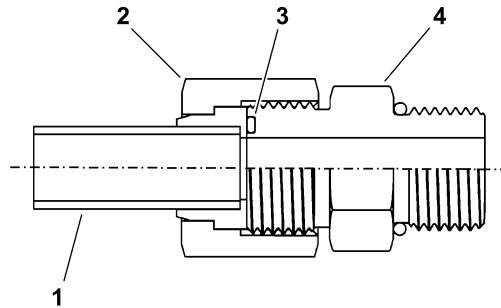
- **Keep your body and hands away from pin-hole leaks or nozzles that eject hydraulic fluid under high pressure.**
- **Do not use your hands to search for leaks; use a piece of paper or cardboard.**
- **Hydraulic fluid escaping under pressure can have sufficient force to penetrate the skin and cause 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 (layline) 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)



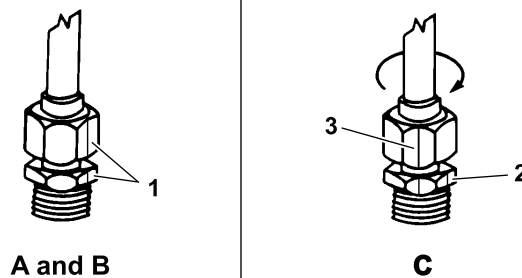
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Figure 34

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

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 \(page 2–10\)](#).



g212098

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

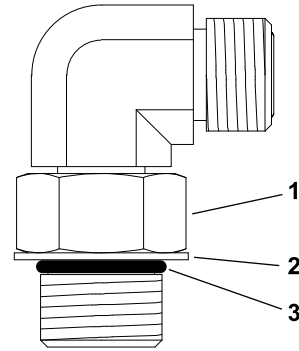
Fitting Dash Size	Hose/Tube Side Thread Size (inch)—threads per inch	Installation Torque
4	9/16—18	25 to 29 N·m (18 to 22 ft-lb)
6	11/16—16	37 to 44 N·m (27 to 33 ft-lb)
8	13/16—16	51 to 63 N·m (37 to 47 ft-lb)
10	1—14	82 to 100 N·m (60 to 74 ft-lb)
12	1-3/16—12	116 to 142 N·m (85 to 105 ft-lb)
16	1-7/16—12	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 [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](#)).

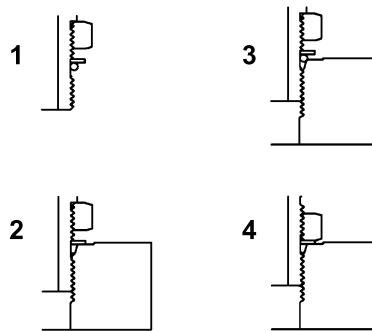
Installing an Adjustable Fitting



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Figure 37

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



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Figure 38

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

Installing an Adjustable Fitting (continued)

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-adaptor 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

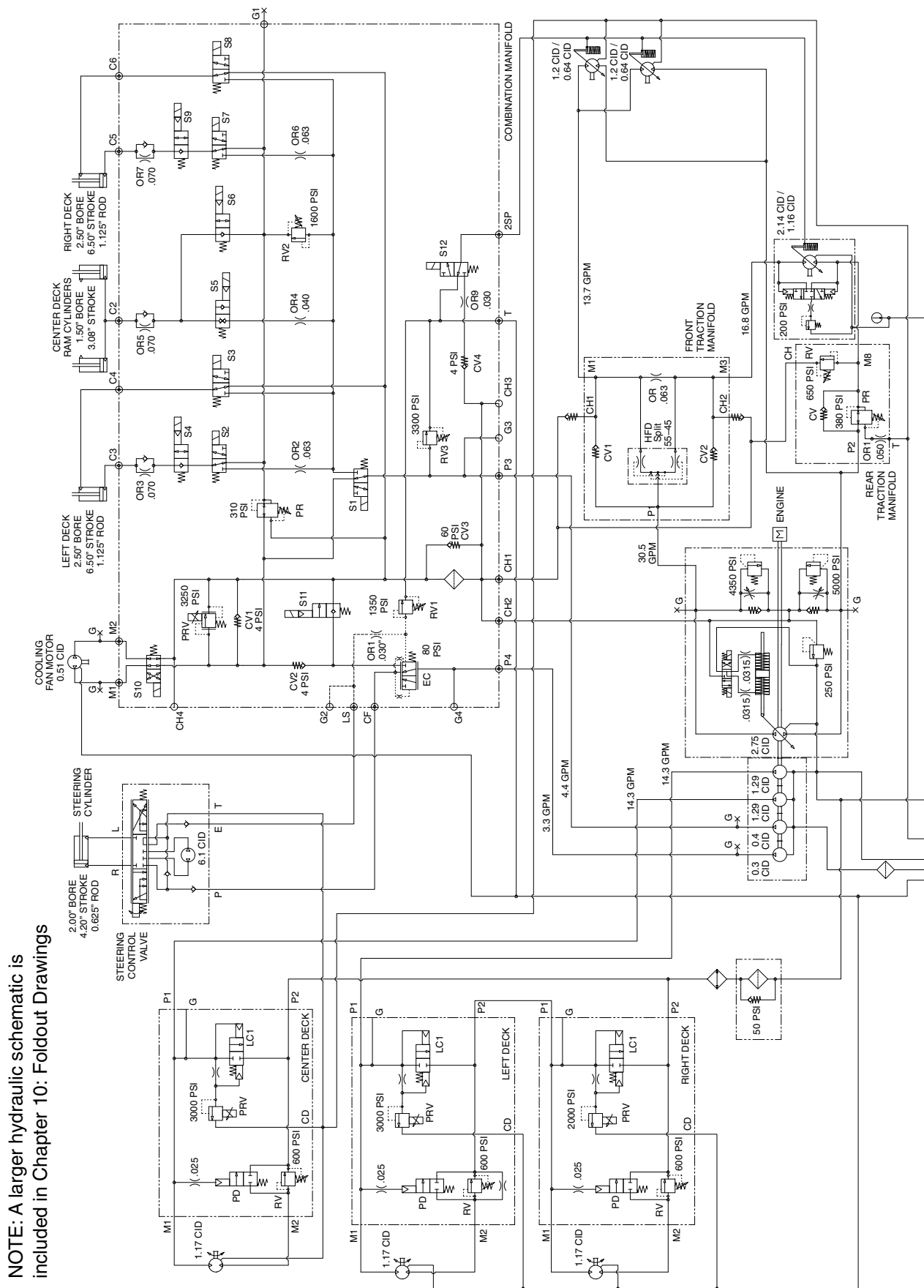


Figure 39

Hydraulic Flow Diagrams



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.

A traction circuit flow divider splits traction pump hydraulic flow between the front wheel motors (approximately 45%) and rear axle motor (approximately 55%) to prevent excessive circuit flow going to a spinning wheel. The flow divider is located in the front traction manifold mounted to the right, rear side of the front frame.

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.

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

Forward Direction (continued)

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 through the front traction manifold.

Traction Circuit: HI Speed (Transport)

Traction Circuit: HI Speed (Transport) (Forward Shown)

Working Pressure
Low Pressure (Charge)
Return or Suction
Flow



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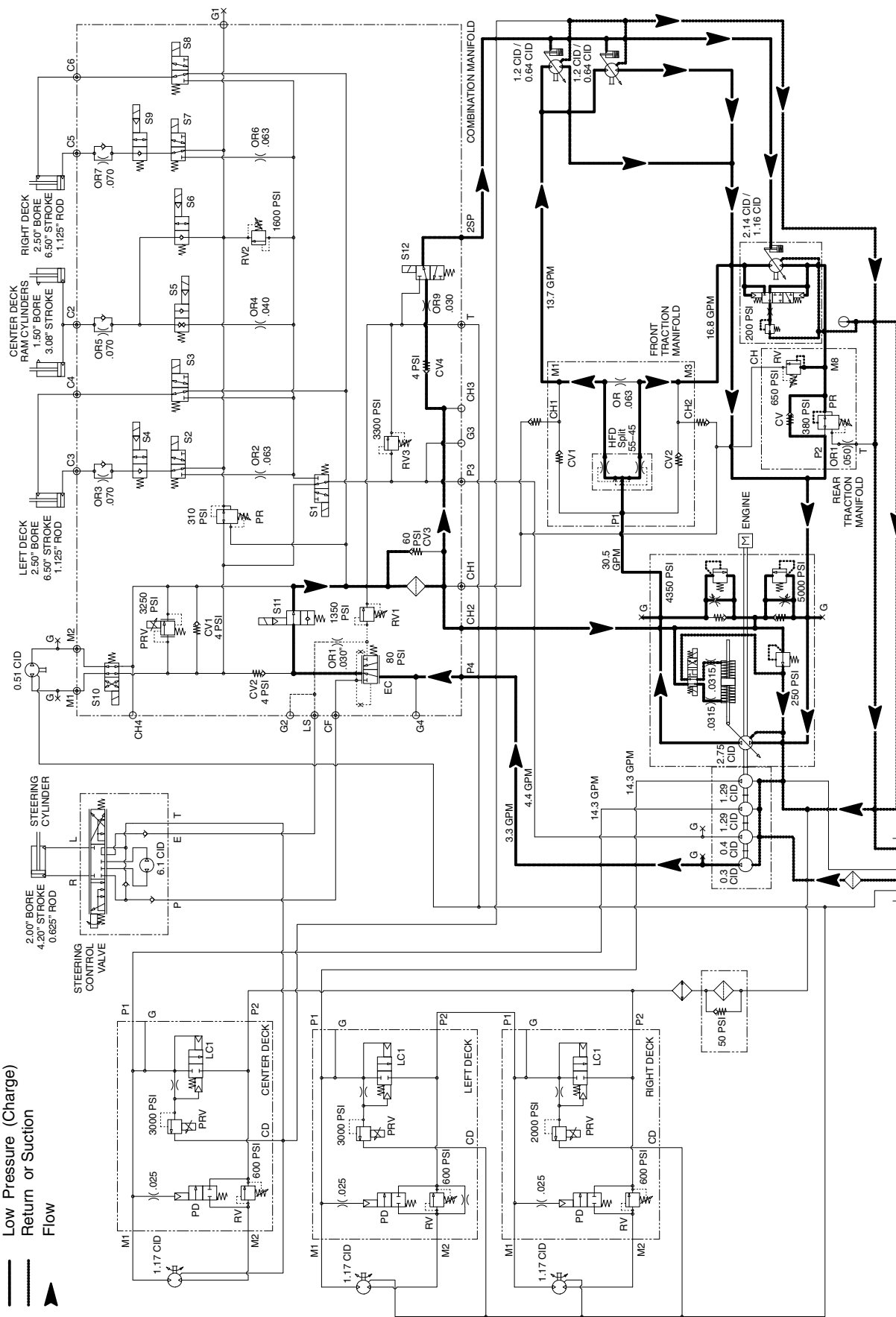


Figure 41

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.

A traction circuit flow divider splits traction pump hydraulic flow between the front wheel motors (approximately 45%) and rear axle motor (approximately 55%) to prevent excessive circuit flow going to a spinning wheel. The flow divider is located in the front traction manifold mounted to the right, rear side of the front frame.

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.

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 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.

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 through the front traction manifold.

Lower Cutting Deck Circuit

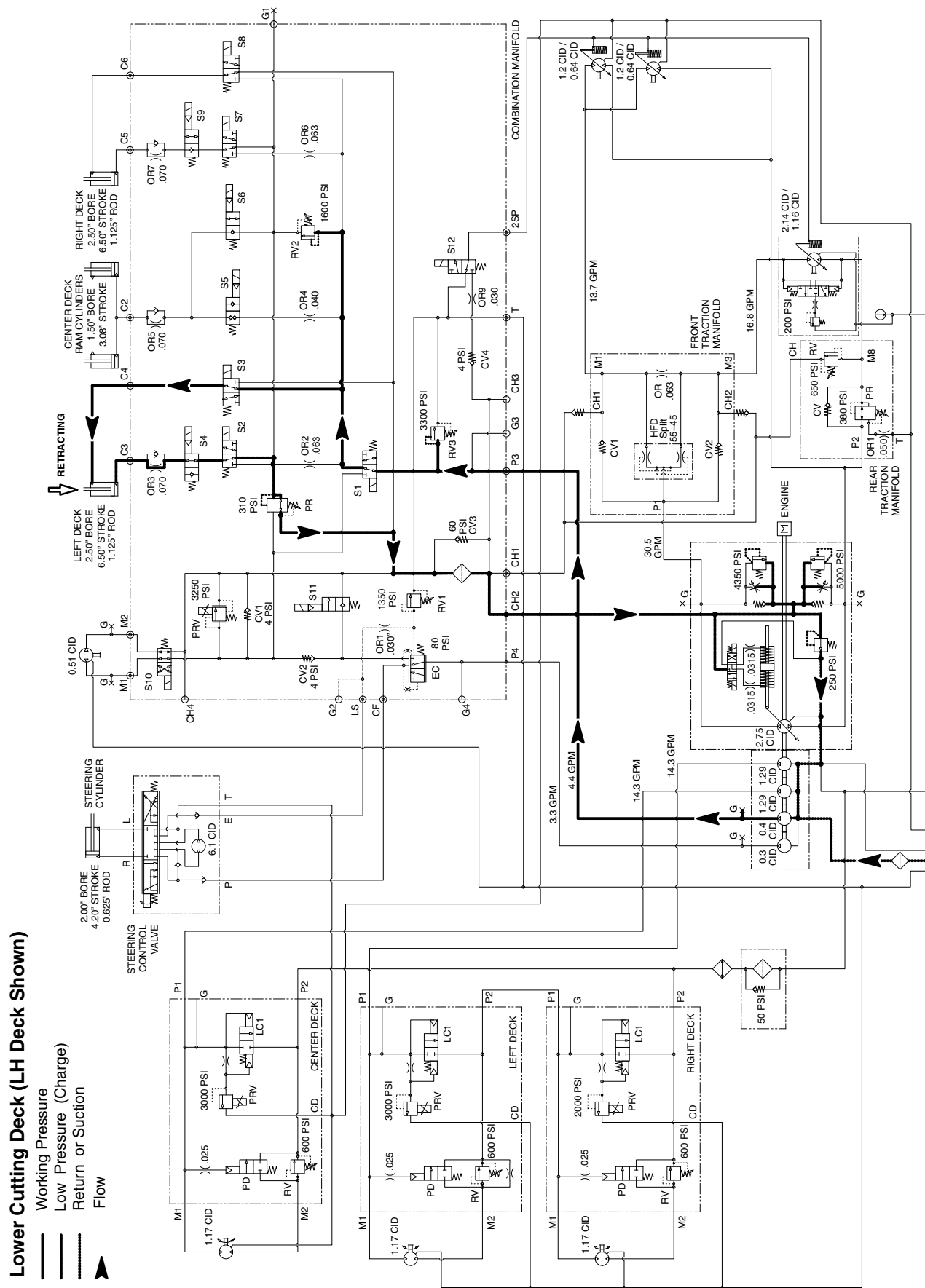


Figure 42

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 Center 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 Cutting 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 Cutting 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 ignition 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.

Groundsmaster® 4000-D & 4010-D
13202SL Rev G

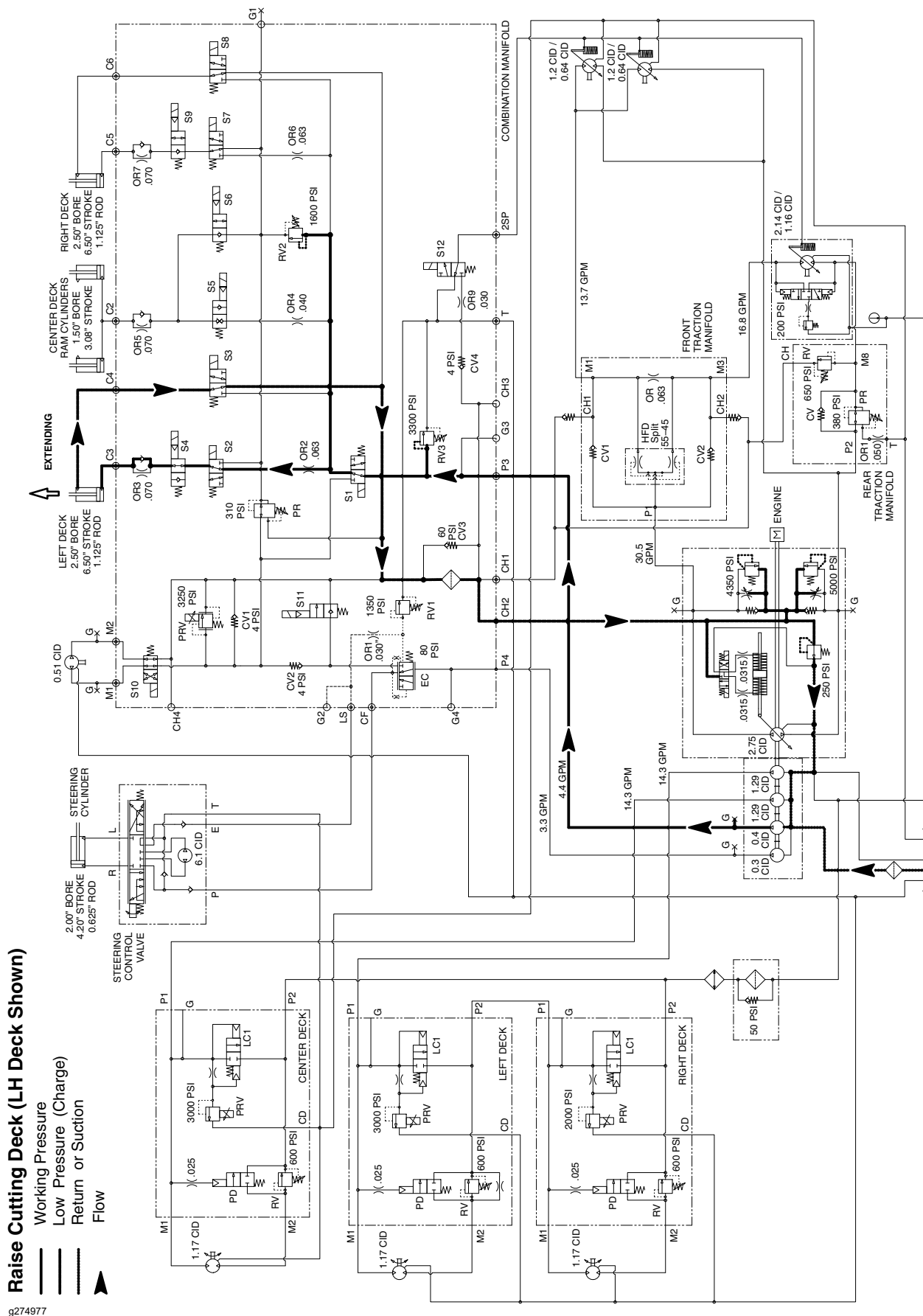


Figure 43

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.

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.

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

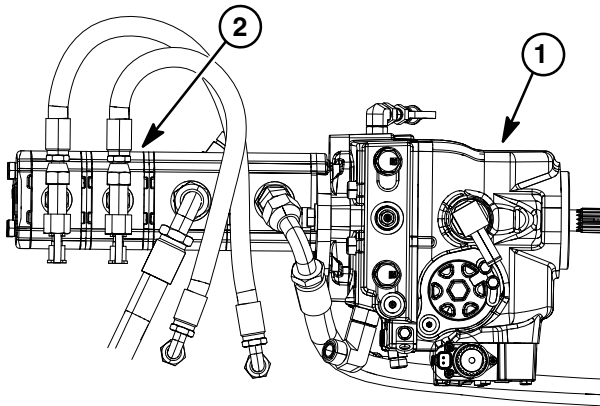
When the lift/lower circuit is not being used (all lift switches in the neutral position), solenoid valve S1 in the combination manifold is not energized and gear pump section oil flow is directed toward the engine cooling fan motor

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.

When the lift switch is released, the manifold solenoids are de-energized and the center deck lift cylinders and center cutting deck are held in position.



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Figure 44

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

Raise Right Cutting Deck

To raise the right 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 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 cutting deck. Orifice OR6 (.063) controls the raising of the cutting deck. Check orifice OR7 is bypassed when raising the right cutting deck. Oil from the extending cylinder is directed through S8 (de-energized), to the oil filter and then to the traction charge circuit.

When the lift switch is released, the manifold solenoids are de-energized and the lift cylinder and right cutting deck are held in position.

Raise Left Cutting 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.

When the lift switch is released, the manifold solenoids are de-energized and the lift cylinder and left cutting deck are held in position.

Mow Circuit

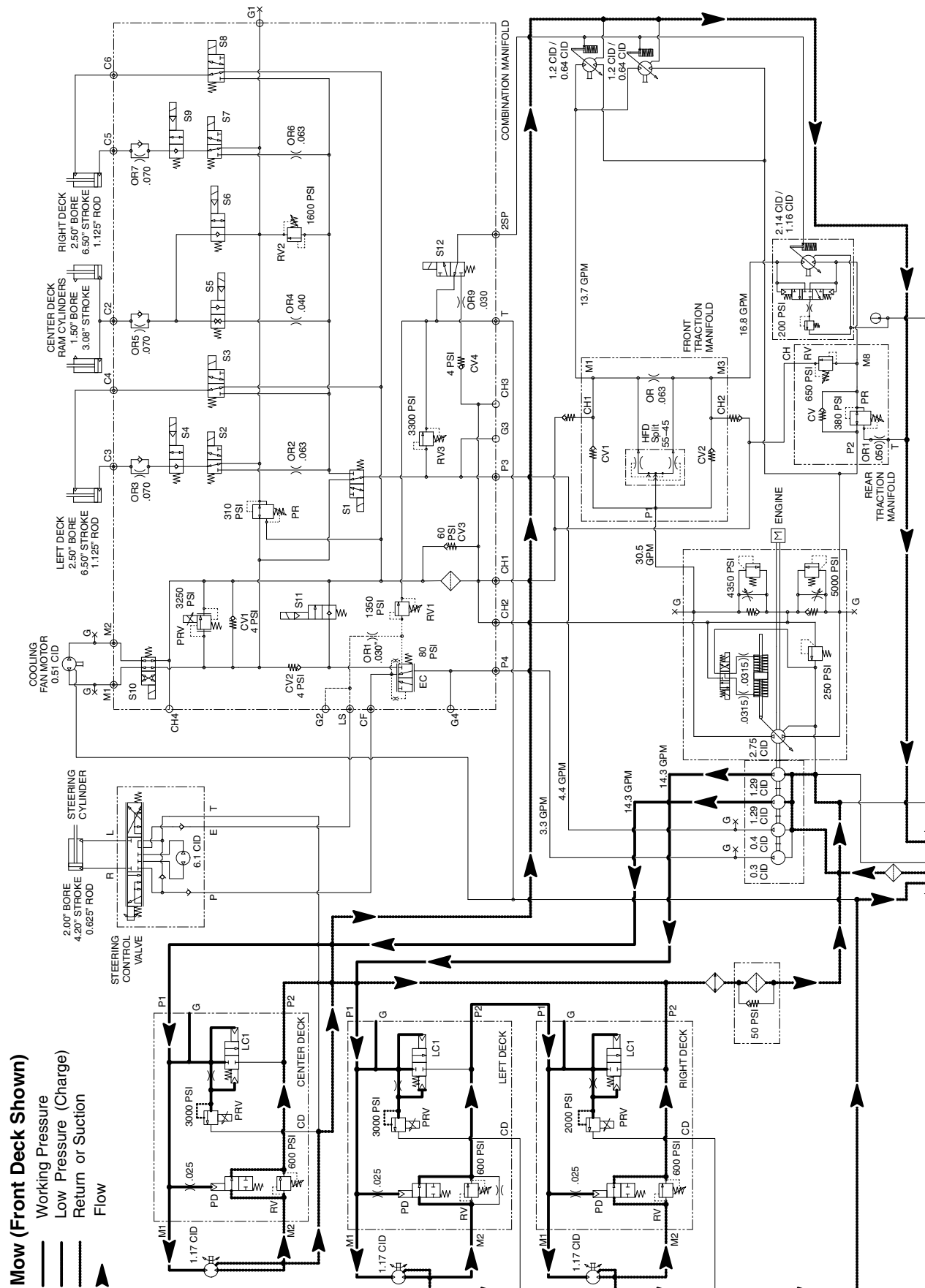


Figure 45

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.

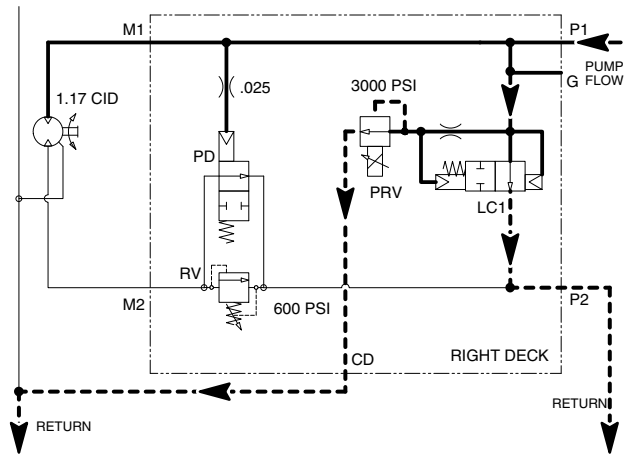
Return flow from the front and right PTO manifolds is routed through the oil cooler, oil filter and then to the gear pump input. Return flow from the left PTO manifold provides supply for the right deck.

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



**DECK MOTOR STALLED
PRV ENERGIZED
PRV AND LC1 SHIFTED**

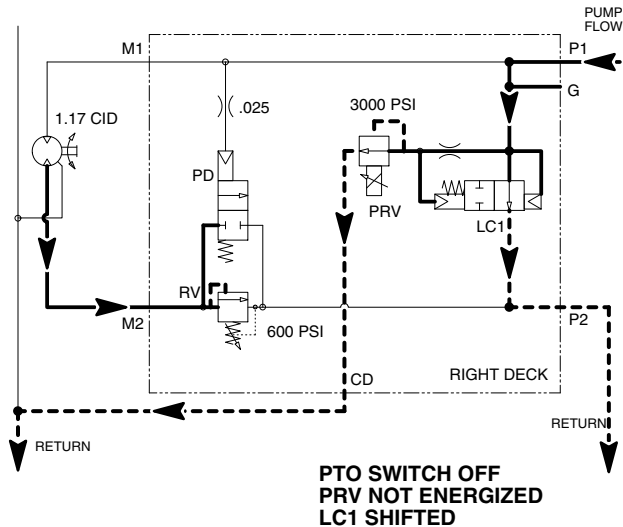
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Figure 46

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).

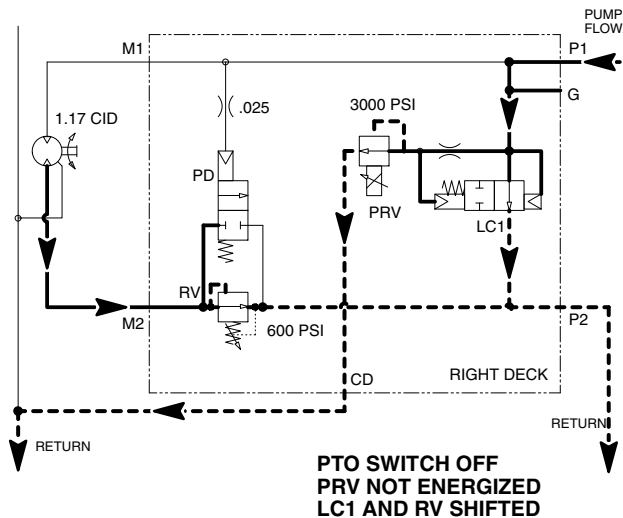
Proportional relief valve (PRV) and logic valve (LC1) work together as a two stage circuit relief. When increased circuit resistance is met (e.g. a cutting blade strikes an object), the pressure increase is felt at the proportional relief valve. If the pressure should exceed the relief valve setting, 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



g274971

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

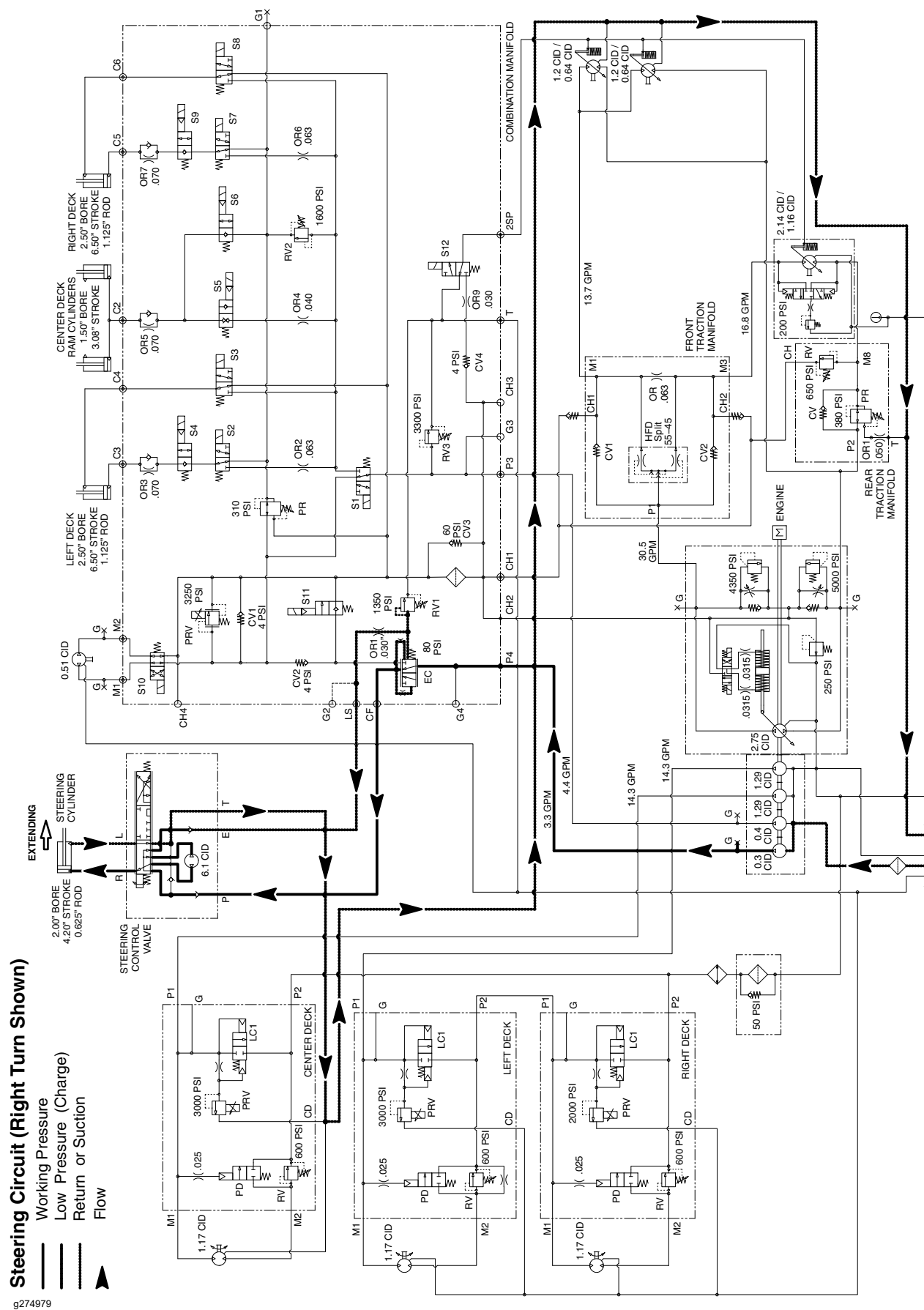


Figure 49

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

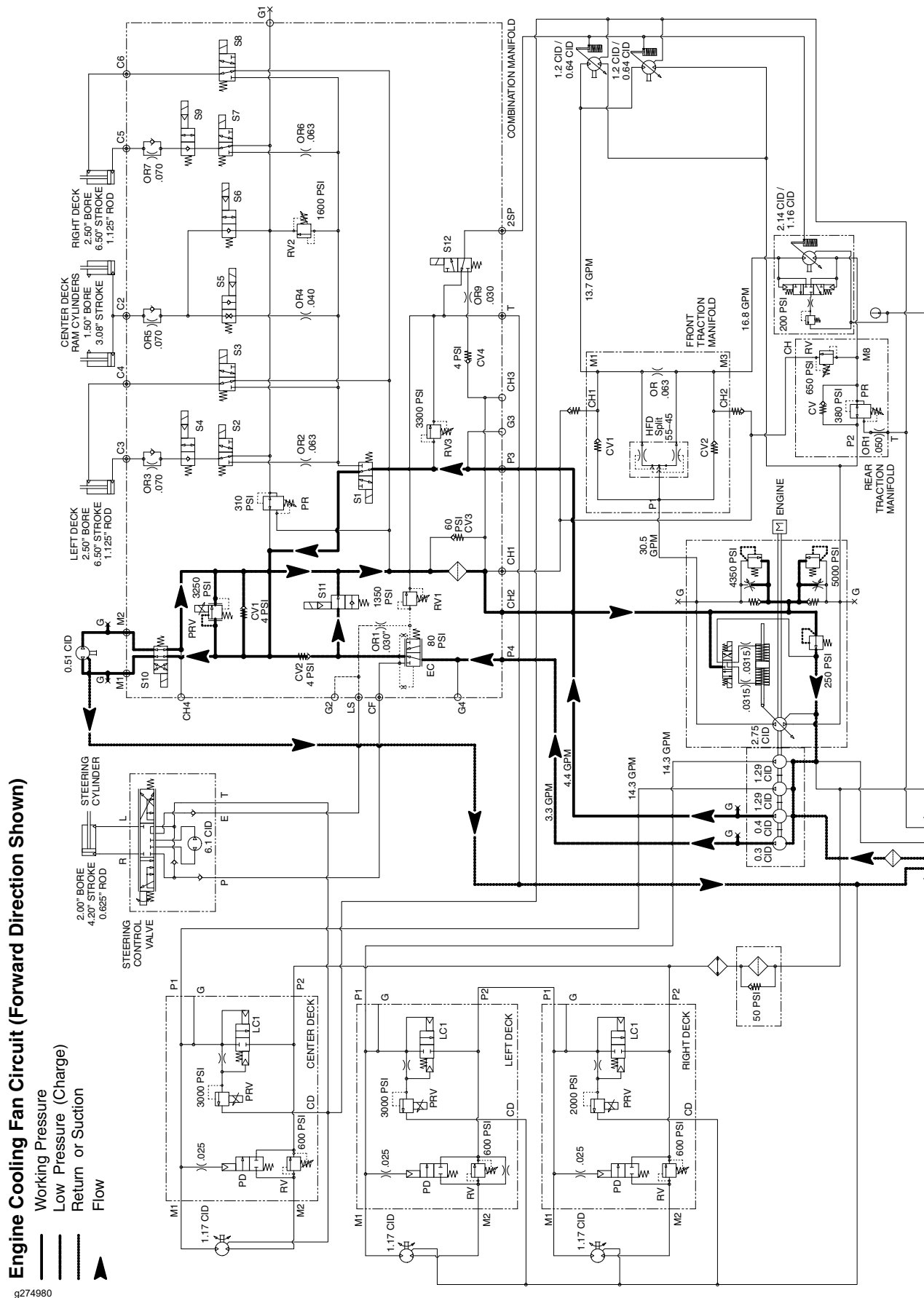
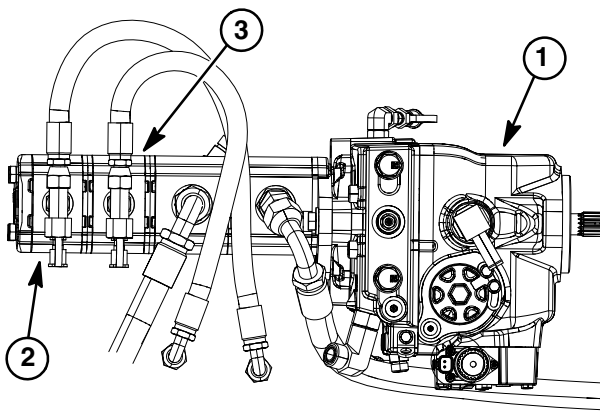


Figure 50



g274972

Figure 51

- | | |
|--------------------------------------|--------------------------------------|
| 1. Piston (traction) pump | 3. 3 rd gear pump section |
| 2. 4 th 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 \(page 2–17\)](#) Special Tools section in this Chapter).

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.

Precautions for Hydraulic Testing (continued)

3. Put metal caps or plugs on any hydraulic lines left open or exposed during testing or removal of components.
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 \(Models 30603, 30605 and 30635\) \(page 2–4\)](#) and [Engine \(Models 30607, 30609 and 30636\) \(page 2–5\)](#).
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.

Which Hydraulic Tests Are Necessary? (continued)

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.

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

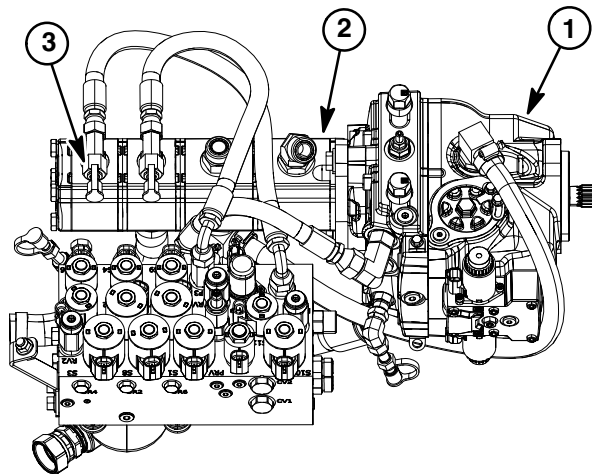


CAUTION



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

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.



g275054

Figure 53

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

3. Connect a 70 bar (1000 PSI) pressure gauge to test fitting attached to tee fitting in final section of gear pump (Figure 53).

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 \(Using Tester with Pressure Gauge and Flow Meter\) \(page 5–79\)](#)).

Procedure for Traction Circuit Charge Pressure Test (continued)

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)

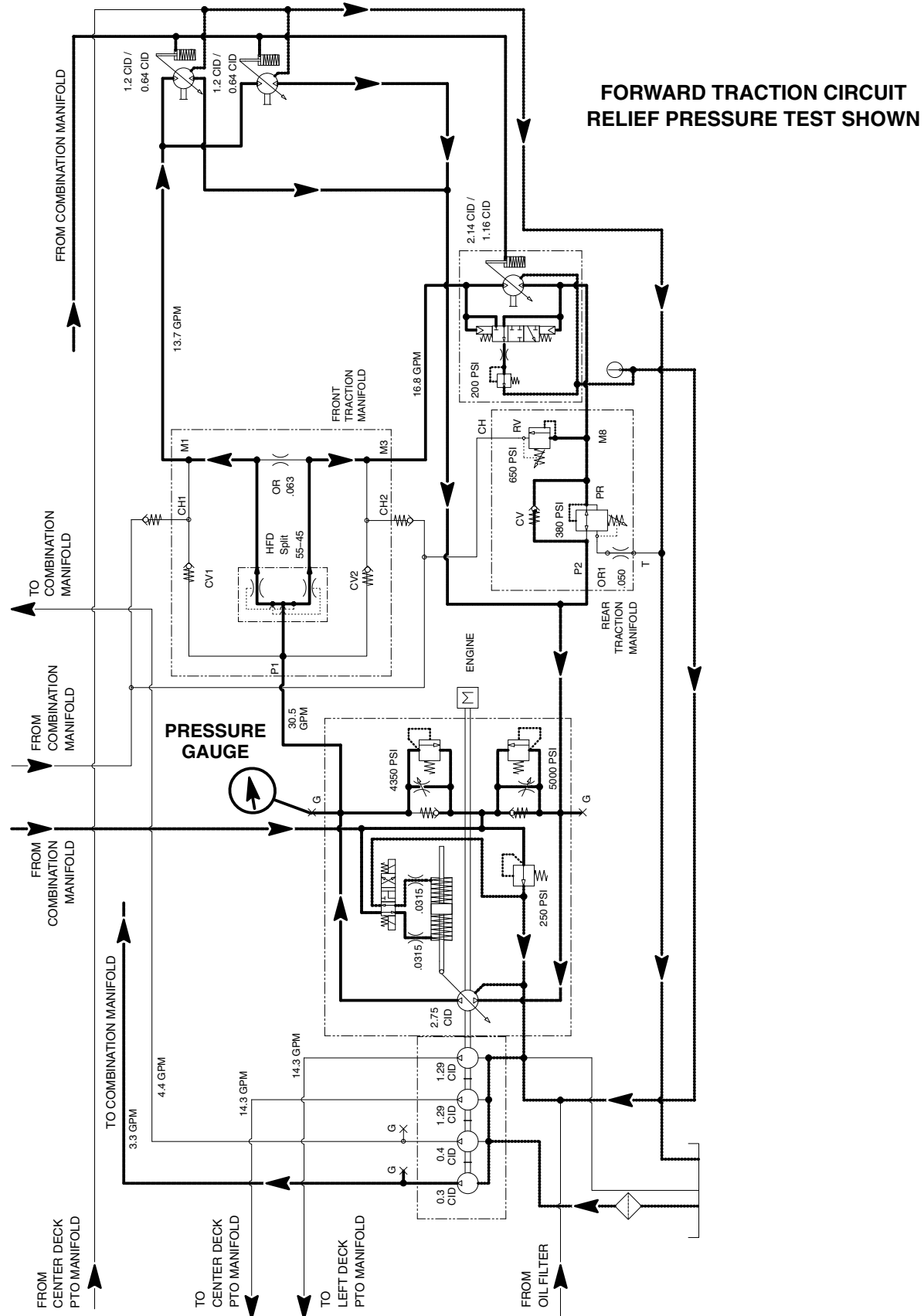
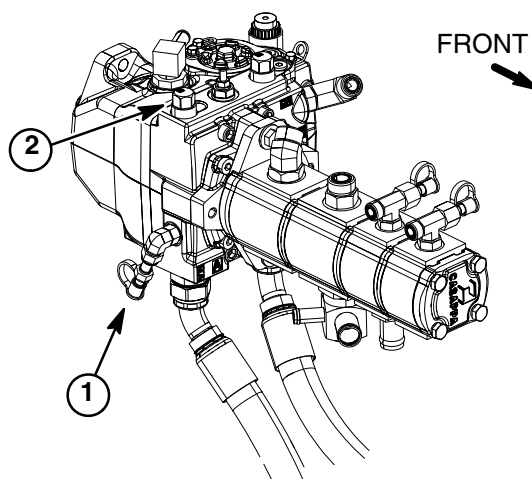


Figure 54

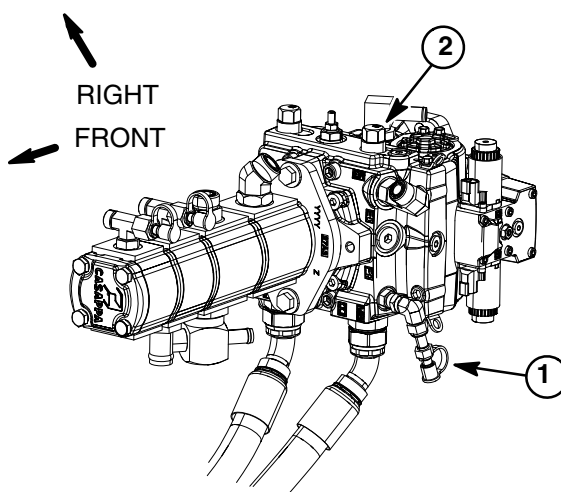
Procedure for Traction Circuit Relief Pressure Test



g275055

Figure 55

1. Forward traction port
2. Forward relief valve



g275056

Figure 56

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)



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 55](#) or [Figure 56](#)).
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:

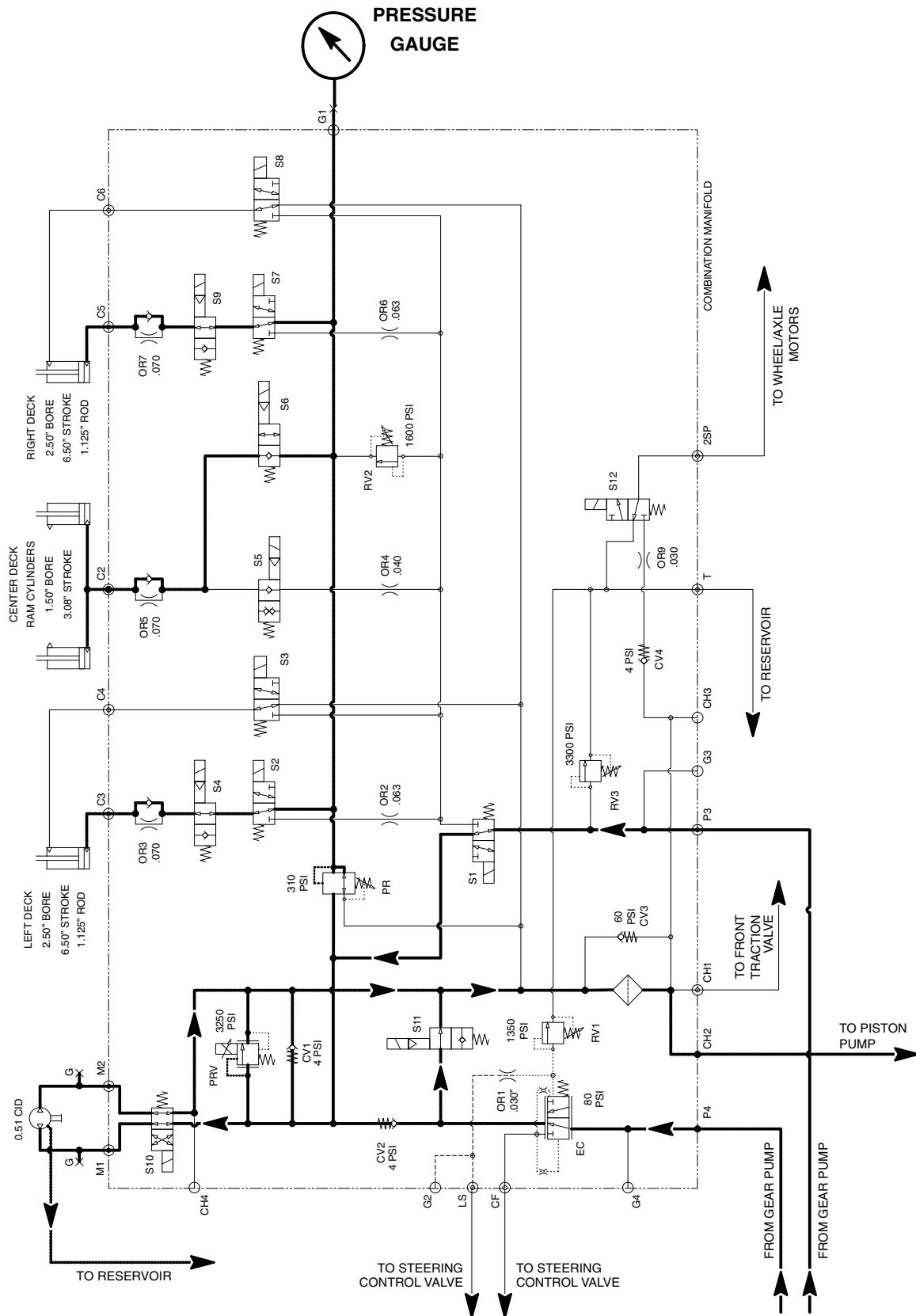
GAUGE READING TO BE:

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.
7. If traction pressure is too low, inspect traction pump relief valves ([Figure 55](#) or [Figure 56](#)). 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.

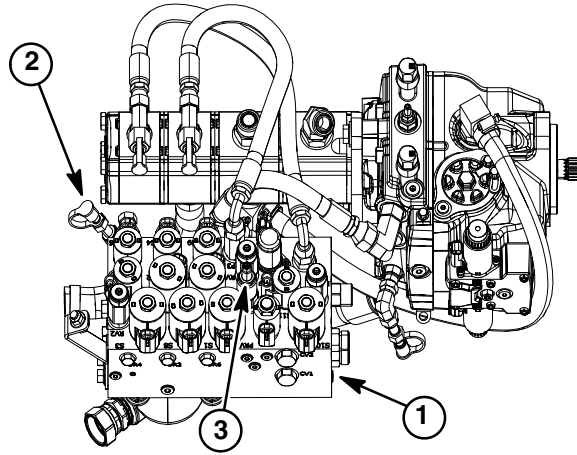
Counterbalance Pressure (Using Pressure Gauge)



g275076

Figure 57

Procedure for Counterbalance Pressure Test



g275057

Figure 58

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 58).

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.

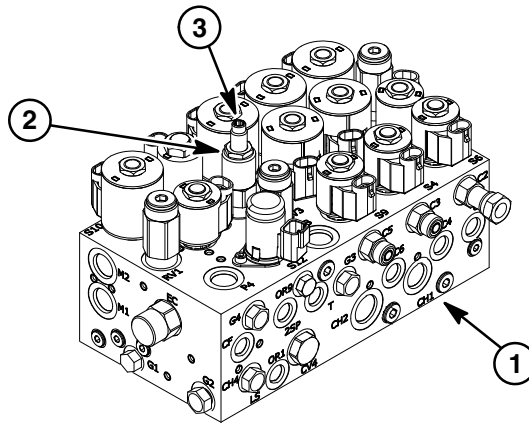
4. Start engine and increase engine speed to high idle speed with no load on the hydraulic system. **Do not engage the cutting decks.**

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

Note: The recommended counterbalance pressure for your Groundsmaster® is 22.4 bar (325 PSI).

5. Stop engine and record test results.

Procedure for Counterbalance Pressure Test (continued)



g275058

Figure 59

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

-
6. The pressure reducing valve on the combination manifold is used to set the counterbalance pressure (Figure 59). 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 59). 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)

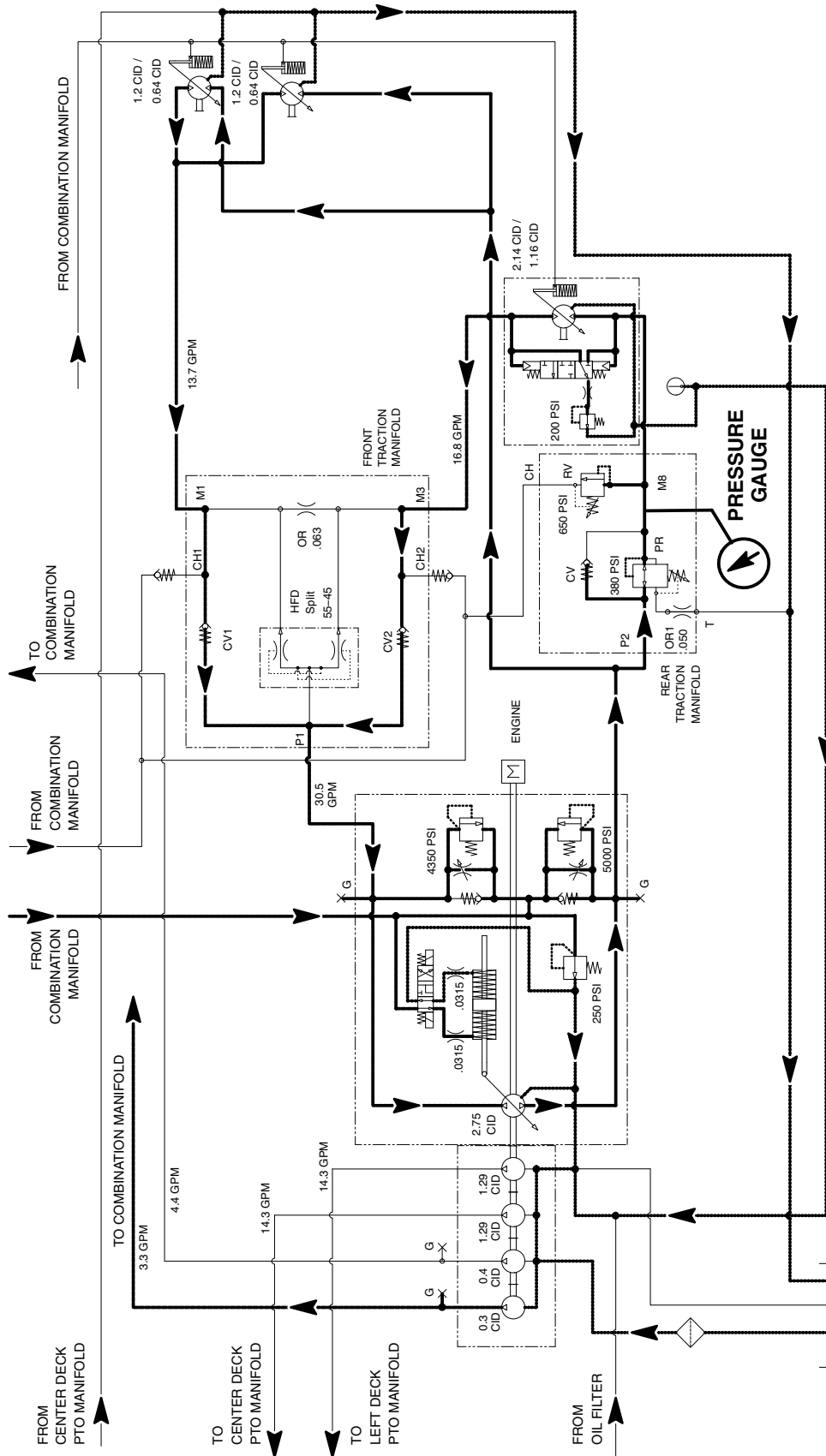


Figure 60

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.



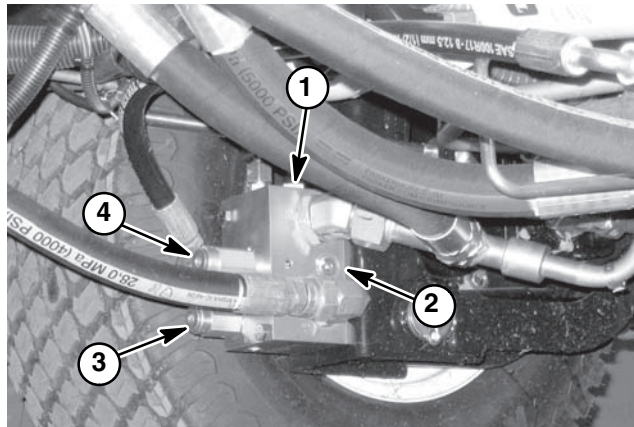
CAUTION



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.

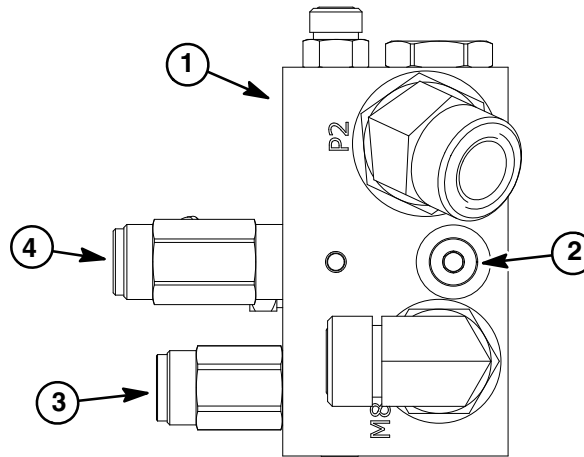


g275059

Figure 61

- | | |
|---------------------------|------------------------|
| 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 61). 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 62

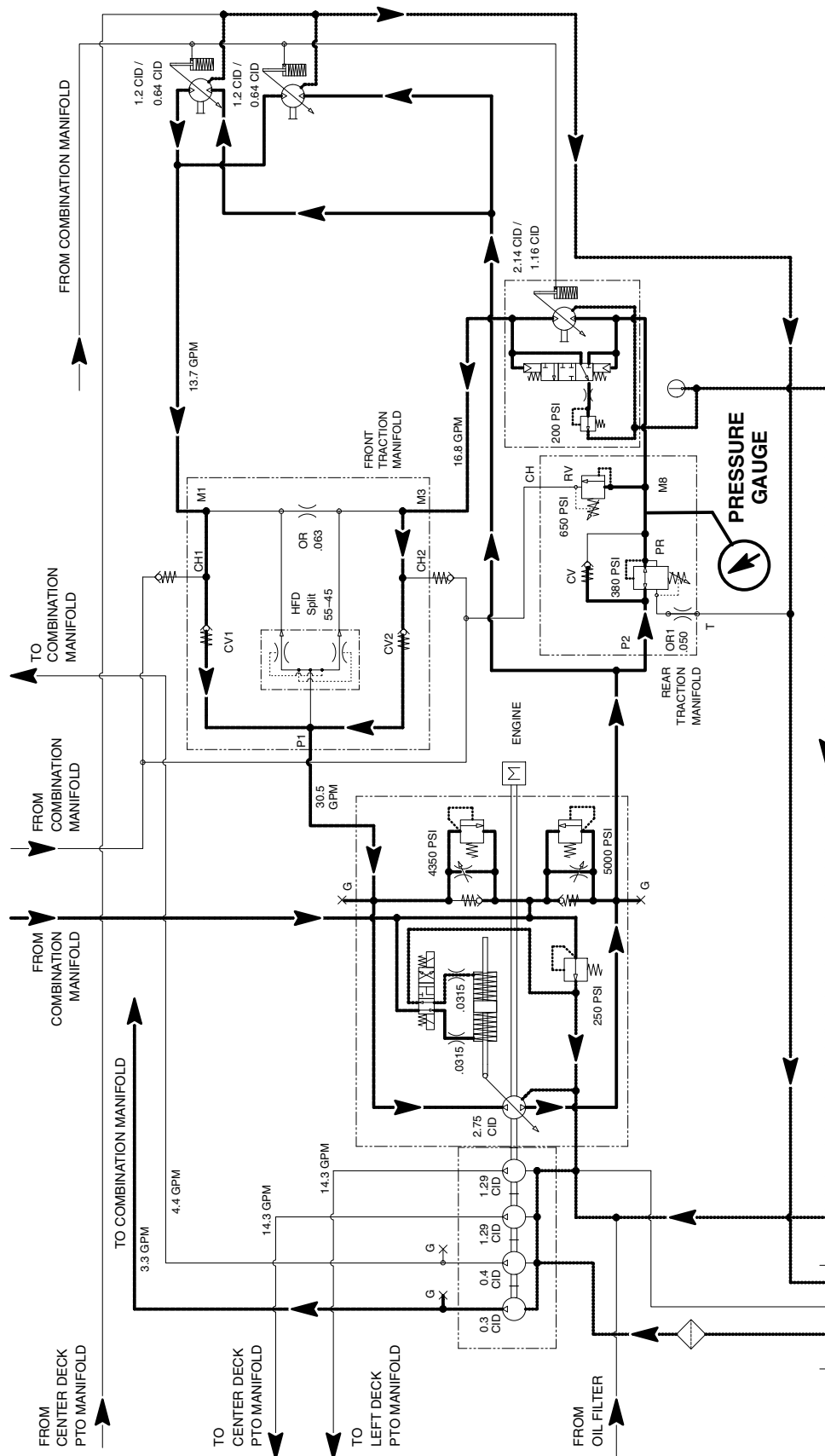
- | | |
|---------------------------|------------------------|
| 1. Rear traction manifold | 3. Relief (RV) valve |
| 2. #6 zero leak plug | 4. Reducing (PR) valve |

-
7. The pressure reducing (PR) valve is located on the rear side of the rear traction manifold ([Figure 61](#) and [Figure 62](#)). 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. If necessary, conduct 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)



g275078

Figure 63

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

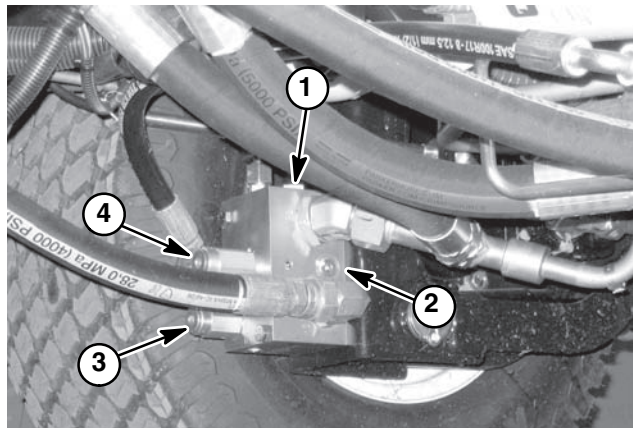


Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS and Precautions for Hydraulic Testing at the beginning of this section.

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 64

- | | |
|---------------------------|------------------------|
| 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 64). 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.

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

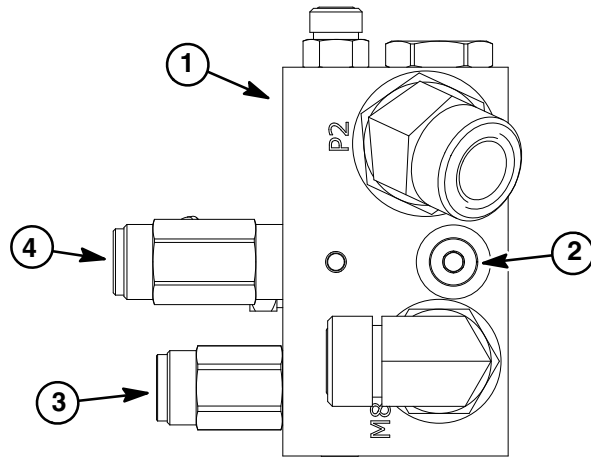


Figure 65

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

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.

- The rear traction circuit relief valve (RV) is located on the rear side of the rear traction manifold ([Figure 64](#) and [Figure 65](#)). If test pressure is incorrect, adjust relief valve (RV) (see [Adjust Control Manifold Relief Valves \(page 5–82\)](#)).
- 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)

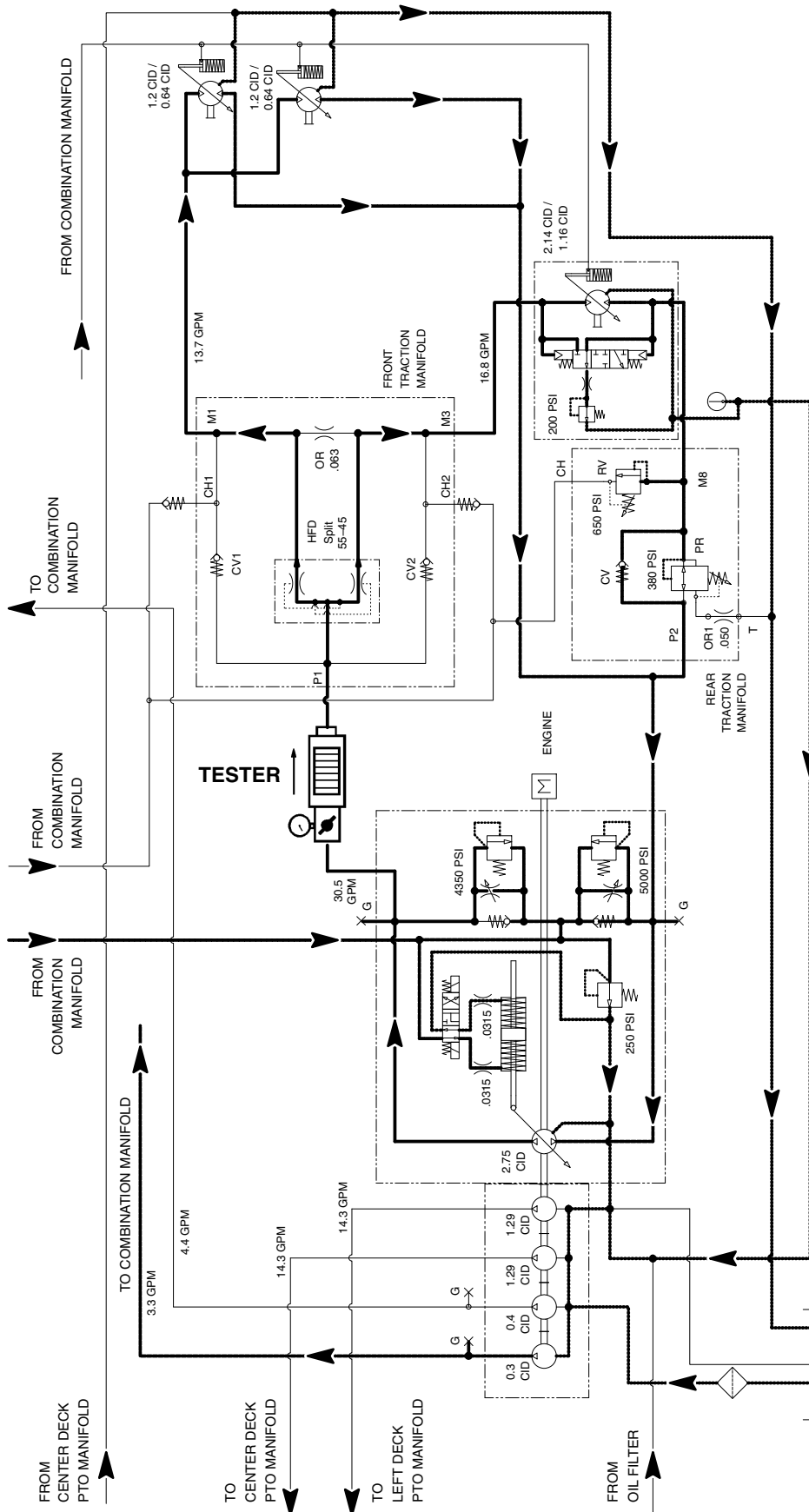


Figure 66

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 4000/4010 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.

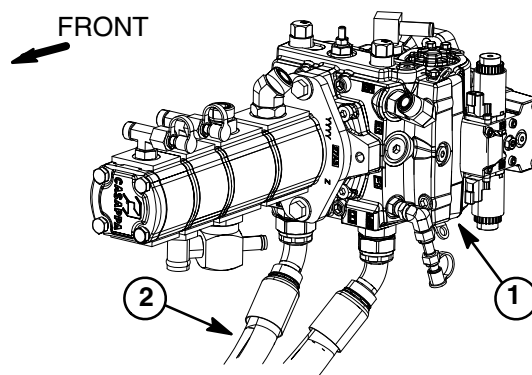


CAUTION



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 \(page 1–7\)](#)).



g275063

Figure 67

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 67](#)). 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.

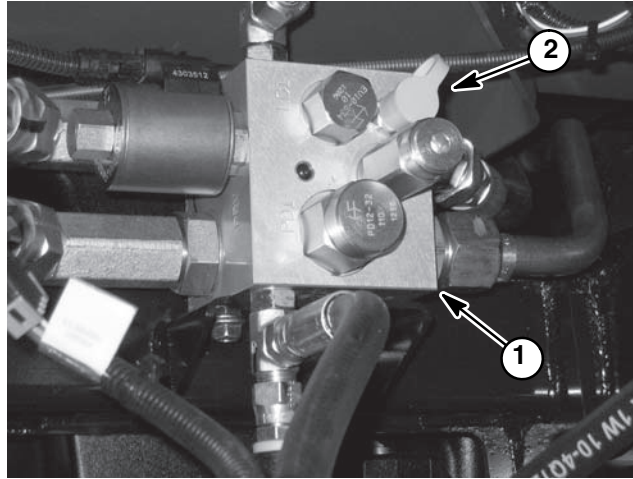
Note: If engine speed drops during testing, pump flow will decrease and flow test results will be inaccurate.

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 \(page 6–22\)](#)).
 - 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.

FRONT DECK CIRCUIT PRESSURE TEST SHOWN



Procedure for Cutting Deck Circuit Pressure Test



g275064

Figure 69

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 69).



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)

FRONT PTO RELIEF PRESSURE TEST SHOWN

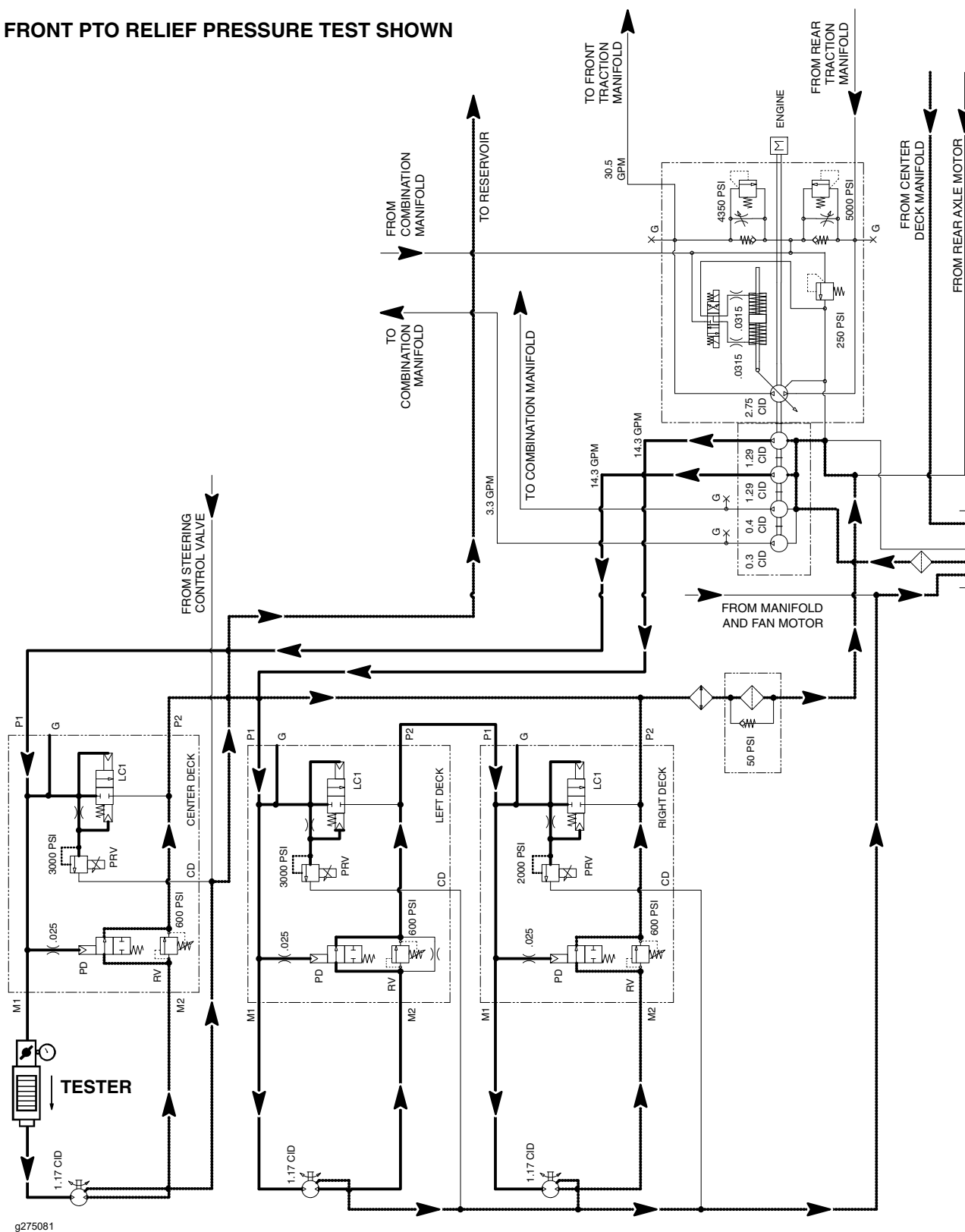


Figure 70

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

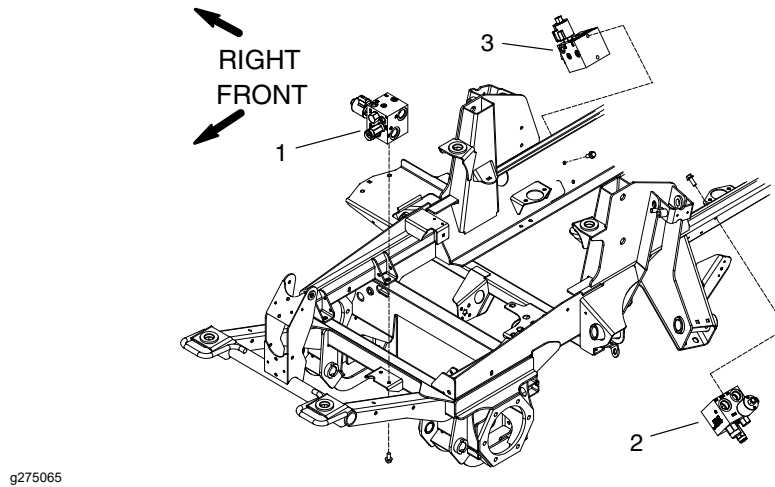


Figure 71

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

LEFT PTO MANIFOLD SHOWN

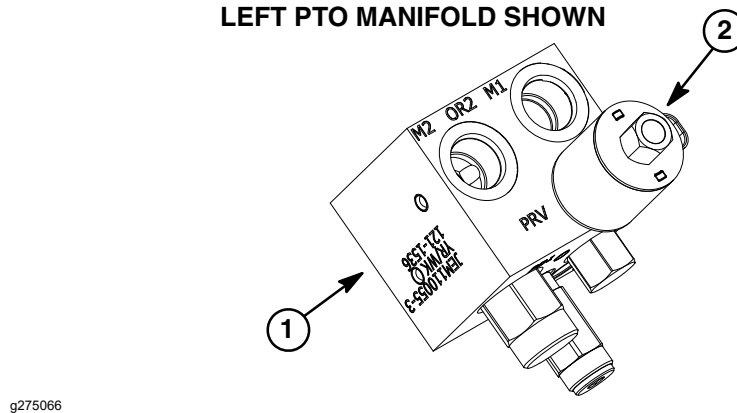


Figure 72

- | | |
|-----------------|--------------|
| 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 71). 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.



CAUTION

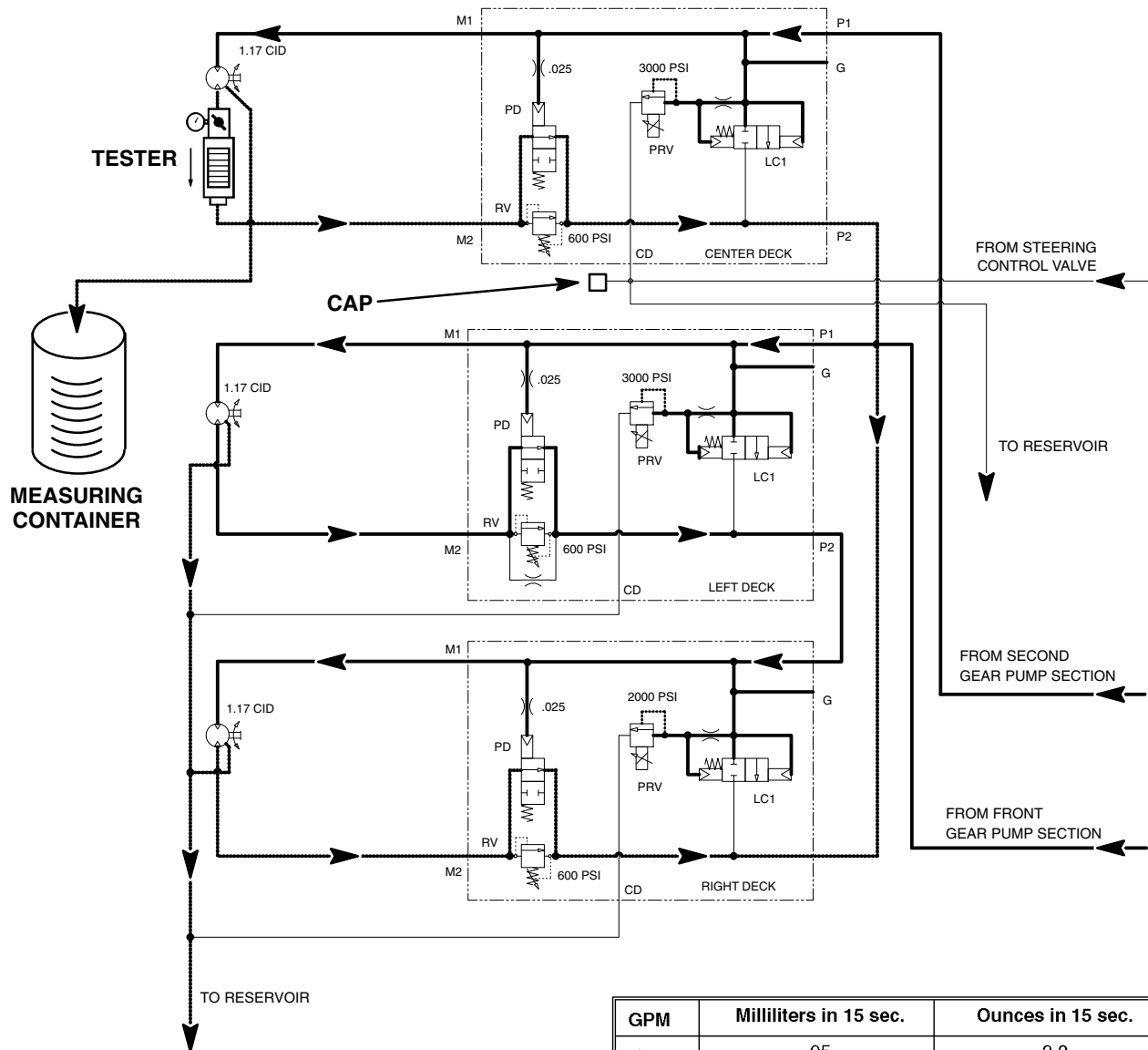


Cutting deck blades will rotate when cutting decks are lowered with PTO switch in ON position. Keep away from cutting decks during test to prevent personal injury from rotating blades. Do not stand in front of the machine.

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 \(page 5–167\)](#)). 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)

CENTER CUTTING DECK MOTOR
CASE DRAIN LEAKAGE TEST SHOWN



g275082

Figure 73

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.



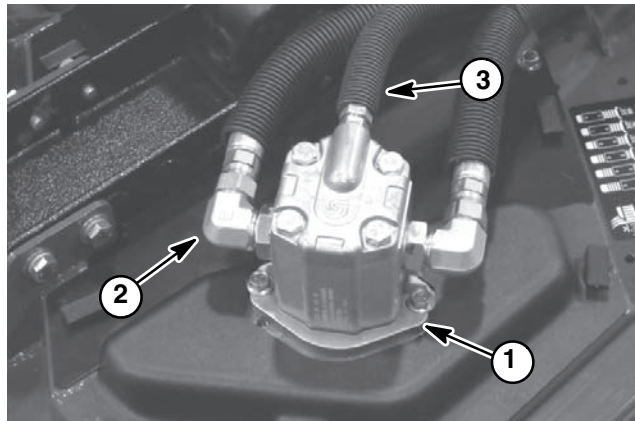
CAUTION



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 74

1. Deck motor (RH shown)
 2. Return hose
 3. Case drain hose
2. Disconnect hose from return of the motor to be tested ([Figure 74](#)). 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.

Procedure for Cutting Deck Motor Case Drain Leakage 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. 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.



Figure 75

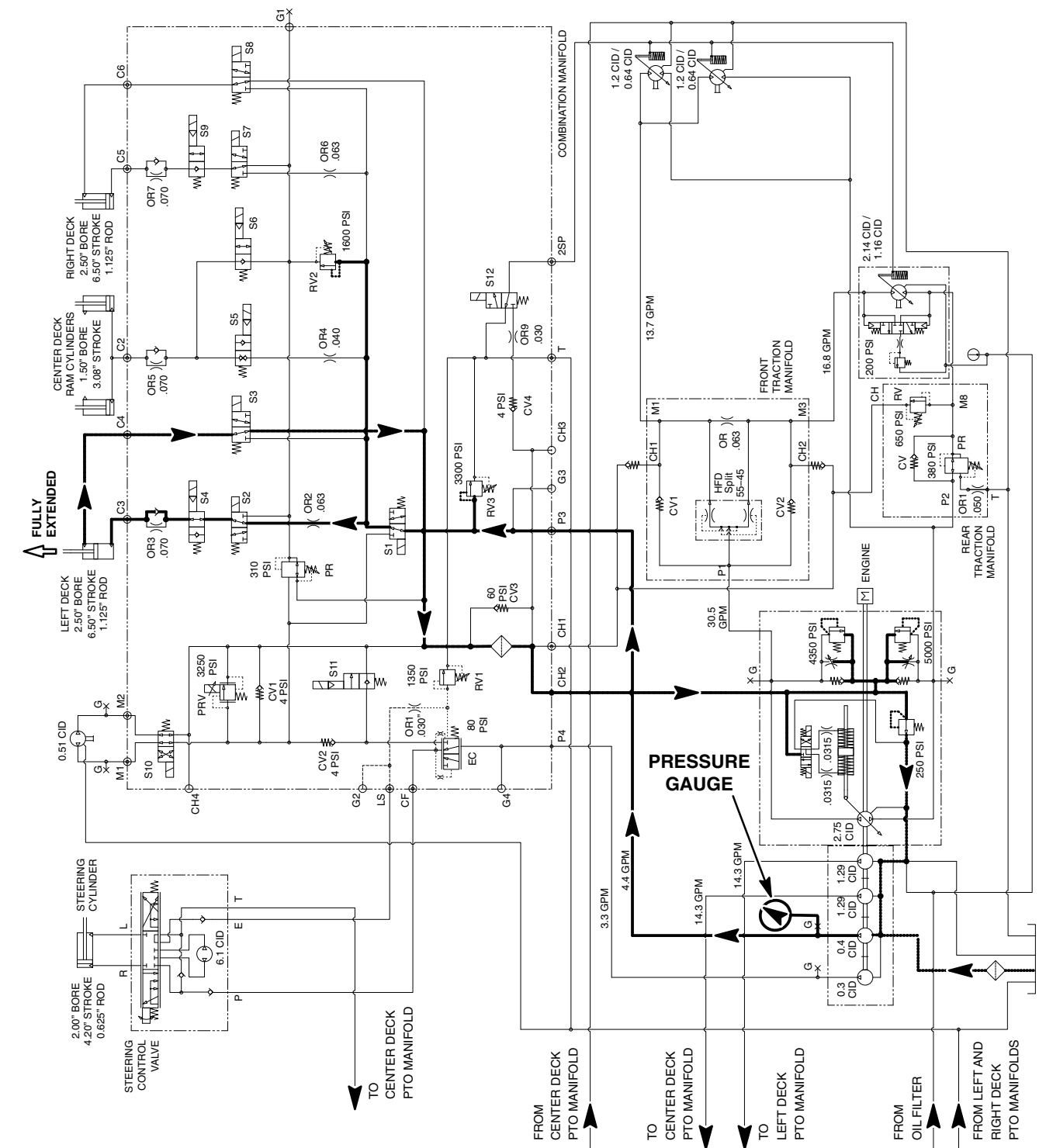
5. While watching pressure gauge, slowly close flow control valve on tester until a pressure of 83 bar (1200 PSI) is obtained.

Note: Use a graduated container, special tool TOR4077, to measure case drain leakage (Figure 75).

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 75). 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.



LEFT DECK LIFT SWITCH PRESSED IS SHOWN

g275083

Figure 76

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

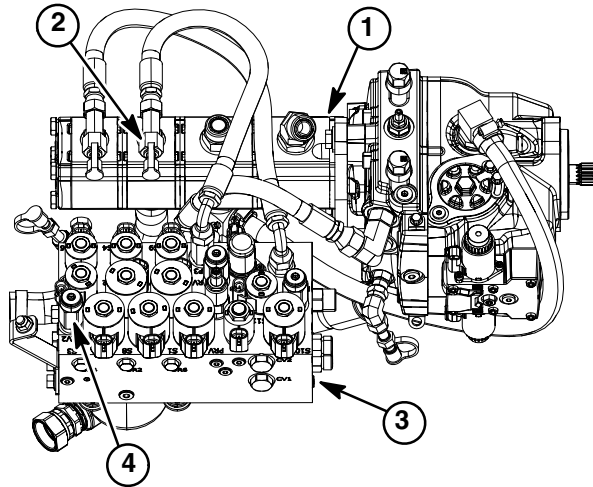


Figure 77

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

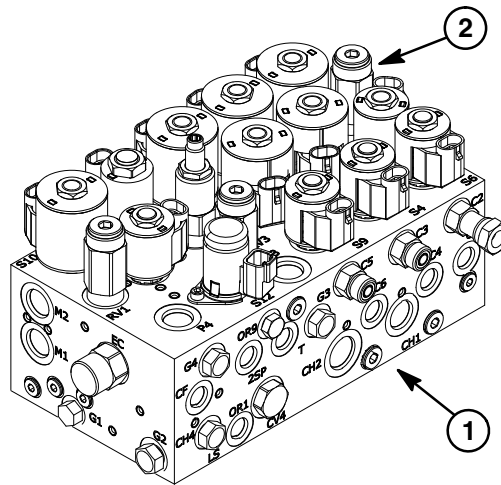


Figure 78

- | | |
|-------------------------|---------------------|
| 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 77](#)).
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 107 to 113 bar (1550 to 1650 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 \(page 5-129\)](#)).
 - 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)

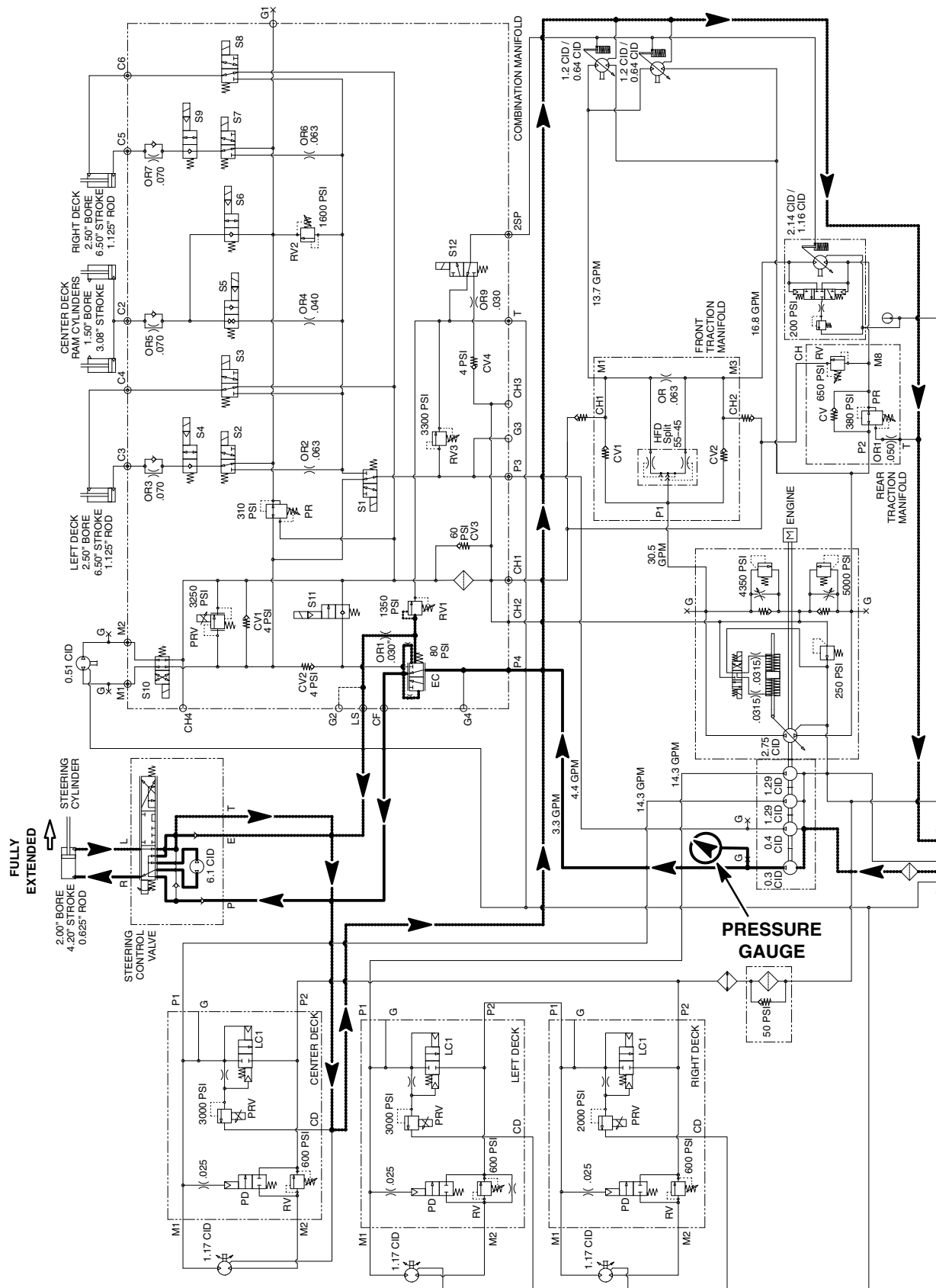


Figure 79

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

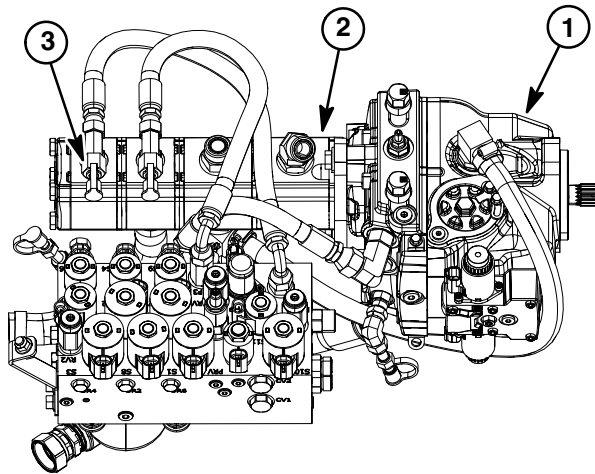


CAUTION



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.



g275070

Figure 80

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 80).
 4. Start engine and increase engine speed to high idle speed.

IMPORTANT

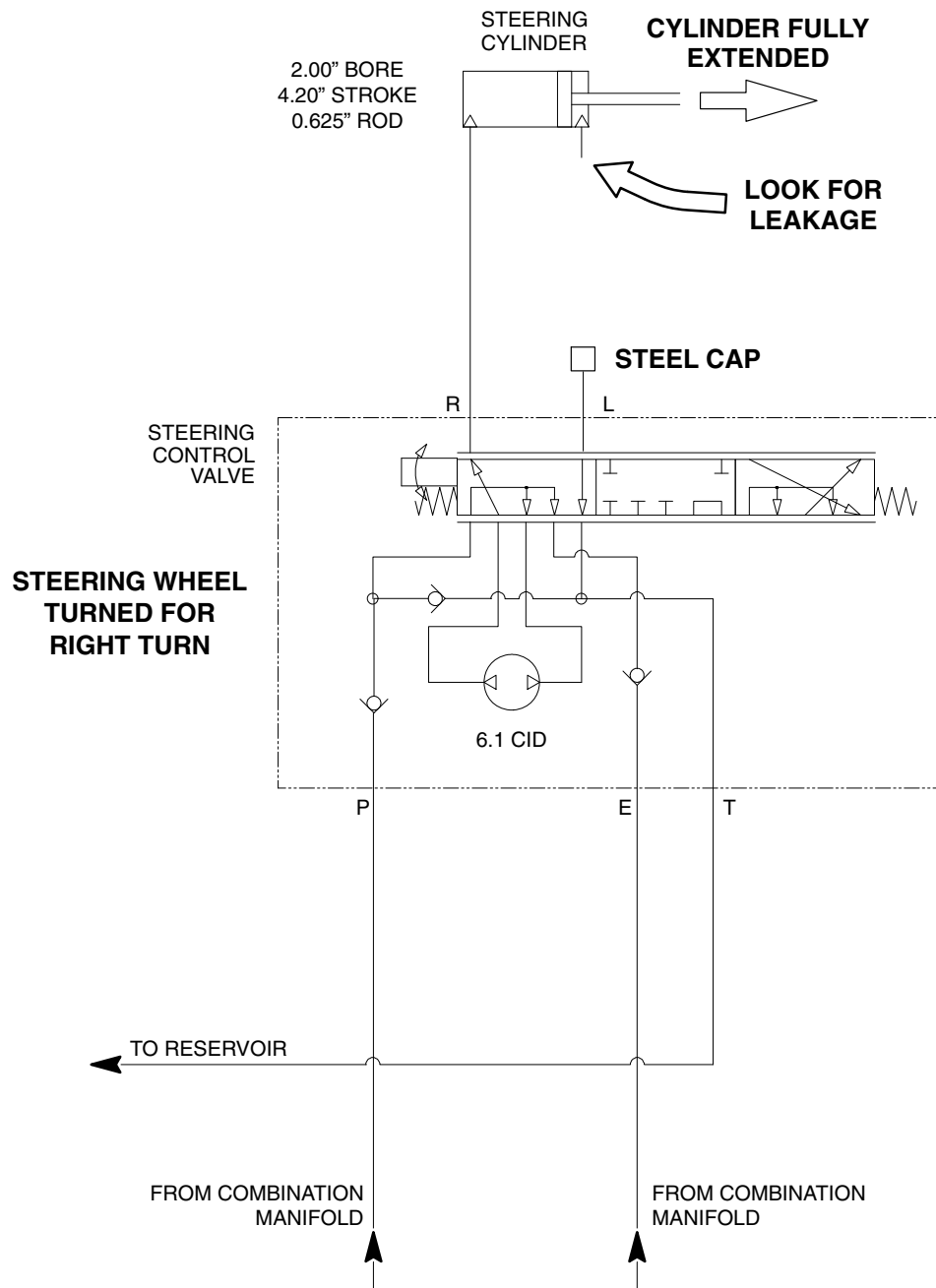
Hold steering wheel at full lock only long enough to get a system relief pressure reading. Holding the steering wheel against the stop for an extended period can damage the steering control valve.

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 \(For machines serial number below: 400000000\) \(page 5–140\)](#)). 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



g275085

Figure 81

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 \(page 5-142\)](#) and [Steering Cylinder Service \(page 5-144\)](#)). 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 \(page 5-142\)](#) and [Steering Cylinder Service \(page 5-144\)](#)).
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)

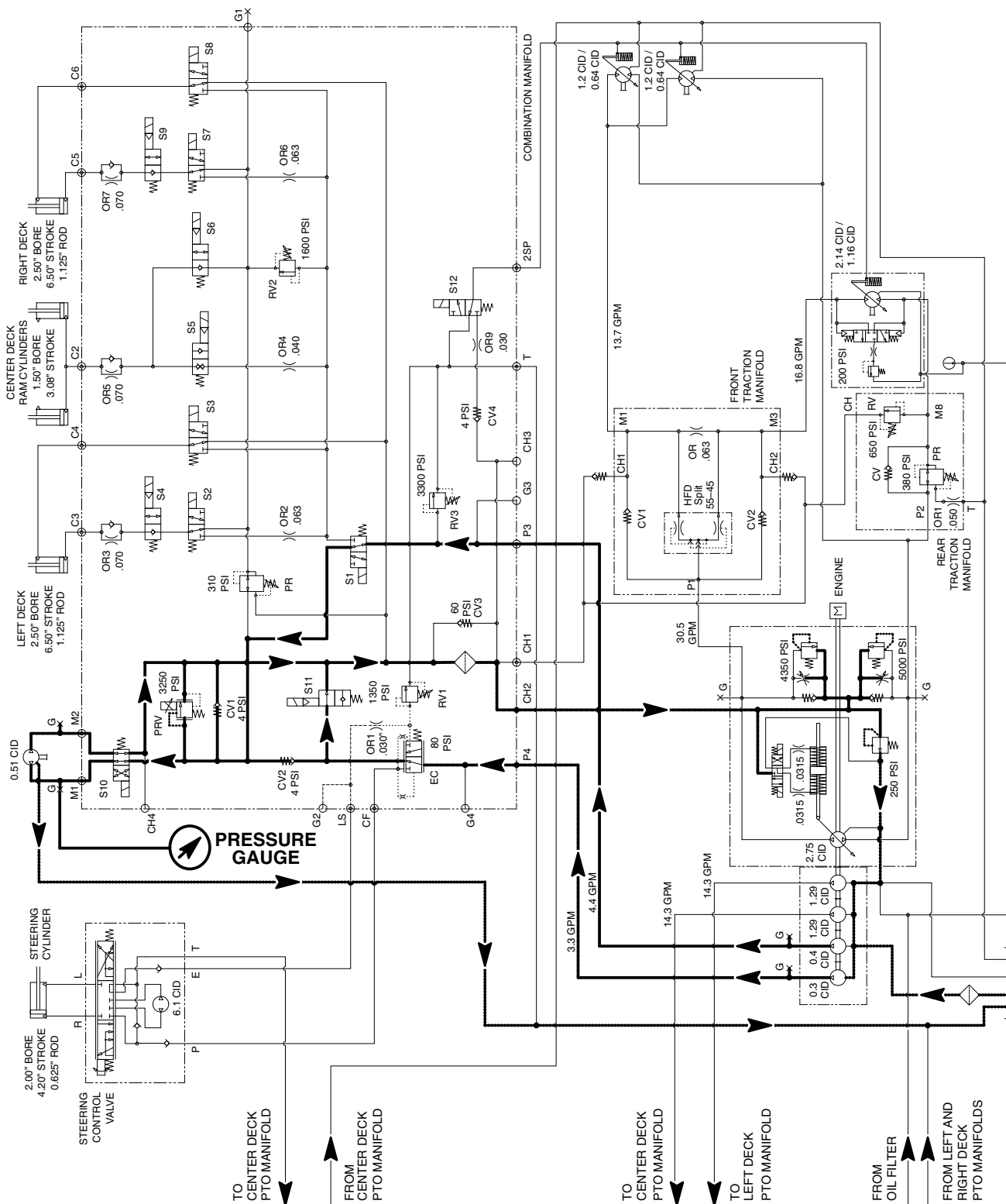
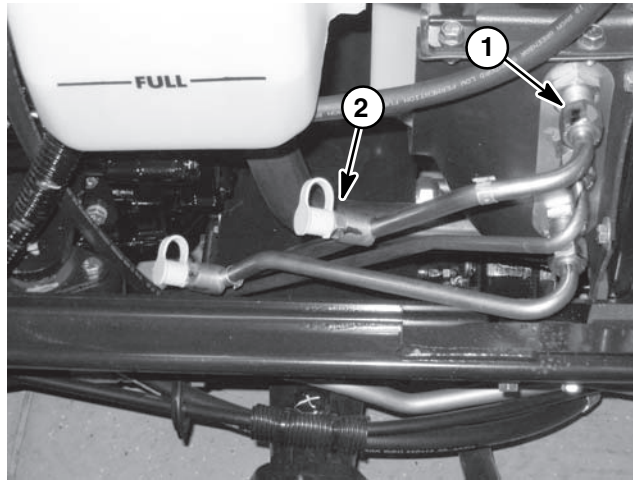


Figure 82

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.

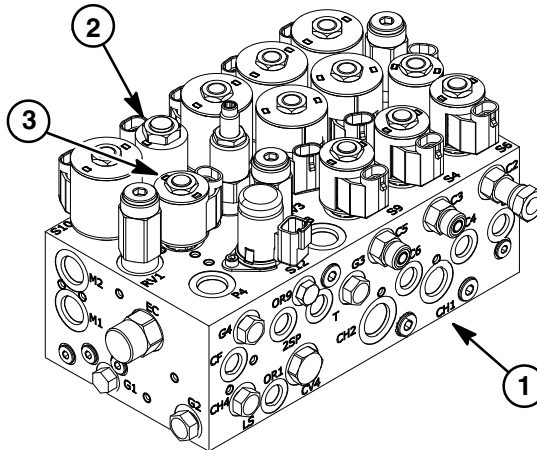
Procedure for Engine Cooling Fan Circuit Test



g275071

Figure 83

1. Upper hydraulic tube
2. Test port



g275072

Figure 84

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 83). 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 84). 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 84](#)). 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.

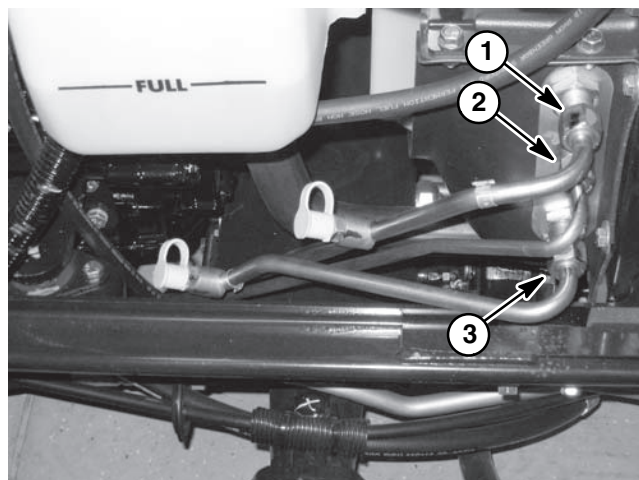
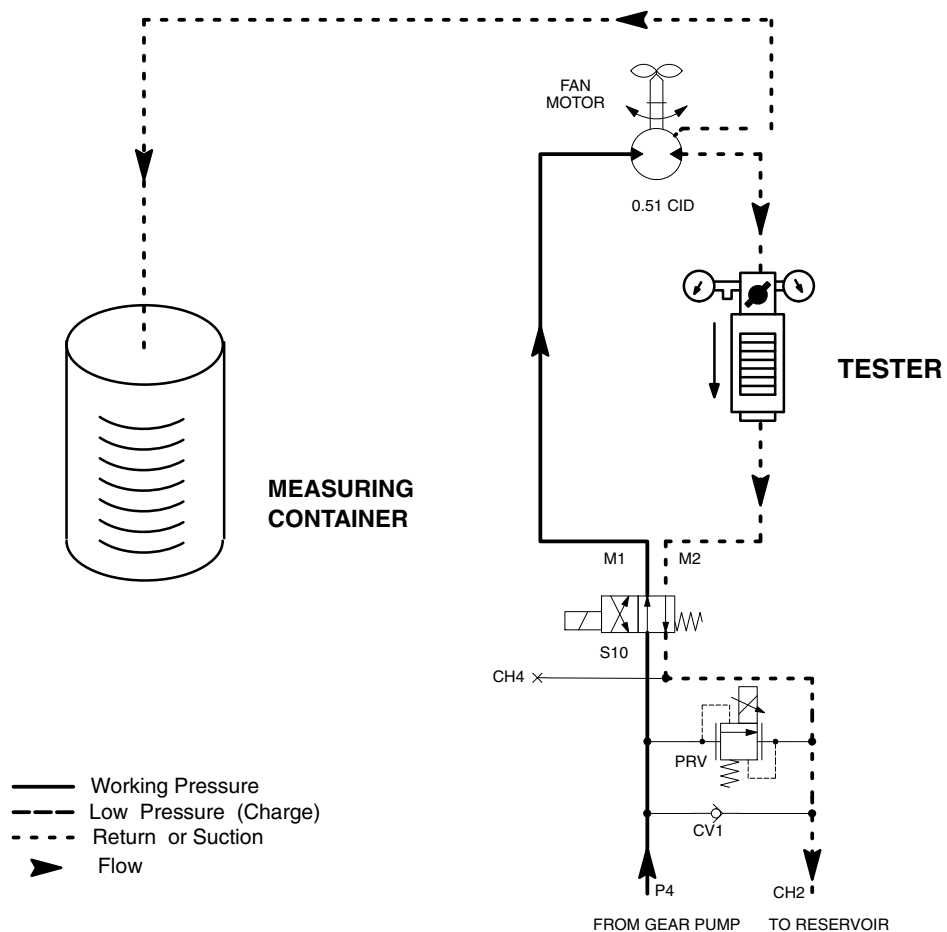
Note: The cooling fan speed will depend on hydraulic oil temperature. Higher oil temperatures will result in slower fan speed.

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 5–129)).

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



g284143



Figure 85

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 30603, 30605 and 30635.
 - B. Use the InfoCenter display to verify the engine RPM is 2700 RPM for Models 30607, 30609 and 30636.
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.

Procedure for Engine Cooling Fan Motor Case Drain Leakage Test (continued)



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)

SECOND GEAR PUMP SECTION FLOW TEST SHOWN

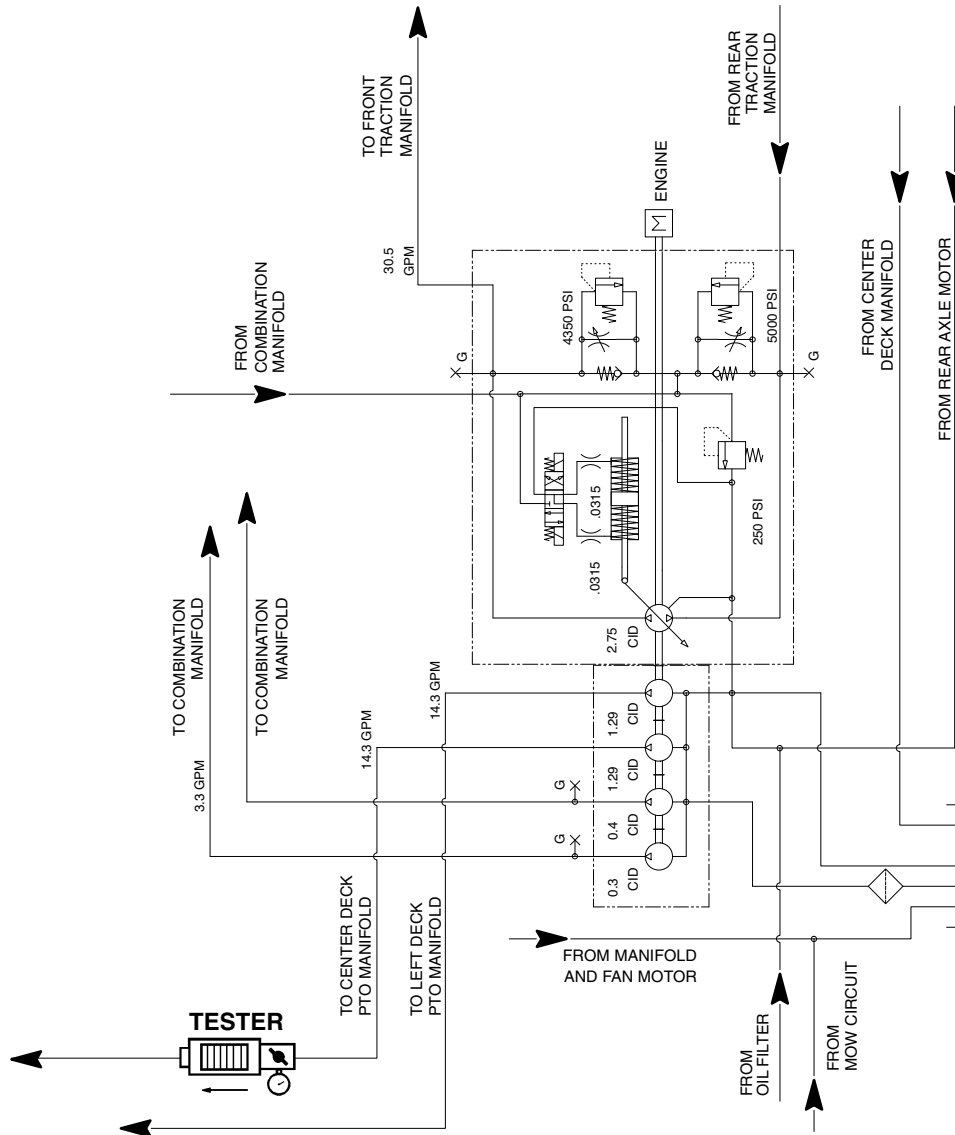
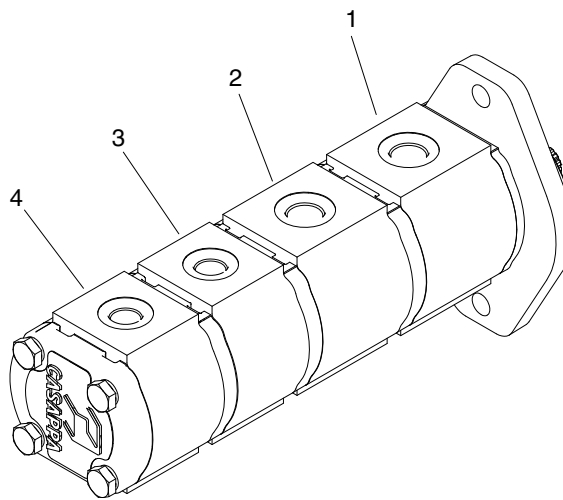


Figure 86



g275073

Figure 87

1. Front pump section (LH and RH PTO)
2. 2nd pump section (front PTO)
3. 3rd pump section (cooling fan, lift/lower and charge)
4. 4th 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 87). 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 87).
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.

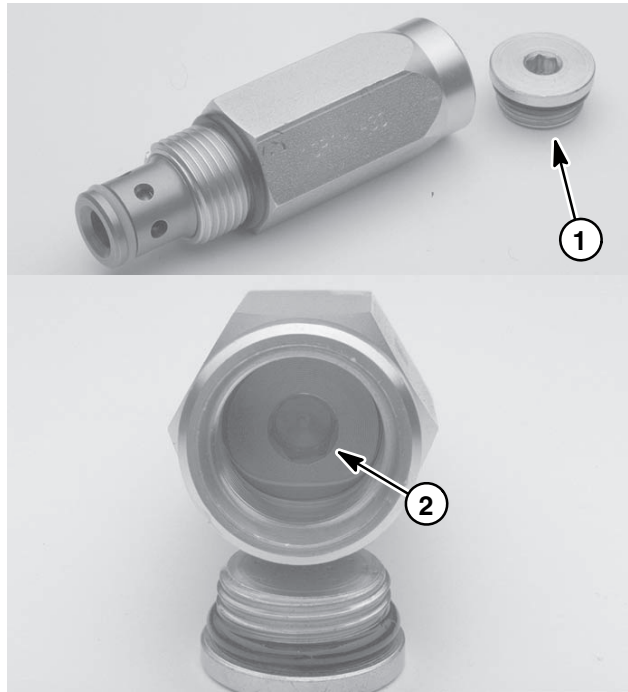
8. Normal flow indication for the four (4) gear pump sections is listed in below table:

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 88

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 ignition 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; refer to [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 ignition switch is in the OFF position and key is removed from switch.

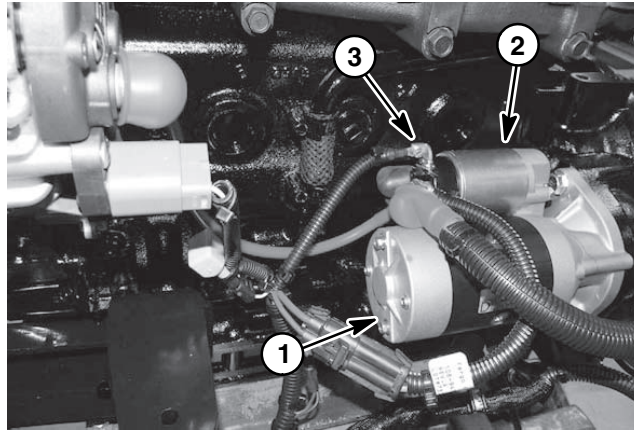


Figure 89

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

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

Note: A blue wire connects to the starter motor solenoid B+ terminal ([Figure 89](#)). 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 ignition switch.



WARNING



Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved; refer to [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)

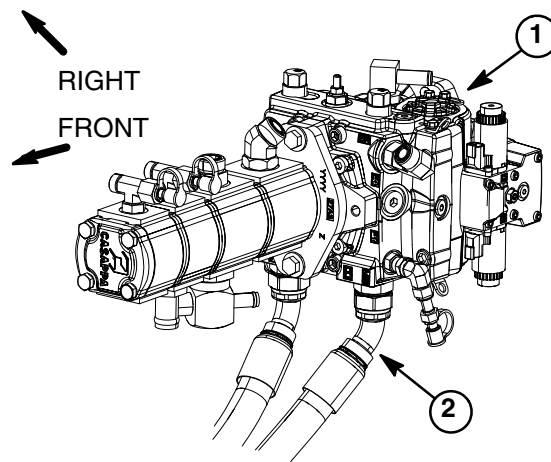
8. Prime hydraulic pumps (see [Priming Hydraulic Pumps \(page 5–86\)](#)).
9. Start engine and let it run at low idle speed for a minimum of two (2) minutes. Increase engine speed to high idle for minimum of one (1) minute under no load.
10. Raise and lower cutting decks several times. Turn steering 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 ignition 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.



g275417

Figure 90

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 90](#)). 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 ignition 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 ignition 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

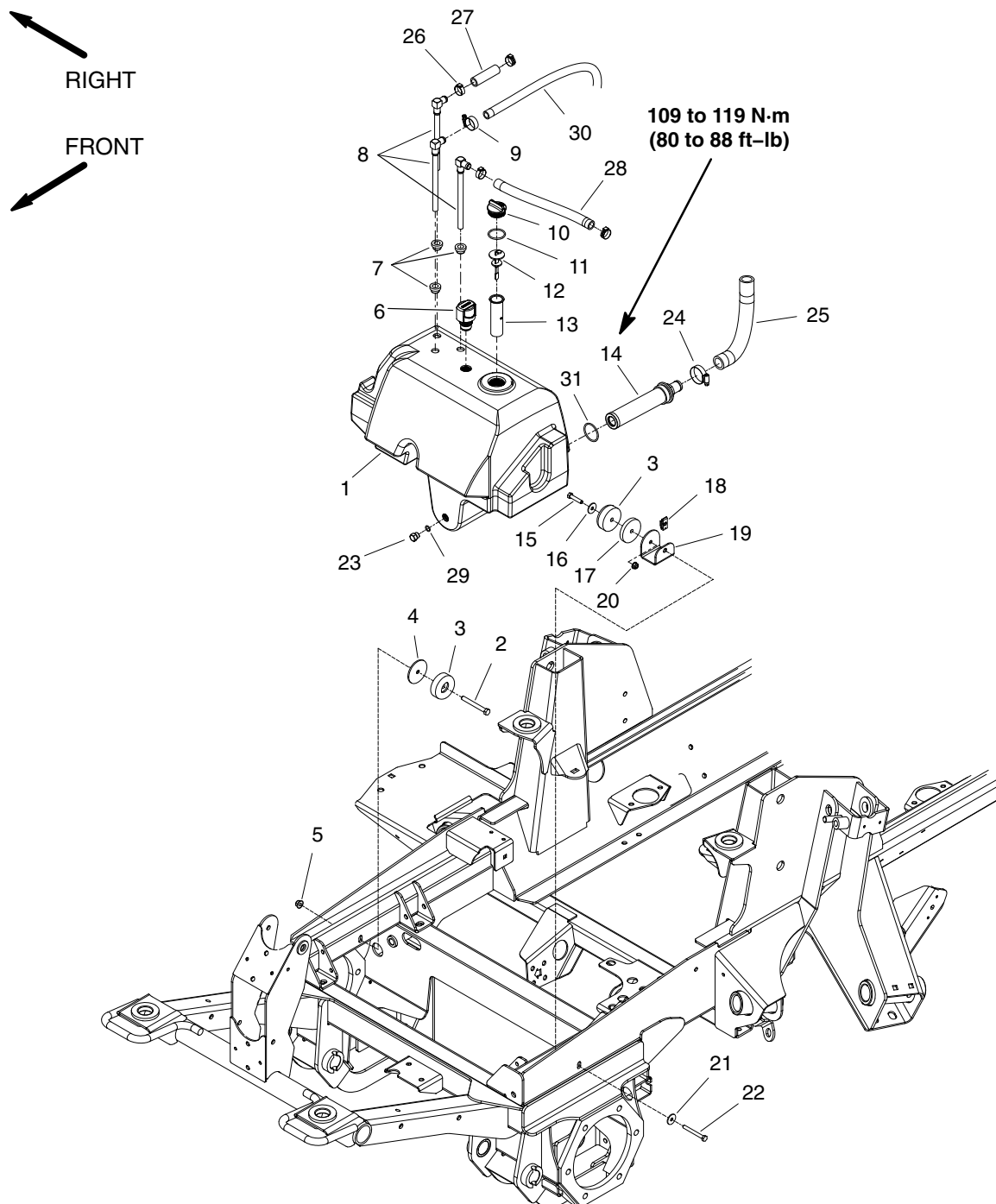
During initial operation, check hydraulic reservoir oil level frequently and add oil as necessary.

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 \(page 6–25\)](#)).
 12. With engine not running and ignition 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



g275418

Figure 91

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

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 \(page 8–28\)](#)).

Removal ([Figure 91](#))

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

4. Raise and support operator platform from the main frame to allow clearance to remove the hydraulic reservoir from the machine (see [Operator Platform \(page 8–28\)](#)).
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

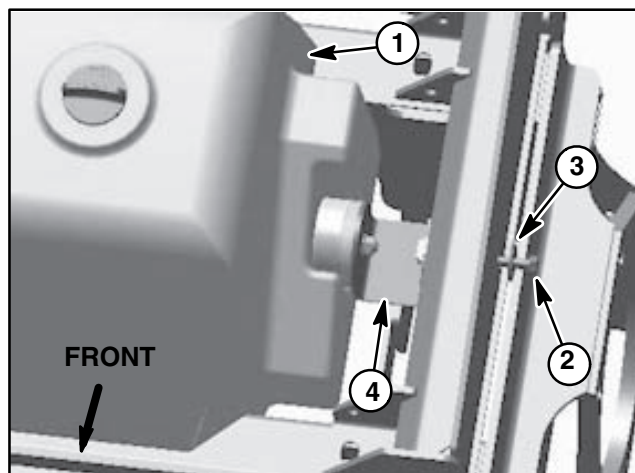
1. Clean hydraulic reservoir and tank strainer with solvent.
2. Inspect reservoir for leaks, cracks or other damage.

Installation ([Figure 91](#))

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 91](#)) (continued)



g275419

Figure 92

- | | |
|------------------------|----------------|
| 1. Hydraulic reservoir | 3. Flat washer |
| 2. Cap screw | 4. Tank mount |
-
- 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 92](#)).
 - Install tank strainer into reservoir port and torque from **109 to 119 N·m (80 to 88 ft-lb)**.
 - 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.

- Carefully lower operator platform to the main frame (see [Operator Platform \(page 8–28\)](#)). 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.

- Fill reservoir with new hydraulic oil to proper level.
- Properly fill hydraulic system (see [Charge Hydraulic System \(page 5–91\)](#)).
- Stop engine and check for hydraulic oil leaks. Check hydraulic reservoir oil level.

Radiator and Oil Cooler Assembly

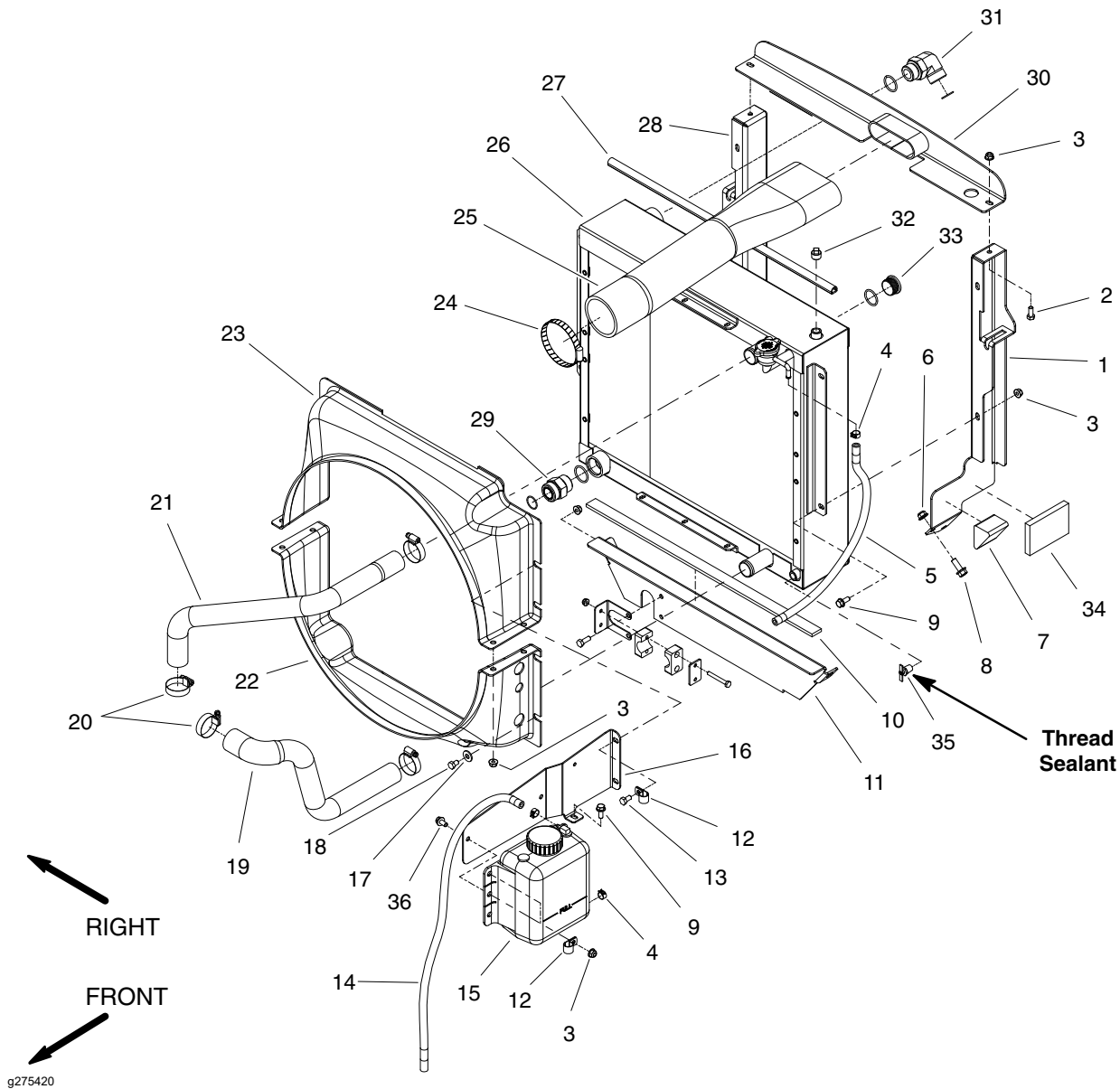
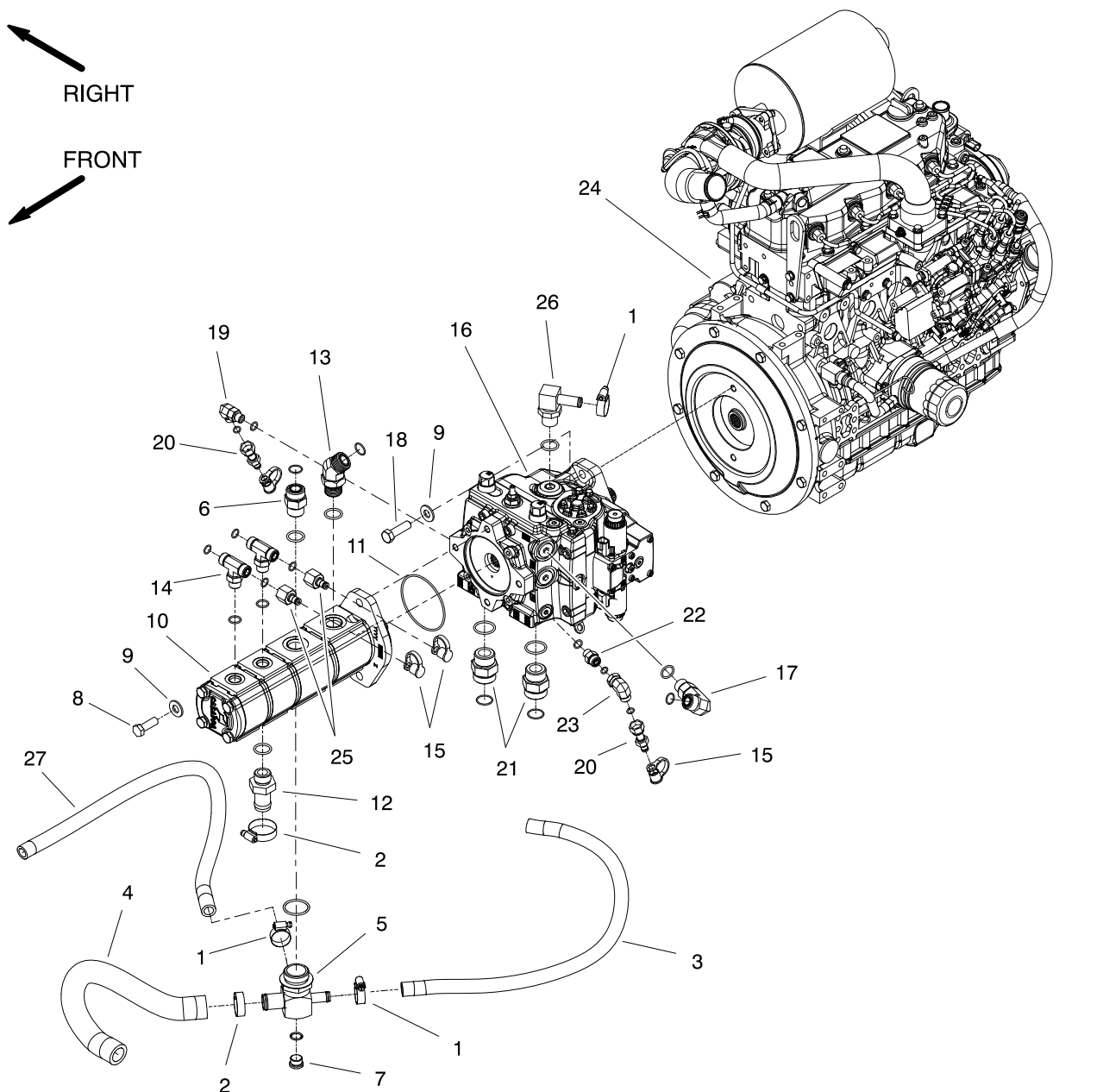


Figure 93

- | | | |
|-------------------------------|---------------------------|-----------------------------------|
| 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. 90° 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

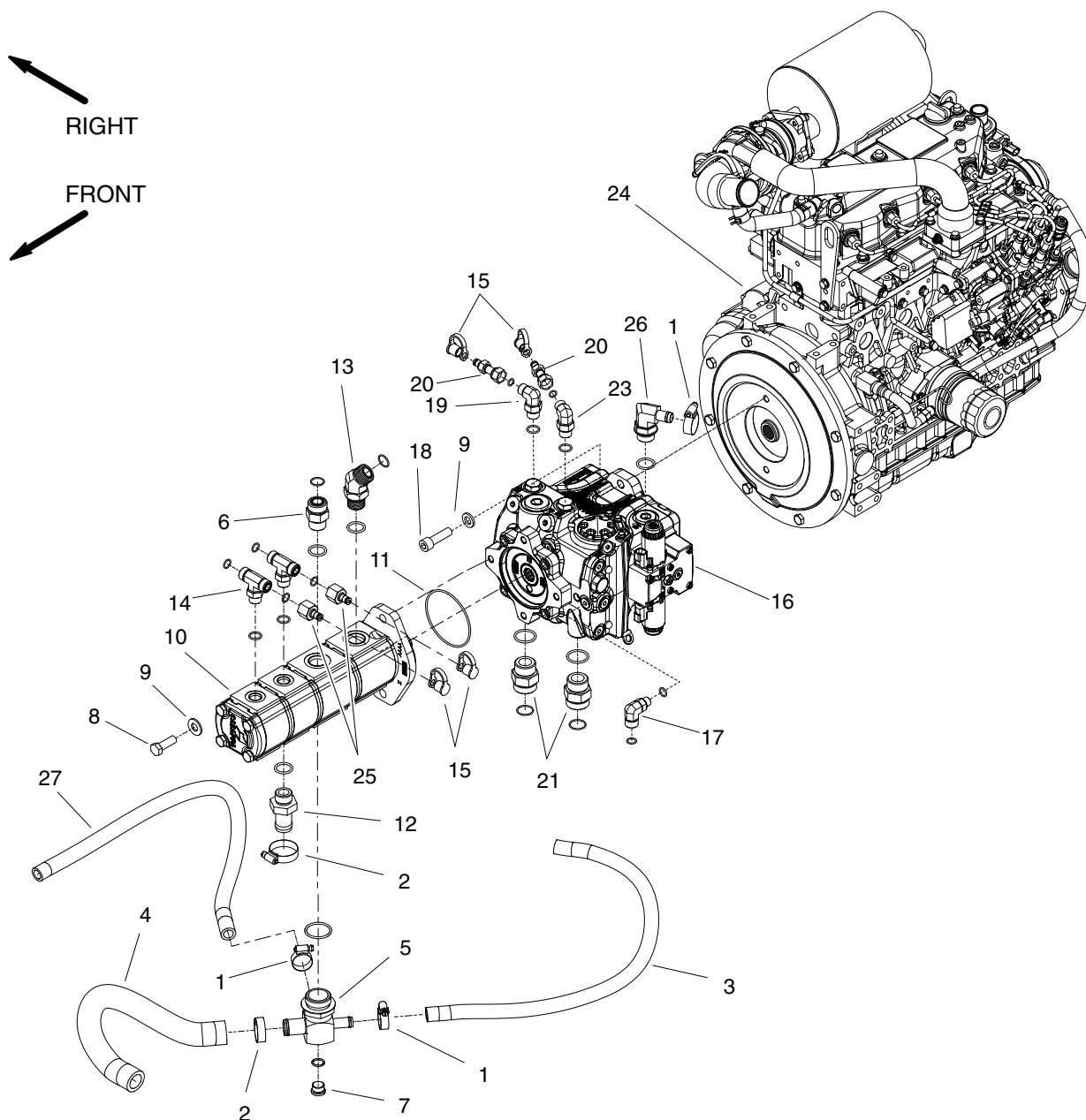


g275421

Figure 94

(For machines serial number below: 400000000)

- | | | |
|-------------------------------|------------------------------------|---|
| 1. Hose clamp (3 used) | 10. Gear pump | 19. 90° hydraulic fitting |
| 2. Hose clamp (2 used) | 11. O-ring | 20. Test nipple (2 used) |
| 3. Hydraulic hose | 12. Hydraulic fitting | 21. Straight hydraulic fitting (2 used) |
| 4. Suction hose | 13. 45° hydraulic fitting | 22. Straight hydraulic fitting |
| 5. Tee fitting | 14. Hydraulic tee fitting (2 used) | 23. 90° hydraulic fitting |
| 6. Straight hydraulic fitting | 15. Dust cap (4 used) | 24. Engine (model 30603/30605 shown) |
| 7. Plug | 16. Piston pump | 25. Test fitting (2 used) |
| 8. Cap screw (2 used) | 17. 90° hydraulic fitting | 26. 90° barbed hydraulic fitting |
| 9. Flat washer (4 used) | 18. Cap screw (2 used) | 27. Hydraulic hose |



g278628

Figure 95

(For machines serial number above: 400000000)

- | | | |
|-------------------------------|------------------------------------|---|
| 1. Hose clamp (3 used) | 10. Gear pump | 19. 90° hydraulic fitting |
| 2. Hose clamp (2 used) | 11. O-ring | 20. Test nipple (2 used) |
| 3. Hydraulic hose | 12. Hydraulic fitting | 21. Straight hydraulic fitting (2 used) |
| 4. Suction hose | 13. 45° hydraulic fitting | 22. Straight hydraulic fitting |
| 5. Tee fitting | 14. Hydraulic tee fitting (2 used) | 23. 90° hydraulic fitting |
| 6. Straight hydraulic fitting | 15. Dust cap (4 used) | 24. Engine (model 30603/30605 shown) |
| 7. Plug | 16. Piston pump | 25. Test fitting (2 used) |
| 8. Cap screw (2 used) | 17. 90° hydraulic fitting | 26. 90° barbed hydraulic fitting |
| 9. Flat washer (4 used) | 18. Cap screw (2 used) | 27. Hydraulic hose |

Removal (Figure 94 and Figure 95)

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

Removal (Figure 94 and Figure 95) (continued)

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

IMPORTANT

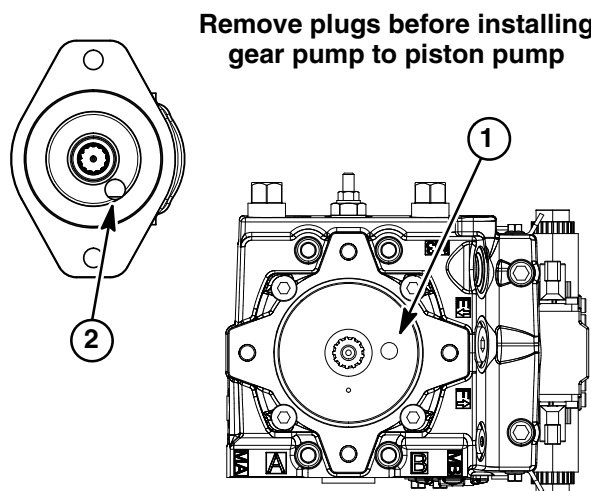
Follow all local codes and regulations when recycling or disposing hydraulic fluid.

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.



g275422

Figure 96

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 96). 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 94](#) and [Figure 95](#))

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.

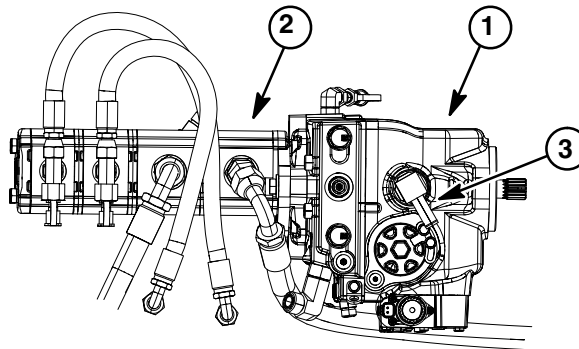
IMPORTANT

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 96](#)). 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 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)).



g275423

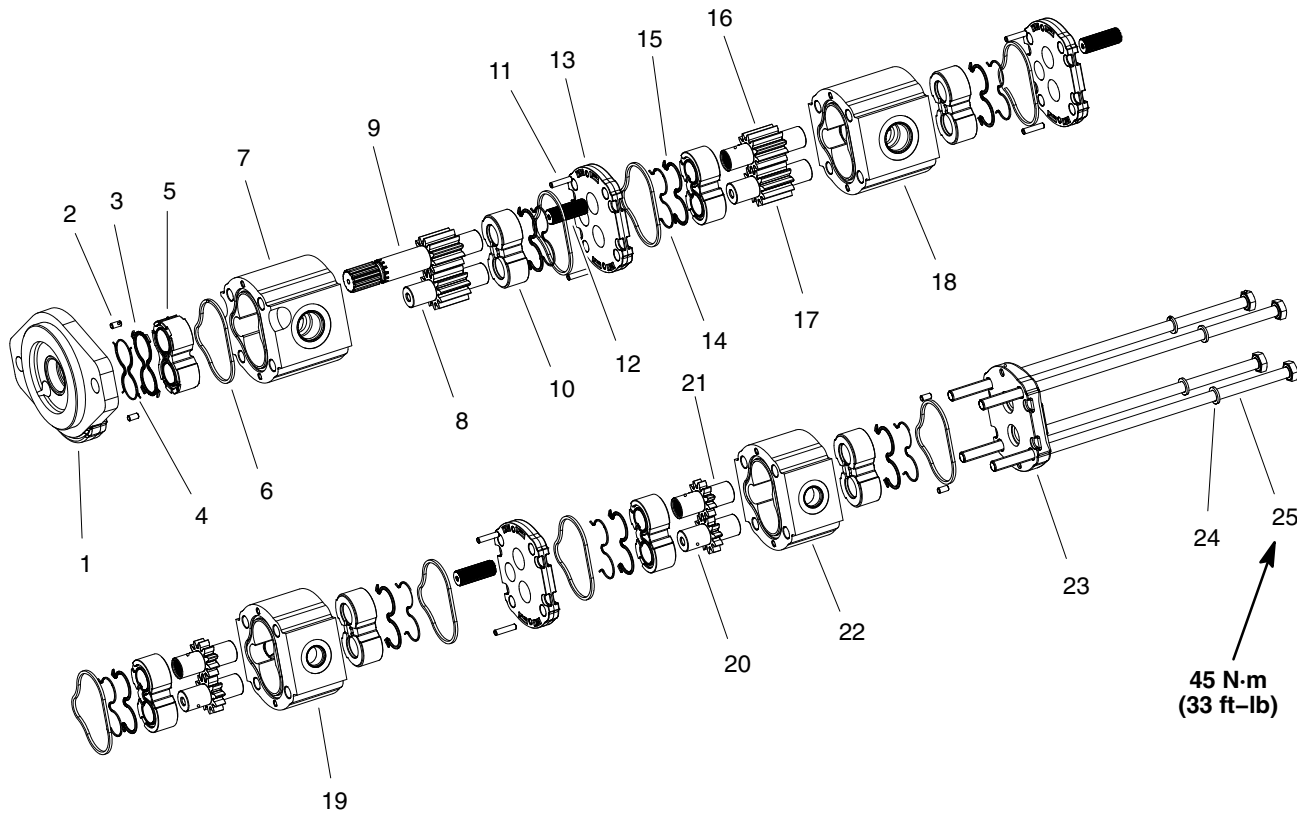
Figure 97

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

Installation ([Figure 94](#) and [Figure 95](#)) (continued)

8. Fill piston pump housing through case drain (90° barbed fitting) with new hydraulic oil ([Figure 97](#)). 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



g275424

Figure 98

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

Disassembly (Figure 98)

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.

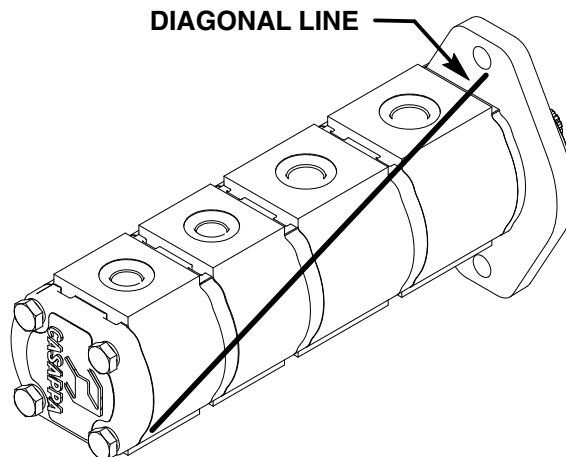


Figure 99

-
2. Use a marker to make a diagonal line across the gear pump for assembly purposes (Figure 99).
-

IMPORTANT

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

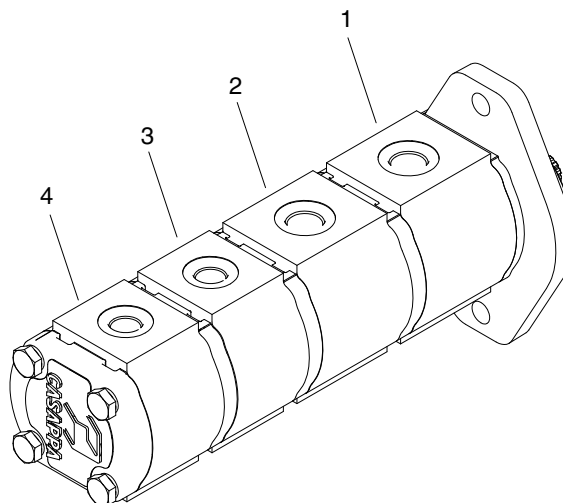
3. Secure the front cover of the pump in a vise with the drive shaft pointing down.
 4. Loosen the four (4) cap screws that secure pump assembly.
 5. Remove pump from vise and remove fasteners.
 6. Support the pump assembly and gently tap the pump case with a soft face hammer to loosen the pump sections. 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 98)



g275426

Figure 100

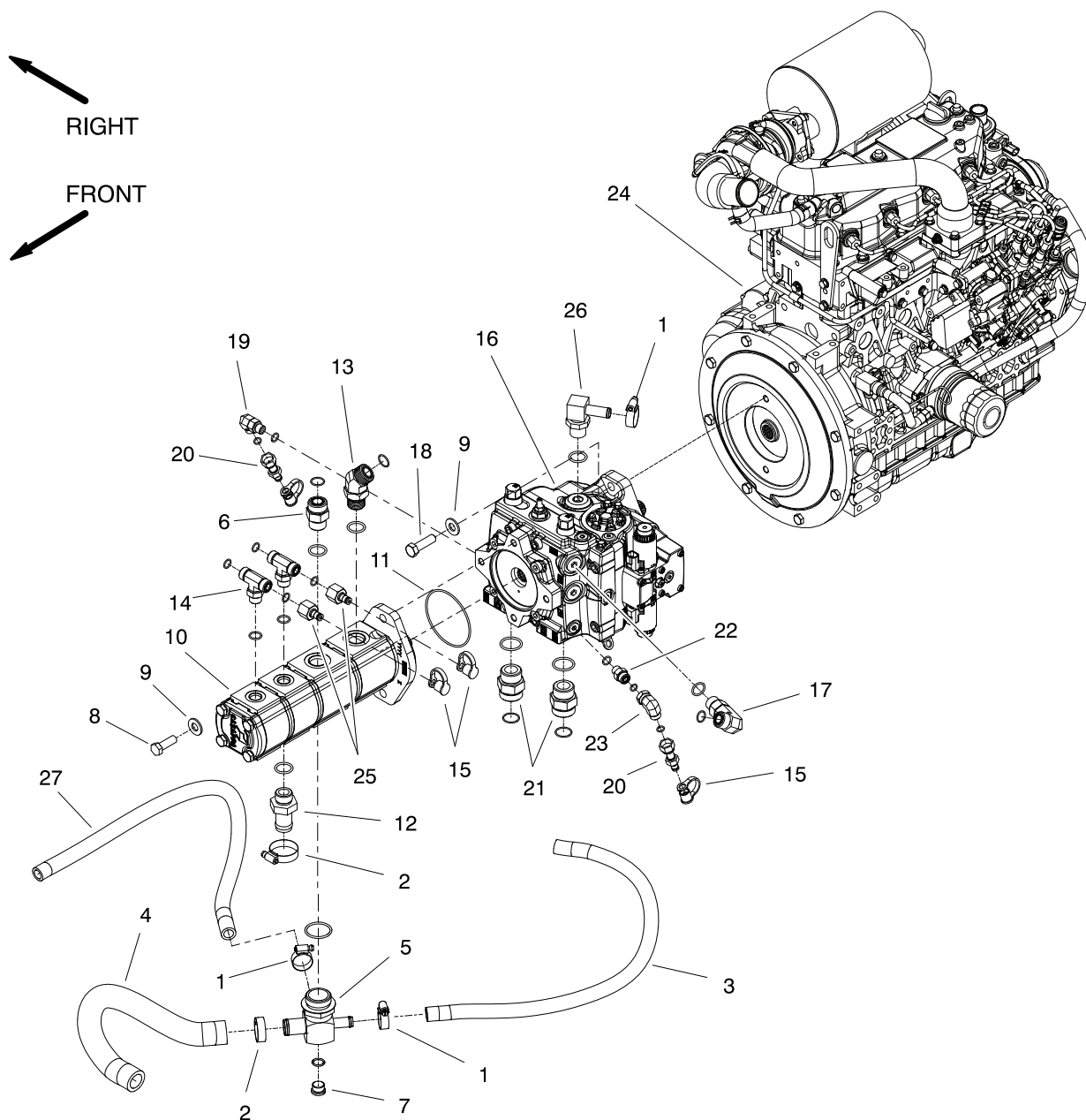
- | | |
|-------------------------------|--|
| 1. LH and RH PTO pump section | 3. Cooling fan, lift/lower and charge pump section |
| 2. Front PTO pump section | 4. Steering, charge and cooling fan pump section |

-
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

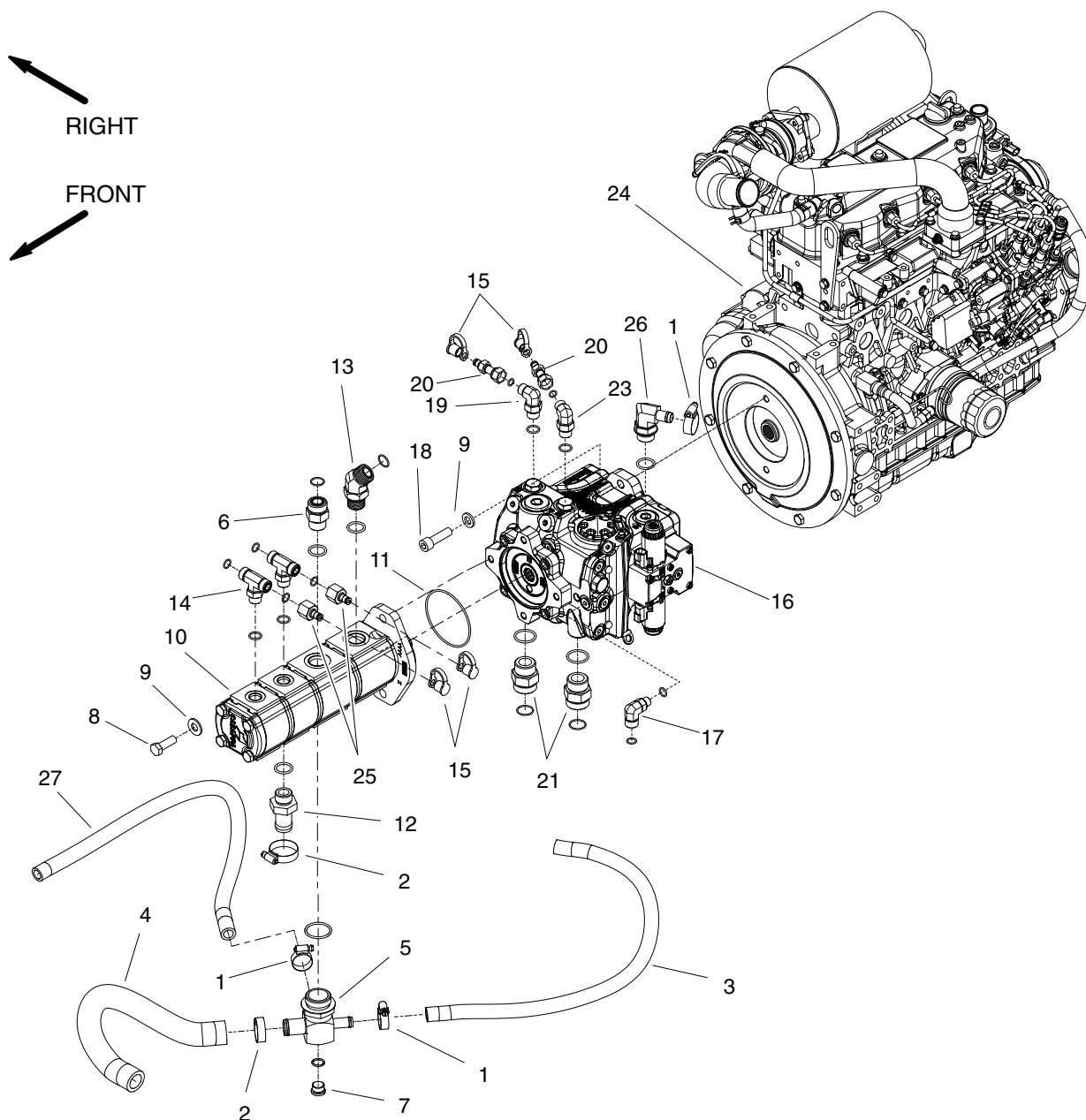


g275427

Figure 101

(For machines serial number below: 400000000)

- | | | |
|-------------------------------|------------------------------------|---|
| 1. Hose clamp (3 used) | 10. Gear pump | 19. 90° hydraulic fitting |
| 2. Hose clamp (2 used) | 11. O-ring | 20. Test nipple (2 used) |
| 3. Hydraulic hose | 12. Hydraulic fitting | 21. Straight hydraulic fitting (2 used) |
| 4. Suction hose | 13. 45° hydraulic fitting | 22. Straight hydraulic fitting |
| 5. Tee fitting | 14. Hydraulic tee fitting (2 used) | 23. 90° hydraulic fitting |
| 6. Straight hydraulic fitting | 15. Dust cap (4 used) | 24. Engine (model 30603/30605 shown) |
| 7. Plug | 16. Piston pump | 25. Test fitting (2 used) |
| 8. Cap screw (2 used) | 17. 90° hydraulic fitting | 26. 90° barbed hydraulic fitting |
| 9. Flat washer (4 used) | 18. Cap screw (2 used) | 27. Hydraulic hose |



g278628

Figure 102
(For machines serial number above: 400000000)

- | | | |
|-------------------------------|------------------------------------|---|
| 1. Hose clamp (3 used) | 10. Gear pump | 19. 90° hydraulic fitting |
| 2. Hose clamp (2 used) | 11. O-ring | 20. Test nipple (2 used) |
| 3. Hydraulic hose | 12. Hydraulic fitting | 21. Straight hydraulic fitting (2 used) |
| 4. Suction hose | 13. 45° hydraulic fitting | 22. Straight hydraulic fitting |
| 5. Tee fitting | 14. Hydraulic tee fitting (2 used) | 23. 90° hydraulic fitting |
| 6. Straight hydraulic fitting | 15. Dust cap (4 used) | 24. Engine (model 30603/30605 shown) |
| 7. Plug | 16. Piston pump | 25. Test fitting (2 used) |
| 8. Cap screw (2 used) | 17. 90° hydraulic fitting | 26. 90° barbed hydraulic fitting |
| 9. Flat washer (4 used) | 18. Cap screw (2 used) | 27. Hydraulic hose |

Removal ([Figure 101](#) and [Figure 102](#))

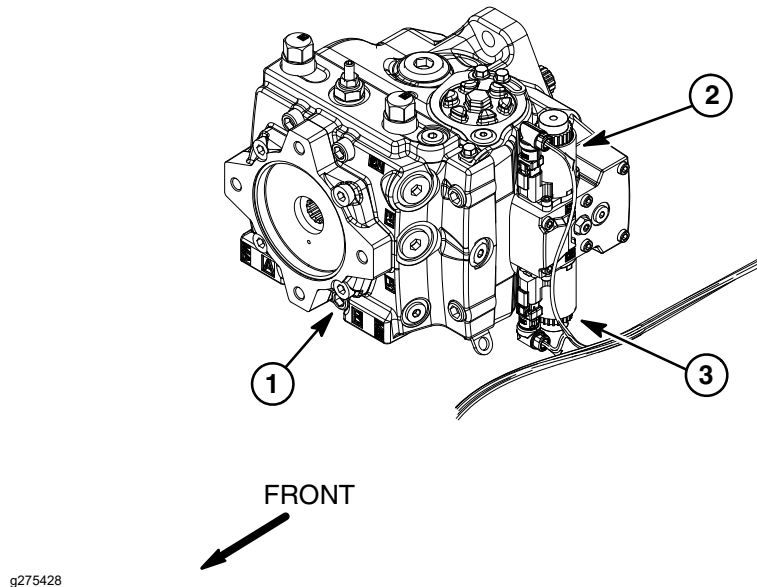


Figure 103

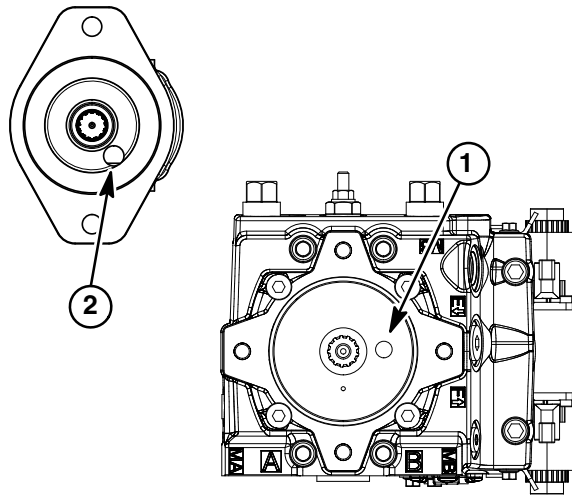
- | | |
|----------------------------|----------------------------|
| 1. Piston pump | 3. Solenoid coil (reverse) |
| 2. Solenoid coil (forward) | |

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the ignition 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 103](#)). 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 101 and Figure 102) (continued)

To prevent draining the pumps, install plugs in piston pump case drain and gear pump suction port after gear pump is removed. Remove plugs before installing gear pump to piston pump



g275429

Figure 104

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 104). 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 101 and Figure 102)

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.

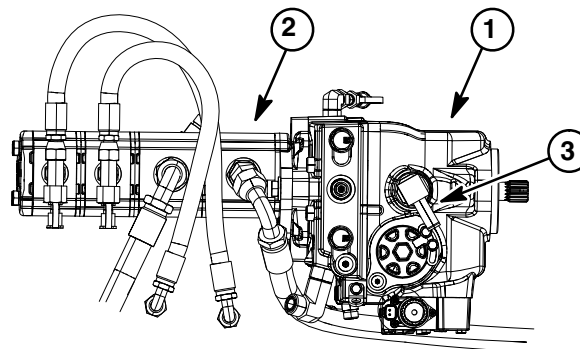
Installation (Figure 101 and Figure 102) (continued)

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 104). 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 105

- | | |
|---------------------------|---------------------------|
| 1. Piston (traction) pump | 3. Piston pump case drain |
| 2. Gear pump | |
-
7. Fill piston (traction) pump housing with new hydraulic oil through the case drain (90° barbed fitting) at the top of the pump (Figure 105). 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.

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)

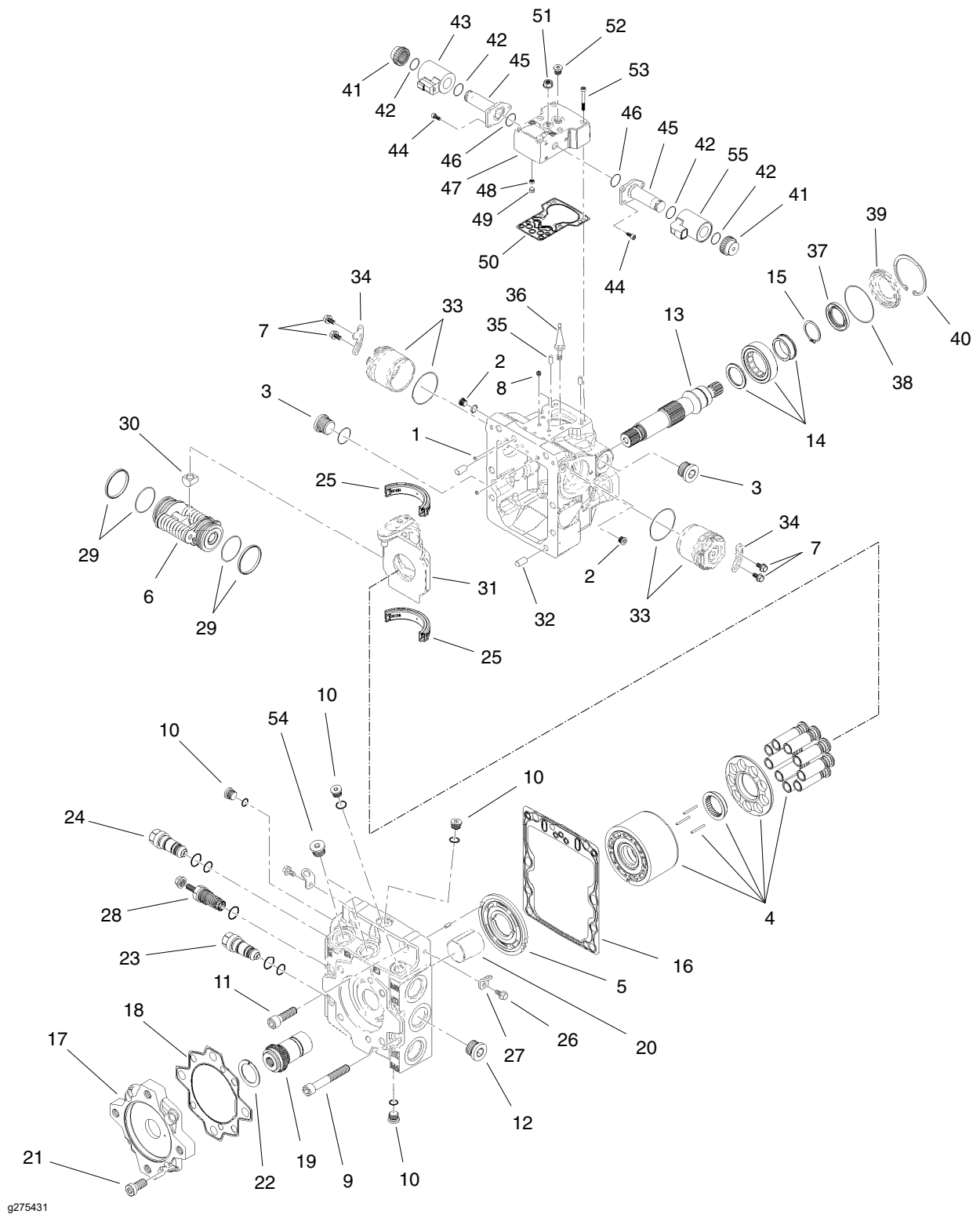


Figure 106

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

Figure 106 (continued)

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

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)

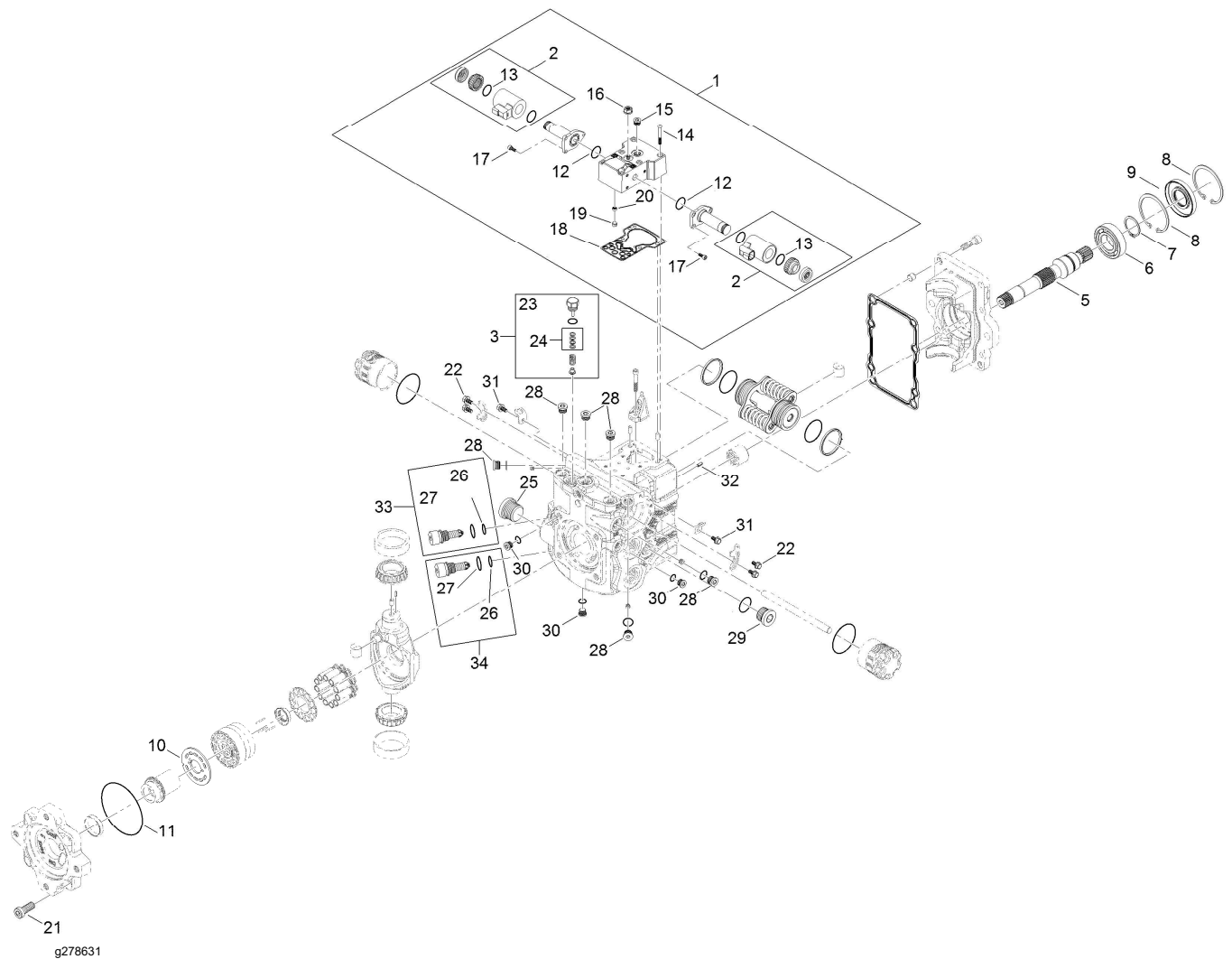


Figure 107

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

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

Rear Axle Motor

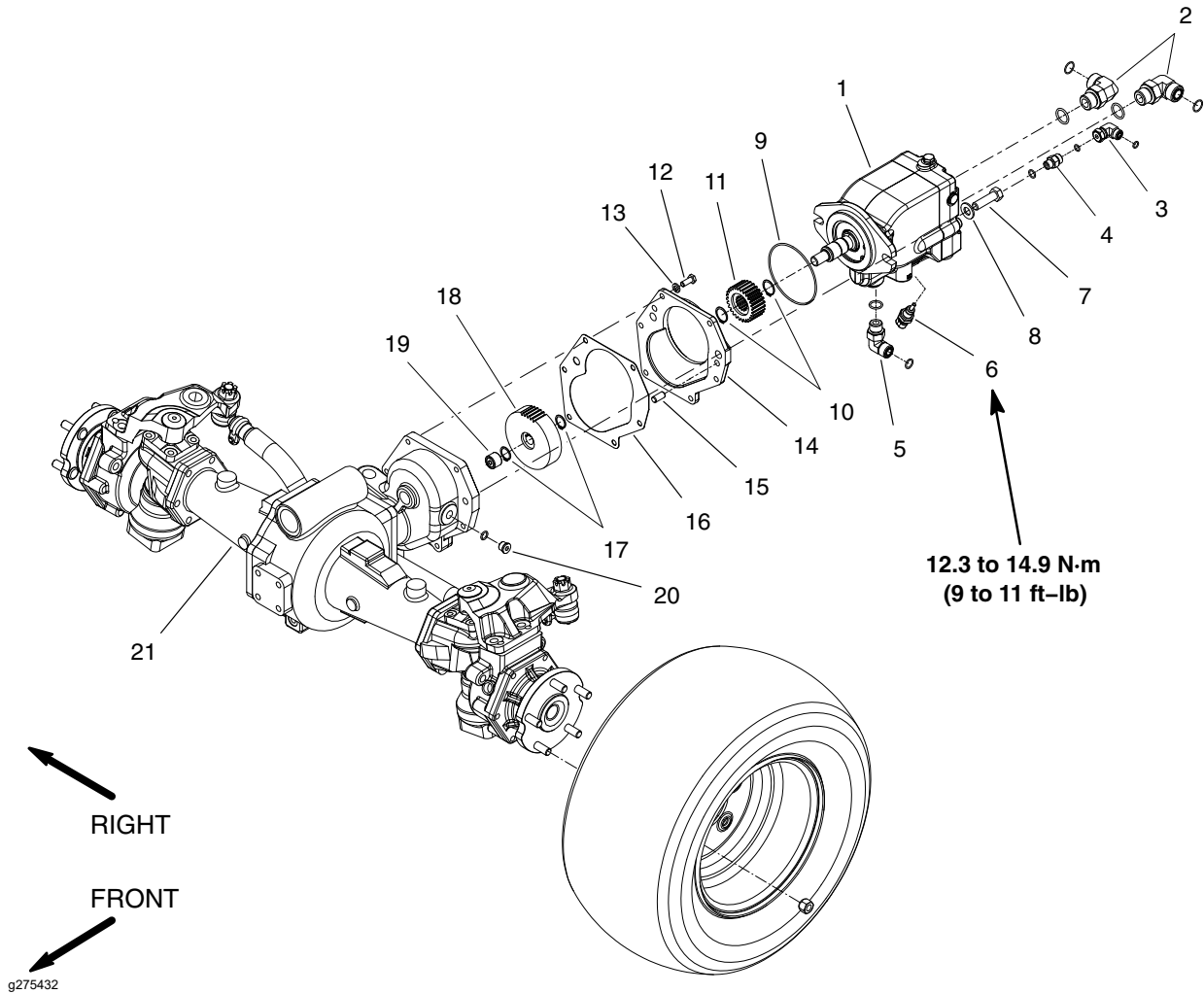


Figure 108

- | | | |
|-----------------------------------|---------------------------------|---------------------------------|
| 1. Rear axle motor | 8. Flat washer (2 used) | 15. Dowel pin (2 used) |
| 2. 90° hydraulic fitting (2 used) | 9. O-ring | 16. Gasket |
| 3. 90° 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. 90° 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 108)

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the ignition 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 108](#)) (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 108](#) 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 108](#))

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

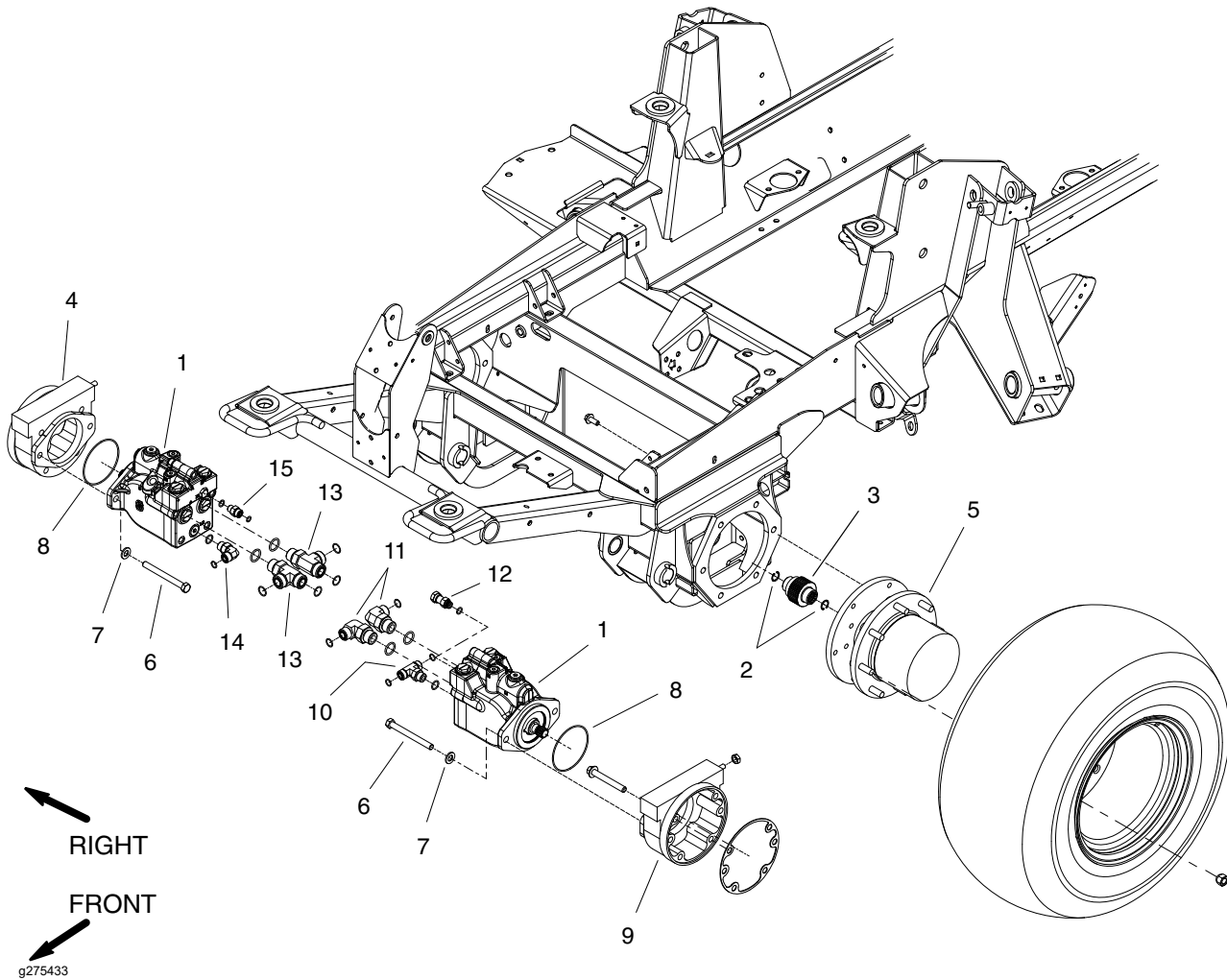


Figure 109

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

Removal (Figure 109)

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the ignition 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 109](#)) (continued)

IMPORTANT

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

5. Remove wheel motor using [Figure 109](#) 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.

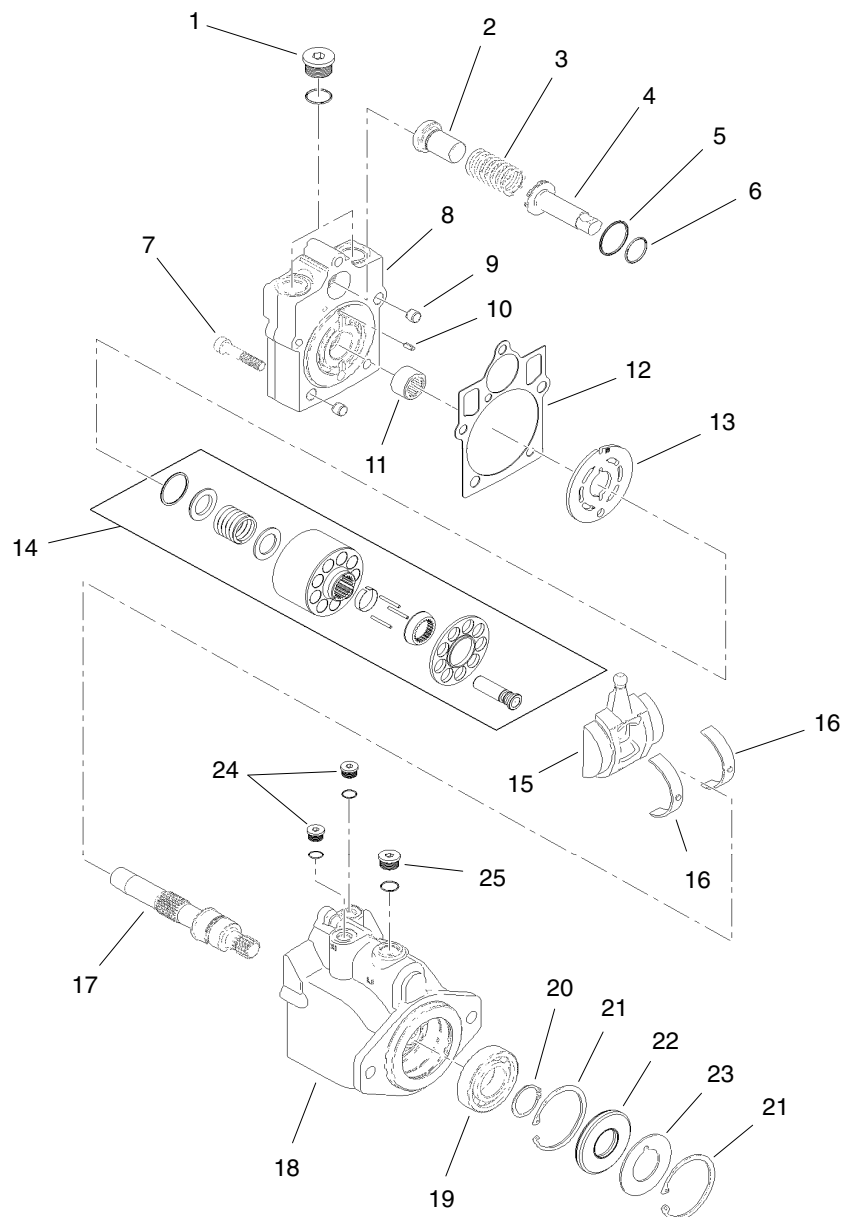
Installation ([Figure 109](#))

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



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Figure 110

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

Rear Axle and Front Wheel Motor Service (continued)

REAR AXLE MOTOR FLUSHING VALVE

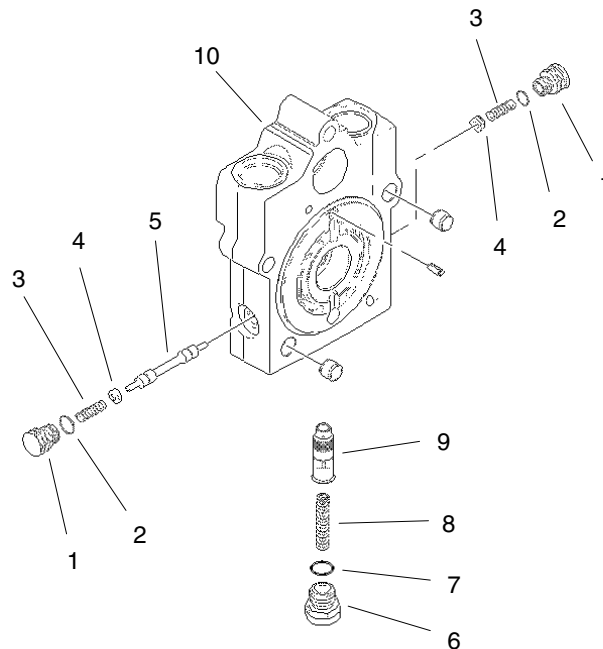


Figure 111

- | | |
|----------------------------|---------------------|
| 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 110](#)). 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 111](#)). 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

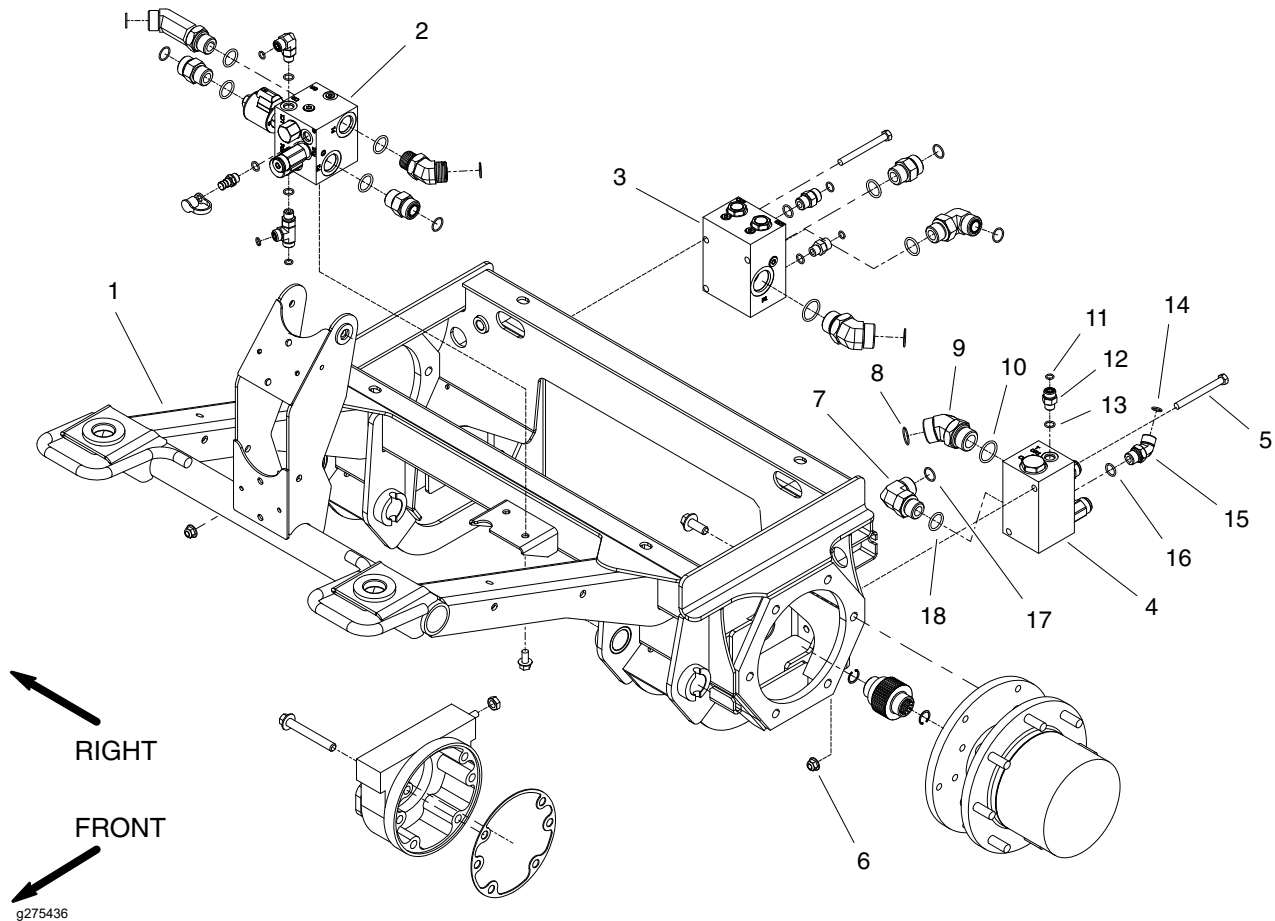


Figure 112

- | | | |
|-------------------------------|--------------------------|---------------------------|
| 1. Front frame | 7. 90° hydraulic fitting | 13. O-ring |
| 2. PTO manifold (center deck) | 8. O-ring | 14. O-ring |
| 3. Front traction manifold | 9. 45° hydraulic fitting | 15. 45° hydraulic fitting |
| 4. Rear traction manifold | 10. O-ring | 16. O-ring |
| 5. Cap screw (2 used) | 11. O-ring | 17. O-ring |
| 6. Flange nut (2 used) | 12. Straight fitting | 18. 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).

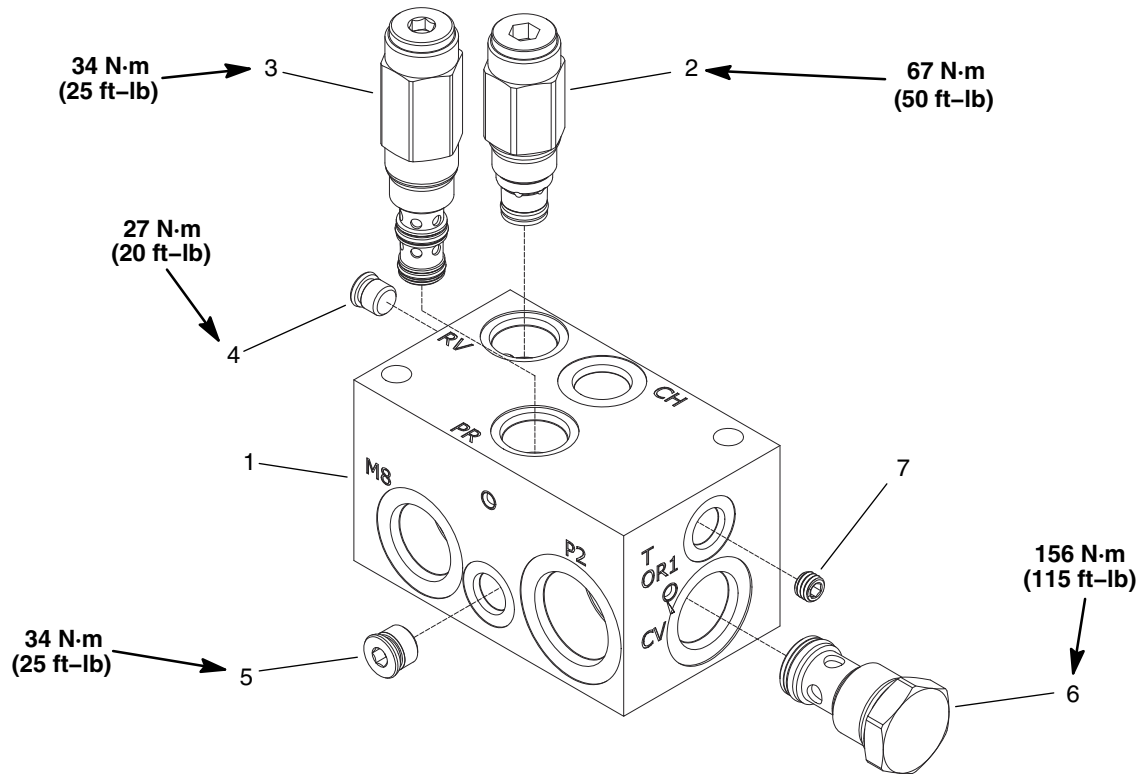
Removal ([Figure 112](#))

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.
4. Remove hydraulic manifold from the frame using [Figure 112](#) 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 112](#))

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 112](#) 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



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Figure 113

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

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 \(page 5-131\)](#). Refer to [Figure 113](#) 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.

Front Traction Manifold

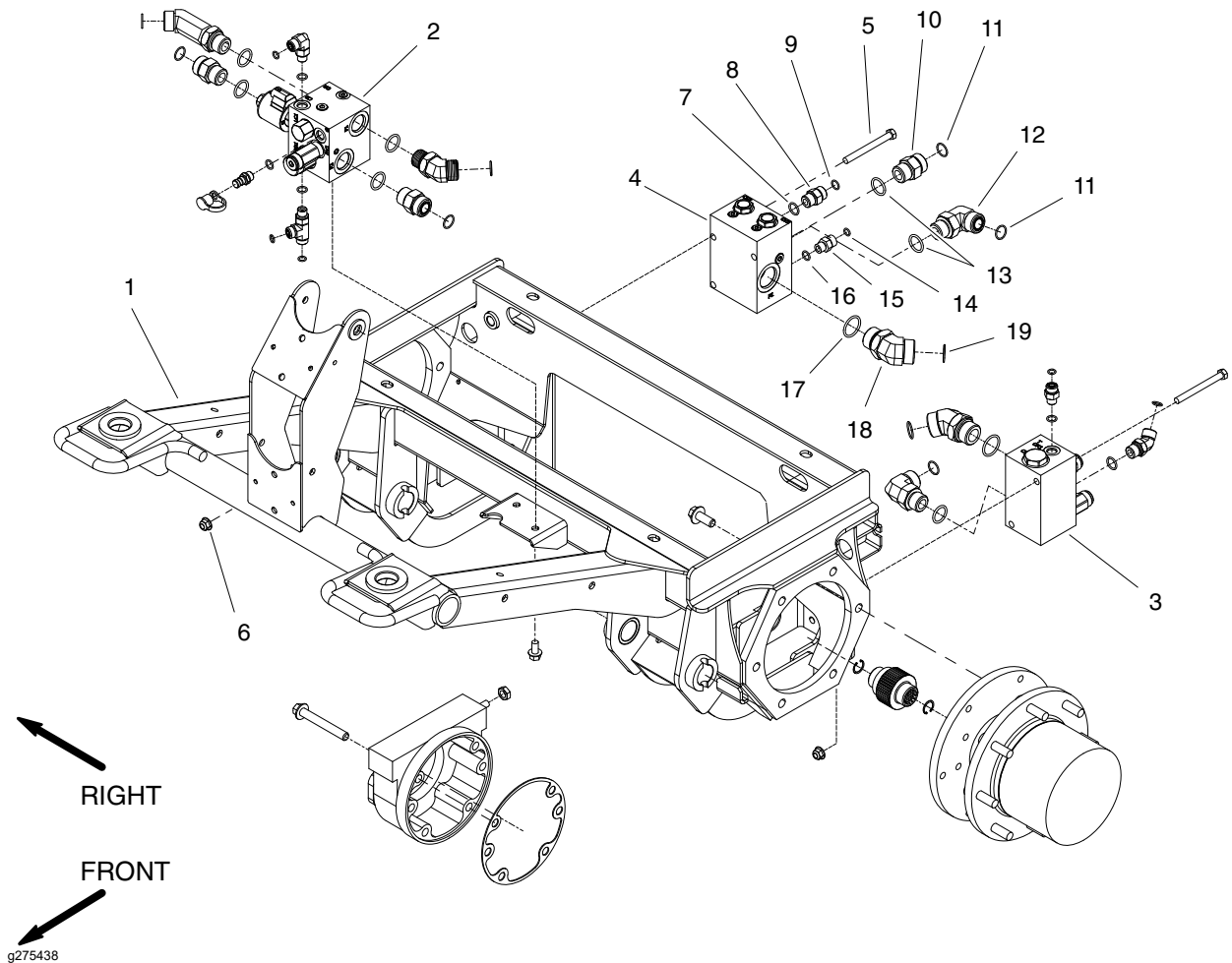


Figure 114

- | | | |
|-------------------------------|--------------------------------|-------------------------|
| 1. Front frame | 8. Check fitting | 15. Check adapter |
| 2. PTO manifold (center deck) | 9. O-ring | 16. O-ring |
| 3. Rear traction manifold | 10. Hydraulic straight fitting | 17. O-ring |
| 4. Front traction manifold | 11. O-ring | 18. 45° hydraulic elbow |
| 5. Cap screw (2 used) | 12. 90° hydraulic elbow | 19. O-ring |
| 6. Flange nut (2 used) | 13. O-ring | |
| 7. O-ring | 14. O-ring | |

Note: The ports on the front traction manifold are marked for easy identification of components. Example: P1 is the gear pump connection port and HFD is the location for the flow divider valve (see [A Hydraulic Schematic \(page A-5\)](#) to identify the function of the hydraulic lines and cartridge valves at each manifold 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 reassembly.

Removal ([Figure 114](#)) (continued)

4. Remove front traction 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 front traction 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.

Front Traction Manifold Service

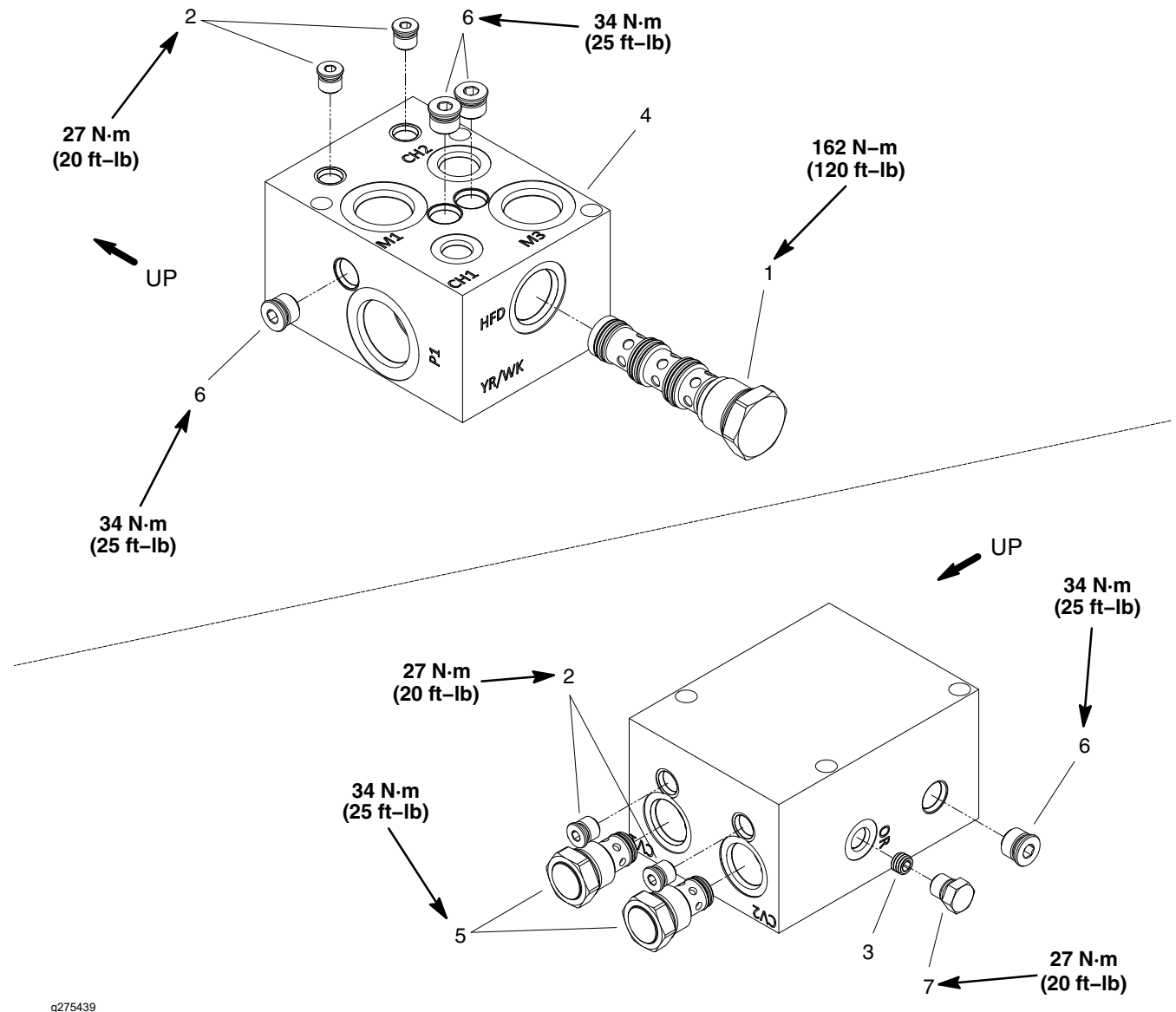


Figure 115

- | | | |
|----------------------------------|------------------------------------|----------------------------------|
| 1. Flow divider valve (port HFD) | 4. Front traction manifold | 7. #4 zero leak plug with O-ring |
| 2. SAE #4 plug with O-ring | 5. Check valve (ports CV1 and CV2) | |
| 3. Orifice (0.063) (port OR) | 6. SAE #6 plug with O-ring | |

Note: The ports on the front traction manifold are marked for easy identification of components. Example: P1 is the gear pump connection port and HFD is the location for the flow divider valve (see [A Hydraulic Schematic \(page A-5\)](#) to identify the function of the hydraulic lines and cartridge valves at each manifold port).

Front Traction Manifold Service ([Figure 115](#))

For front traction manifold cartridge valve service procedures, see [Control Manifold Cartridge Valve Service \(page 5-131\)](#). Refer to [Figure 115](#) for front traction manifold cartridge valve and plug installation torque.

IMPORTANT

A flow control orifice is located beneath the plug in the front traction manifold port OR. If the orifice is removed from the 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

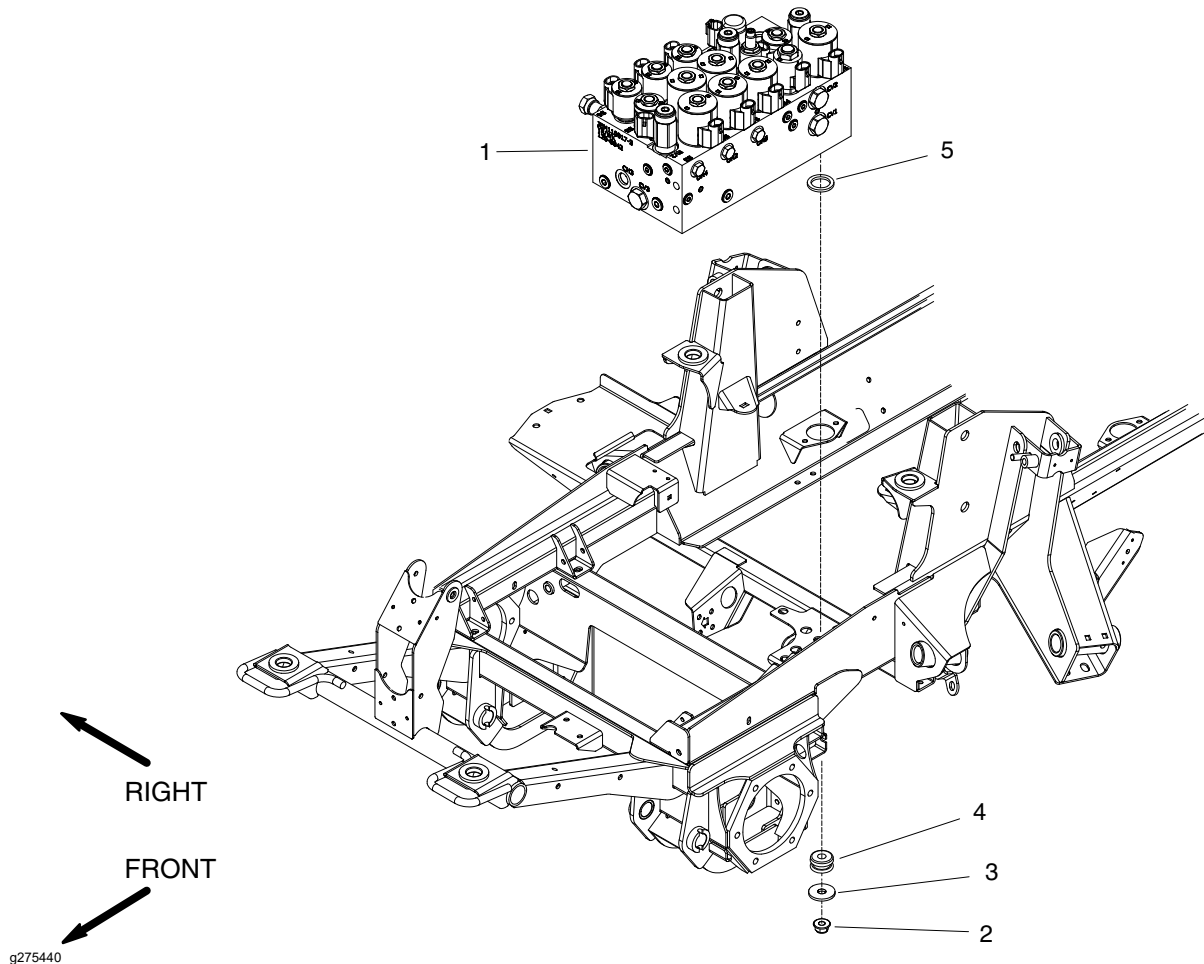


Figure 116

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

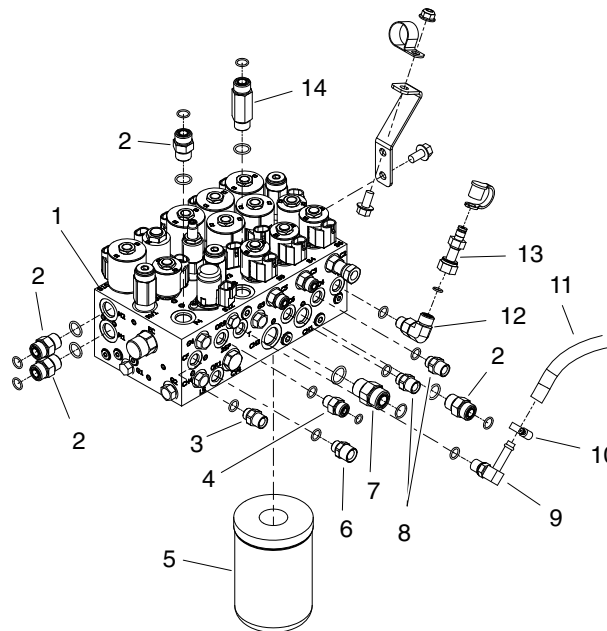
Removal ([Figure 116](#))

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)



g275441

Figure 117

- | | |
|---------------------|-----------------------|
| 1. Manifold | 8. Straight fitting |
| 2. Straight fitting | 9. Barbed 90° fitting |
| 3. Straight fitting | 10. Hose clamp |
| 4. Straight fitting | 11. Hose |
| 5. Oil filter | 12. 90° 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 the Hydraulic Fittings \(SAE Straight Thread O-Ring Fittings\)](#) (page 5–10)).
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

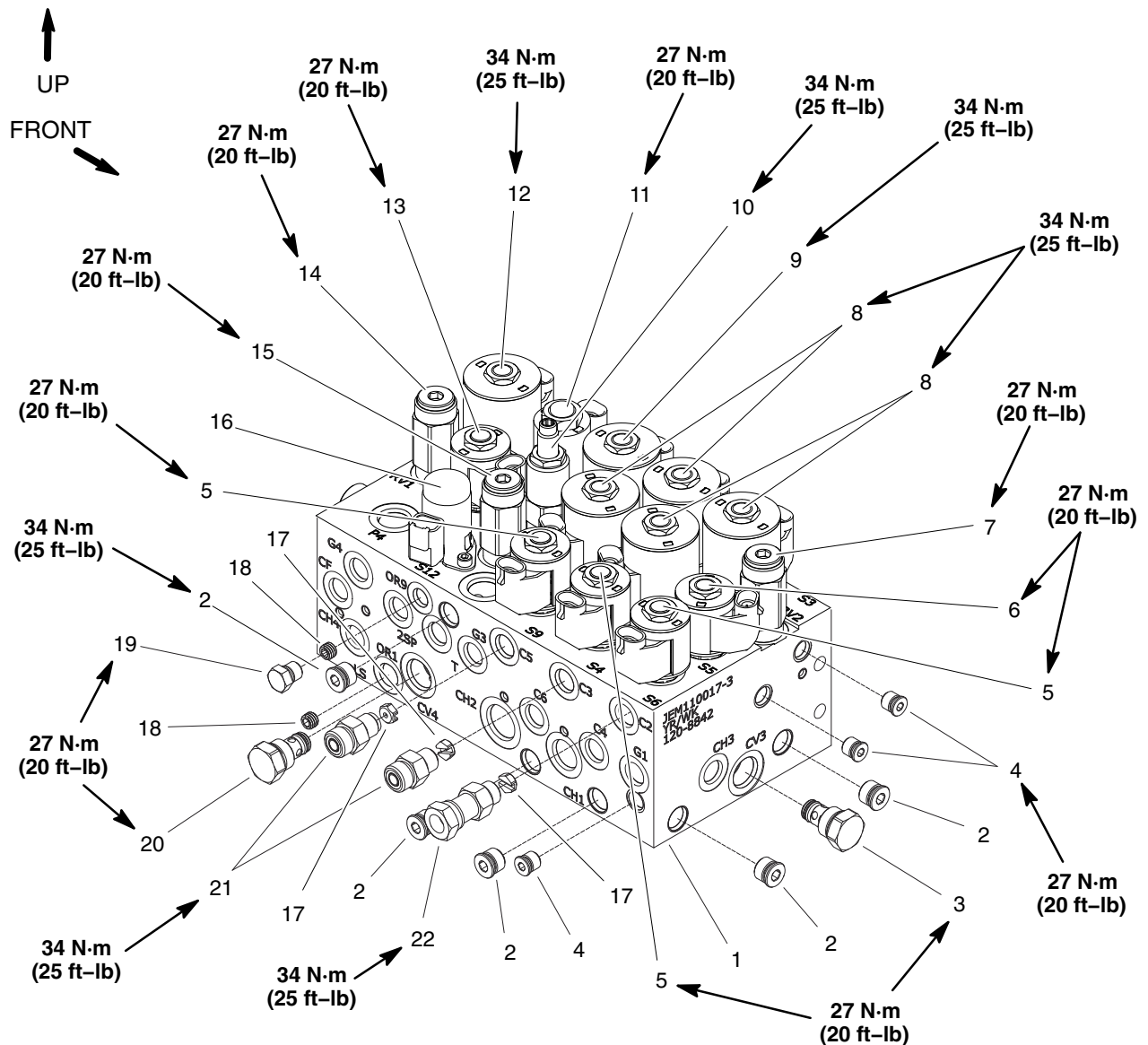


Figure 118

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

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

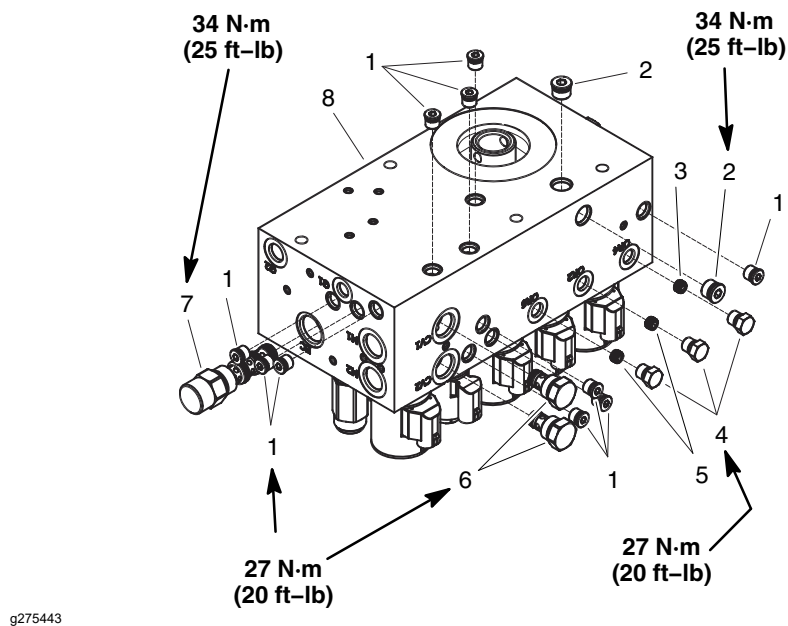


Figure 119

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

Combination Manifold Service (continued)

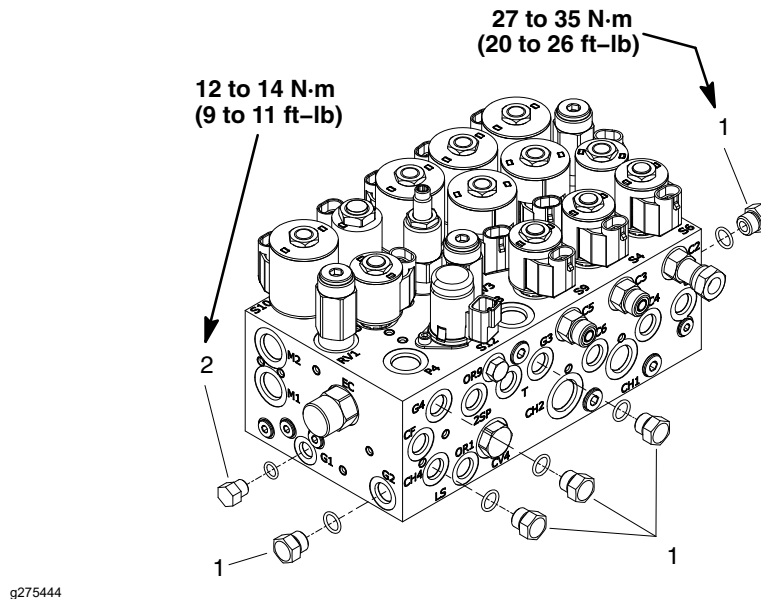


Figure 120

1. #6 hex head plug

2. #4 hex head plug

For combination manifold cartridge valve service procedures, see [Control Manifold Cartridge Valve Service \(page 5–131\)](#). 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.
 - 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)**.

Control Manifold Cartridge Valve Service (continued)

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

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

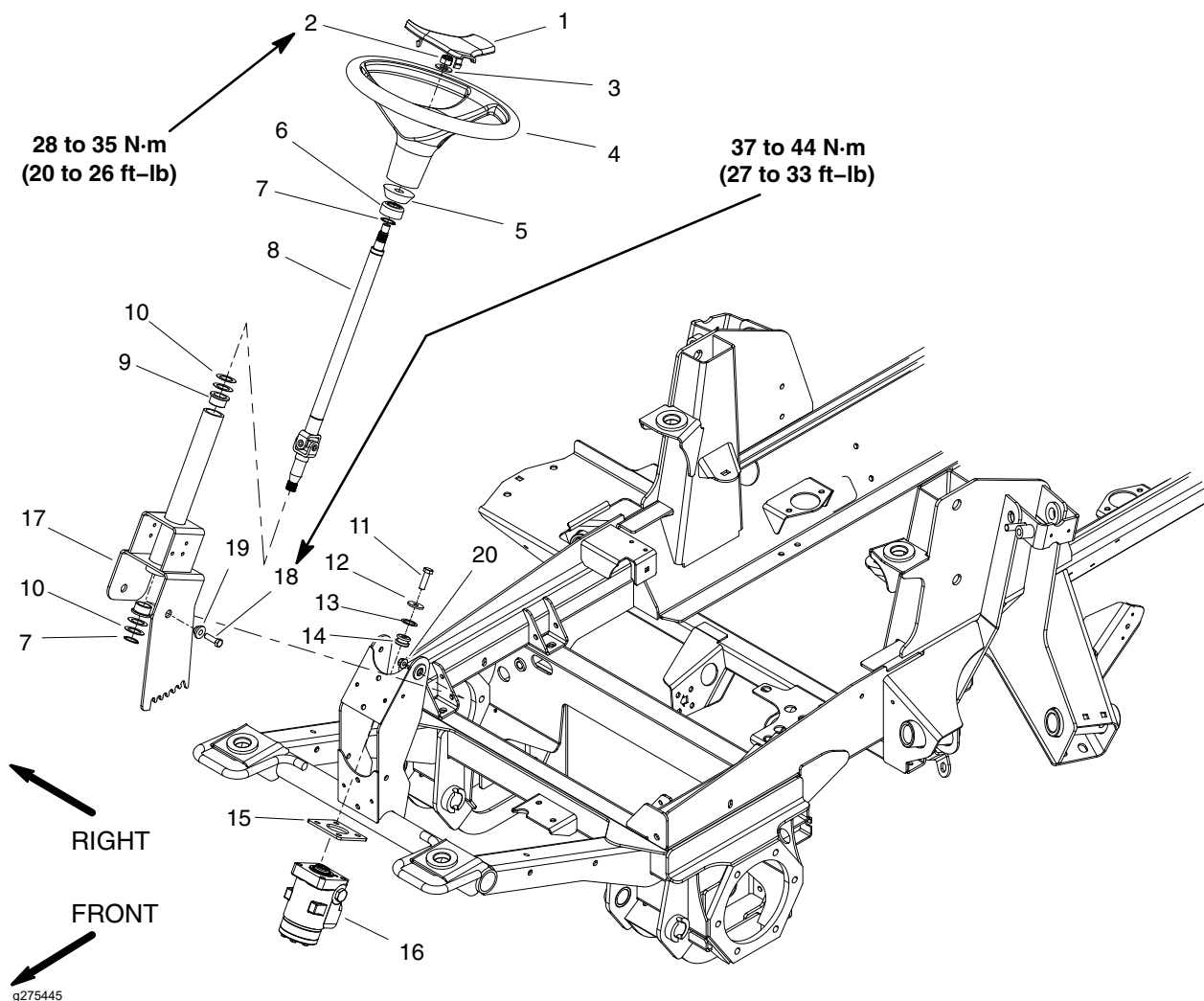


Figure 121

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

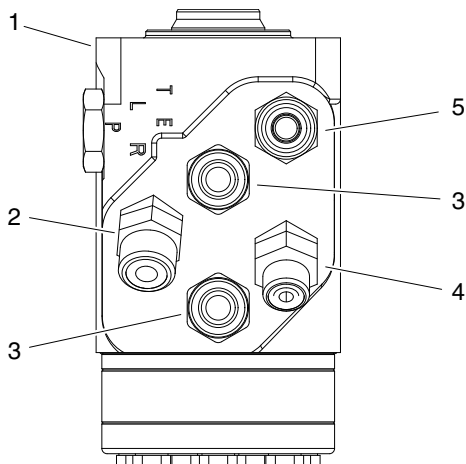
Removal ([Figure 121](#))

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

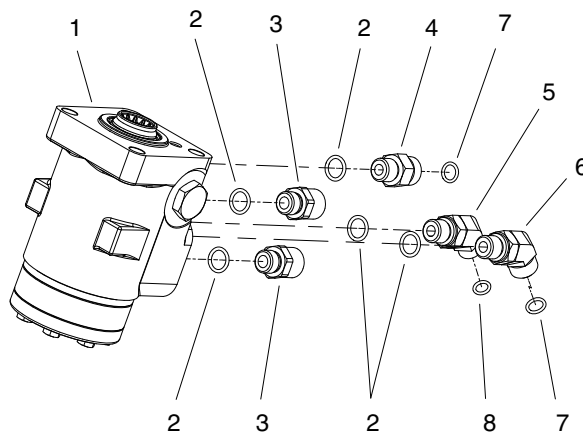
5. Remove hydraulic lines from steering control valve.
6. Remove steering control valve from machine using Figure 121 as a guide.



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Figure 122

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



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Figure 123

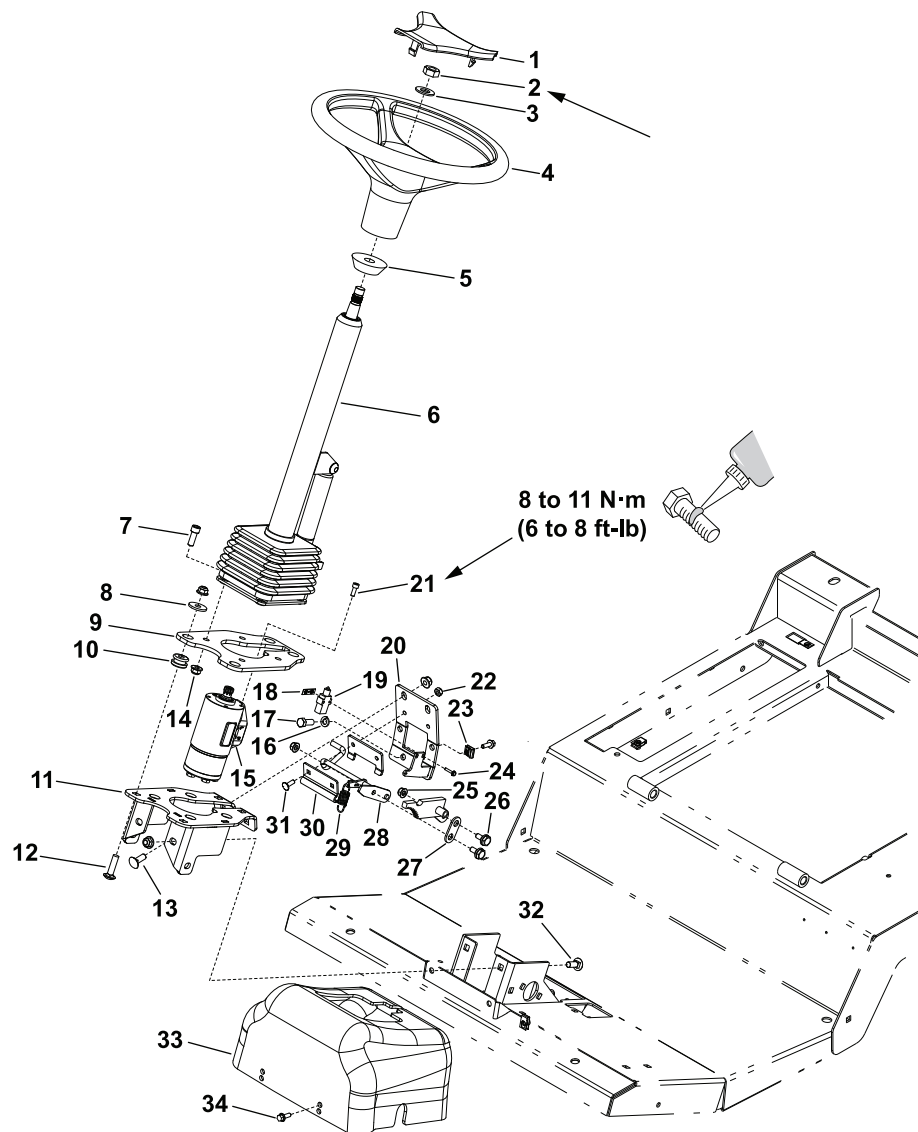
- | | |
|---------------------------|----------------|
| 1. Steering control valve | 5. 45° fitting |
| 2. O-ring | 6. 45° fitting |
| 3. Straight fitting | 7. O-ring |
| 4. Straight fitting | 8. O-ring |

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 the Hydraulic Fittings \(SAE Straight Thread O-Ring Fittings\)](#) (page 5–10)).
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)



g278210

Figure 124

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

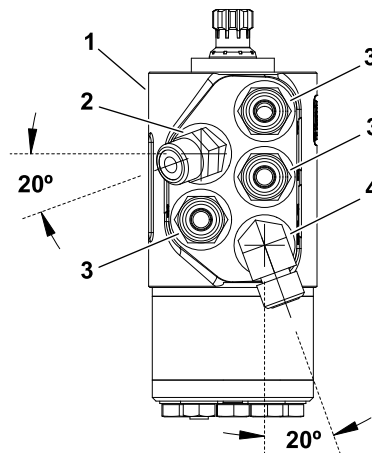


CAUTION



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](#).



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Figure 125

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

Removal (Figure 124) (continued)

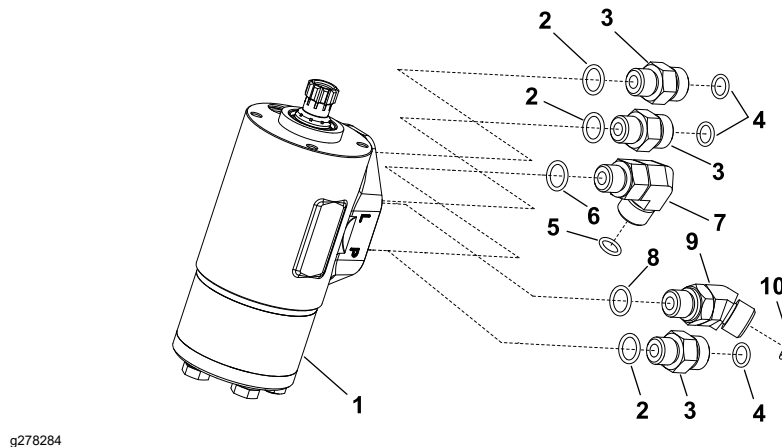


Figure 126

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

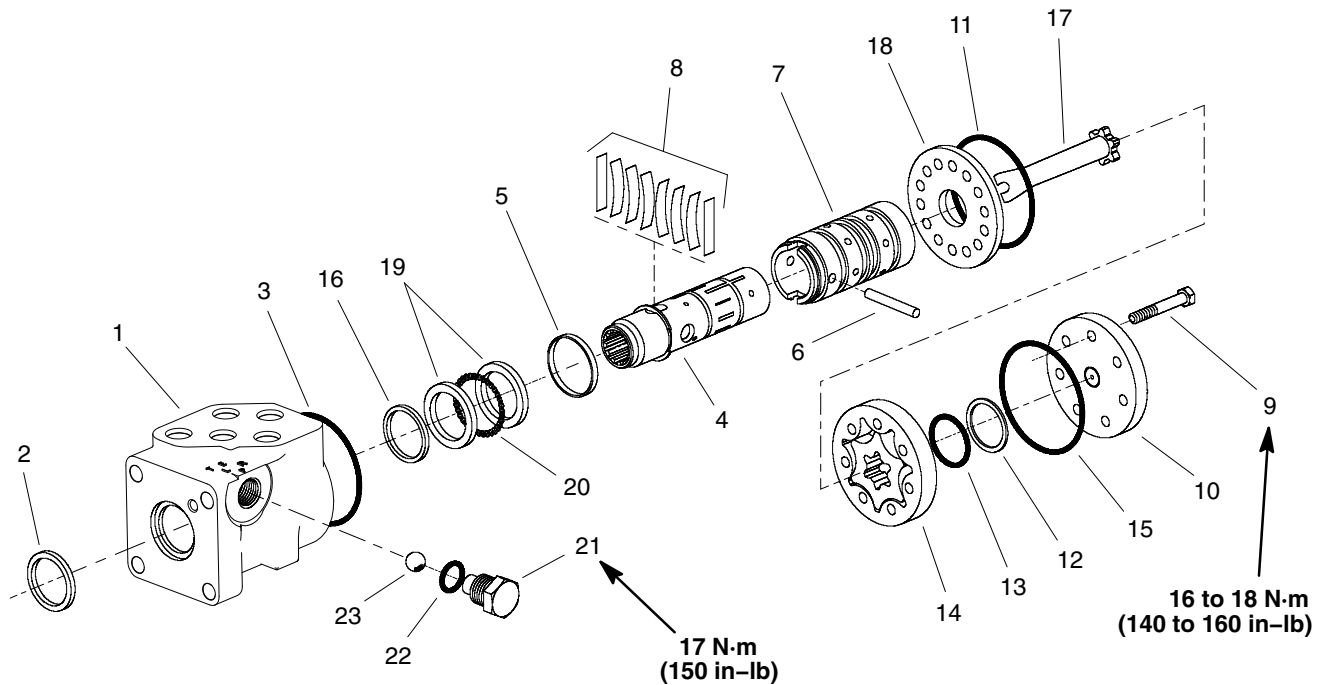
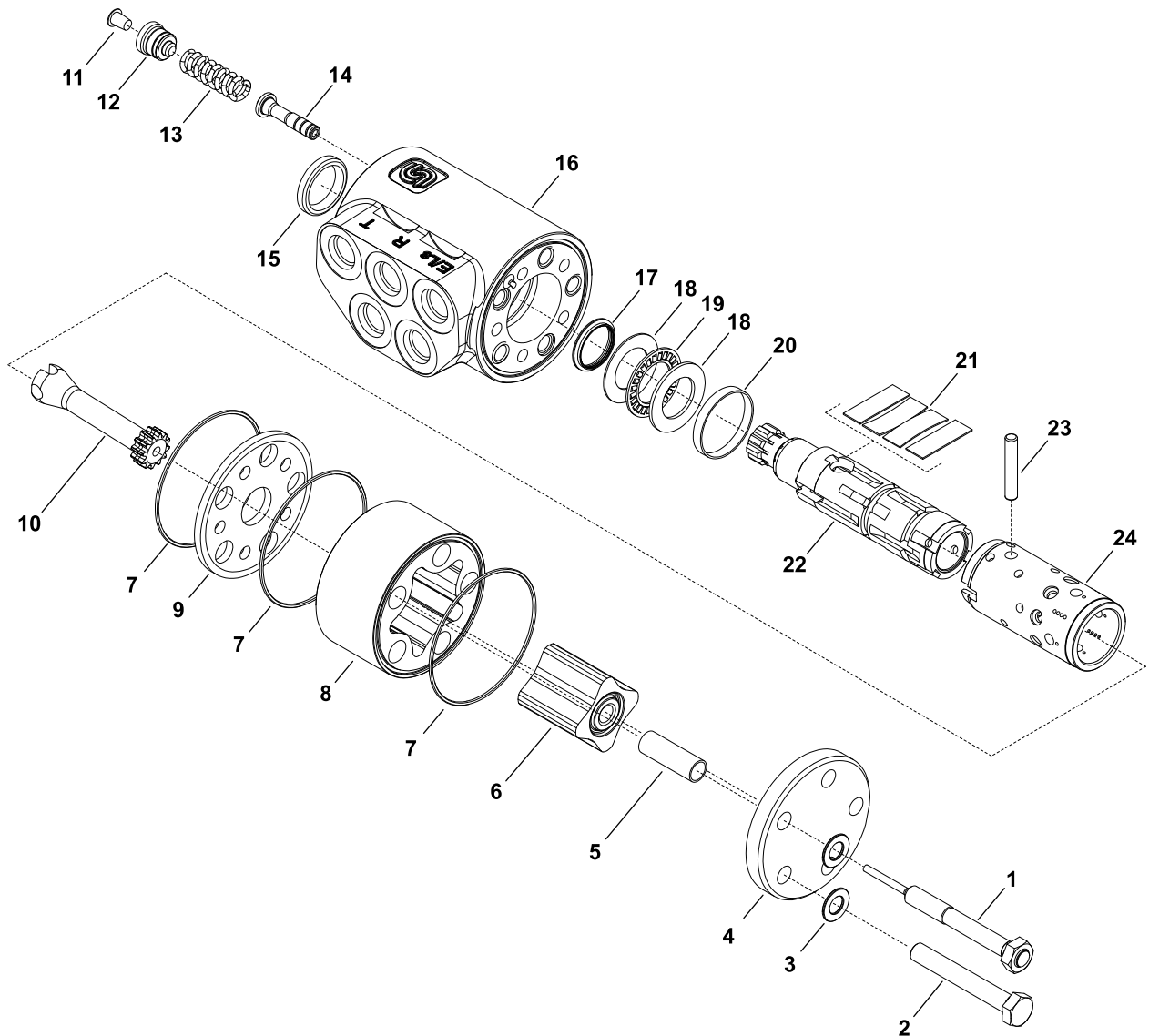


Figure 127

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

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)



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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

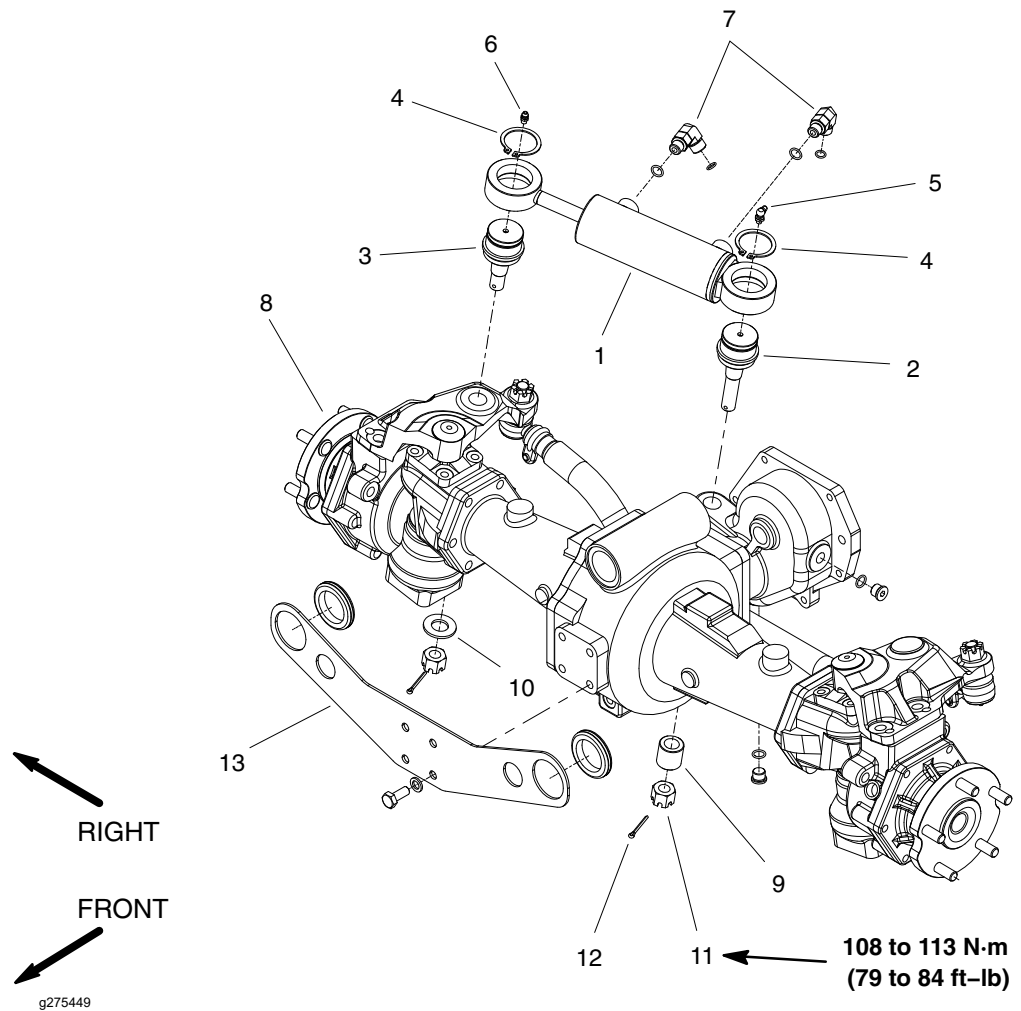


Figure 129

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

Removal (Figure 129)

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

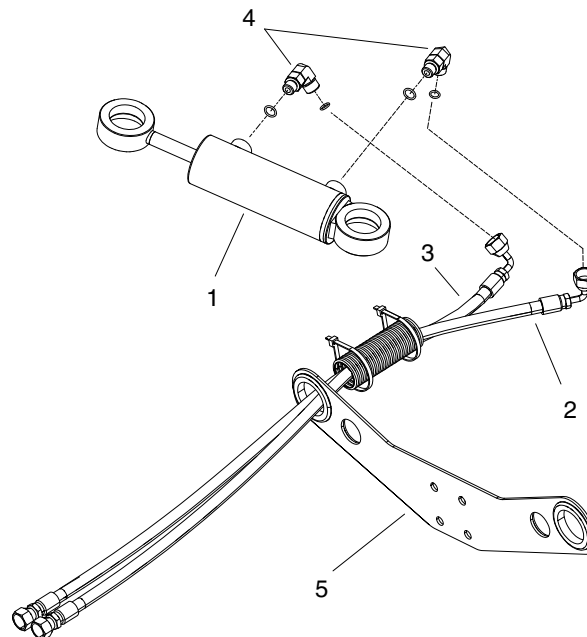


Figure 130

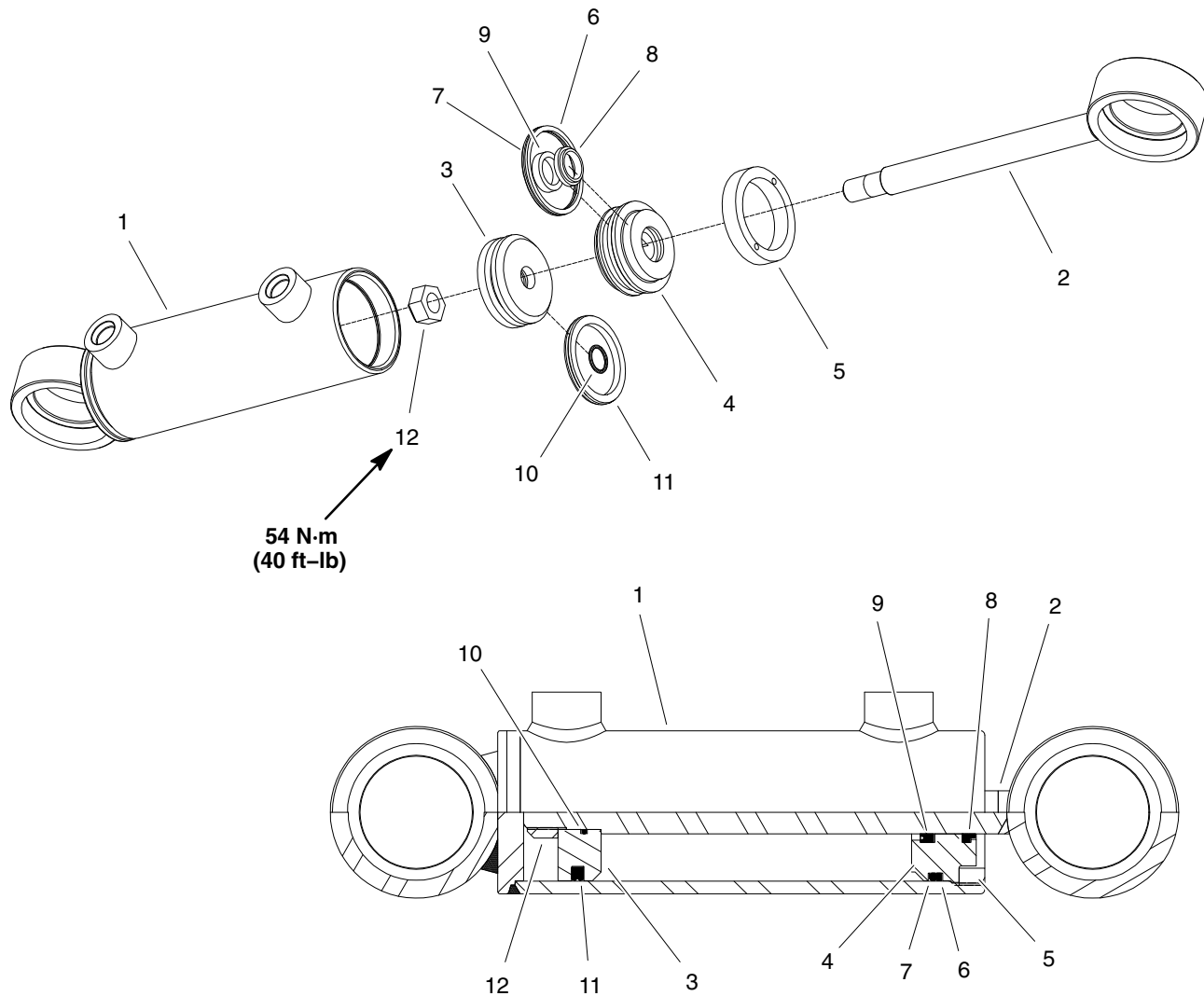
- | | |
|----------------------|--------------------------|
| 1. Steering cylinder | 4. 90° hydraulic fitting |
| 2. Hydraulic hose | 5. Bulkhead mount plate |
| 3. Hydraulic hose | |

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



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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.

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.

Assembly (Figure 131) (continued)

10. Secure head in barrel by using a spanner wrench to install and tighten internal collar (item 5) into barrel.

Engine Cooling Fan Motor

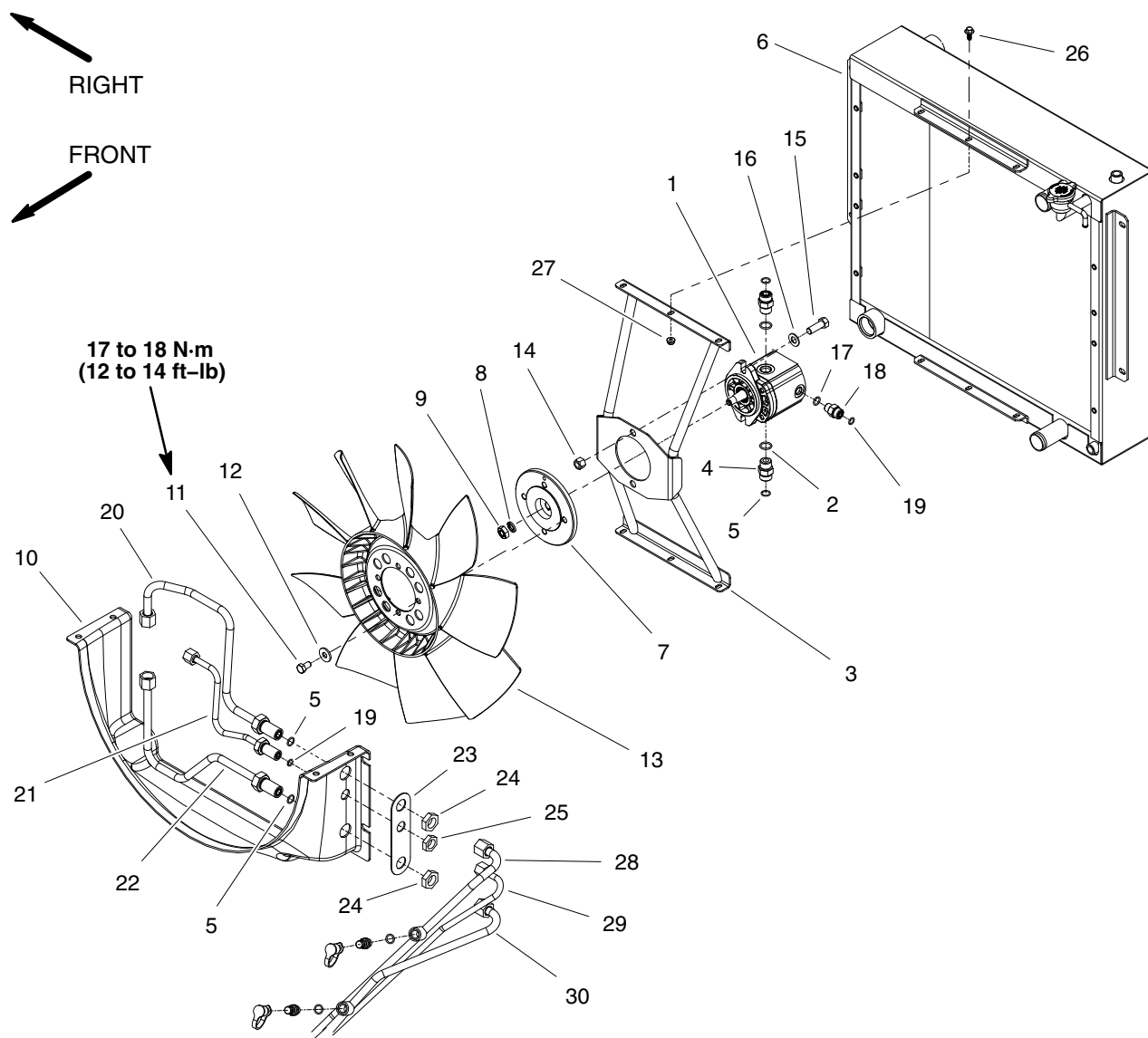


Figure 132

- | | | |
|---------------------------------|--------------------------|---------------------------|
| 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 ignition switch.
2. Unlatch and raise hood.

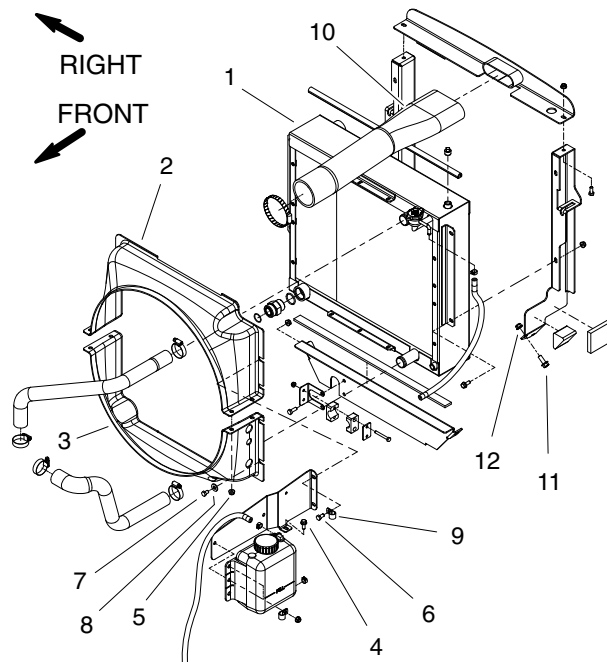


CAUTION



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.



g275453

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.

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)**.
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.

Installation ([Figure 132](#)) (continued)

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

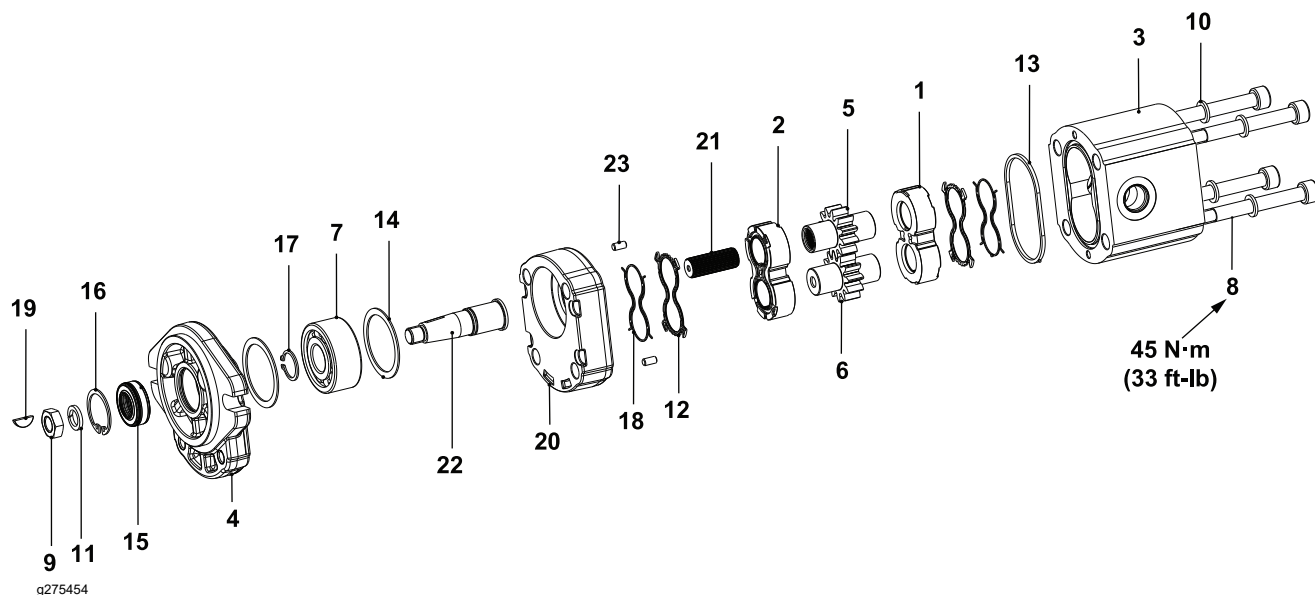


Figure 134

- | | | |
|---------------------|---------------------|------------------------|
| 1. Flange washer | 7. Shaft seal | 13. Cap screw (4 used) |
| 2. O-ring | 8. Backup gasket | 14. Dowel (2 used) |
| 3. Front flange | 9. Pressure seal | 15. Drive gear |
| 4. Dust seal | 10. Rear wear plate | 16. Washer (4 used) |
| 5. Retaining ring | 11. Body | |
| 6. Front wear plate | 12. Idler gear | |

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.

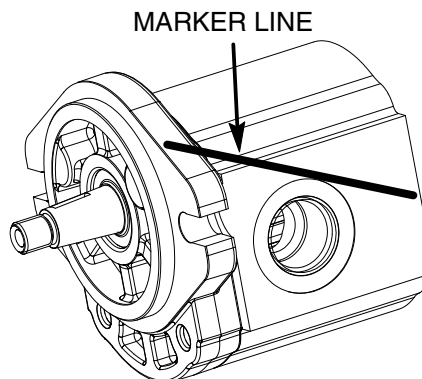


Figure 135

2. Use a marker to make a diagonal line across the front flange and body for assembly purposes (Figure 135).

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.
-

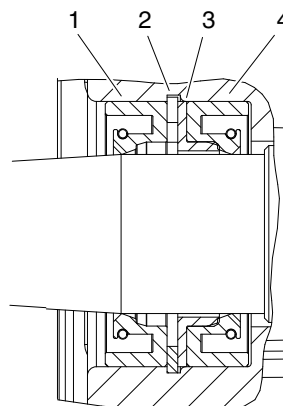
IMPORTANT

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.



g275456

Figure 136

- | | |
|-------------------|------------------|
| 1. Dust seal | 3. Flange washer |
| 2. Retaining ring | 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.

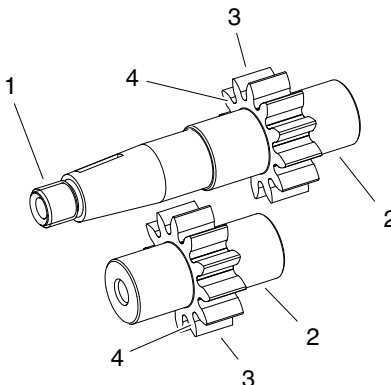


CAUTION



Use eye protection such as goggles when using compressed air.

2. Clean all parts with solvent. Dry all parts with compressed air.



g275457

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

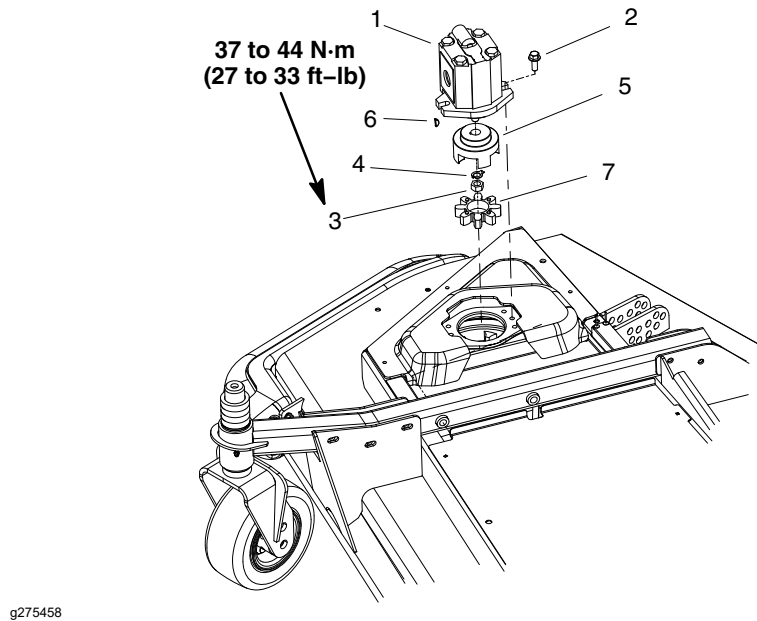


Figure 138

- | | |
|--------------------------|-----------------|
| 1. Cutting deck motor | 5. Spider hub |
| 2. Flange screw (2 used) | 6. Woodruff key |
| 3. Nut | 7. Spider |
| 4. Tab washer | |

Removal

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the ignition switch.
2. Read the [General Precautions for Removing and Installing Hydraulic System Components \(page 5–83\)](#).
3. Thoroughly clean exterior of deck motor and fittings. Disconnect hydraulic lines from motor. Put caps or plugs on fittings and hoses to prevent contamination. Label hydraulic lines for proper installation.
4. Remove two (2) flange head screws that secure hydraulic motor to motor mount ([Figure 138](#)).
5. Carefully remove hydraulic motor from cutting deck taking care not to damage spider hub attached to motor. Locate and remove spider from the deck.
6. If necessary, straighten tab washer and remove nut, tab washer and spider hub from motor shaft.

Removal (continued)

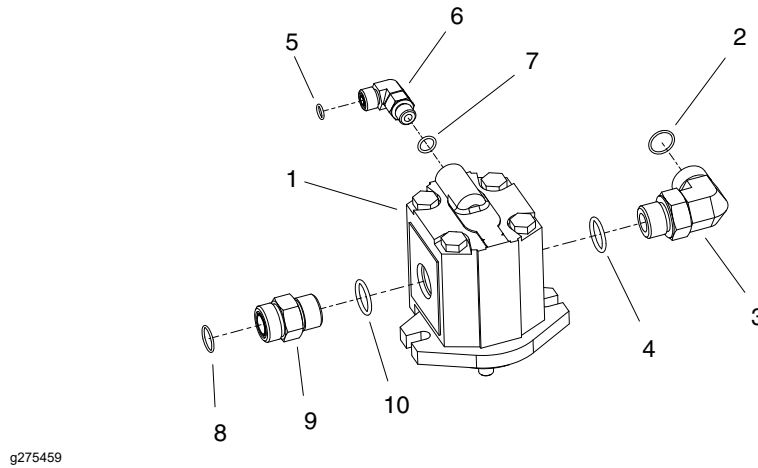


Figure 139

- | | |
|------------------------|----------------------|
| 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 |

-
7. 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 the Hydraulic Fittings \(SAE Straight Thread O-Ring Fittings\)](#) (page 5–10)).
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](#)).
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.

Cutting Deck Motor Service (Sauer-Danfoss)

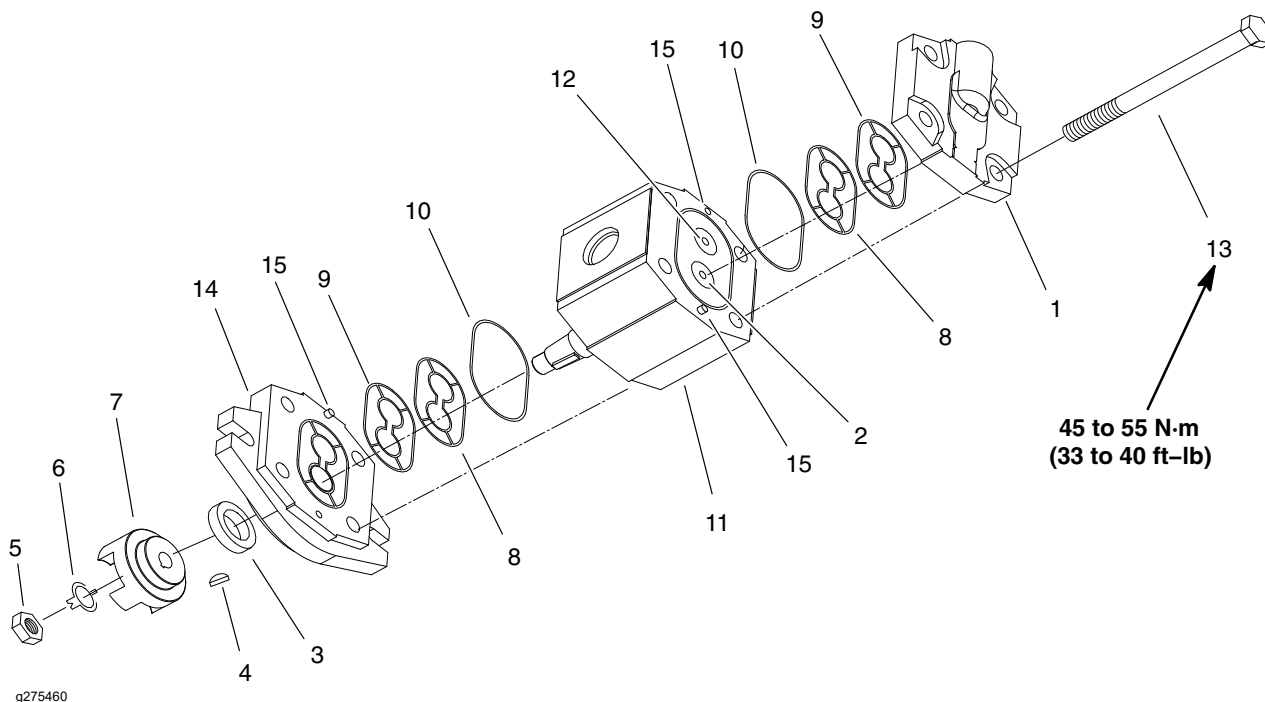


Figure 140

- | | | |
|-----------------|------------------|------------------------|
| 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. 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.

3. Clamp mounting flange of motor in a vise with the shaft end down.
4. Loosen cap screws on the rear cover.

Disassembly (Figure 140) (continued)

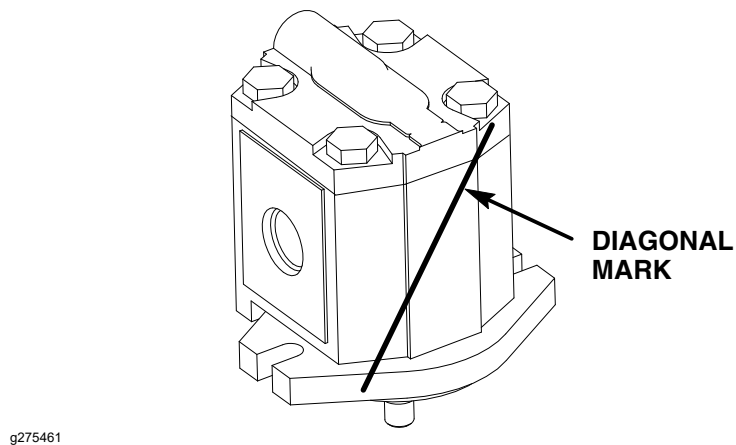


Figure 141

5. Take motor from the vise and remove cap screws.
6. 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.

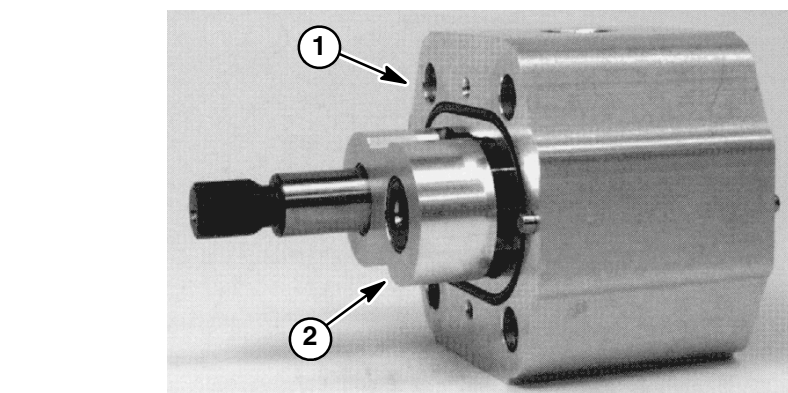
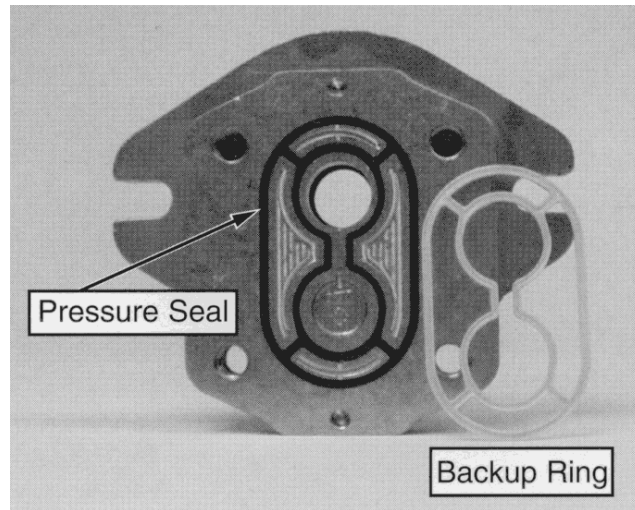


Figure 142

1. Motor body
2. Bearing block & gear set

Disassembly (Figure 140) (continued)



g275463

Figure 143

7. Place the motor on its side and push on the rear bearing block to remove the bearing block and gear set (Figure 142).
8. 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.

9. 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)

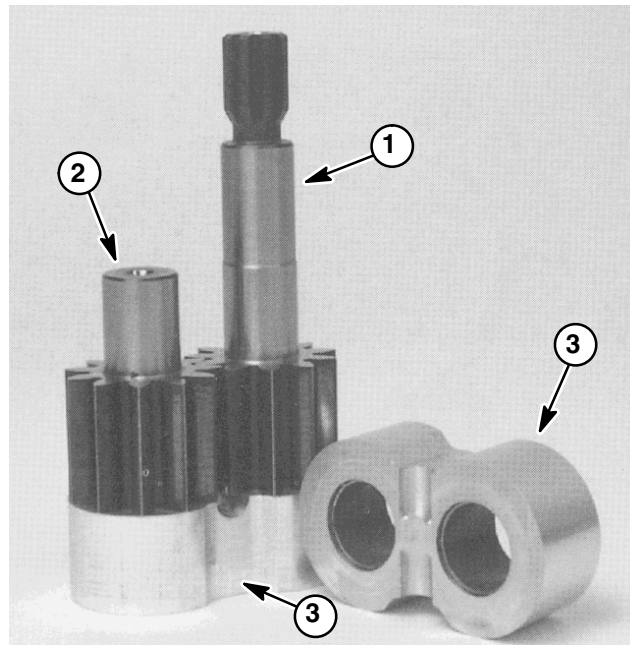


Figure 144

- | | |
|---------------|------------------|
| 1. Drive gear | 3. Bearing block |
| 2. Idler gear | |

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.

Note: 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. Remove motor from vise.

Cutting Deck Motor Service (Casappa)

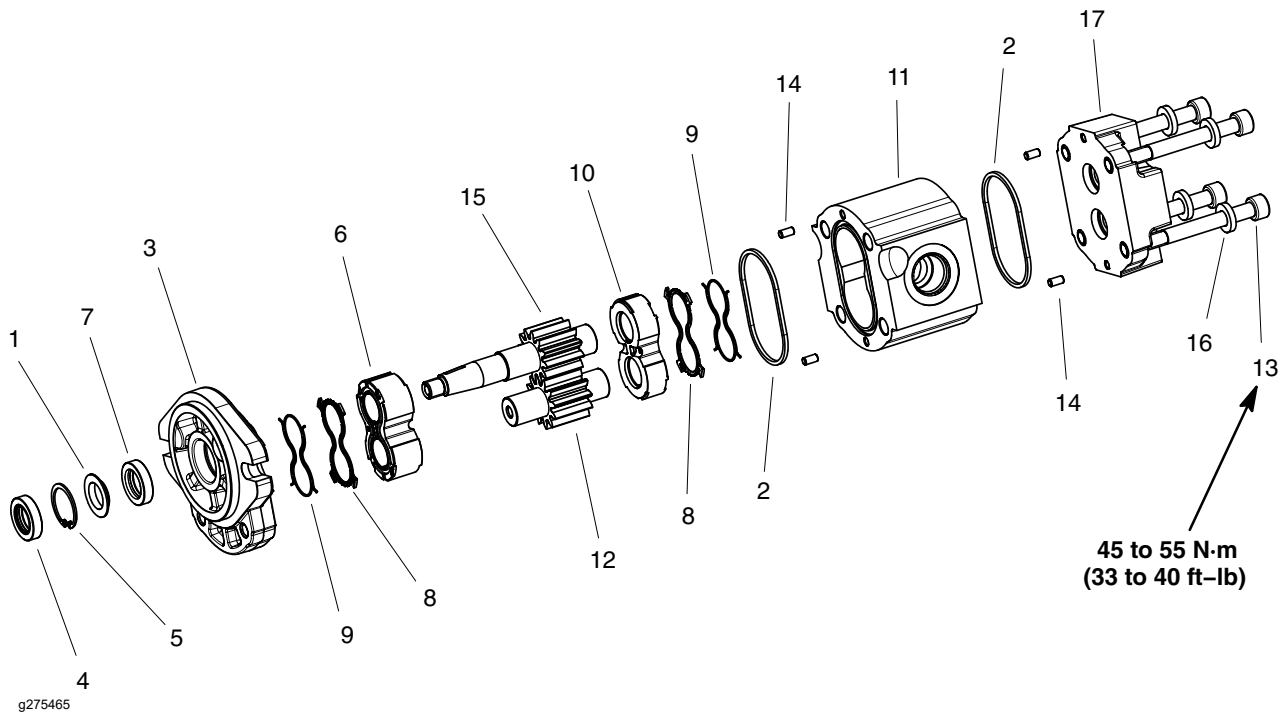


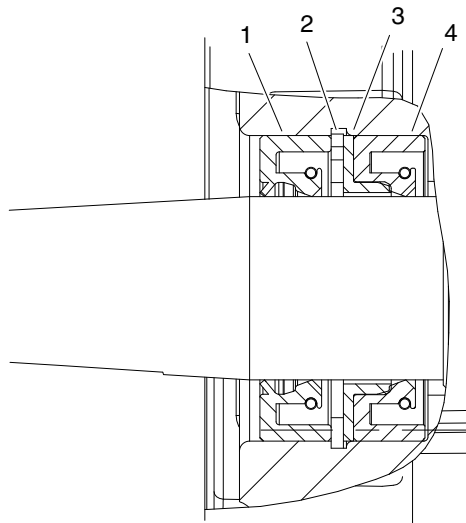
Figure 145

- | | | |
|---------------------|---------------------|------------------------|
| 1. Flange washer | 7. Shaft seal | 13. Cap screw (4 used) |
| 2. O-ring | 8. Backup gasket | 14. Dowel (4 used) |
| 3. Front flange | 9. Pressure seal | 15. Drive gear |
| 4. Dust seal | 10. Rear wear plate | 16. Washer (4 used) |
| 5. Retaining ring | 11. Body | 17. Rear cover |
| 6. Front wear plate | 12. Idler gear | |

The Casappa cutting deck motors have similar construction as the cooling fan motor (also a Casappa brand) used on the Groundsmaster 4000-D and 4010-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 \(page 5–151\)](#). 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)



g275406

Figure 146

- | | |
|-------------------|------------------|
| 1. Dust seal | 3. Flange washer |
| 2. Retaining ring | 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

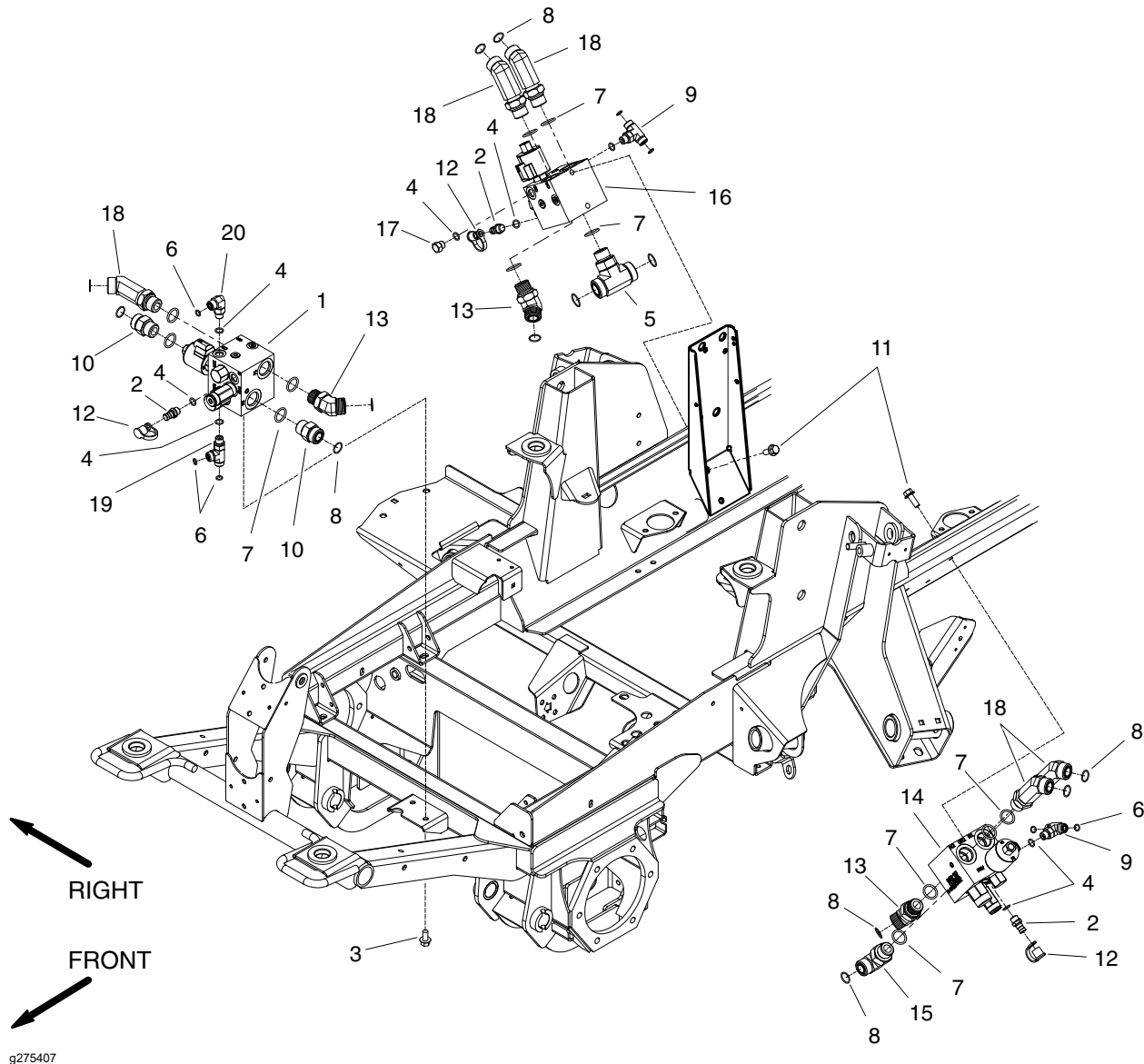


Figure 147

- | | | |
|---|--|--------------------------------------|
| 1. Hydraulic PTO manifold (center deck) | 8. O-ring | 15. 90° hydraulic fitting |
| 2. Quick fitting (1 used per manifold) | 9. Hydraulic adapter | 16. Hydraulic PTO manifold (RH deck) |
| 3. Flange screw (2 used per manifold) | 10. Straight fitting | 17. Hex head plug |
| 4. O-ring | 11. Flange screw (2 used per manifold) | 18. 45° hydraulic fitting |
| 5. Hydraulic tee fitting | 12. Dust cap | 19. Hydraulic tee fitting |
| 6. O-ring | 13. 45° hydraulic fitting | 20. 90° hydraulic fitting |
| 7. O-ring | 14. Hydraulic PTO manifold (LH deck) | |

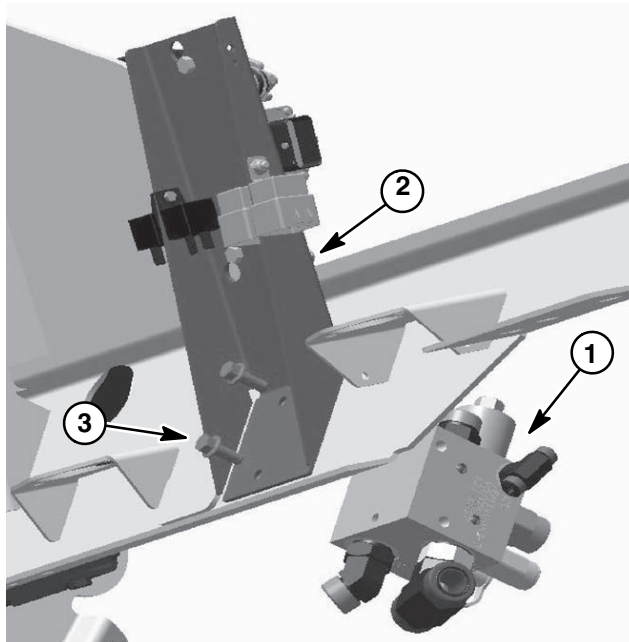
Note: The ports on the manifold are marked for easy identification of components. Example: PRV is the proportional relief valve and P1 is a gear pump connection port (see [A Hydraulic Schematic \(page A-5\)](#) to identify the function of the hydraulic lines and cartridge valves at each port).

Removal (Figure 147)

1. Read the [General Precautions for Removing and Installing Hydraulic System Components \(page 5-83\)](#).

Removal (Figure 147) (continued)

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.



g275408

Figure 148

- | | |
|---------------------|--------------------------|
| 1. RH PTO manifold | 3. Flange screw (2 used) |
| 2. Controller mount | |

-
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.

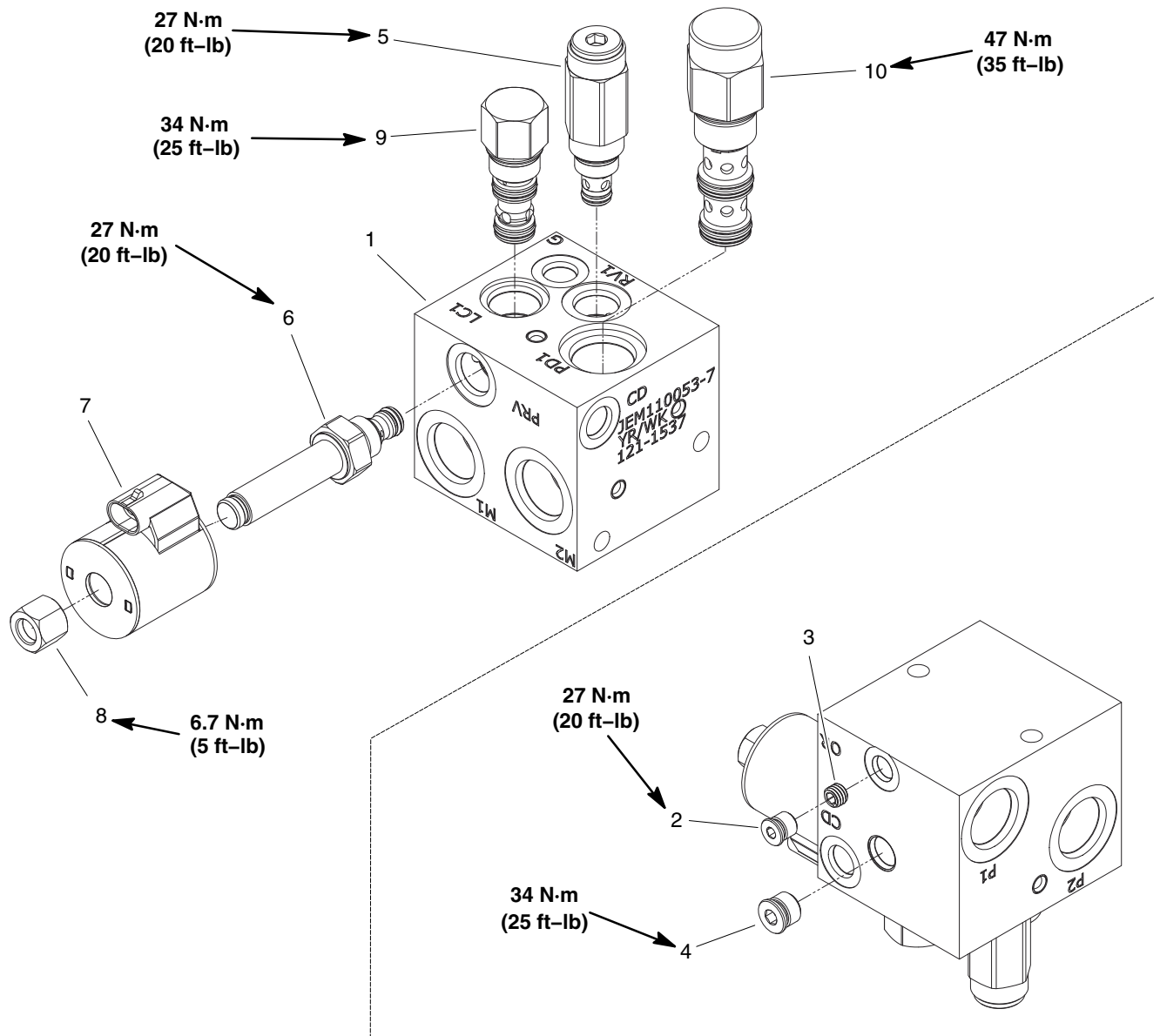
Note: Make sure that the controller mount is secured when installing the right side PTO manifold ([Figure 148](#)).

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.

Installation (Figure 147) (continued)

5. Make sure hydraulic tank is full. Add correct oil if necessary before returning machine to service.

PTO Manifold Service



g275409

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.

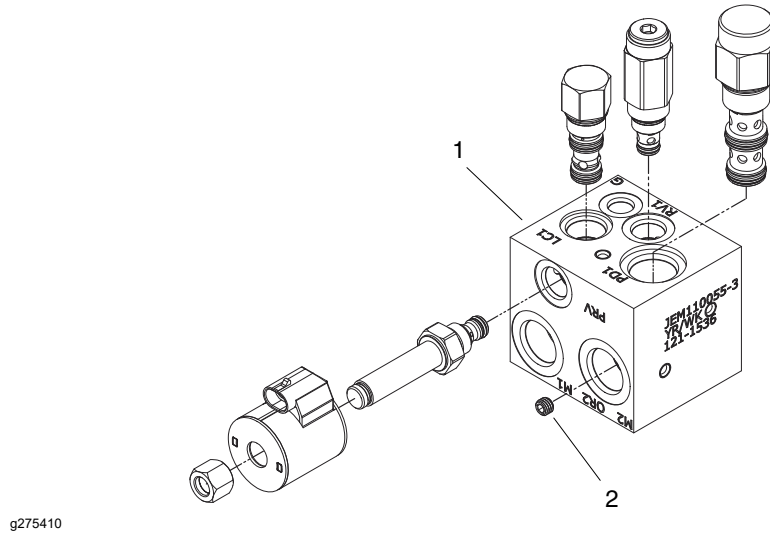


Figure 150

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 \(page 5–131\)](#). Refer to [Figure 149](#) for PTO manifold cartridge valve and plug installation torque.

Side Deck Lift Cylinders

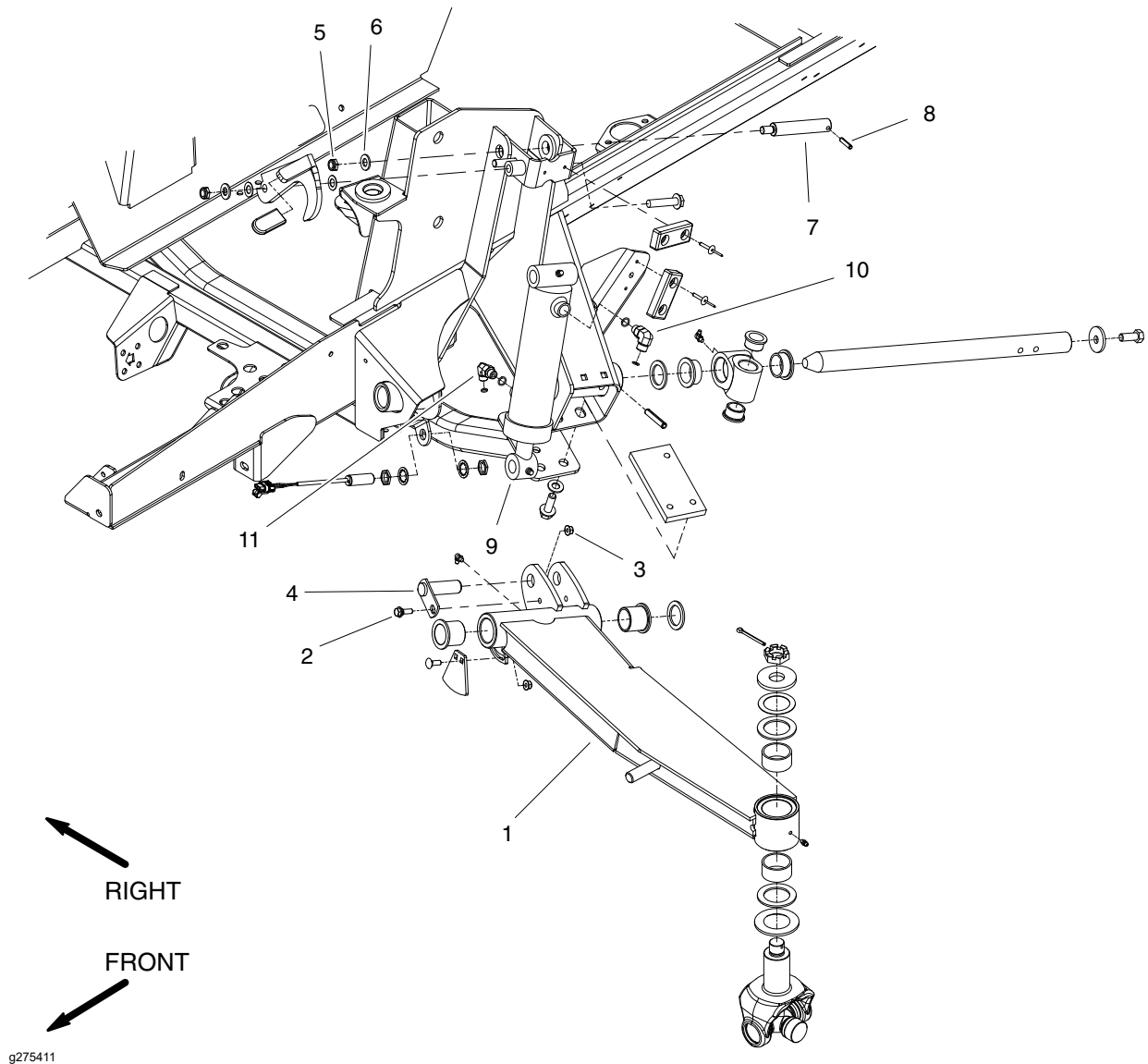


Figure 151

- | | | |
|---------------------------------|-----------------|---------------------------|
| 1. Lift arm assembly (LH shown) | 5. Lock nut | 9. Lift cylinder |
| 2. Shoulder screw | 6. Flat washer | 10. 90° hydraulic fitting |
| 3. Flange nut | 7. Cylinder pin | 11. 90° hydraulic fitting |
| 4. Pin assembly | 8. Spring pin | |

Removal (Figure 151)

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

Removal (Figure 151) (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.

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

4. Disconnect hydraulic hoses from lift cylinder.
5. Remove shoulder screw and flange nut that secure the pin assembly (item 4) to the lift arm. Remove pin assembly from lift arm and cylinder rod clevis.
6. Remove lock nut and flat washer from the cylinder pin (item 7). Remove cylinder pin with spring pin from the frame and cylinder barrel clevis.
7. Remove lift cylinder from machine.
8. 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.

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. Tighten fittings (see [Installing Hydraulic Hoses and Tubes \(O-Ring Face Seal\) \(page 5–8\)](#)).
2. Position cylinder barrel clevis to frame and insert cylinder pin (item 7) through the frame and cylinder barrel clevis. Secure pin with flat washer and lock nut.
3. Insert pin assembly (item 4) through the lift arm and cylinder rod clevis. Secure pin assembly to lift arm with shoulder screw and flange nut.
4. Attach hydraulic hoses to lift cylinder (see [Installing Hydraulic Hoses and Tubes \(O-Ring Face Seal\) \(page 5–8\)](#)).
5. Fill reservoir with hydraulic fluid as required.
6. After installation is completed, operate lift cylinder to verify that lift cylinder, hydraulic hoses and fittings are not contacted by anything.

Center Deck Lift Cylinders

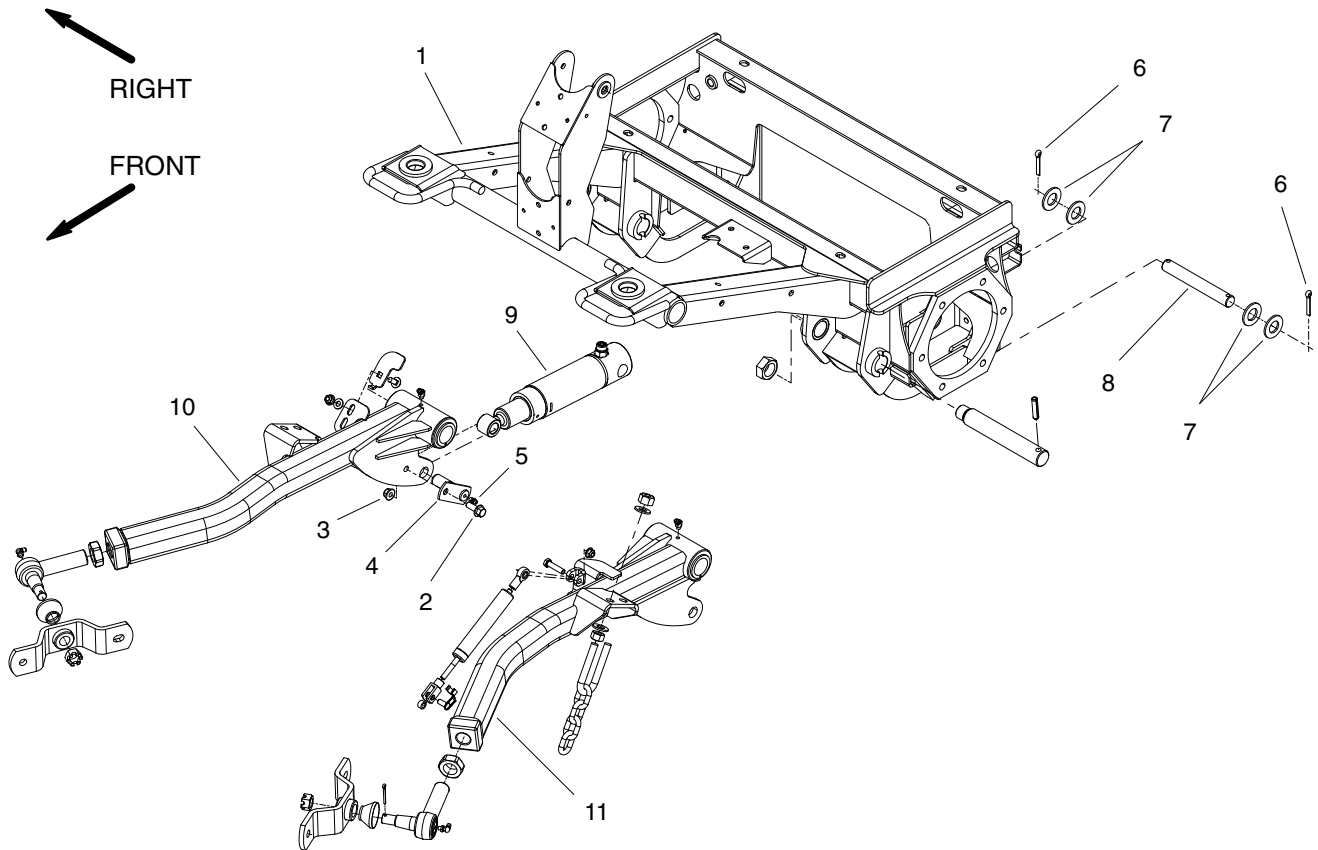


Figure 152

- | | | |
|----------------------|---------------------------------|---------------------------|
| 1. Front frame | 5. Grease fitting | 9. Lift cylinder (2 used) |
| 2. Flange head screw | 6. Cotter pin (2 used per pin) | 10. RH lift arm assembly |
| 3. Flange nut | 7. Flat washer (4 used per pin) | 11. LH lift arm assembly |
| 4. Pin assembly | 8. Clevis pin | |

Removal (Figure 152)

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

4. Disconnect hydraulic hose from lift cylinder.
5. Remove flange nut and flange head screw that secure the pin assembly (item 4) to the lift arm. Remove pin assembly from lift arm and cylinder rod end which will free lift cylinder from lift arm.

Removal ([Figure 152](#)) (continued)

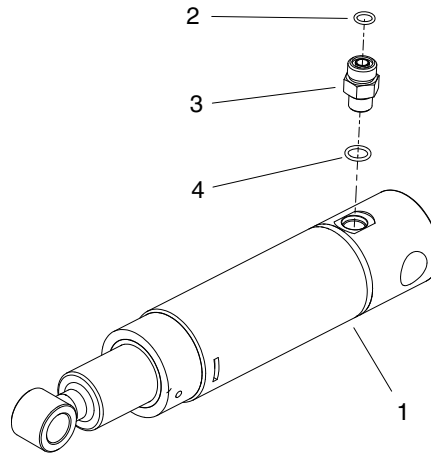


Figure 153

- | | |
|------------------|---------------------|
| 1. Lift cylinder | 3. Straight fitting |
| 2. O-ring | 4. O-ring |

6. Remove one (1) cotter pin and two (2) flat washers from one end of the clevis pin (item 8) that secures barrel end of lift cylinder to front frame. Pull clevis pin from frame and cylinder barrel.
7. Remove lift cylinder from machine.
8. If necessary, remove hydraulic fitting from cylinder and discard O-rings ([Figure 153](#)).

Installation ([Figure 152](#))

1. If fitting was removed from lift cylinder, lubricate and place new O-rings onto fitting. Install fitting into cylinder port. 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 the clevis pin (item 8).
3. Position cylinder barrel to frame and insert clevis pin through frame and cylinder barrel. Secure clevis pin with two (2) flat washers and cotter pin.
4. Insert pin assembly (item 4) through lift arm and cylinder rod end. Secure pin to lift arm with flange nut and flange head screw.
5. Attach hydraulic hose to lift cylinder (see [Installing Hydraulic Hoses and Tubes \(O-Ring Face Seal\)](#) (page 5–8)).
6. Fill reservoir with hydraulic fluid as required.
7. After assembly is completed, operate center deck lift cylinders to verify that lift cylinders, hydraulic hoses and fittings are not contacted by anything.

Lift Cylinder Service

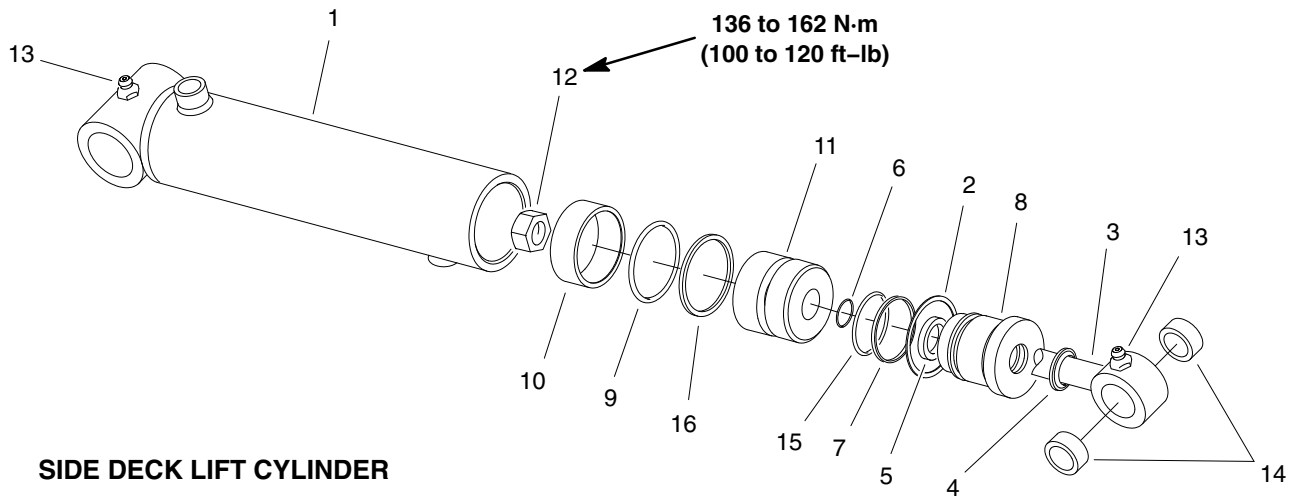


Figure 154

- | | | |
|-----------------------|-----------------|--------------------|
| 1. Barrel with clevis | 7. Back-up ring | 13. Grease fitting |
| 2. Retaining ring | 8. Head | 14. Bushing |
| 3. Shaft with clevis | 9. O-ring | 15. O-ring |
| 4. Dust seal | 10. Wear ring | 16. Seal |
| 5. Rod seal | 11. Piston | |
| 6. O-ring | 12. Lock nut | |

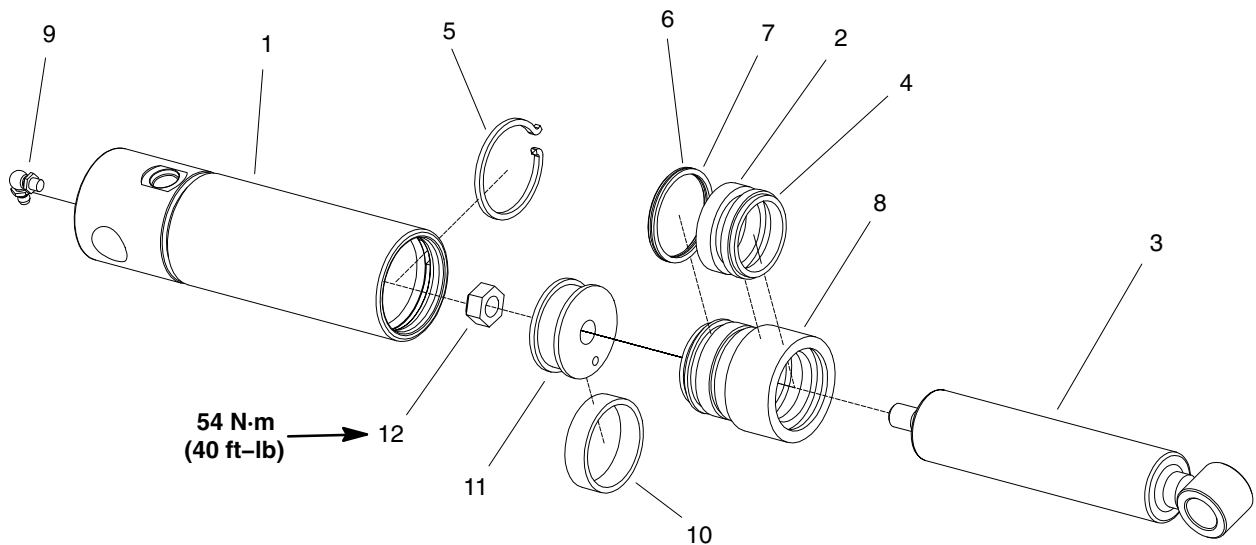


Figure 155

- | | | |
|----------------------|-------------------|-------------------|
| 1. Barrel | 5. Retaining ring | 9. Grease fitting |
| 2. Seal | 6. O-ring | 10. Wear ring |
| 3. Shaft with clevis | 7. Back-up ring | 11. Piston |
| 4. Dust seal | 8. Head | 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. Loosen head from barrel:
 - A. Use a spanner wrench to rotate head clockwise until the edge of the retaining ring (item 2 in Figure 154 or item 5 in Figure 155) 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. Then, rotate the head counter-clockwise to remove retaining ring from barrel and head.
4. Extract shaft with head and piston by carefully twisting and pulling on the shaft.

IMPORTANT

Do not clamp vise jaws against the shaft surface.

5. Mount shaft securely in a vise by clamping on the clevis of the shaft. Use of a vise with soft jaws is recommended.
6. Remove lock nut and piston from the shaft. Slide head off the 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. Install new lubricated seals and O-rings to the piston and head.

IMPORTANT

Do not clamp vise jaws against the shaft surface.

Assembly (Figure 154 and Figure 155) (continued)

3. Mount shaft securely in a vise by clamping on the clevis of the shaft. Use of a vise with soft jaws is recommended.
 - A. Coat shaft with clean hydraulic oil.
 - B. Carefully slide head and then piston onto the shaft. Secure piston to shaft with lock nut.
 - C. Torque lock nut to specification in Figure 154 (side deck cylinder) or Figure 155 (center deck cylinder).
4. Remove shaft assembly from vise.

IMPORTANT

Prevent damage when clamping the hydraulic cylinder into a vise; clamp on the clevis end of the barrel ONLY

5. Mount barrel securely in a vise by clamping on the clevis end of the barrel. Use of a vise with soft jaws is recommended.

IMPORTANT

When installing the head into the barrel of the lift cylinder, pay careful attention to the retaining ring slot in the barrel to insure that the piston and head seals do not lodge in the slot.

6. Coat all internal parts with a light coat of clean hydraulic oil. Slide piston, shaft and head assembly into the barrel being careful to not damage the seals.
7. Secure head in barrel:
 - 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.



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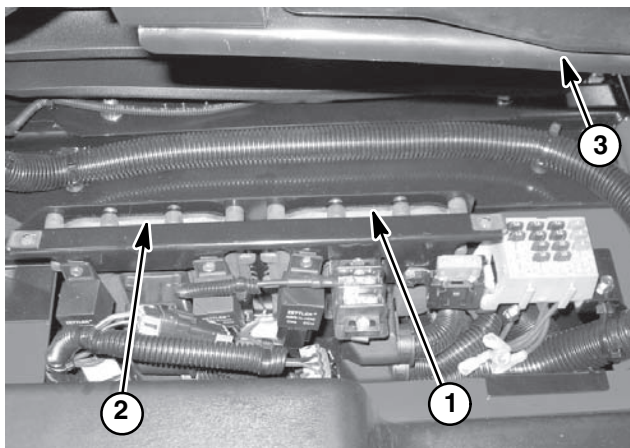
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General Information

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 | 3. Operator seat |
| 2. Rear TEC controller | |

Groundsmaster 4000-D and 4010-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.

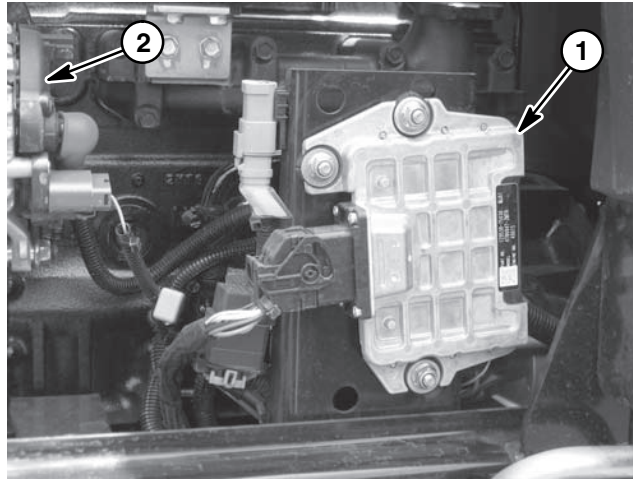
The TEC controllers are attached to the machine under the power center cover next to the operator seat. The TEC controllers are visually identical but they have different software and therefore cannot be interchanged.

Note: 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)**.

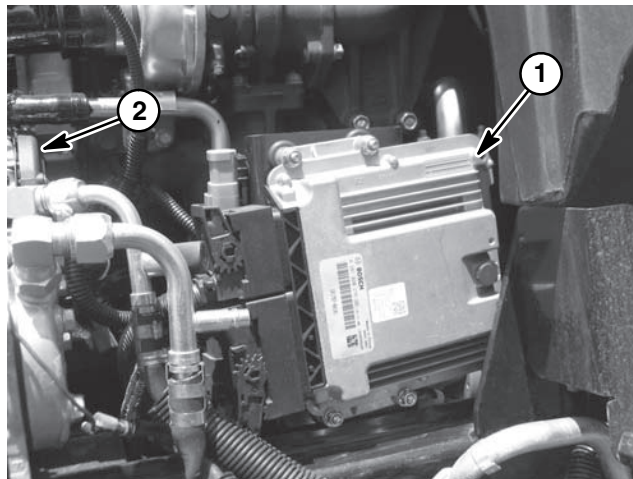
Yanmar Engine Electronic Control Unit (ECU)



g275700

Figure 157

1. Electronic control unit (model 30603 / 30605 / 30635) 2. Alternator
-



g275701

Figure 158

1. Electronic control unit (model 30607 / 30609 / 30636) 2. Alternator
-

The Yanmar engine that powers the Groundsmaster 4000-D and 4010-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 ignition 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 ignition 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 4000–D and 4010–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.

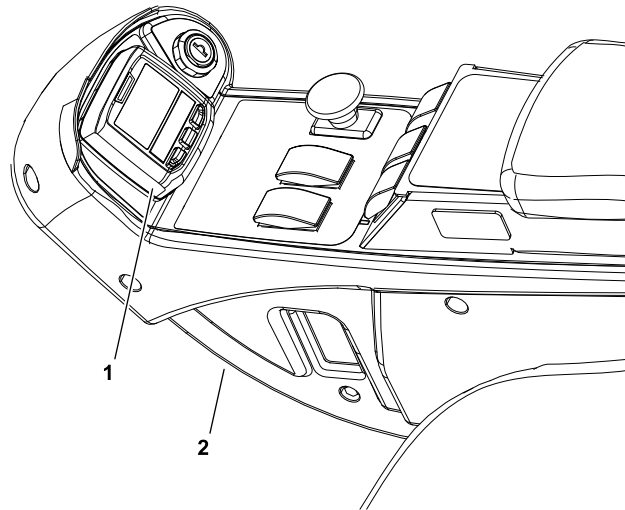
CAN identifies the Controller Area Network that is used between the controllers on the Groundsmaster. Two (2) specially designed, twisted wires form the bus. These wires provide the data pathways between the controllers (the TEC controllers and the Yanmar electronic control unit) and the InfoCenter Display 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 ignition switch ON input for both the TEC and engine ECU to be activated.

Electrical Drawings

The electrical schematics and wire harness drawings for Groundsmaster 4000–D and 4010–D machines are located in [Appendix A \(page A–1\)](#).

InfoCenter Display



g280073

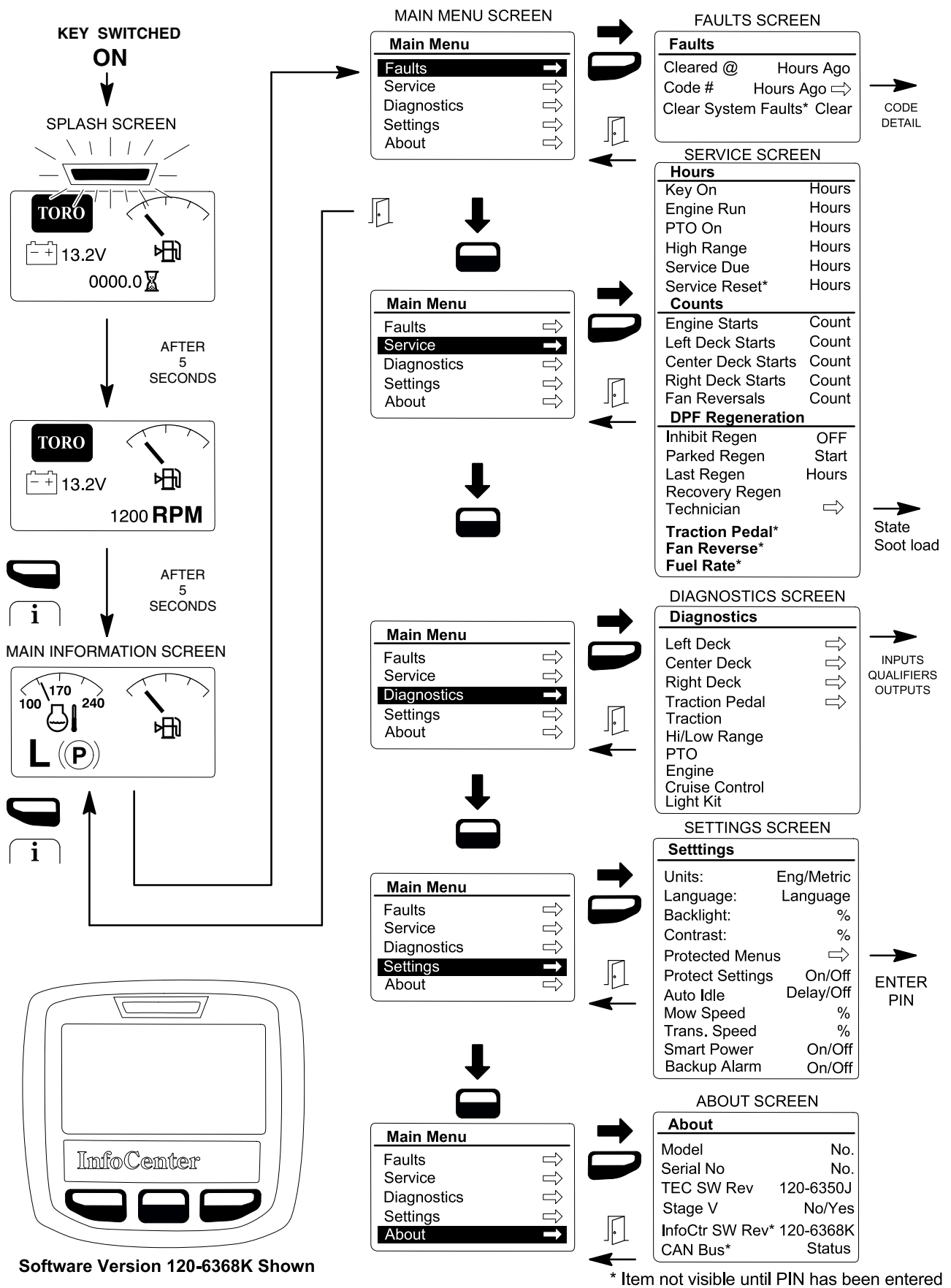
Figure 159

- | | |
|-----------------------|----------------|
| 1. InfoCenter display | 2. Control arm |
|-----------------------|----------------|

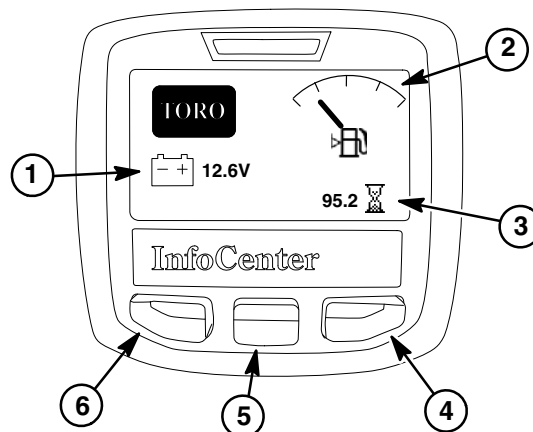
The InfoCenter Display used on your Groundsmaster is a LCD device that is located on the console. The InfoCenter provides information for the machine operator during machine operation, provides electrical system diagnostic assistance for technicians and allows inputs for adjustable machine settings.

Power for the InfoCenter is available when energized by the main power relay (ignition 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.



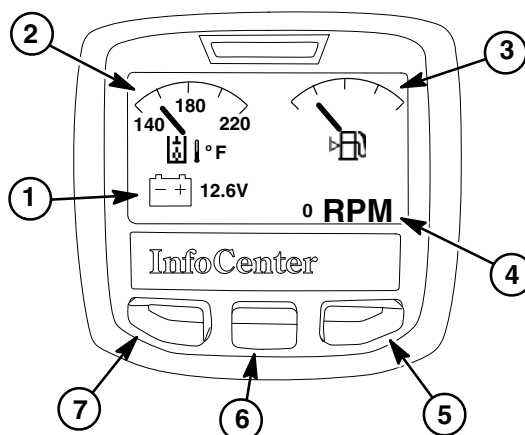
Splash Screen



g275702

Figure 161

- | | |
|--------------------|---------------------|
| 1. Battery voltage | 4. Right button |
| 2. Fuel gauge | 5. Down button |
| 3. Hour meter | 6. Menu/back button |



g275703

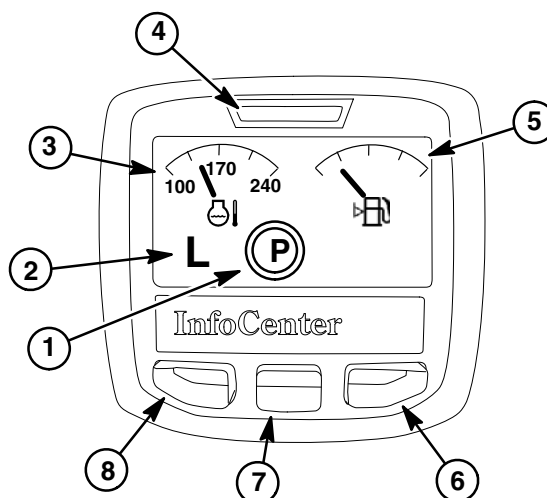
Figure 162

- | | |
|------------------------------|---------------------|
| 1. Battery voltage | 5. Right button |
| 2. Hydraulic oil temperature | 6. Down button |
| 3. Fuel gauge | 7. Menu/back button |
| 4. Engine RPM | |

The two (2) InfoCenter splash screens (Figure 161 and Figure 162) are displayed when the ignition 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, hourmeter reading, hydraulic oil temperature and engine status.

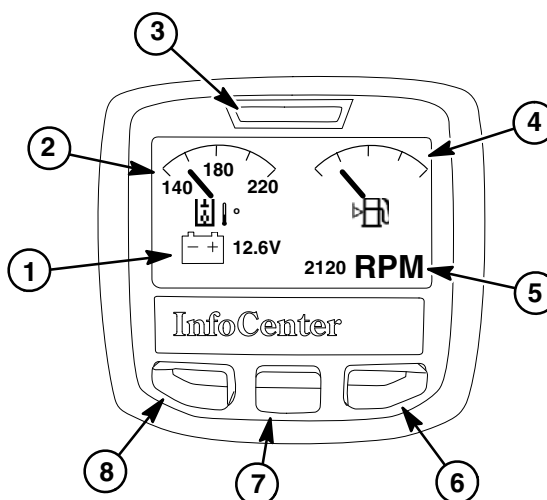
Main Information Screen



g275691

Figure 163

- | | |
|--------------------------|---------------------|
| 1. Parking brake applied | 5. Fuel gauge |
| 2. Traction speed | 6. Right button |
| 3. Coolant temperature | 7. Down button |
| 4. Fault indicator | 8. Menu/back button |



g275692

Figure 164

- | | |
|------------------------------|---------------------|
| 1. Battery voltage | 5. Engine RPM |
| 2. Hydraulic oil temperature | 6. Right button |
| 3. Fault indicator | 7. Down button |
| 4. Fuel gauge | 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

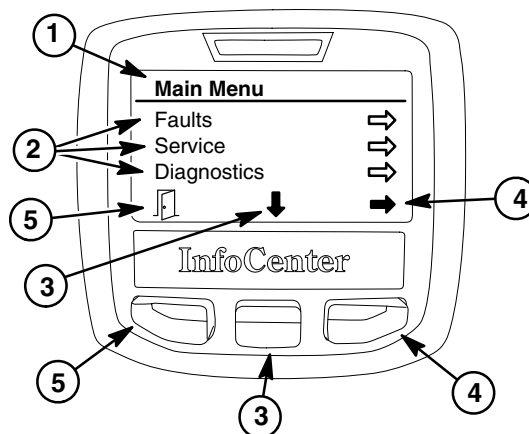


Figure 165

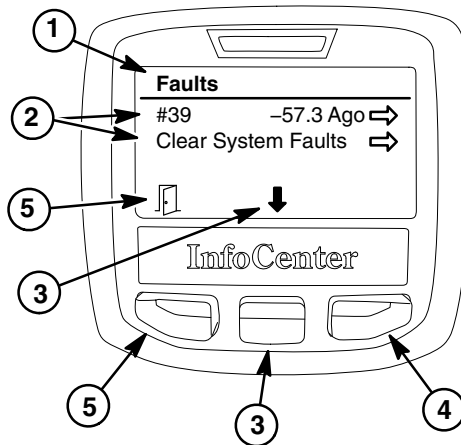
- | | |
|-----------------------|---------------------|
| 1. Main menu | 4. Choose menu item |
| 2. Menu items | 5. Back button |
| 3. Move to menu items | |

The main menu screen can be accessed from the InfoCenter 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 | 4. Choose menu item |
| 2. Fault items | 5. Back button |
| 3. Move to menu items | |

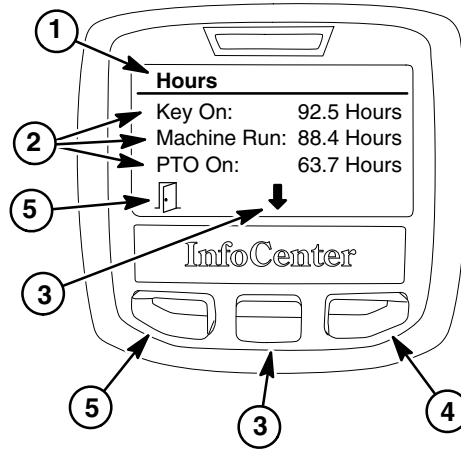
The faults screen ([Figure 166](#)) will list all machine electrical faults that have occurred since the faults were last cleared from the InfoCenter. The faults will be identified by a fault number and when the fault occurred. Faults that might occur on the machine are listed in Fault Codes in the Troubleshooting 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 ignition 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 | 4. Choose menu item |
| 2. Service items | 5. Back button |
| 3. Move to menu items | |

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 ignition 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)

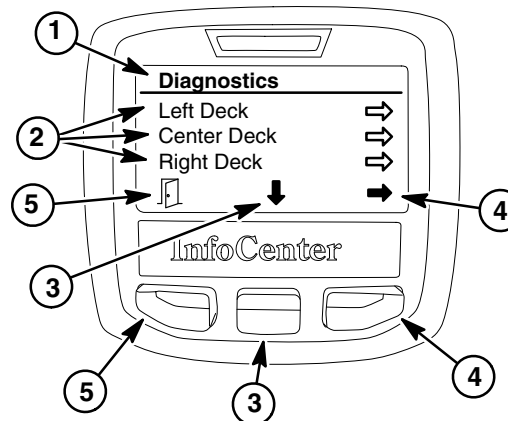
- **Fan – Oil** identifies the number of times that hydraulic oil temperature caused the engine cooling fan speed to change.
- **Inlet** identifies the temperature of the inlet air into the engine intake system.

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 30607, 30609 and 30636). 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 \(page 6–22\)](#)).
- **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



g275696

Figure 168

- | | |
|-----------------------|---------------------|
| 1. Diagnostics menu | 4. Choose menu item |
| 2. Diagnostics items | 5. Back button |
| 3. Move to menu items | |

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:

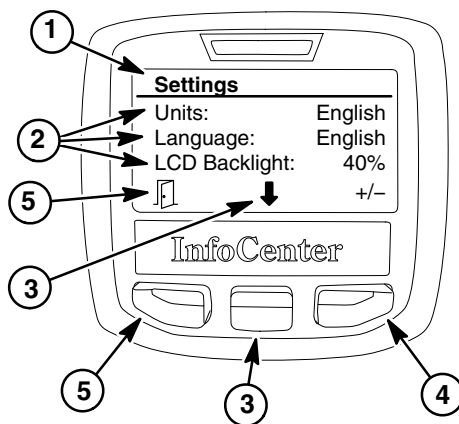
- **Left Deck** identifies machine requirements to allow the left deck to raise and lower. Inputs indicate the state of the left deck lift/lower switch and whether the machine is in LOW range speed. Qualifiers include the LOW range speed, seat switch and parking brake position. Identified outputs consist 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 ignition 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).

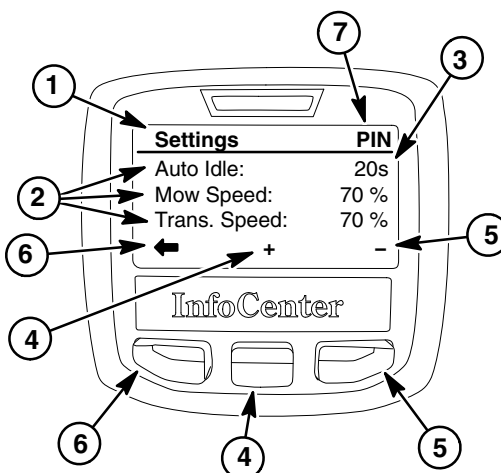
Settings Screen



g275697

Figure 169

- | | |
|-----------------------|---------------------|
| 1. Settings menu | 4. Change menu item |
| 2. Settings items | 5. Back button |
| 3. Move to menu items | |



g275698

Figure 170

- | | |
|---------------------|---------------------|
| 1. Settings menu | 5. Decrease setting |
| 2. Settings items | 6. Back button |
| 3. Current setting | 7. PIN activated |
| 4. Increase setting | |

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 traction pedal sensor calibration, cooling fan reversal demonstration, Smart Power™ ON/OFF and exhaust system DPF regeneration (Tier4 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 ignition 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

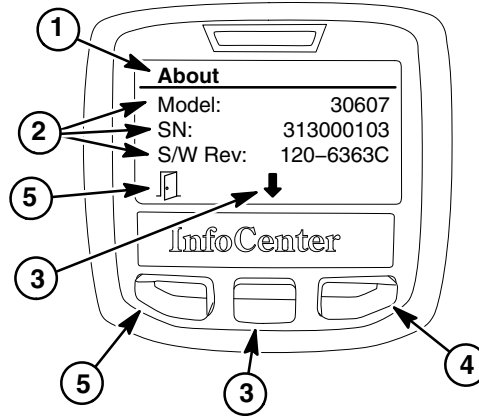


Figure 171

- | | |
|-----------------------|---------------------|
| 1. About menu | 4. Choose menu item |
| 2. About items | 5. Back button |
| 3. Move to menu items | |

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

Cutting Deck Position Switch Adjustment

Adjustment

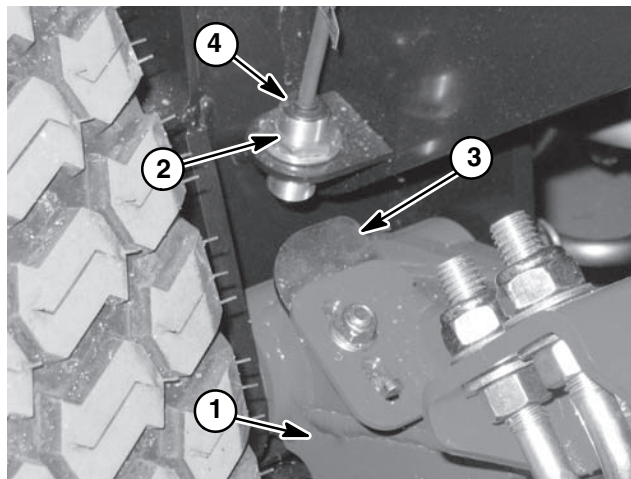


Figure 172

- | | |
|--------------------|------------------|
| 1. Front lift arm | 3. Sensing plate |
| 2. Position switch | 4. Switch LED |

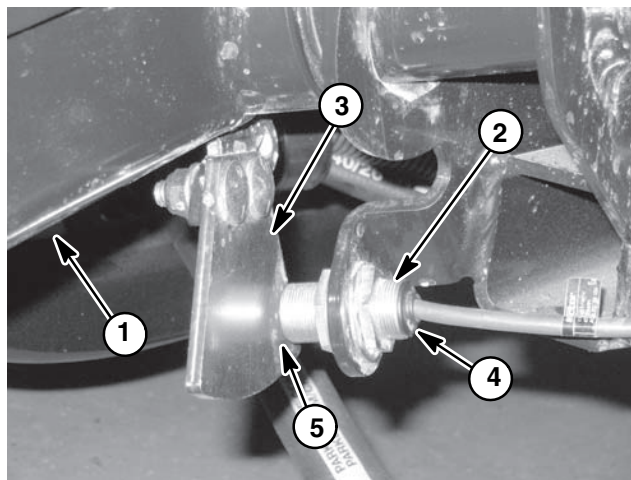
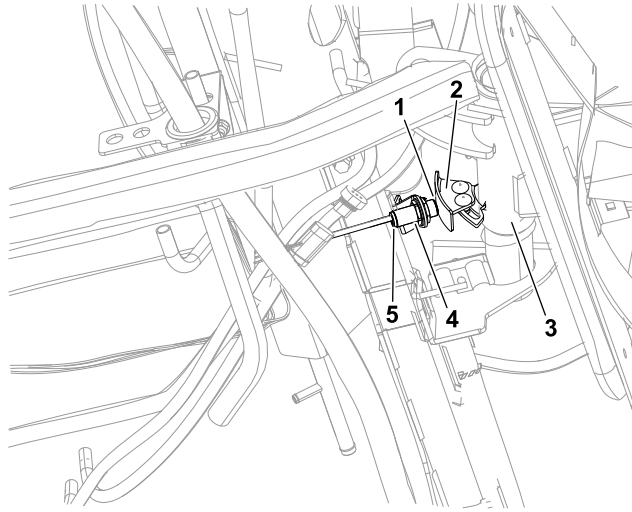


Figure 173

(For machines serial number below 400000000)

- | | |
|-----------------------------|---------------|
| 1. Side lift arm (RH shown) | 4. Switch LED |
| 2. Position switch | 5. Clearance |
| 3. Sensing plate | |

Adjustment (continued)



g278112

Figure 174

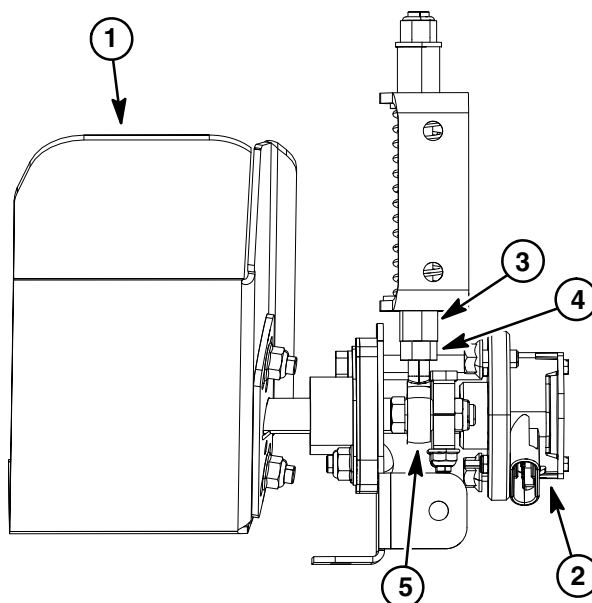
(For machines serial number above 400000000)

- | | |
|-----------------------------|--------------------|
| 1. Clearance | 4. Position switch |
| 2. Sensing plate | 5. Switch LED |
| 3. Side lift arm (LH shown) | |

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 ignition switch.
2. There should be from **1.8 to 3.3 mm (0.070 to 0.130 in)** clearance between the target surface end of position switch and the sensing plate on lift arm.
3. If necessary, loosen jam nuts on switch and adjust switch location to allow proper clearance between switch and sensing plate.
4. After adjustment, torque jam nuts from **18.7 to 22.0 N·m (165 to 195 in-lb)**. Check that proper clearance between switch and sensing plate still exists after tightening jam nuts.

Note: The cutting deck position switches include a LED on the cable end of the switch body. The switch LED should be illuminated when the cutting decks are fully lowered.

Traction Pedal Adjustment



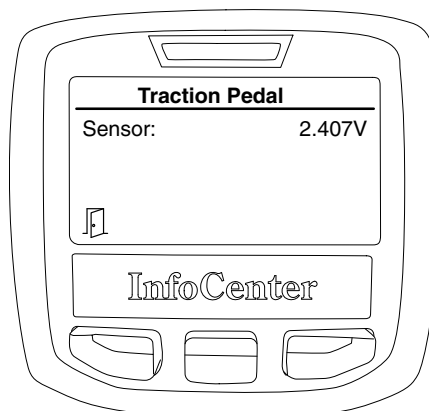
g275984

Figure 175

- | | |
|--------------------------|--------------------|
| 1. Traction pedal | 4. Hex nut |
| 2. Pedal position sensor | 5. Rod end bearing |
| 3. Spring shaft | |

The traction pedal includes a neutral assembly that is used to adjust the traction neutral position ([Figure 175](#)). 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 ignition switch to RUN but do not start engine.



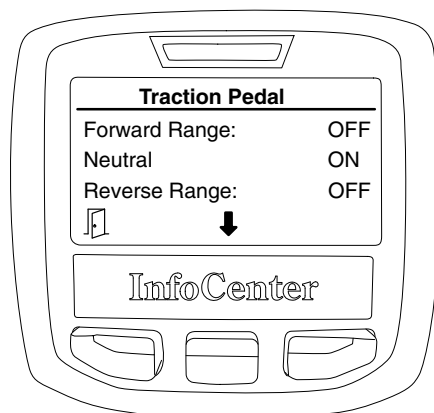
g275985

Figure 176

3. Use the InfoCenter Display Diagnostics menu (see [InfoCenter Display \(page 6–6\)](#)) to obtain and select the Traction Pedal menu item. Choose Inputs and the InfoCenter display should identify sensor voltage ([Figure 176](#)).
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 175](#)).
 - A. Remove steering cover to access traction pedal components (see [Steering Tower \(For machines serial number below: 400000000\) \(page 8–3\)](#)).
 - 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 \(For machines serial number below: 400000000\) \(page 8–3\)](#)).



g275986

Figure 177

- 6. After any adjustment of the spring shaft and rod end bearing, use the InfoCenter Display Diagnostics menu (see [InfoCenter Display \(page 6–6\)](#)) to obtain and select the Traction Pedal menu item. Choose Outputs and the InfoCenter display will identify the traction pedal position ([Figure 177](#)).
 - 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 \(page 6–22\)](#)).

Traction Pedal Position Sensor Calibration

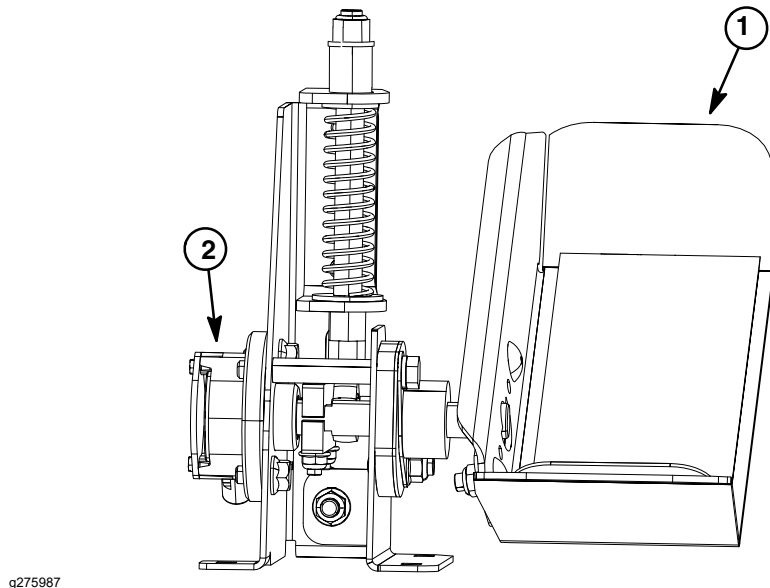


Figure 178

1. Traction pedal
2. Pedal position sensor

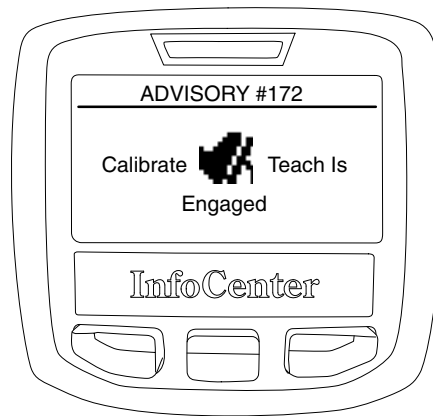
IMPORTANT

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 ignition switch to RUN but do not start engine.
3. Use the InfoCenter Display Settings menu (see [InfoCenter Display \(page 6–6\)](#)) 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 179

4. Use the InfoCenter Display Service menu (see [InfoCenter Display \(page 6–6\)](#)) to obtain and select the Traction Pedal menu item. The InfoCenter display should indicate that the traction pedal calibration process is engaged ([Figure 179](#)).
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.



g275989

Figure 180

- F. Check that InfoCenter display indicates a successful calibration process ([Figure 180](#)).
6. Turn ignition 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 60° to 100° F (16° to 38° C). The ignition 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 ignition 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.

Ignition Switch

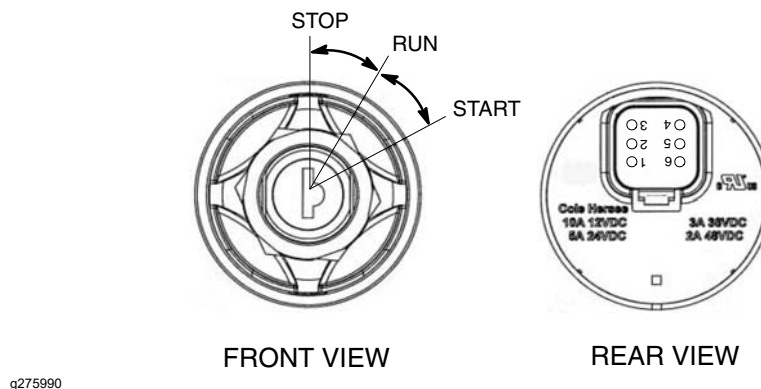


Figure 181

The ignition (key) switch is located on the control panel and has three (3) positions: STOP, RUN and START (Figure 181). The Toro Electronic Controller (TEC) monitors the operation of the ignition switch.

Testing

1. Park machine on a level surface, lower cutting decks, engage parking brake and stop engine. Remove key from ignition switch.
2. Before disconnecting the ignition 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 6–6)). If input testing verifies that the ignition switch and circuit wiring are functioning correctly, no further ignition switch testing is necessary. If, however, input testing determines that the ignition switch and circuit wiring are not functioning correctly, proceed with the following ignition switch testing procedure.
3. Remove control arm covers to gain access to ignition switch (see Control Arm (page 8–22)).
4. Make sure ignition switch is in the OFF position. Disconnect wire harness connector from ignition switch.
5. The ignition switch terminals are identified in Figure 181 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: Ignition 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 ignition switch if testing determines that it is faulty.
7. If the ignition 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 ignition switch. Secure control arm covers to machine with removed fasteners (see Control Arm (page 8–22)).

Fuses

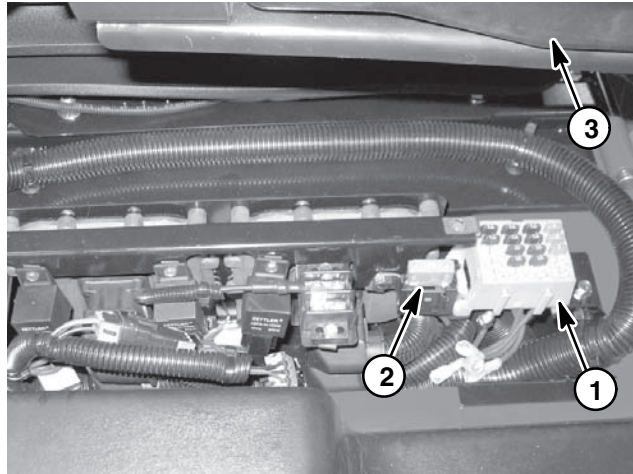


Figure 182

1. Fuse block
2. 60 Amp fuse
3. Operator seat

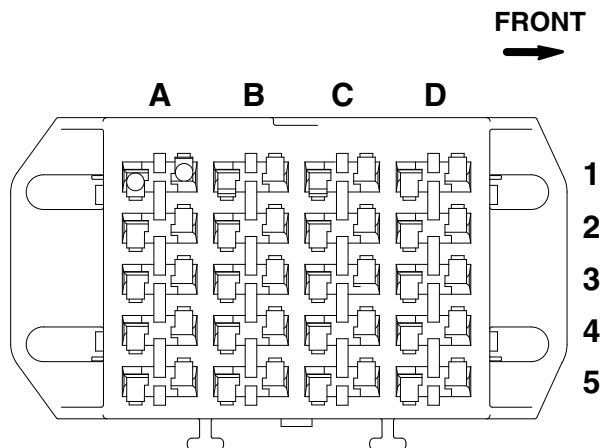


Figure 183

The fuse block is located under the controller cover next to the operator seat (Figure 182).

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 182).

Fuse Identification and Function

Use Figure 183 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 30603, 30605 and 30635).

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 ignition 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.

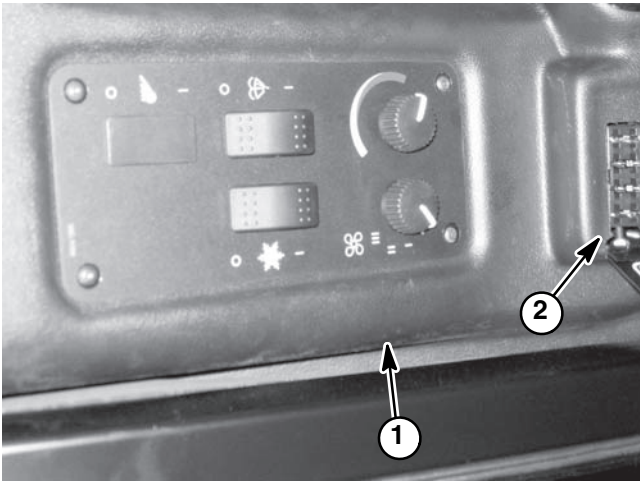
1. Ensure that the key switch is in OFF position and the key is removed from the key switch.
2. Remove the fuse(s) from the fuse holder for testing. The fuse should have continuity between the fuse terminals.

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.

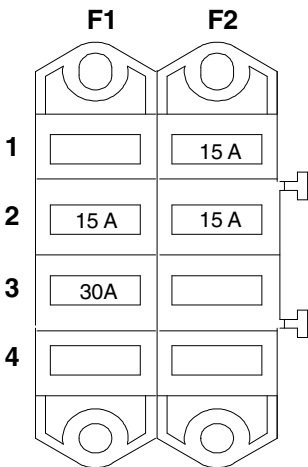
Operator Cab Fuses (Groundsmaster 4010-D)



g275993

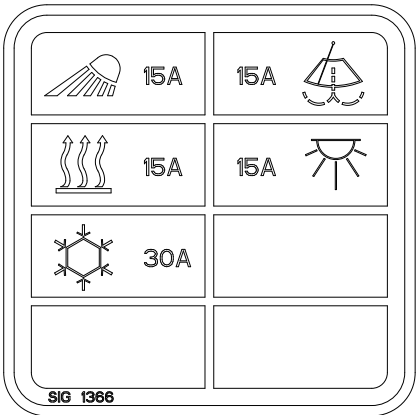
Figure 184

1. Cab headliner
2. Cab fuse blocks



g275994

Figure 185



g275995

Figure 186

The operator cab fuse blocks are located in the cab headliner ([Figure 184](#)).

Identification and Function ([Figure 184](#) and [Figure 185](#)) for models 30603 and 30607

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).

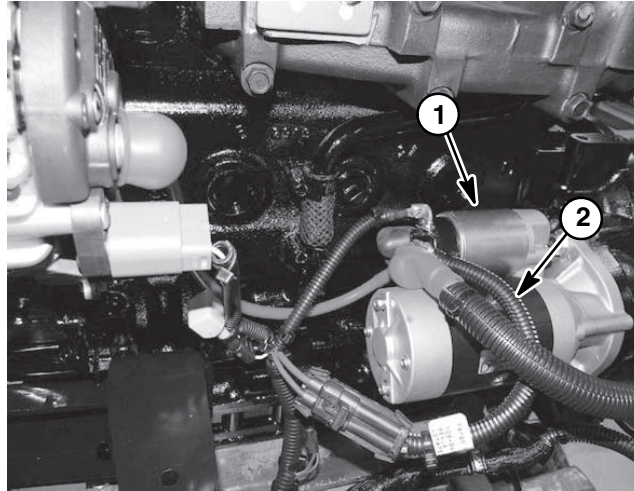
Fuses F1-4 and F2-4 are available for optional equipment.

Testing

Turn ignition 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 ignition 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

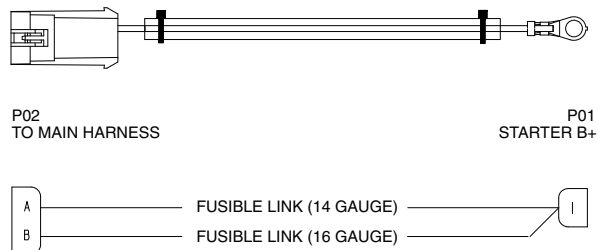


g275996

Figure 187

1. Starter motor

2. Fusible link harness



g275997

Figure 188

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 187](#)). 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.

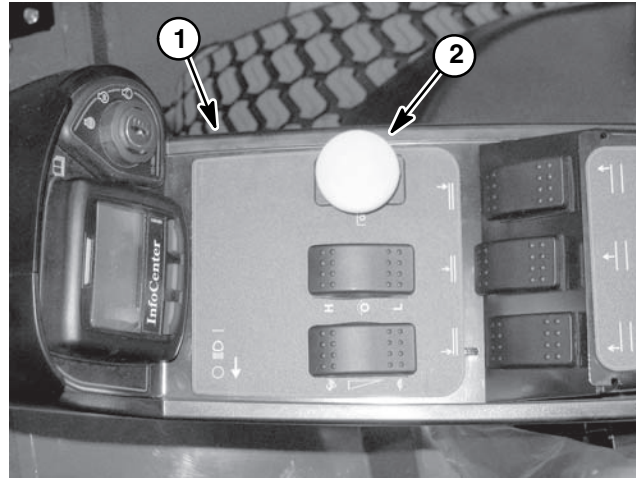
Testing

Make sure that ignition 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



g275998

Figure 189

1. Control arm
2. PTO switch

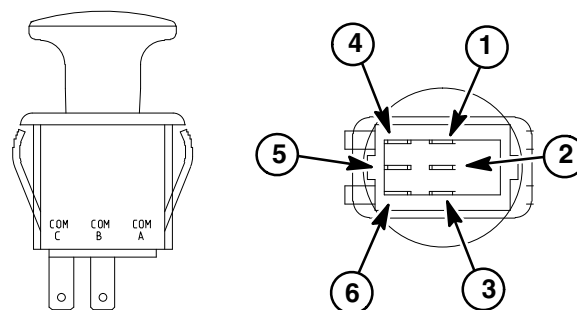
The PTO switch is located on the control arm ([Figure 189](#)). The PTO switch is pulled up to engage the PTO and pushed in to disengage the PTO.

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 \(page 6–6\)](#)). 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 ignition switch is OFF. Remove key from ignition switch.
3. Disassemble control arm to gain access to PTO switch (see [Control Arm \(page 8–22\)](#)).
4. Disconnect harness electrical connector from the PTO switch.



g275999

Figure 190

1. COM B terminal
2. NO B terminal
3. NC B terminal
4. COM C terminal
5. NO C terminal
6. NC C terminal

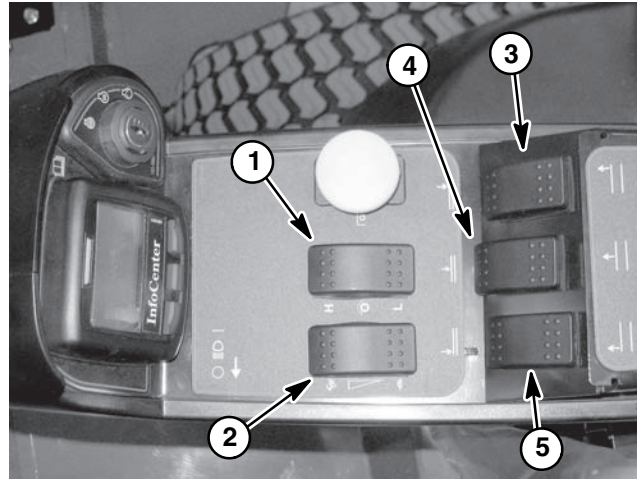
Testing (continued)

5. The switch terminals are marked as shown in [Figure 190](#). 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 B + NO B
	COM C + NC C	COM C + NO C
ON (UP)	COM B + NO B	COM B + NC B
	COM C + NO C	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 \(page 8-22\)](#)).

HI/LOW Speed, Engine Speed and Cutting Deck Lift Switches



g276000

Figure 191

- | | |
|------------------------|----------------------------|
| 1. HI/LOW speed switch | 4. Center deck lift switch |
| 2. Engine speed switch | 5. LH deck lift switch |
| 3. RH 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 191](#)).

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.

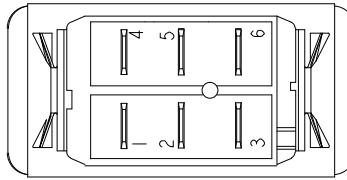
The cutting deck lift switches are used as inputs for the TEC controller to raise or lower the cutting decks. When the front of a lift switch is depressed, the controlled decks will lower. When the rear of a lift switch is depressed and held, the controlled decks will raise.

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 \(page 6–6\)](#)). 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 ignition switch is OFF. Remove key from ignition switch.
3. Disassemble control arm to gain access to switch that is to be tested (see [Control Arm \(page 8–22\)](#)).
4. Disconnect harness electrical connector from the switch that is to be tested.

Testing (continued)



BACK OF SWITCH

g276001

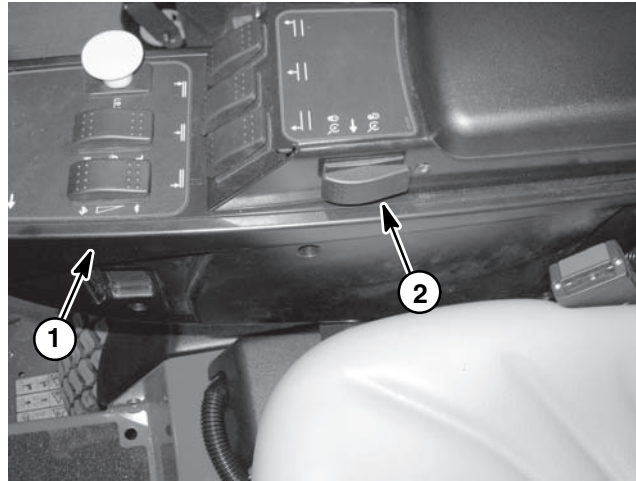
Figure 192

5. The switch terminals are marked as shown in [Figure 192](#). 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	2 + 1
	5 + 6	5 + 4
NEUTRAL	NONE	ALL
REAR OF SWITCH PRESSED	2 + 1	2 + 3
	5 + 4	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 \(page 8-22\)](#)).

Cruise Control Switch



g276002

Figure 193

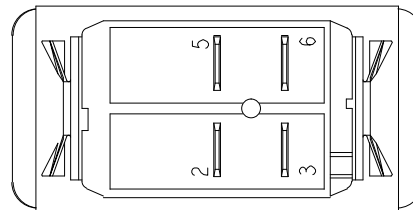
1. Control arm
2. Cruise control switch

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 193](#)). 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 \(page 6–6\)](#)). 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 ignition switch is OFF. Remove key from ignition switch.
3. Disassemble control arm to gain access to the cruise control switch (see [Control Arm \(page 8–22\)](#)).
4. Disconnect harness electrical connector from the switch.



BACK OF SWITCH

Figure 194

g276003

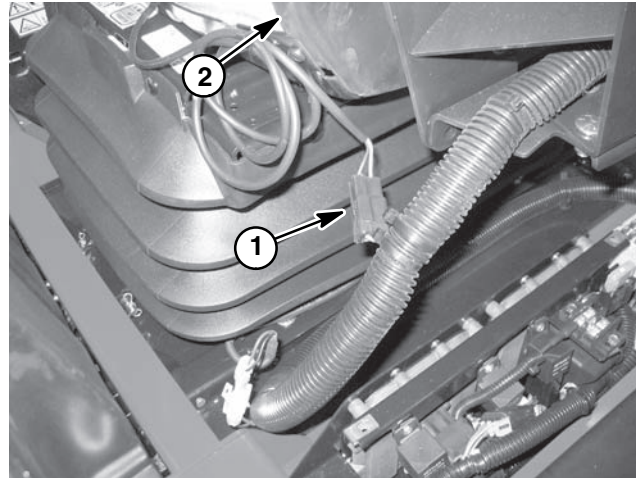
Testing (continued)

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 194](#). 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 \(page 8-22\)](#)).

Seat Switch



g276004

Figure 195

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 195](#)).

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 \(page 6–6\)](#)). 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 ignition switch is OFF. Remove key from ignition 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 \(page 8–36\)](#)).
8. Connect seat switch connector to wire harness connector after testing is complete.

Parking Brake Switch

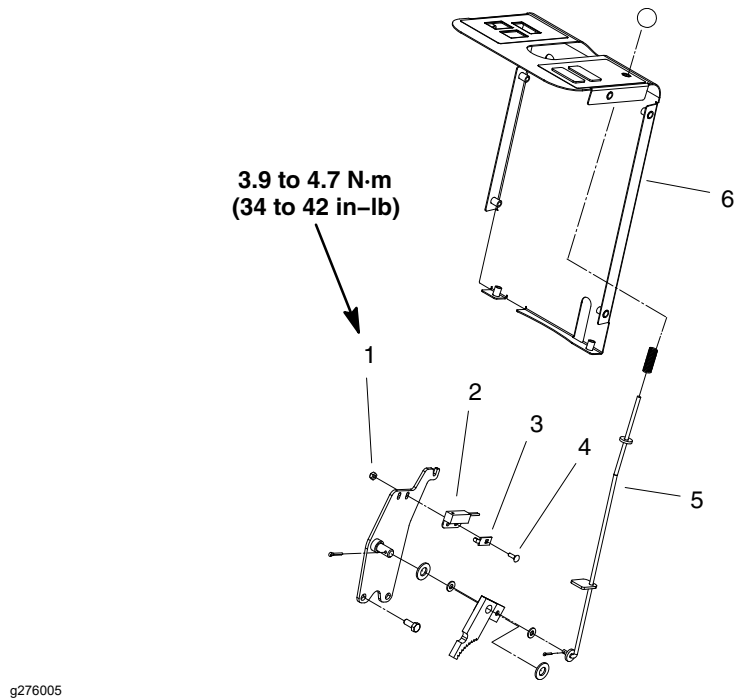


Figure 196

- | | |
|-------------------------|-------------------------|
| 1. Lock nut | 4. Carriage bolt |
| 2. Parking brake switch | 5. Parking brake rod |
| 3. Switch plate | 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 196](#)). 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 \(page 6–6\)](#)). 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 ignition switch is OFF. Remove key from ignition 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

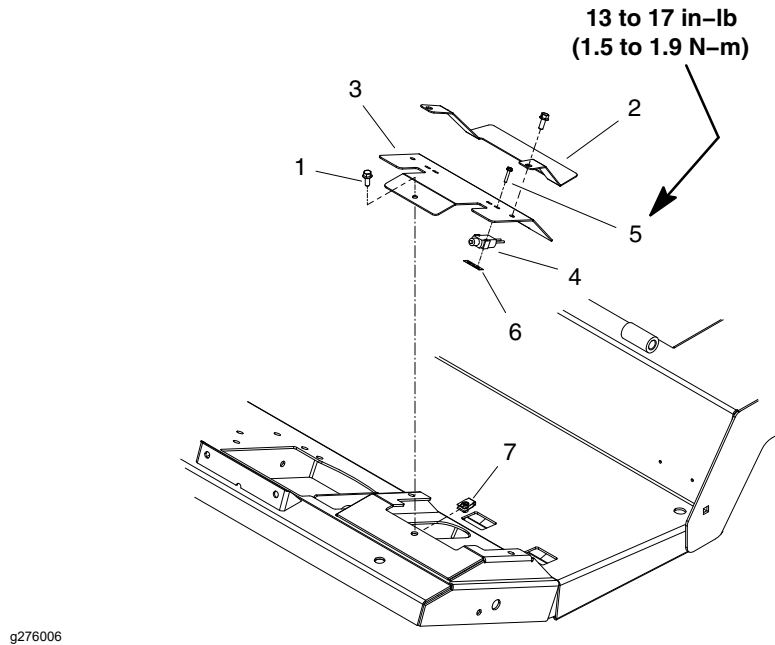


Figure 197

- | | |
|--------------------------|-------------------------|
| 1. Flange screw (3 used) | 5. Screw (2 per switch) |
| 2. Cover | 6. Switch nut (2 used) |
| 3. Switch bracket | 7. Clip (3 used) |
| 4. Brake switch (2 used) | |

The two (2) switches used for the service brakes are normally open switches that are located under the footrest panel ([Figure 197](#)). 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.

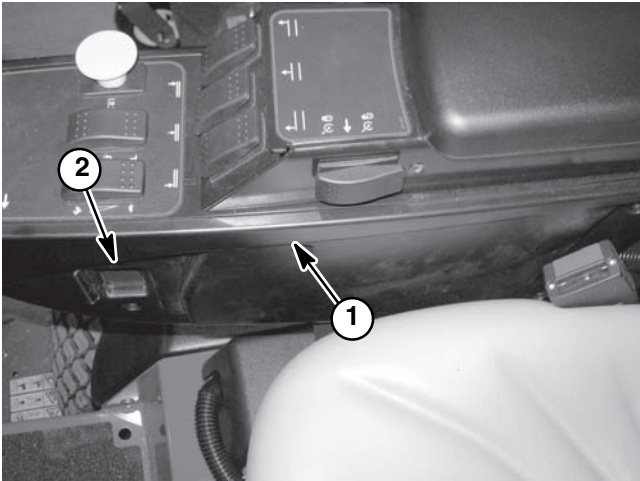
Testing

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 \(page 6–6\)](#)). 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 ignition switch is OFF. Remove key from ignition switch.
3. Remove brake cover and switch plate on operator platform to access service brake switches ([Figure 197](#)).
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 4010-D)



g276007

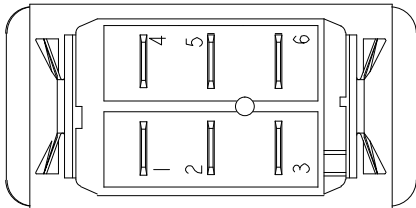
Figure 198

1. Control arm
2. Headlight switch

The Groundsmaster 4010-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 ignition switch is OFF. Remove key from ignition switch.
2. Disassemble control arm to gain access to headlight switch (see [Control Arm \(page 8–22\)](#)).
3. Disconnect harness electrical connector from the headlight switch.



g276008

BACK OF SWITCH

Figure 199

Note: Switch terminals 1, 4, 5 and 6 are not used on Groundsmaster 4010-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 199](#). The circuitry of the switch is shown in the chart below. Verify continuity between switch terminals. Replace switch if testing identifies a faulty switch.

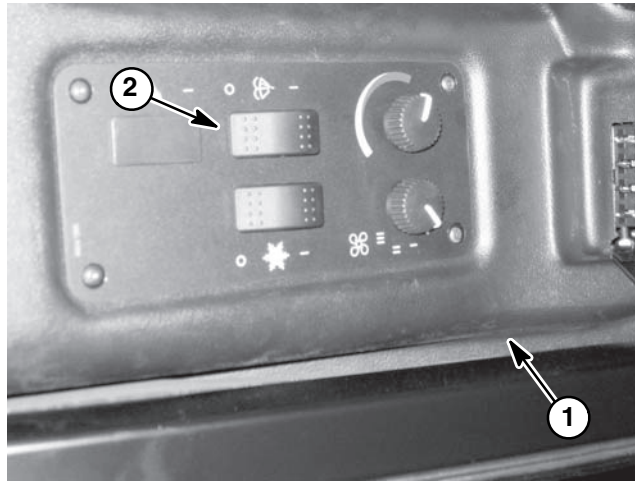
SWITCH POSITION	CIRCUIT 1	CIRCUIT 2
ON	2 + 3	5 + 6
OFF	2 + 1	5 + 4

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 \(page 8–22\)](#)).

Windshield Wiper/Washer Switch (Groundsmaster 4010-D)



g276009

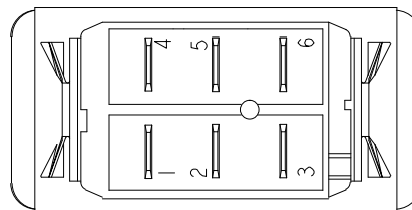
Figure 200

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 4010-D. The windshield wiper/washer switch is located in the cab headliner ([Figure 200](#)).

Testing

1. Make sure ignition switch is OFF. Remove key from ignition 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 201

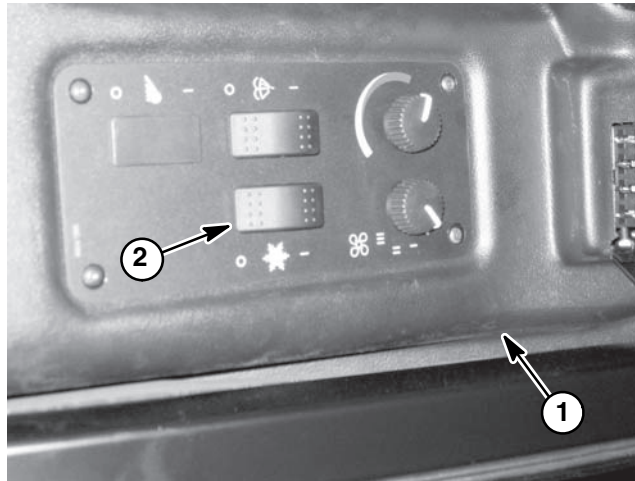
4. The switch terminals are marked as shown in [Figure 201](#). The circuit logic of the wiper/washer switch is shown in the chart below. With the use of a multimeter (ohms setting), the switch functions may be tested to determine whether continuity exists between the various terminals for each position. 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 4010-D)



g276011

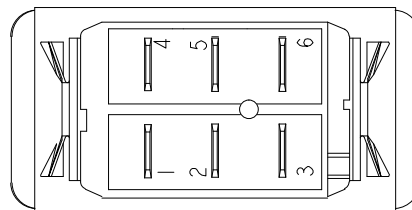
Figure 202

1. Cab headliner
2. Air conditioning switch

The air conditioning switch is used to control operation of the air conditioning system on the Groundsmaster 4010-D. The switch is located in the cab headliner ([Figure 202](#)).

Testing

1. Make sure ignition switch is OFF. Remove key from ignition switch.
2. Remove switch plate from cab headliner.
3. Locate air conditioning switch and unplug wire harness connector from switch.



g276012

BACK OF SWITCH

Figure 203

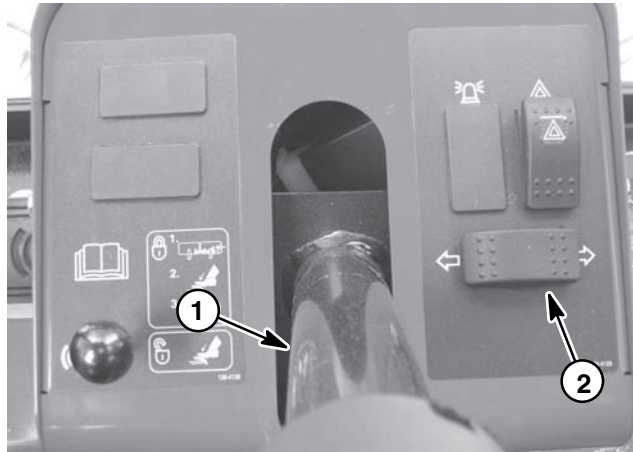
4. The switch terminals are marked as shown in [Figure 203](#). The circuit logic of the air conditioning switch is shown in the chart below. With the use of a multimeter (ohms setting), the switch functions may be tested to determine whether continuity exists between the various terminals for each position. Verify continuity between switch terminals. Replace switch if testing identifies a faulty switch.

SWITCH POSITION	CLOSED CIRCUITS	OPEN CIRCUITS
AC OFF	2 + 1	2 + 3
	5 + 4	5 + 6
AC ON	2 + 3	2 + 1
	5 + 6	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 4010-D)



g276013

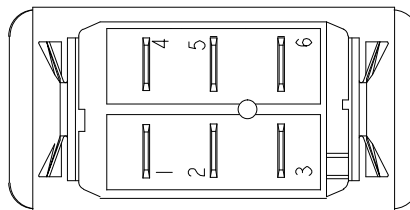
Figure 204

1. Steering column
2. Turn signal switch

On Groundsmaster 4010-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 204](#)).

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 \(page 6-6\)](#)). 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 ignition switch is OFF. Remove key from ignition 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 205

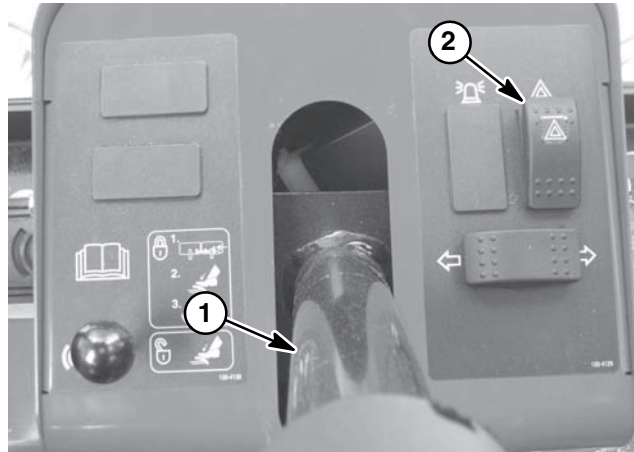
5. The switch terminals are marked as shown in [Figure 205](#). The circuit logic of the turn signal switch is shown in the chart below. With the use of a multimeter (ohms setting), the switch functions may be tested to determine whether continuity exists between the various terminals for each position. 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	2 + 1
	5 + 6	5 + 4
NEUTRAL	NONE	ALL
LEFT TURN	2 + 1	2 + 3
	5 + 4	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 4010-D)



g276015

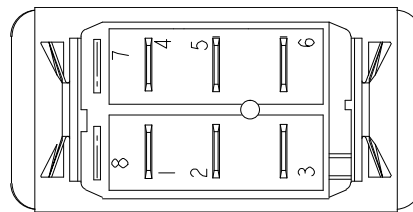
Figure 206

1. Steering column
2. Flasher switch

On Groundsmaster 4010-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 206).

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 \(page 6-6\)](#)). 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 ignition switch is OFF. Remove key from ignition 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 207

5. The switch terminals are marked as shown in Figure 207. 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	2 + 1
	5 + 6	5 + 4
OFF	2 + 1	2 + 3
	5 + 4	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

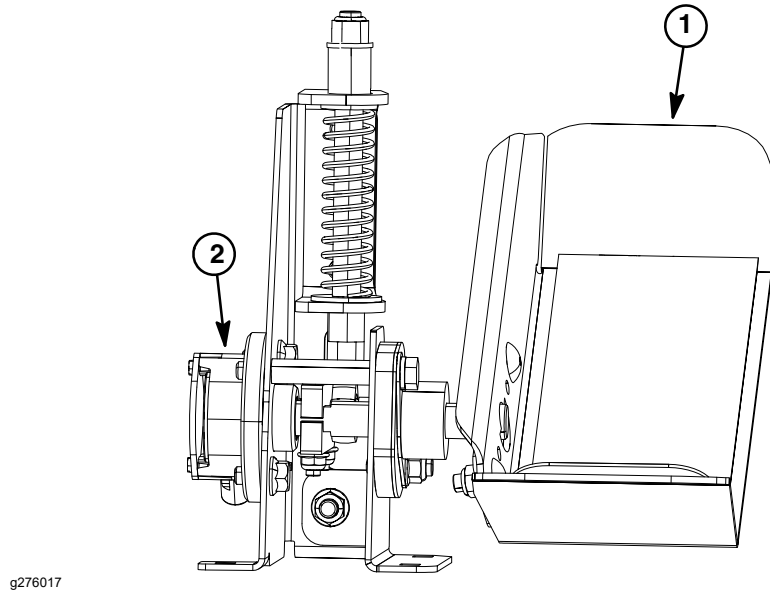


Figure 208

1. Traction pedal
2. Pedal position sensor

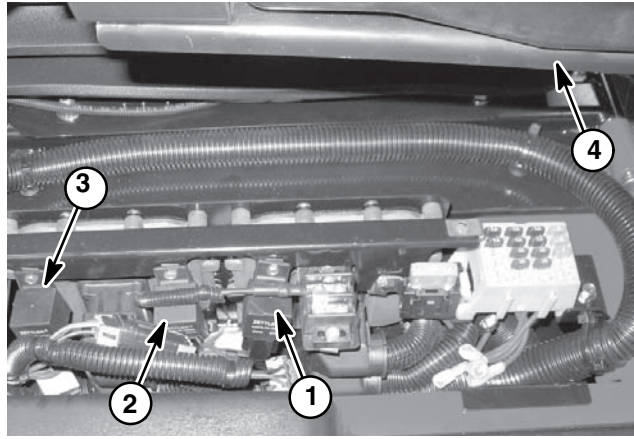
The traction pedal position sensor is connected to the traction pedal assembly ([Figure 208](#)). This position sensor determines the neutral band for the traction pedal, the direction of travel desired by the operator and the traction speed. The position sensor is a single analog, dual digital signal 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 (deadband) 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 \(page 6–6\)](#)). 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 \(page 8–24\)](#).

Relays with Four (4) Terminals



g276018

Figure 209

- | | |
|---------------------|--------------------|
| 1. Main power relay | 3. Cab power relay |
| 2. TEC 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 ignition switch is in the RUN or START position.

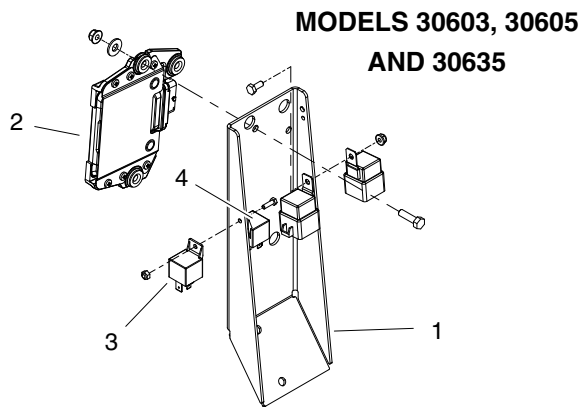
The TEC power relay is used to provide current to the fuse protected circuits for the TEC controller. The TEC power relay is energized when the ignition switch is in the RUN or START position.

The cab power relay is used on Groundsmaster 4010-D machines to provide current to the operator cab electrical components. The cab power relay is energized when the ignition 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 30603, 30605 and 30635 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.

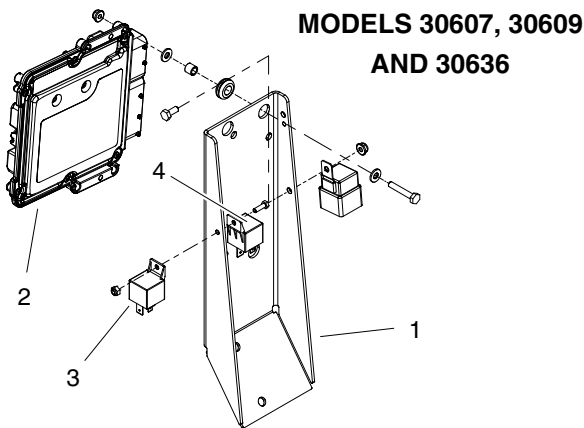
The glow relay is used on models 30607, 30609 and 30636 to provide current to the engine glow plugs when energized by the engine ECU.



g276019

Figure 210

- | | |
|---------------------|---------------------|
| 1. Controller mount | 3. Start relay |
| 2. Engine ECU | 4. Air heater relay |



g276020

Figure 211

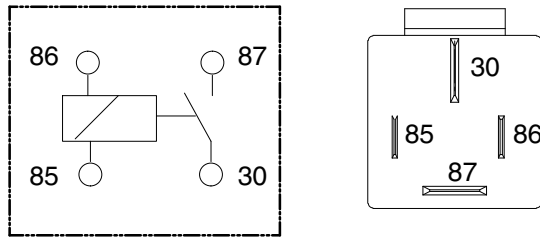
- | | |
|---------------------|----------------|
| 1. Controller mount | 3. Start relay |
| 2. Engine ECU | 4. Glow relay |

The main power, TEC power and cab power relays are located under the controller cover next to the operator seat ([Figure 209](#)). The start, air heater and glow relays are attached to the controller mount on the right side of the engine ([Figure 210](#) or [Figure 211](#)).

Testing

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

Testing (continued)



g276021

Figure 212

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 \(page 6–91\)](#)).

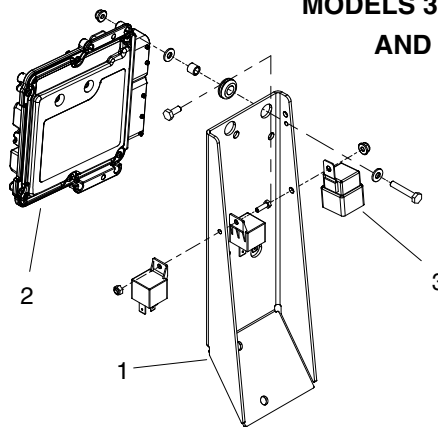
Relays with Five (5) Terminals

g276022

Figure 213

- | | |
|---------------------|------------------------|
| 1. Controller mount | 3. Main relay |
| 2. Engine ECU | 4. Rack actuator relay |

**MODELS 30607, 30609
AND 30636**



g276023

Figure 214

- | | |
|---------------------|--------------|
| 1. Controller mount | 3. EGR relay |
| 2. Engine ECU | |

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 4010-D. When energized by the air conditioning switch, the relay provides current for the air conditioning components.

The main relay is used on models 30603, 30605 and 30635 to provide current for several engine components when energized by the engine ECU.

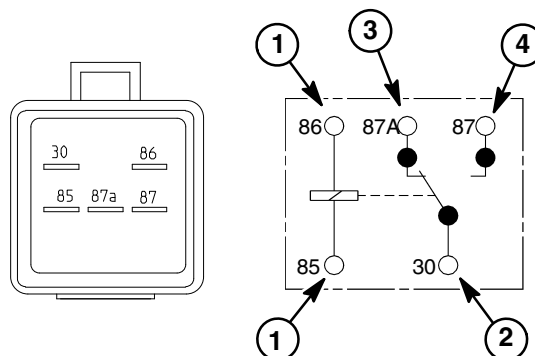
The rack actuator relay is used on models 30603, 30605 and 30635 to provide current for the engine rack actuator when energized by the engine ECU.

The EGR relay is used on models 30607, 30609 and 30636 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 213](#) or [Figure 214](#)).

Testing

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



g276024

Figure 215

1. Coil terminal
 2. Common terminal
 3. Normally closed term.
 4. Normally open term.
-
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)

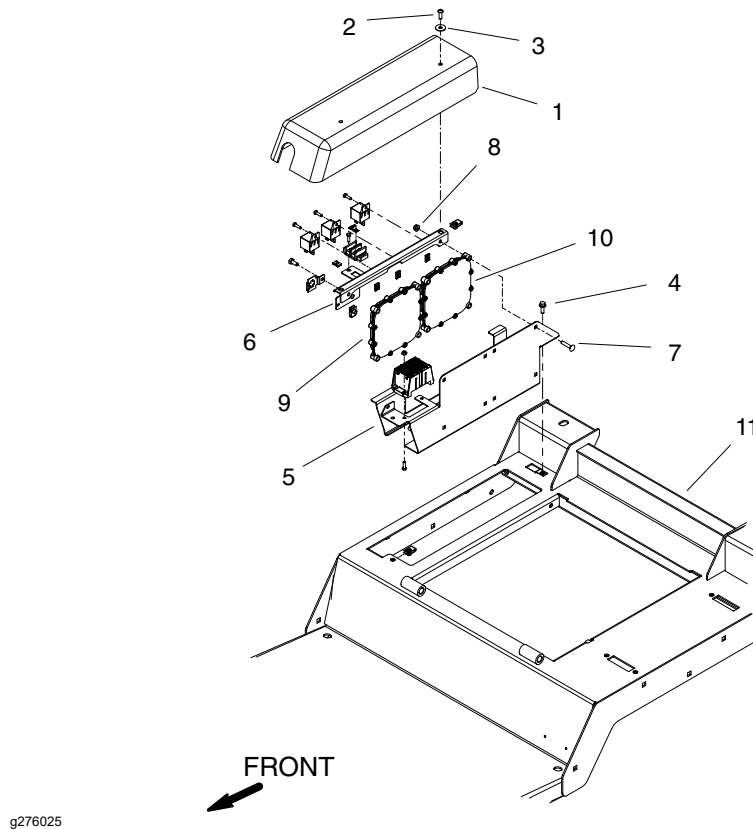


Figure 216

- | | |
|--------------------------|----------------------------|
| 1. Controller cover | 7. Carriage screw (8 used) |
| 2. Screw (2 used) | 8. Flange nut (8 used) |
| 3. Flat washer (2 used) | 9. Front TEC controller |
| 4. Flange screw (2 used) | 10. Rear TEC controller |
| 5. Power mount | 11. Operator platform |
| 6. Relay mount | |

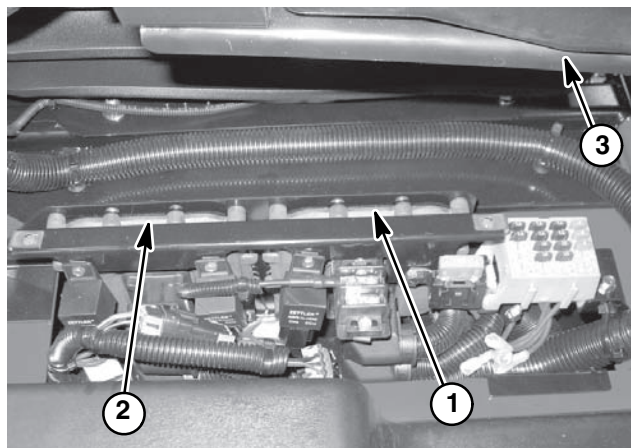


Figure 217

- | | |
|-------------------------|------------------|
| 1. Front TEC controller | 3. Operator seat |
| 2. Rear TEC controller | |

Groundsmaster 4000-D and 4010-D machines use two (2) Toro Electronic Controllers (TEC) to control electrical system operation. The controllers are

Toro Electronic Controllers (TEC) (continued)

attached to the operator platform under the controller cover ([Figure 216](#) and [Figure 217](#)).

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 monitors the states of the following components as inputs: ignition 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).

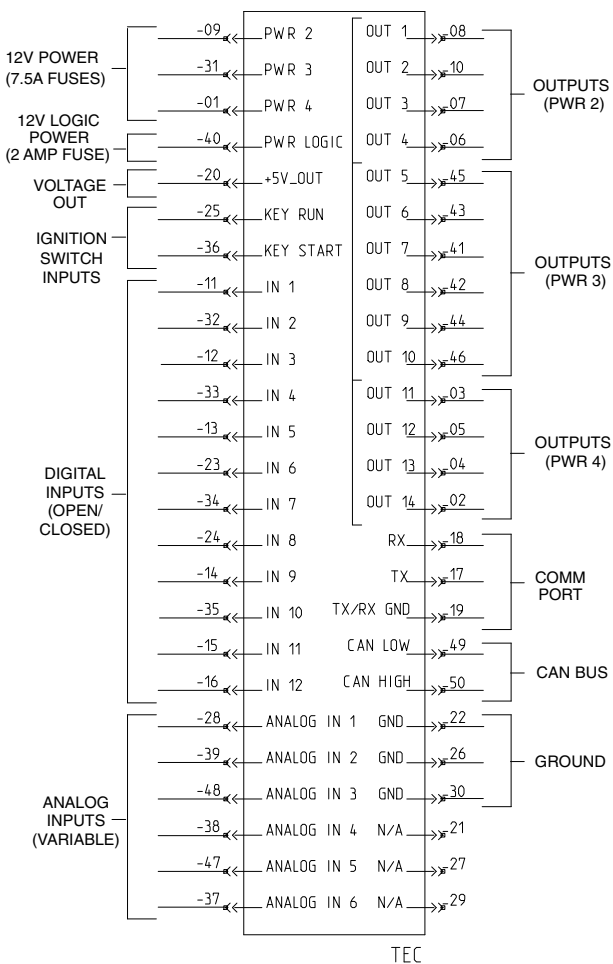
The front TEC controller controls electrical output to the engine ECU (start and run functions), fan drive solenoid coils (direction and flow source), traction (piston) pump solenoids (forward and reverse) and traction solenoid coil (HI/LOW speed). Additionally, electrical outputs for brake lights, turn lights and warning lights on Groundsmaster 4010-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 monitors the states of the following components as inputs: ignition 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)

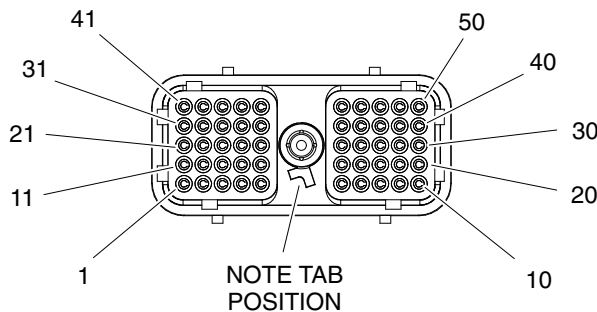


g276027

Figure 218

The diagram in [Figure 218](#) 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 218](#). The layout of the wire harness connectors that plug into the TEC controllers is shown in [Figure 219](#).

WIRE HARNESS CONNECTOR FOR TEC CONTROLLERS



g276028

Figure 219

Toro Electronic Controllers (TEC) (continued)

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).

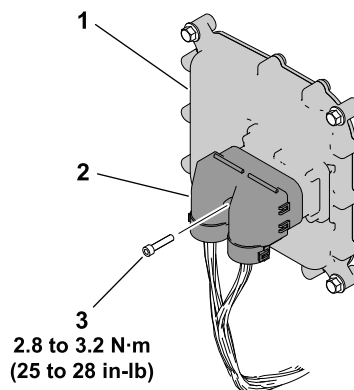
Because of the solid state circuitry built into the TEC controllers, there is no method to test a controller directly. A controller may be damaged if an attempt is made to test it with an electrical test device (e.g. digital multimeter or test light).

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 216](#)) 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 4000-D and 4010-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.



g321413

Figure 220

- | | |
|------------------------------|----------------------|
| 1. TEC controller | 3. Socket head screw |
| 2. Machine harness connector | |

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

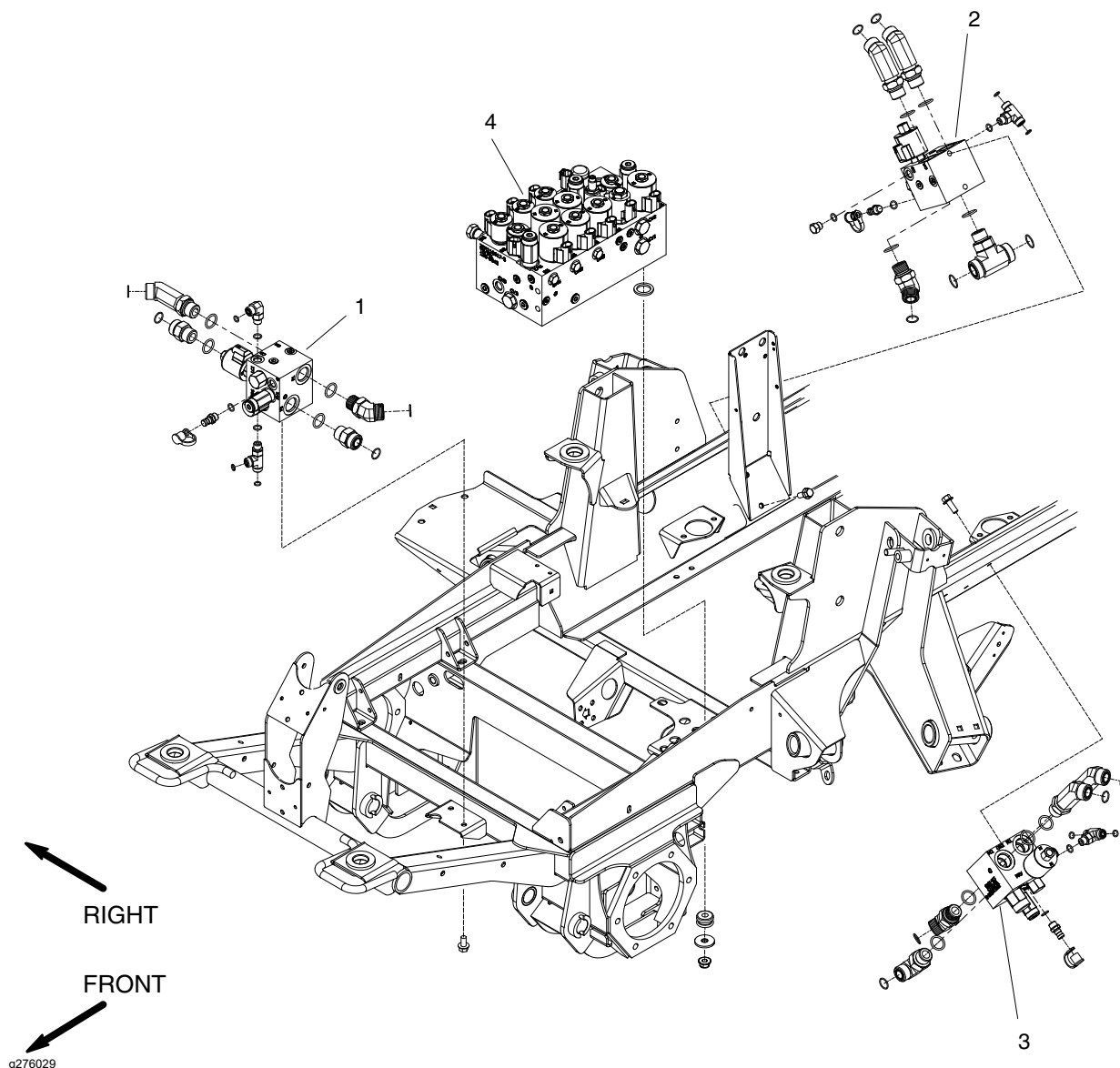


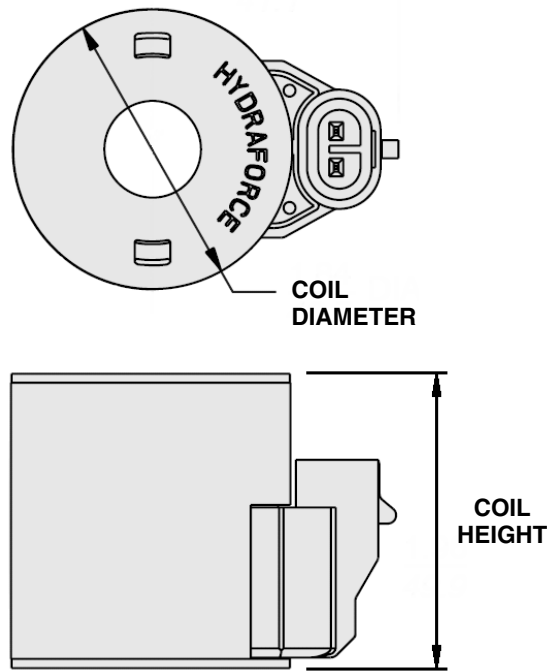
Figure 221

- | | |
|-----------------------|-------------------------|
| 1. Front PTO manifold | 3. LH PTO manifold |
| 2. RH PTO manifold | 4. Combination manifold |

Several hydraulic solenoid valve coils are used on the hydraulic control manifolds of Groundsmaster 4000-D and 4010-D machines. When energized by the TEC controller, these coils provide hydraulic circuit control.

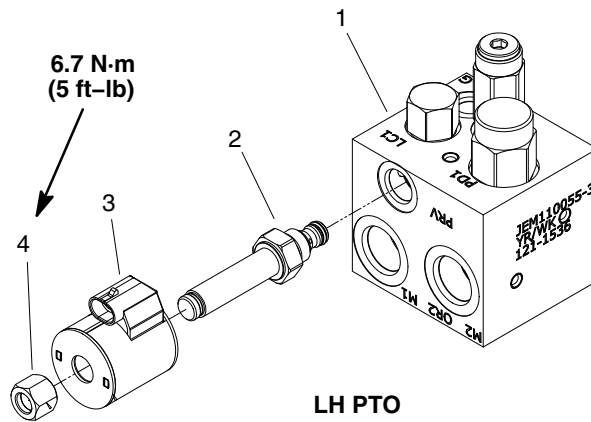
Solenoid valve coils with two (2) different resistance specifications are used on the 4000-D and 4010-D. The correct resistance of a coil can be identified by measuring the height and diameter of the coil ([Figure 222](#)). Resistance testing of the coils can be done with the coil remaining on the hydraulic 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 222



g276031

**LH PTO
MANIFOLD SHOWN**

Figure 223

- | | |
|-----------------------|------------------|
| 1. Hydraulic manifold | 3. Solenoid coil |
| 2. Cartridge valve | 4. Nut |

Testing

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.
2. Locate hydraulic solenoid valve coil to be tested ([Figure 221](#)). Disconnect wire harness connector from coil.
3. Identify coil resistance specification by measuring the coil diameter and coil height ([Figure 222](#)).

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.

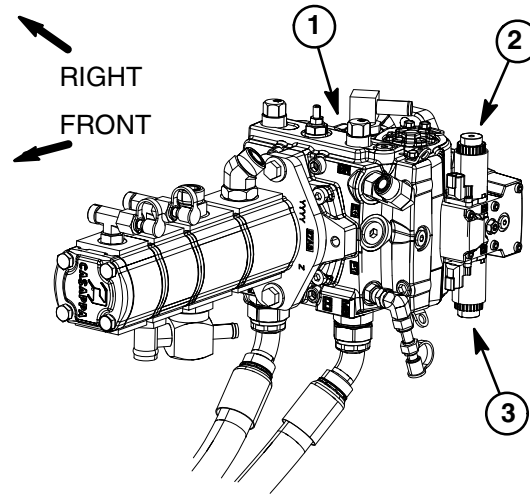
4. Using a multimeter (ohms setting), measure resistance between the two (2) connector terminals on the solenoid valve coil. The correct resistance for the solenoid coil is identified below:

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°C (68°F). 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



g276032

Figure 224

- | | |
|--------------------------|--------------------------|
| 1. Piston pump | 3. Reverse solenoid coil |
| 2. Forward 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 224).

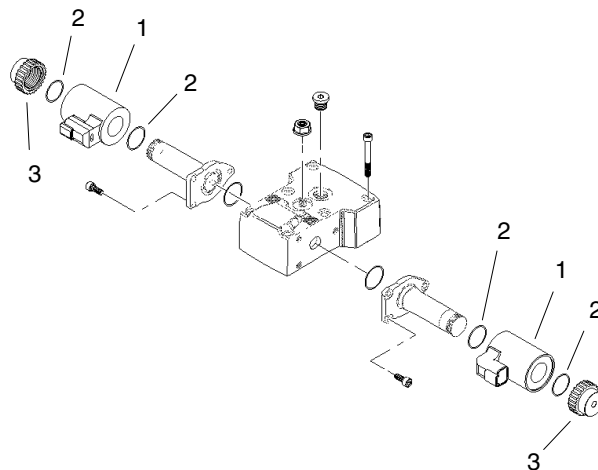
Note: To assist in troubleshooting, the piston pump solenoid coils can be exchanged because they are identical. If the problem follows the exchanged coil, a problem with the coil likely exists. If the problem remains unchanged, something other than the solenoid coil is the problem source (e.g. traction 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 ignition switch.
2. Locate piston pump solenoid coil to be tested (Figure 224). 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.

Solenoid Coil Testing (continued)



g276033

Figure 225

- | | |
|------------------|-------------|
| 1. Solenoid coil | 3. Coil nut |
| 2. O-ring | |

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°C (68°F). 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

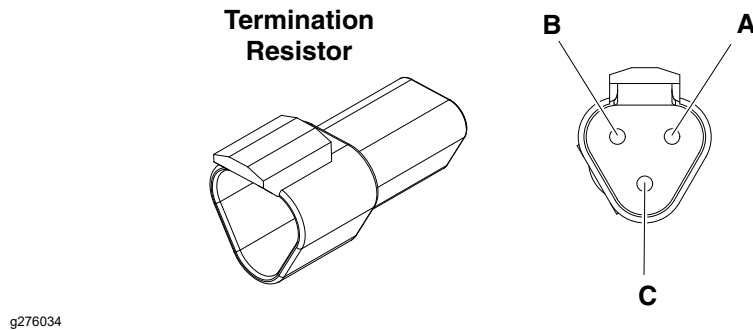


Figure 226

System communication between electrical components on Groundsmaster 4000-D and 4010-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 4000-D and 4010-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 4000-D and 4010-D machines.

Diode Assemblies

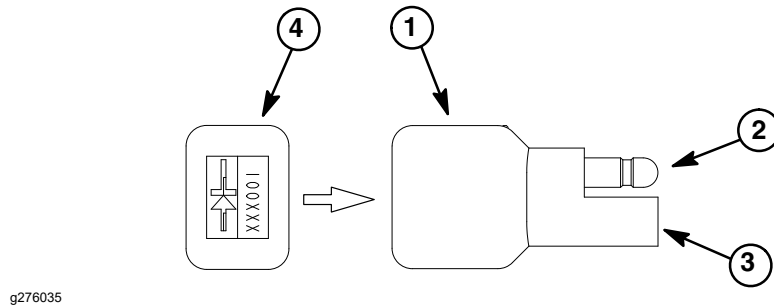


Figure 227

- | | |
|-------------------|----------------------|
| 1. Diode assembly | 3. Female terminal |
| 2. Male 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 30607, 30609 and 30636 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

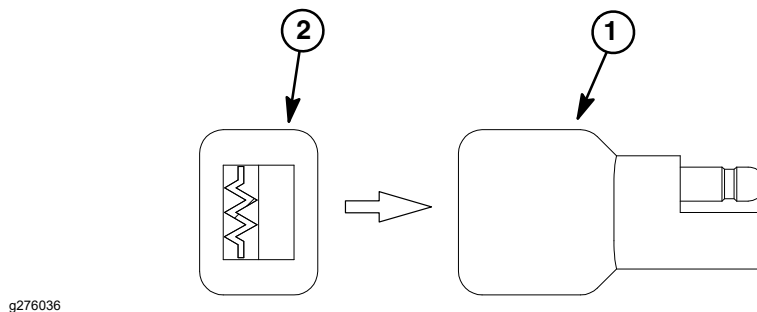


Figure 228

1. Resistor assembly
2. End of resistor body

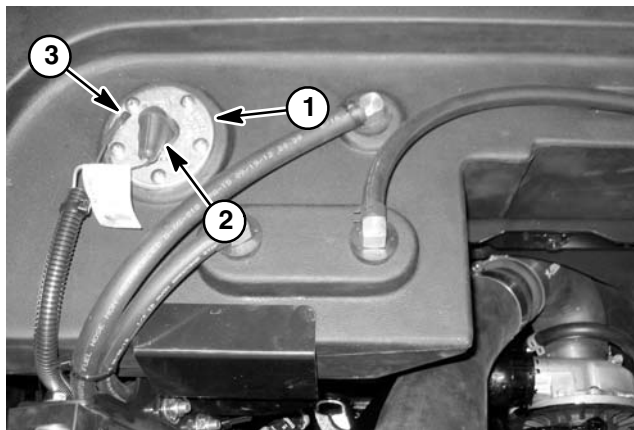
On Groundsmaster machines with an 80 Amp alternator (see [Engine \(Models 30603, 30605 and 30635\) \(page 2–4\)](#) and [Engine \(Models 30607, 30609 and 30636\) \(page 2–5\)](#)), the engine wire harness contains a resistor that is necessary for ignition switch operation. The resistor plugs into the 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 TEC controller uses the fuel sender as an input to generate an output for the InfoCenter fuel gauge.

Two (2) styles of fuel senders have been used on Groundsmaster 4000-D and 4010-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 ignition switch is OFF. Remove key from ignition 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 ignition 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 ignition switch to RUN. InfoCenter fuel gauge should indicate full. Turn ignition switch OFF and continue testing fuel sender if circuit wiring and gauge are acceptable.

Testing (continued)

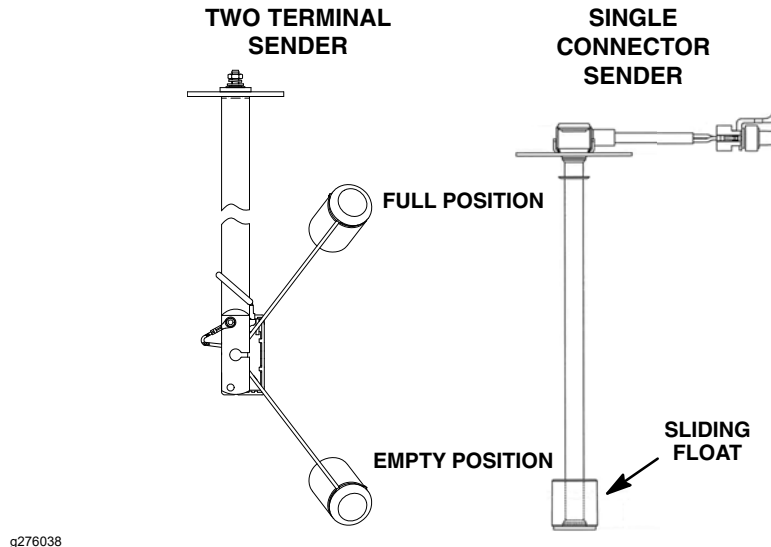


Figure 230

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



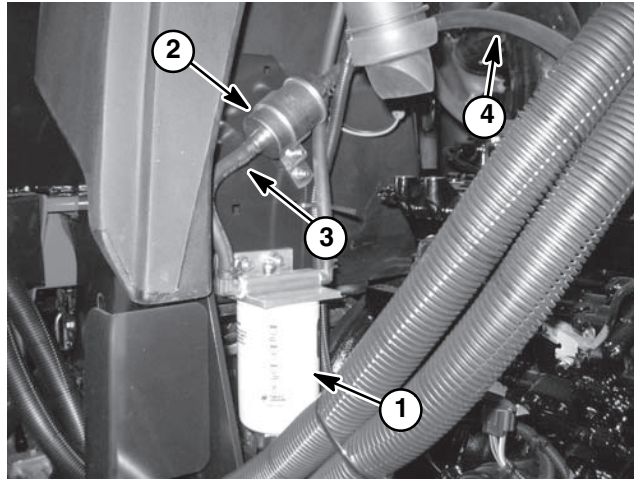
Make sure fuel sender is completely dry (no fuel on it) before testing. Perform test away from the fuel tank to prevent an explosion or fire from sparks.

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.

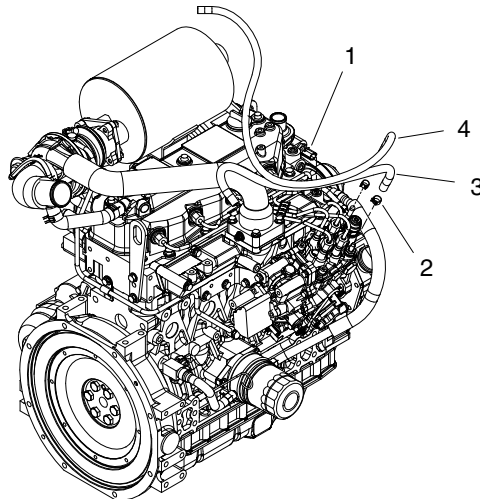
Fuel Pump (Models 30603, 30605 and 30635)



g276039

Figure 231

- | | |
|-------------------------|------------------------|
| 1. Fuel water separator | 3. Pump inlet hose |
| 2. Fuel pump | 4. Pump discharge hose |



g276040

Figure 232

- | | |
|-------------------|---------------------|
| 1. Tier 4i engine | 3. Fuel supply hose |
| 2. Hose clamp | 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 ignition switch to the START position.

5. Collect fuel in the graduated cylinder by turning ignition 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 16 fl oz (475 ml) after fifteen (15) seconds.
7. Replace fuel pump as necessary.

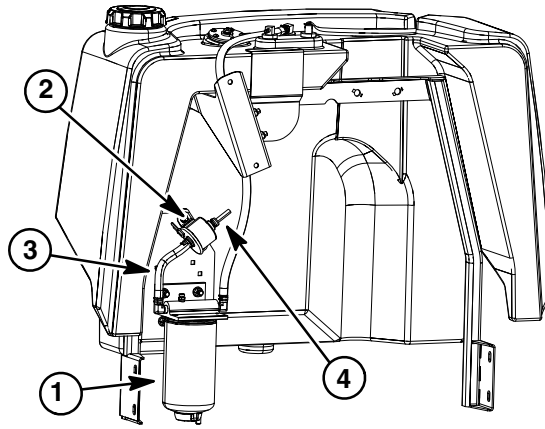
Note: If fuel pump is replaced, make sure that replacement pump is the correct pump for your Groundsmaster by using your Parts Catalog. If incorrect pump is used, fuel system components can be damaged.

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

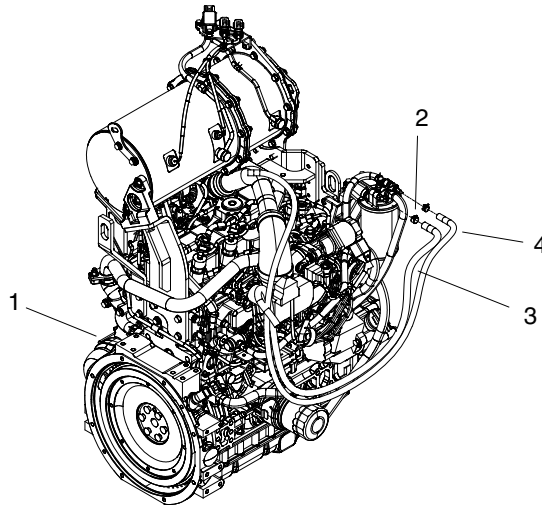
Fuel Pump (Models 30607, 30609 and 30636)



g276041

Figure 233

- | | |
|-------------------------|--------------------|
| 1. Fuel water separator | 3. Pump inlet hose |
| 2. Fuel pump | 4. Pump discharge |



g276042

Figure 234

- | | |
|------------------|------------------------|
| 1. Tier 4 engine | 3. Pump discharge hose |
| 2. Hose clamp | 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).

IMPORTANT

When testing fuel pump output, do not turn ignition switch to the START position.

5. Collect fuel in the graduated cylinder by turning ignition 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

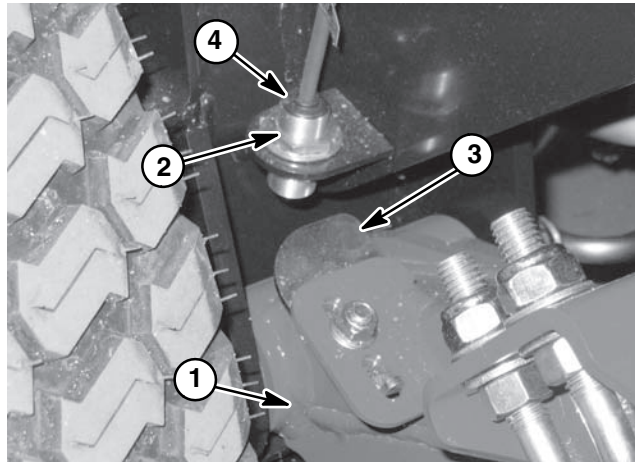
If fuel pump is replaced, make sure that replacement pump is the correct pump for your Groundsmaster by using your Parts Catalog. If incorrect pump is used, fuel system components can be damaged.

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

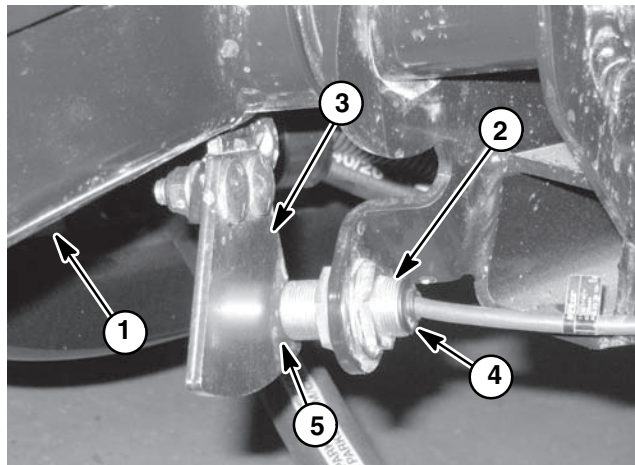
Cutting Deck Position Switches



g276043

Figure 235

- | | |
|--------------------|------------------|
| 1. Front lift arm | 3. Sensing plate |
| 2. Position switch | 4. Switch LED |
-

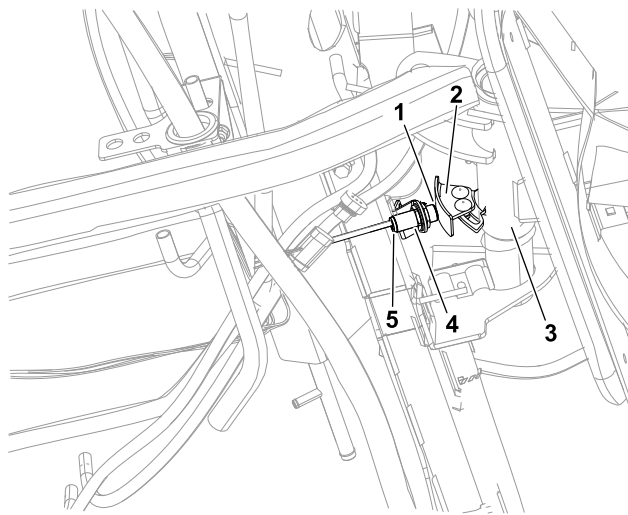


g276044

Figure 236

(For machines serial numbers below: 400000000)

- | | |
|-----------------------------|---------------|
| 1. Side lift arm (RH shown) | 4. Switch LED |
| 2. Position switch | 5. Clearance |
| 3. Sensing plate | |
-



g278112

Figure 237

(For machines serial numbers above: 400000000)

- | | |
|-----------------------------|--------------------|
| 1. Clearance | 4. Position switch |
| 2. Sensing plate | 5. Switch LED |
| 3. Side lift arm (LH shown) | |

Three (3) cutting deck position switches are used on the Groundsmaster 4000-D and 4010-D. These switches are located on the traction unit frame ([Figure 235](#) and [Figure 236](#)). The position switches are powered proximity switches that incorporate an internal reed switch and a LED. The deck position switches are used as inputs for the TEC controller to prevent deck operation when a cutting deck is raised. The switch sensing plates are attached to the cutting deck lift arms. The position switches for front and side decks are different.

The single front cutting deck position switch is a normally closed switch. When the front cutting deck is lowered, the sensing plate on the lift arm is away from the position switch so the switch is in its normally closed state. When the front cutting deck is raised, the sensing plate is moved near the position switch and the switch opens.

The two (2) side cutting deck position switches are normally open switches. When a side cutting deck is lowered, the sensing plate on the lift arm is near the position switch and the switch closes. When a side cutting deck is raised, the sensing plate is moved away from the position switch so the switch is in its normally open state.

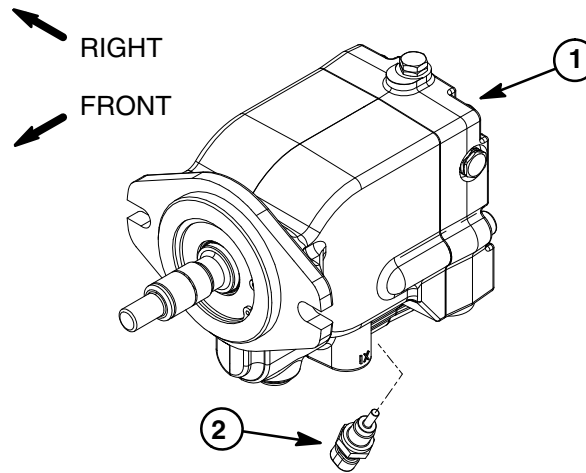
Testing

1. The cutting deck position switches and their circuit wiring should be tested as a TEC input with the InfoCenter Display (see [InfoCenter Display \(page 6-6\)](#)). If the InfoCenter verifies that the position switches and circuit wiring are functioning correctly, no further switch testing is necessary. If, however, the InfoCenter determines that a position switch and circuit wiring are not functioning correctly, proceed with test.
2. Park machine on a level surface, lower cutting decks, stop engine and apply parking brake.
3. Turn ignition switch to the RUN position (do not start engine) and check LED on cable end of position switches ([Figure 235](#) or [Figure 236](#)). Switch LED should be illuminated when the cutting decks are fully lowered.

Testing (continued)

4. Start engine, fully raise cutting decks and then stop engine. Then, turn ignition switch to the RUN position (do not start engine) and check LED on cable end of position switches. Switch LED should not be illuminated when the cutting decks are fully raised.
5. If a position switch LED did not function correctly:
 - A. Position cutting deck so sensing plate on the lift arm is near the position switch (front cutting deck raised and side cutting decks lowered).
 - B. Make sure that ignition switch is OFF and disconnect the switch connector from wire harness.
 - C. Using a multimeter, verify that wire harness connector terminal for pink wire has 12 VDC when the ignition switch is RUN.
 - D. Make sure that clearance between end of position switch and sensing plate is from **1.8 to 3.3 mm (0.070 to 0.130 in)**. If necessary, adjust position switch (see [Cutting Deck Position Switches \(page 6–79\)](#)). Recheck switch operation after adjustment.
 - E. If pink wire has system voltage present and gap is correct but switch LED does not function, replace position switch.
6. After testing is complete, make sure that position switch connector is plugged into wire harness.

Hydraulic Oil Temperature Sender

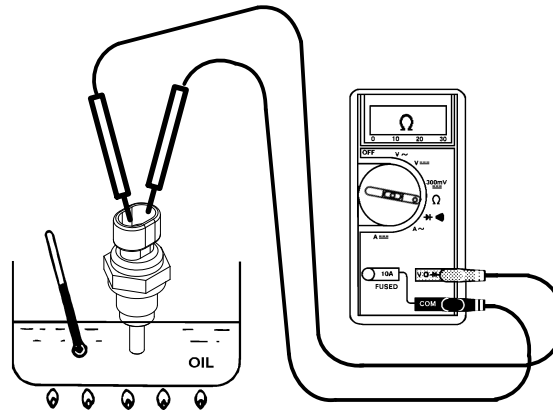


g276045

Figure 238

1. Rear axle motor

2. Oil temp sender



g276046

Figure 239

The Groundsmaster 4000-D and 4010-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 238](#)).

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.
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 239](#)).



CAUTION

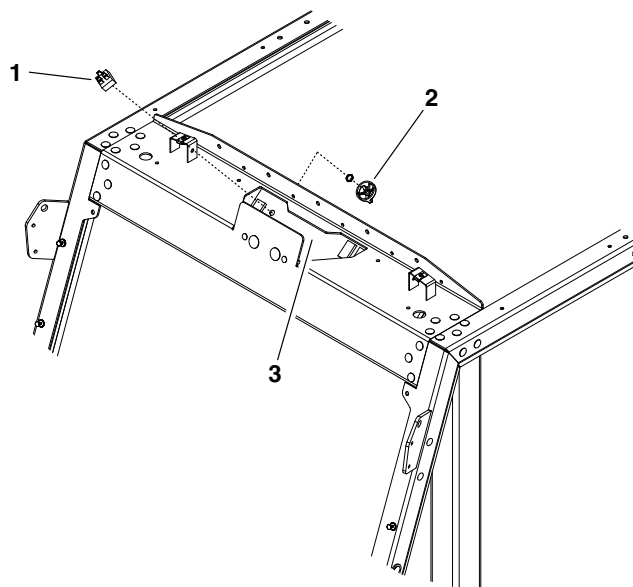


Handle the hot oil with extreme care to prevent personal injury or fire.

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.

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°C (68°F).
 - B. The meter should indicate from 2.3 to 2.5 kilo ohms at 60°C (140°F).
 - C. The meter should indicate from 605 to 669 ohms at 100°C (212°F).
 - 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)



g276047

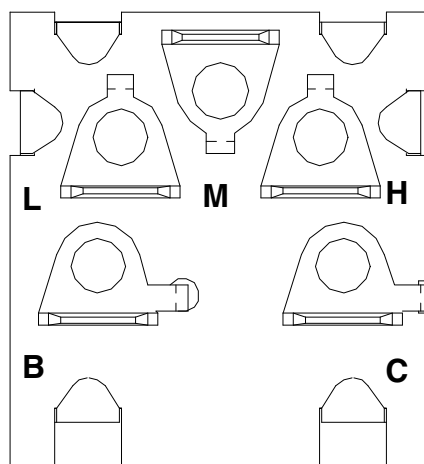
Figure 240

- | | |
|---------------------|------------------|
| 1. Fan speed switch | 3. Control panel |
| 2. Control knob | |

The fan speed switch is attached to the overhead control panel ([Figure 240](#)). 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.



BACK OF SWITCH

g276048

Figure 241

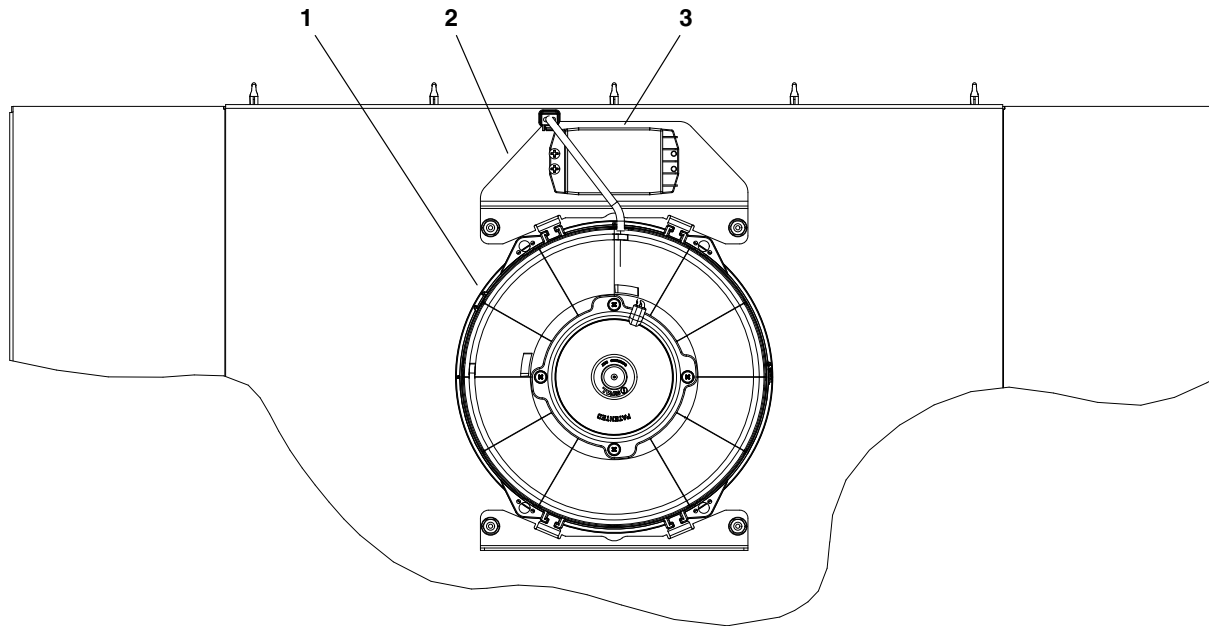
Testing (continued)

4. The switch terminals are identified in ([Figure 241](#)). 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 \(page A-1\)](#).
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)



g276049

Figure 242

- | | |
|----------------------|--------------------|
| 1. Operator's fan | 3. Resistor module |
| 2. Fan mount bracket | |

The resistor module is attached to the rear of the fan mounting bracket ([Figure 242](#)). 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)

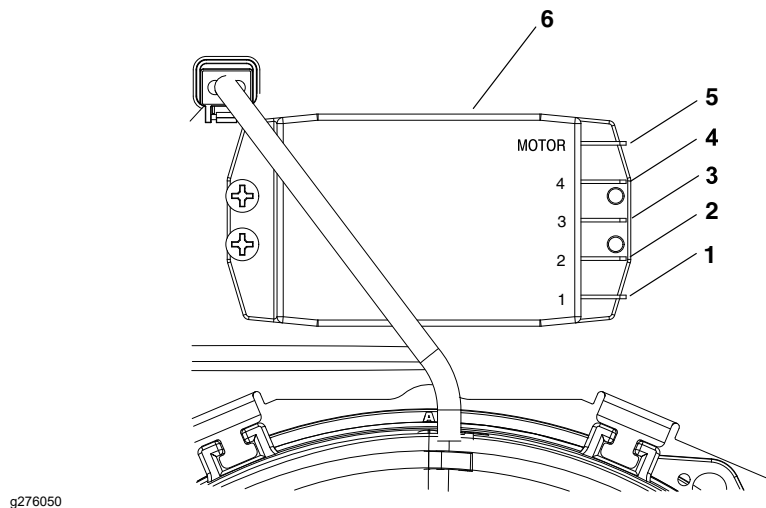


Figure 243

- | | |
|------------------------|---------------------|
| 1. Pin 1 (Violet wire) | 4. Pin 4 (Not used) |
| 2. Pin 2 (Brown wire) | 5. Motor pin |
| 3. Pin 3 (Orange wire) | 6. Resistor module |

4. Use a multimeter to check that the resistance values of the resistor module as below ([Figure 243](#)).

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 \(page A-1\)](#).
7. After you complete the testing, connect the wire harness connectors to the resistor module terminals ([Figure 243](#)) and install the sunshade.

Audio Alarm

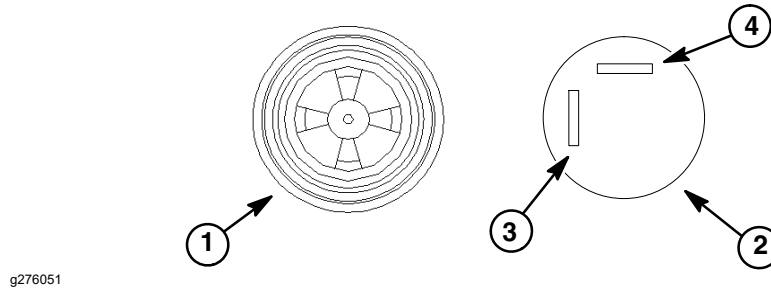


Figure 244

- | | |
|----------------------|--------------------------|
| 1. Alarm top view | 3. Positive (+) terminal |
| 2. Alarm bottom view | 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 electrical current for the alarm. The alarm is attached to the control arm next to the operator seat.

Testing

1. Make sure ignition switch is OFF. Remove key from ignition switch.
2. Disassemble control arm to gain access to the audio alarm (see [Control Arm \(page 8–22\)](#)).
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 244](#)).
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 \(page 8–22\)](#)).

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.



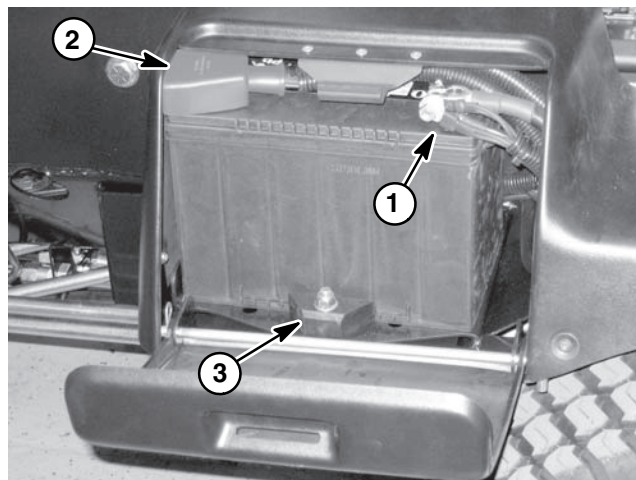
CAUTION



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°C (0°F)
	110 minutes reserve capacity at 27°C (80°F)
Electrolyte Specific Gravity	Fully charged: 1.265 corrected to 27°C (80°F)
	Discharged: less than 1.240

Battery Removal and Installation (Figure 245)



g276327

Figure 245

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 degrees F.
- 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.

Battery Testing (continued)

Minimum Voltage	Battery Temperature	
9.6	70°F (and up)	21°C (and up)
9.5	60°F	16°C
9.4	50°F	10°C
9.3	40°F	4°C
9.1	30°F	-1°C
8.9	20°F	-7°C
8.7	10°F	-12°C
8.5	0°F	-18°C

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°C (10°F) above 26.7°C (80°F) add 0.004 to the specific gravity reading. For each 5.5°C (10°F) below 26.7°C (80°F) subtract 0.004 from the specific gravity reading.

Example:

Cell Temperature: 100°F

Cell Gravity: 1.245

100°F minus 80°F equals 20°F

(37.7°C minus 26.7°C equals 11.0°C)

20°F multiply by 0.004/10°F equals 0.008

(11°C multiply by 0.004/5.5°C equals 0.008)

ADD (conversion above): 0.008

Correction to 26.7°C (80°F): 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°C (60°F) 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

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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.

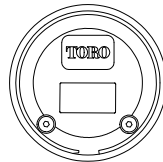
Adjustments

Planetary Drive Assembly Endplay (OPH-2 series planetary drives)

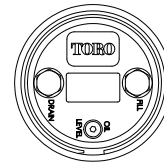
A front planetary drive assembly that is properly operating should have no endplay. Any endplay in a planetary assembly indicates that there are potential problems with the planetary. Check planetary endplay at intervals specified in your Operator's Manual.

Endplay Checking Procedure

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



OPH-2 series planetary



VA02 series planetary

g276498

Figure 246



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.

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.

Brake Assembly

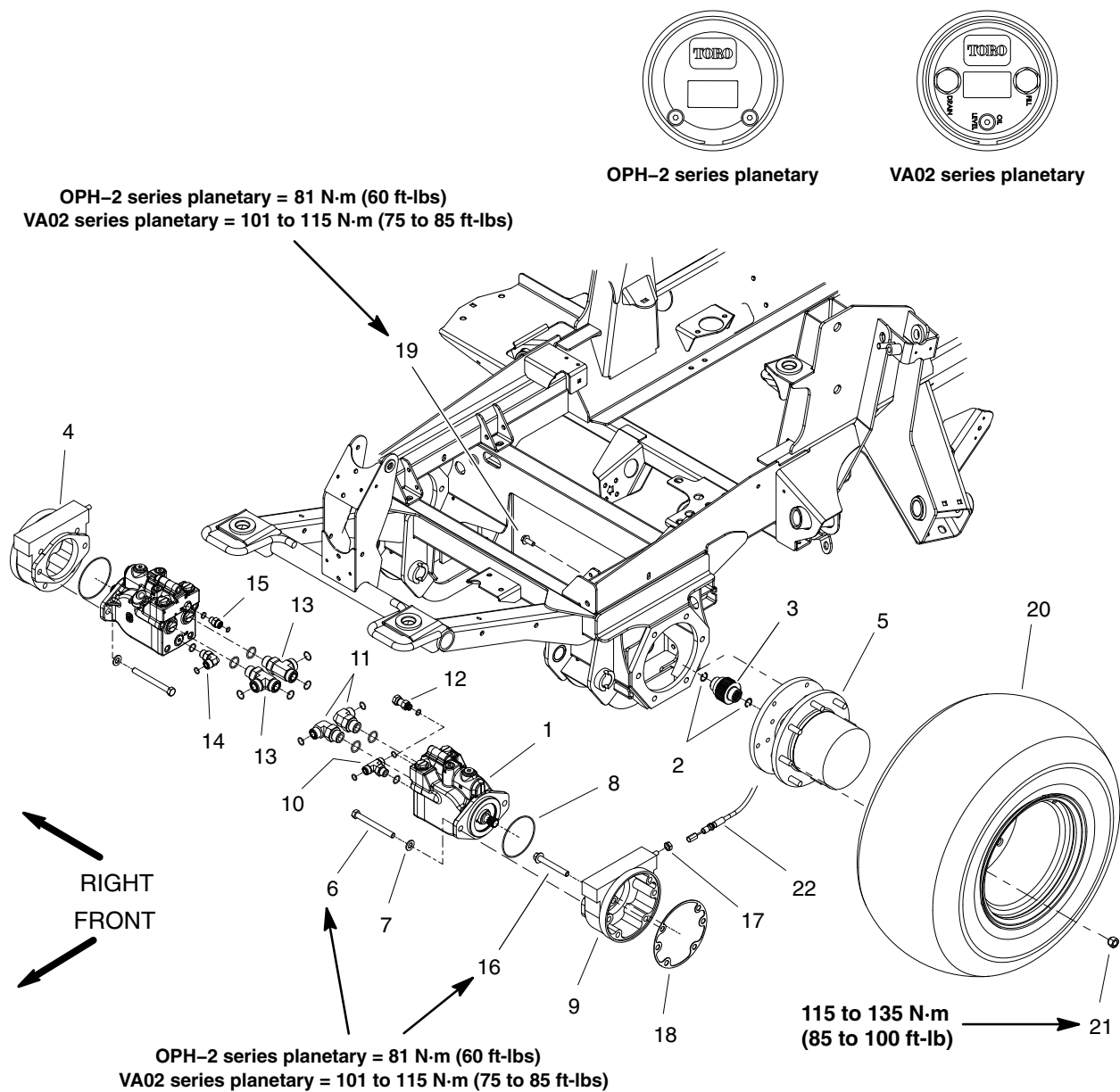


Figure 247

- | | | |
|--|--|------------------------------------|
| 1. Front wheel motor | 9. LH brake assembly | 17. Jam nut |
| 2. Internal retaining ring | 10. Hydraulic tee fitting | 18. Gasket |
| 3. Splined brake shaft | 11. 90° hydraulic fitting (2 used) | 19. Flange screw (6 used per side) |
| 4. RH brake assembly | 12. Hydraulic connector | 20. Front wheel assembly |
| 5. Planetary assembly (2 used) | 13. Hydraulic tee fitting (2 used) | 21. Lug nut (8 used per wheel) |
| 6. Cap screw (2 used per motor)
OPH-2 planetary = 120 mm lg
VA02 planetary = 110 mm lg | 14. 90° hydraulic fitting | 22. Brake cable (RH shown) |
| 7. Flat washer (2 used per motor) | 15. Straight hydraulic fitting | |
| 8. O-ring | 16. Flange screw (4 used per brake)
OPH-2 planetary = 90 mm lg
VA02 planetary = 80 mm lg | |

Removal (Figure 247)

1. Park machine on a level surface, lower cutting decks, stop engine and remove key from the ignition switch.
2. Drain oil from planetary drive and brake assembly; refer to traction unit *Operator's Manual*.



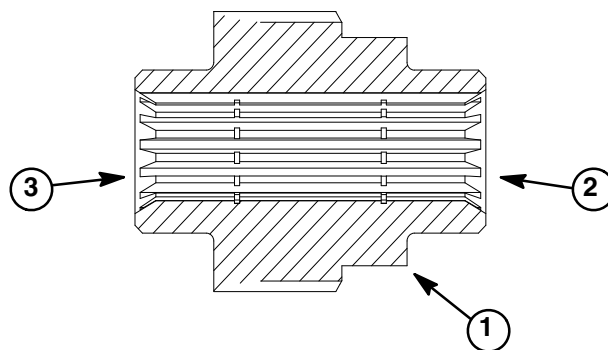
CAUTION



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 247)



g276520

Figure 248

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 248).

1. Install splined brake shaft (item 3) into brake assembly. Make sure that splines engage rotating discs in brake assembly.

Installation (Figure 247) (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.

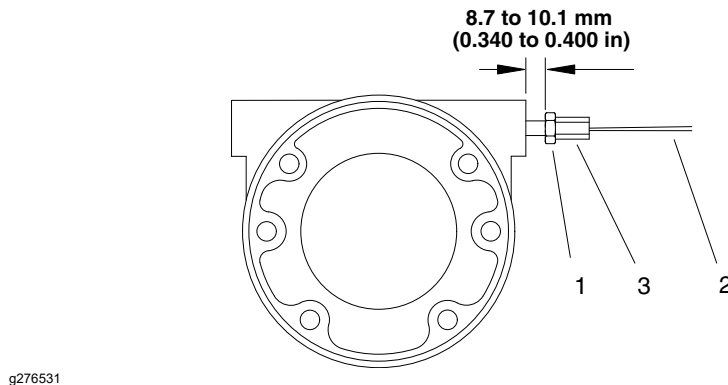


Figure 249

- | | |
|---------------------|--------------------|
| 1. Pull rod jam nut | 3. Brake cable hex |
| 2. Brake cable | |

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 249). Brakes should be adjusted so that both brake pedals have approximately **25 mm (1 in)** of freeplay and have equal brake tension.



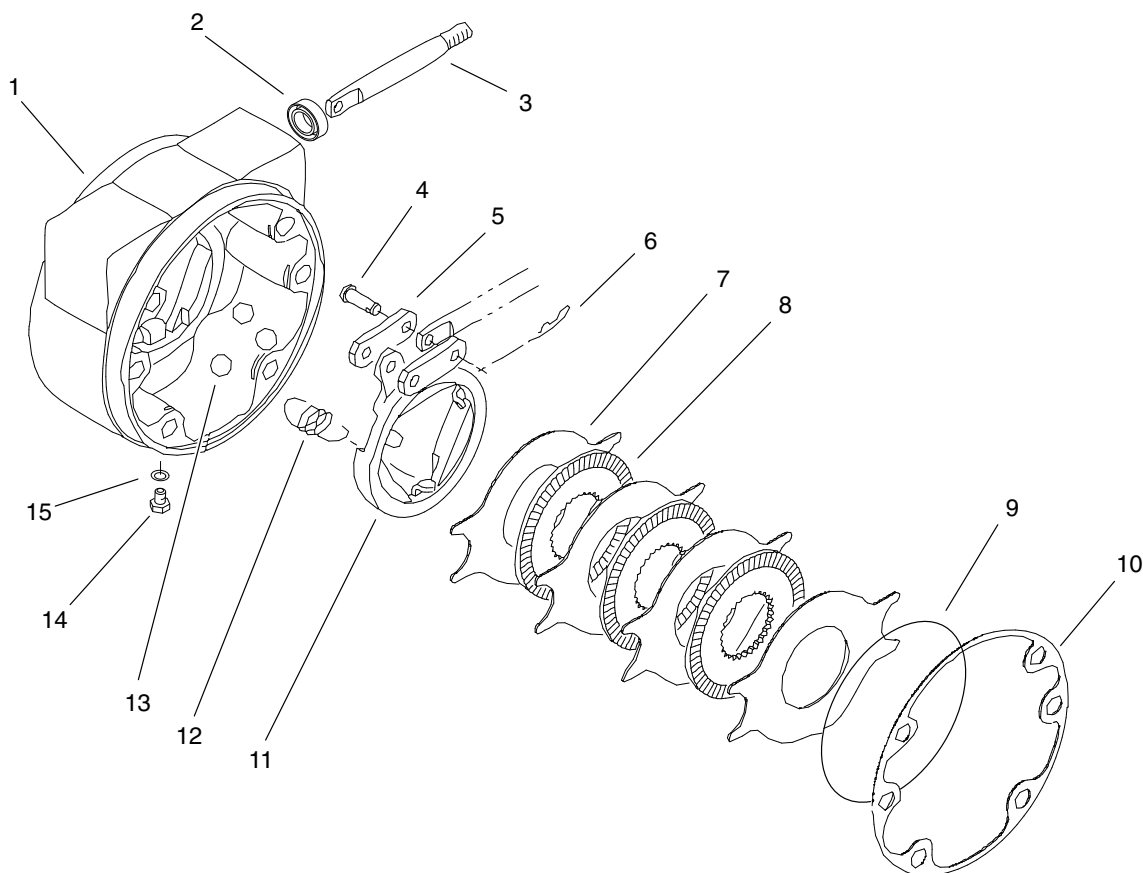
WARNING



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



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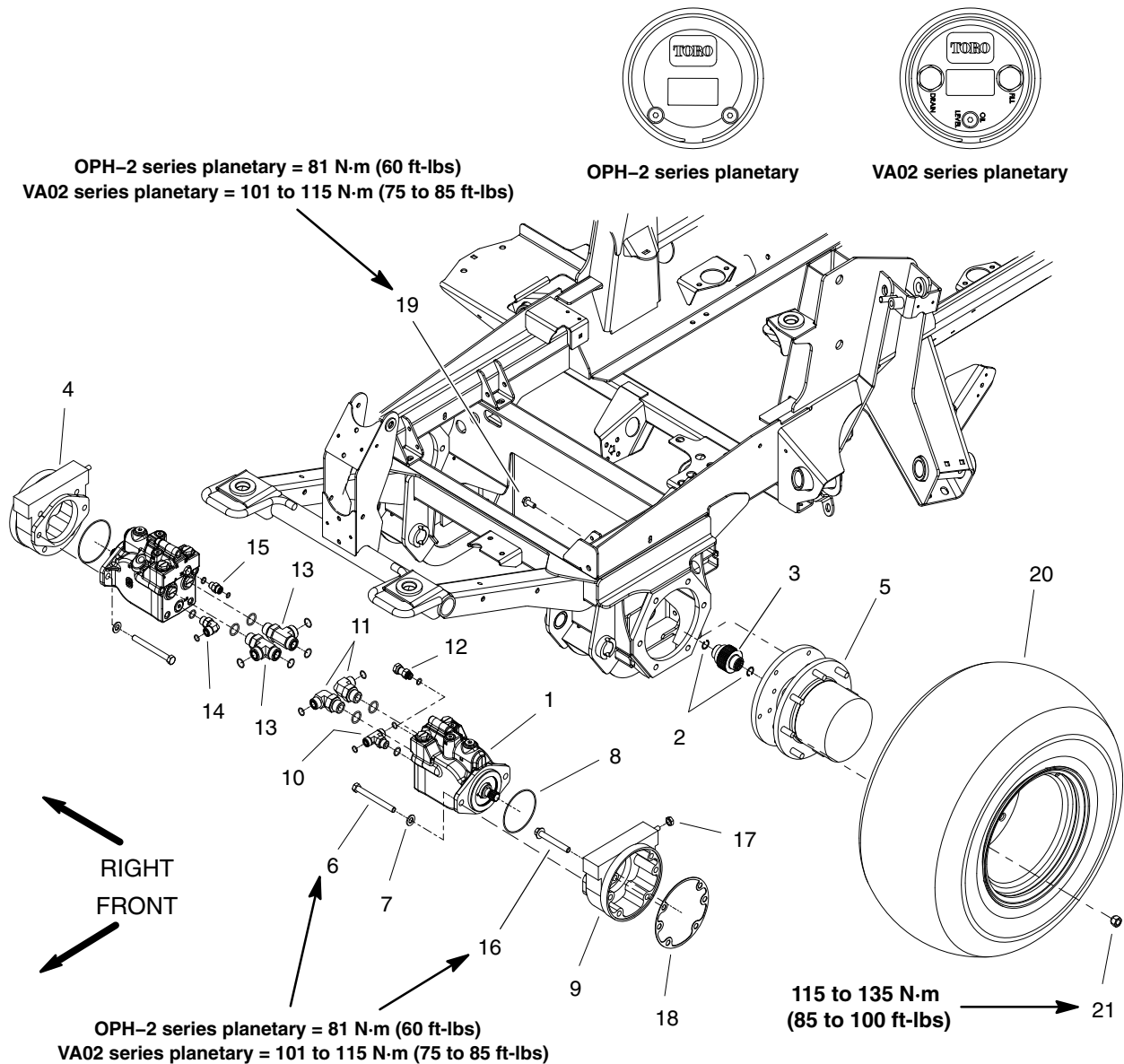
Figure 250

- | | | |
|-----------------------------|-----------------------------|-------------------------------|
| 1. Brake housing (LH shown) | 6. Hitch pin (2 used) | 11. Rotating actuator |
| 2. Seal | 7. Stationary disc (4 used) | 12. Extension spring (3 used) |
| 3. Pull rod | 8. Rotating disc (3 used) | 13. Ball (3 used) |
| 4. Clevis pin (2 used) | 9. Retaining ring | 14. Plug |
| 5. Link (2 used) | 10. Gasket | 15. O-ring |

Brake Inspection and Repair (Figure 250)

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



g276543

Figure 251

- | | | |
|--|------------------------------------|--|
| 1. Front wheel motor | 8. O-ring | 15. Straight hydraulic fitting |
| 2. Internal retaining ring | 9. LH brake assembly | 16. Flange screw (4 used per brake)
OPH-2 planetary = 90 mm lg
VA02 planetary = 80 mm lg |
| 3. Splined brake shaft | 10. Hydraulic tee fitting | 17. Jam nut |
| 4. RH brake assembly | 11. 90° hydraulic fitting (2 used) | 18. Gasket |
| 5. Planetary assembly (2 used) | 12. Hydraulic connector | 19. Flange screw (6 used per side) |
| 6. Cap screw (2 used per motor)
OPH-2 planetary = 120 mm lg
VA02 planetary = 110 mm lg | 13. Hydraulic tee fitting (2 used) | 20. Front wheel assembly |
| 7. Flat washer (2 used per motor) | 14. 90° hydraulic fitting | 21. Lug nut (8 used per wheel) |

Note: The planetary drive assembly can be serviced with the planetary installed to machine (see [Planetary Drive Assembly \(page 7–8\)](#)). Use the following procedure to remove and install the planetary drive assembly from the machine.

Removal (Figure 251)

1. Park machine on a level surface, lower cutting decks, stop engine and remove key from the ignition 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 251)

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 251) (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.



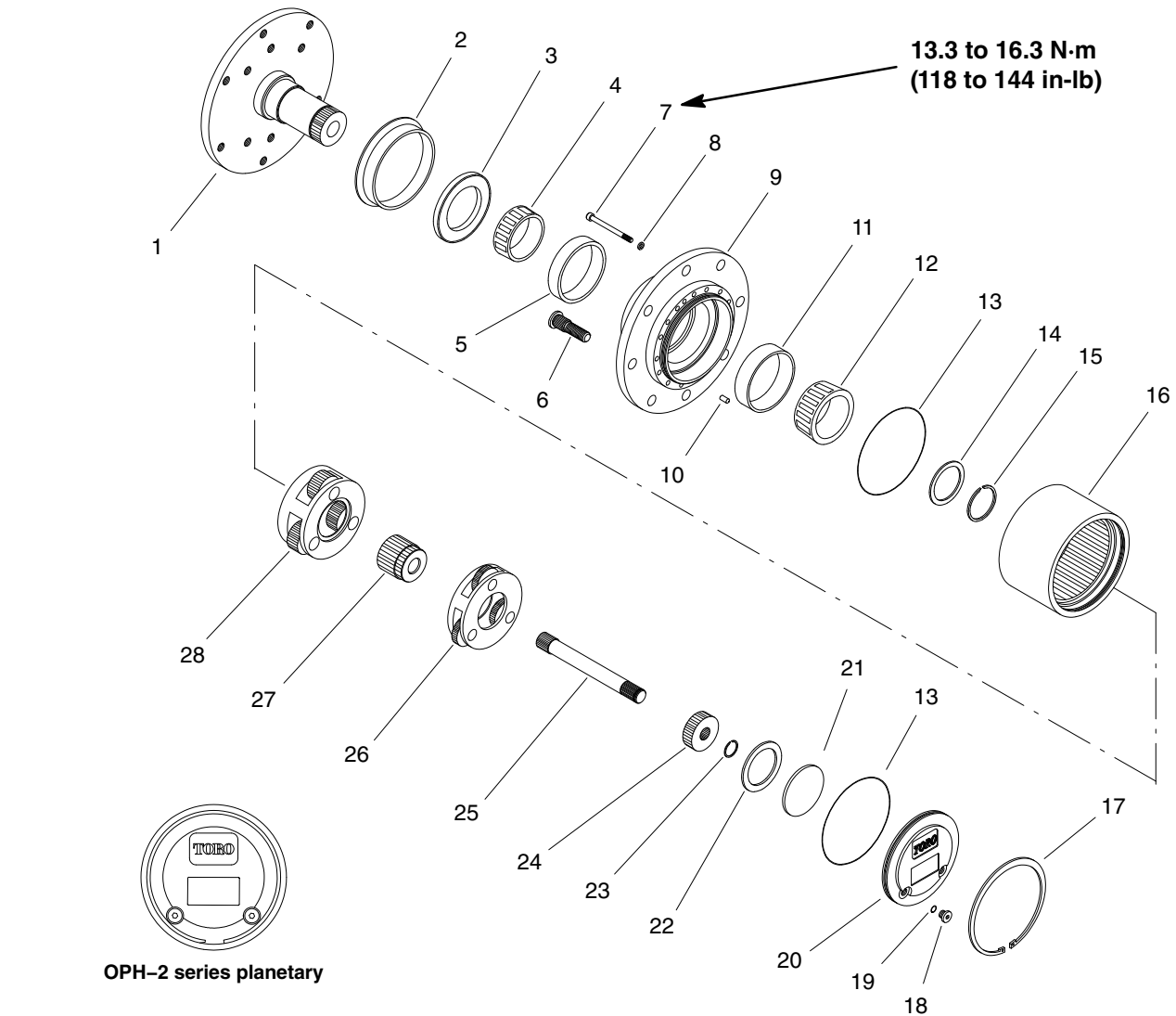
WARNING



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



g276544

Figure 252

- | | | |
|--------------------------------|-------------------------------|--------------------------------|
| 1. Spindle | 11. Outer bearing cup | 21. Thrust plug |
| 2. Boot seal | 12. Outer bearing cone | 22. Thrust washer |
| 3. Oil seal | 13. O-ring | 23. Retaining ring |
| 4. Inner bearing cone | 14. Thrust washer | 24. Primary gear |
| 5. Inner bearing cup | 15. Retaining ring (external) | 25. Drive shaft |
| 6. Wheel stud (8 used) | 16. Ring gear | 26. Primary carrier assembly |
| 7. Socket head screw (16 used) | 17. Retaining ring (internal) | 27. Secondary gear |
| 8. Lock washer (16 used) | 18. Plug (2 used) | 28. Secondary carrier assembly |
| 9. Housing | 19. O-ring (2 used) | |
| 10. Dowel pin (2 used) | 20. End cap | |

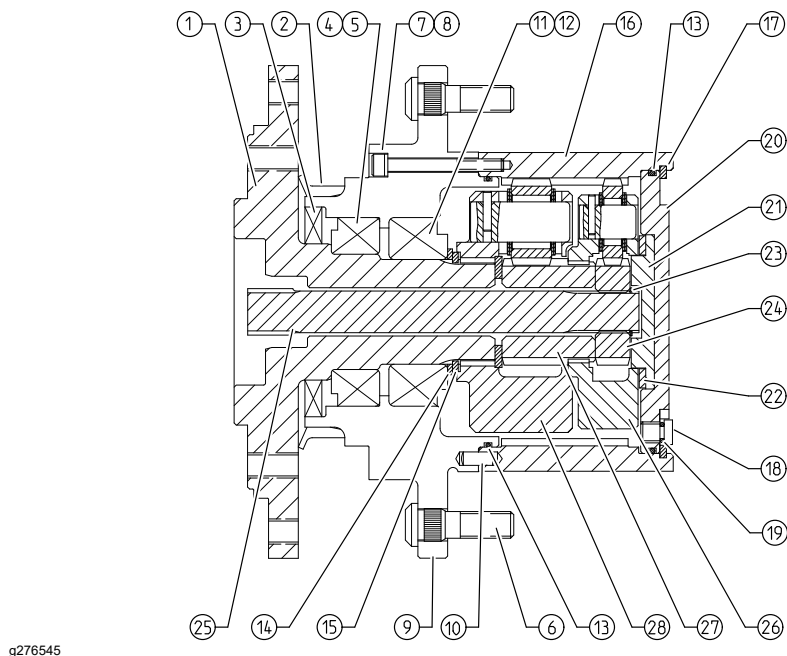


Figure 253

- | | |
|---------------------------|-------------------------------|
| 1. Spindle | 15. Retaining ring (external) |
| 2. Boot seal | 16. Ring gear |
| 3. Oil seal | 17. Retaining ring (internal) |
| 4. Inner bearing cone | 18. Plug (2) |
| 5. Inner bearing cup | 19. O-ring (2) |
| 6. Wheel stud (8) | 20. End cap |
| 7. Socket head screw (16) | 21. Thrust plug |
| 8. Lock washer (16) | 22. Thrust washer |
| 9. Housing | 23. Retaining ring |
| 10. Dowel pin (2) | 24. Primary gear |
| 11. Outer bearing cup | 25. Drive shaft |
| 12. Outer bearing cone | 26. Primary carrier assy. |
| 13. O-ring | 27. Secondary gear |
| 14. Thrust washer | 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 252](#) and [Figure 253](#))

1. Park machine on a level surface, stop engine and remove key from the ignition 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 252 and Figure 253) (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.

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 252 and Figure 253)

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 252 and Figure 253) (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.



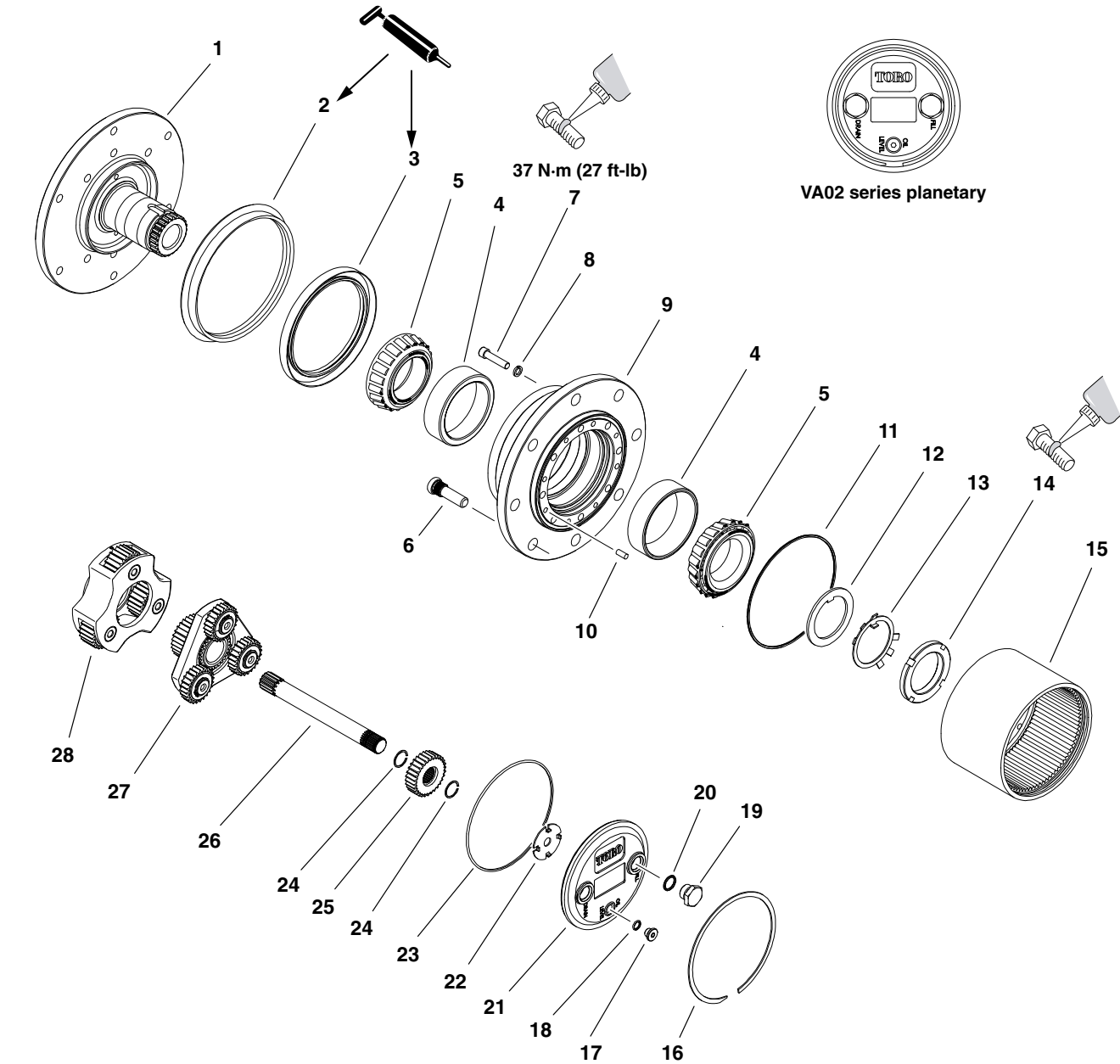
WARNING



Failure to maintain proper wheel lug nut torque could result in failure or loss of wheel and may result in personal injury.

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.

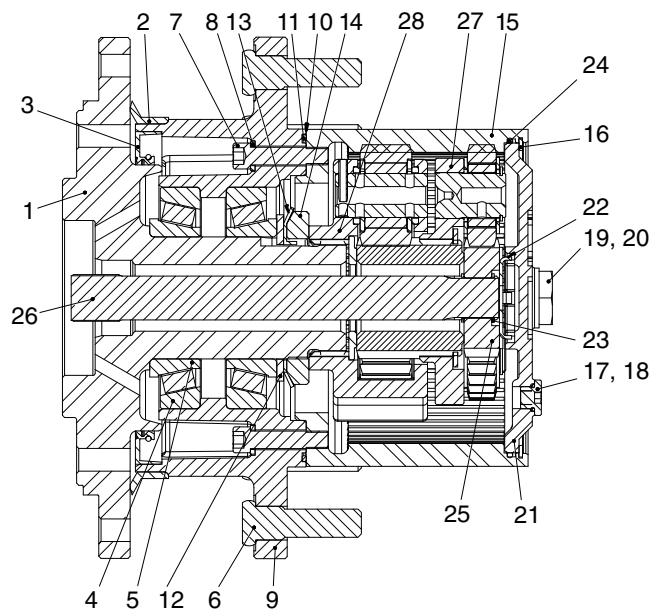
VA02 Series Planetary Drive Service



g276546

Figure 254

- | | | |
|---------------------------|--------------------|--------------------------------|
| 1. Spindle | 11. O-ring | 21. End cap |
| 2. Boot seal | 12. Spacer | 22. Thrust plate |
| 3. Lip seal | 13. Locking washer | 23. O-Ring |
| 4. Inner bearing cup (2) | 14. Lock nut | 24. Retaining ring (2) |
| 5. Inner bearing cone (2) | 15. Ring gear | 25. Primary gear |
| 6. Wheel stud (8) | 16. Retaining ring | 26. Drive shaft |
| 7. Socket head screw (8) | 17. Plug | 27. Primary carrier assembly |
| 8. Lock washer (8) | 18. O-ring | 28. Secondary carrier assembly |
| 9. Housing | 19. Plug (2) | |
| 10. Dowel pin (4) | 20. O-Ring (2) | |



g276499

Figure 255

- | | |
|---------------------------|---------------------------|
| 1. Spindle | 15. Ring gear |
| 2. Boot seal | 16. Retaining ring |
| 3. Lip seal | 17. Plug |
| 4. Inner bearing cup (2) | 18. O-ring |
| 5. Inner bearing cone (2) | 19. Plug (2) |
| 6. Wheel stud (8) | 20. O-Ring (2) |
| 7. Socket head screw (8) | 21. End cap |
| 8. Lock washer (8) | 22. Thrust plate |
| 9. Housing | 23. O-Ring |
| 10. Dowel pin (4) | 24. Retaining ring (2) |
| 11. O-ring | 25. Primary gear |
| 12. Spacer | 26. Drive shaft |
| 13. Locking washer | 27. Primary carrier asm |
| 14. Lock nut | 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 ignition 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.

Rear Axle Assembly

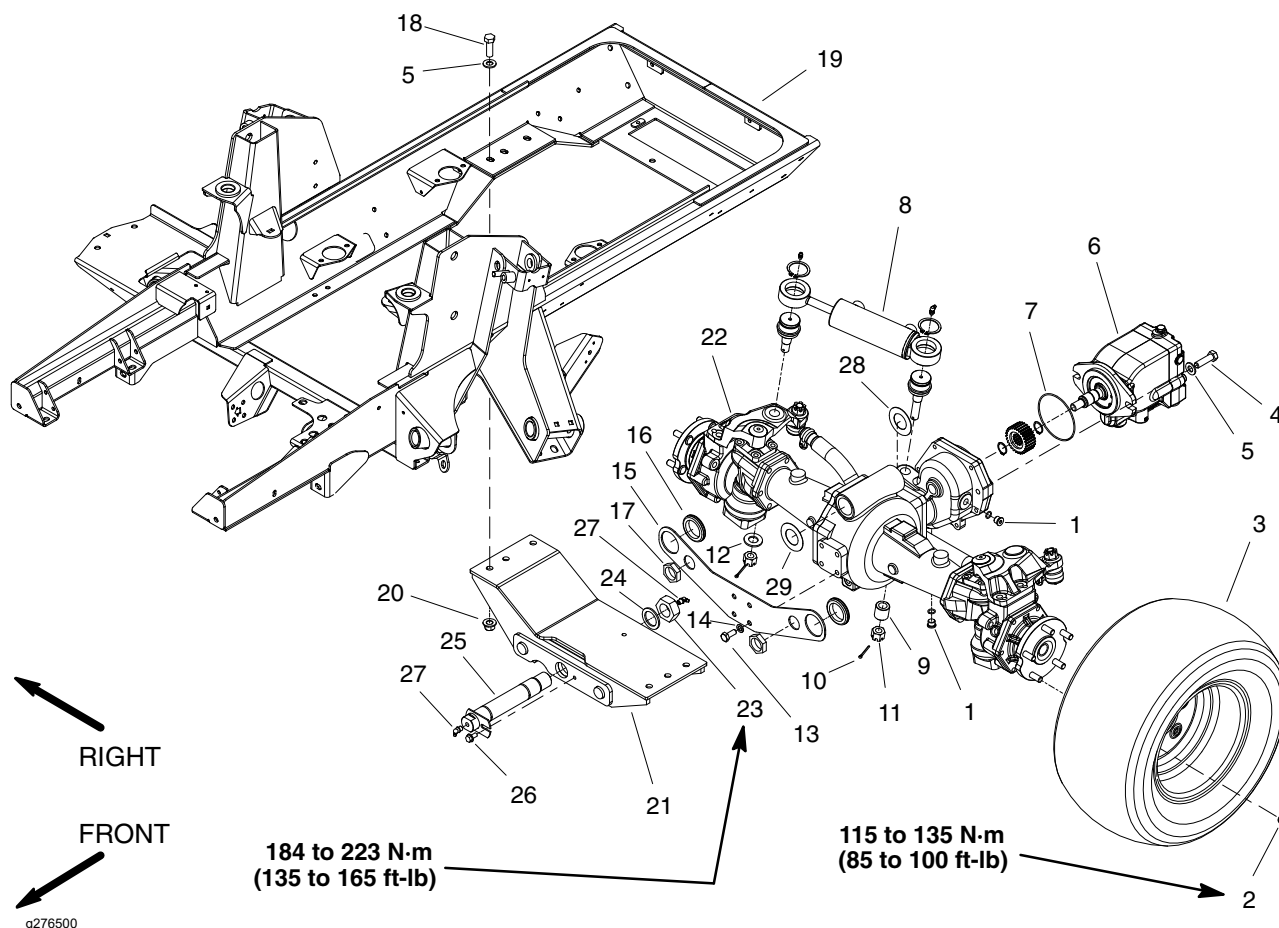


Figure 256

- | | | |
|---------------------------------|------------------------------|----------------------------|
| 1. Plug with O-ring | 11. Slotted hex nut (2 used) | 21. Rear axle mount |
| 2. Lug nut (5 used per wheel) | 12. Washer | 22. Rear axle assembly |
| 3. Rear wheel assembly (2 used) | 13. Cap screw (4 used) | 23. Lock nut |
| 4. Cap screw (2 used) | 14. Lock washer (4 used) | 24. Thrust washer |
| 5. Flat washer (8 used) | 15. Bulkhead mount plate | 25. Rear axle pin |
| 6. Rear axle motor | 16. Grommet (2 used) | 26. Washer head screw |
| 7. O-ring | 17. Bulkhead nut (2 used) | 27. Grease fitting |
| 8. Steering cylinder | 18. Cap screw (6 used) | 28. Thrust washer (0.033") |
| 9. Spacer | 19. Frame assembly | 29. Thrust washer (0.018") |
| 10. Cotter pin (2 used) | 20. Lock nut (6 used) | |



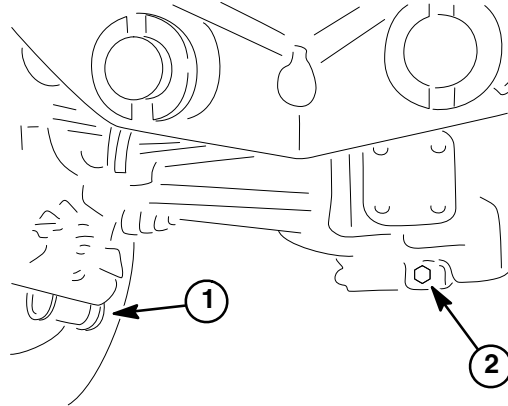
CAUTION



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 256](#))

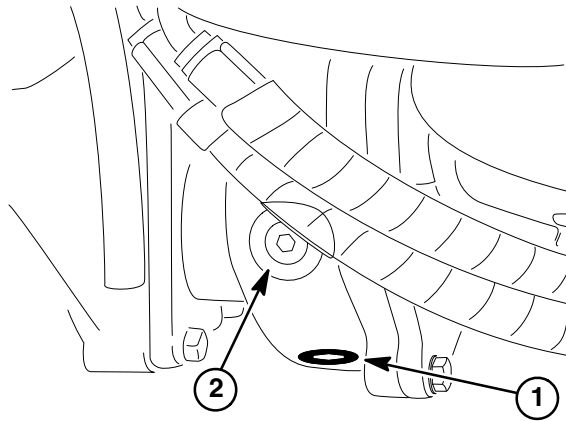
1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the ignition switch.



g276501

Figure 257

1. Center axle drain plug
2. Outside plug (2 used)



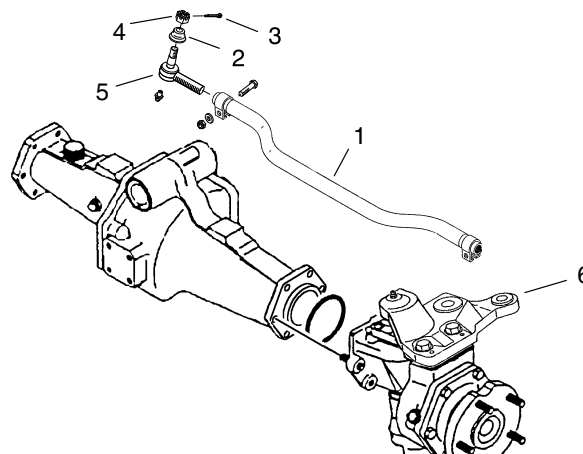
g276502

Figure 258

1. Gearbox drain plug
2. Gearbox fill plug

2. Drain oil from rear axle and axle gearbox ([Figure 257](#) and [Figure 258](#)).
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 \(page 5–142\)](#)).
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 256) (continued)



g276503

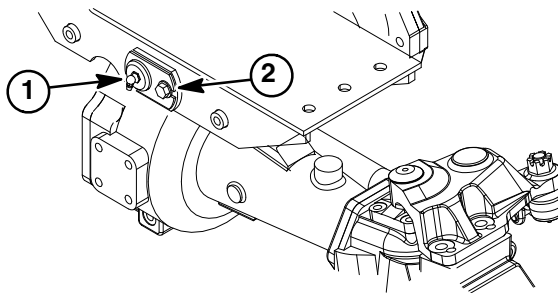
Figure 259

- | | |
|---------------|----------------------|
| 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 259). 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 260).
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 256)

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.



g276504

Figure 260

- | | |
|------------------|----------------------|
| 1. Rear axle pin | 2. Washer head screw |
|------------------|----------------------|

Installation (Figure 256) (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 260).
 - C. Torque lock nut from **184 to 223 N·m (135 to 165 ft-lb)**. After tightening the lock nut, make 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 259). 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 \(page 5-142\)](#)).
8. Install hydraulic motor to rear axle assembly (see [Rear Axle Motor \(page 5-114\)](#)).

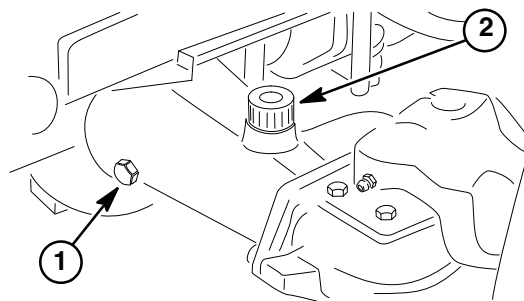


WARNING



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.

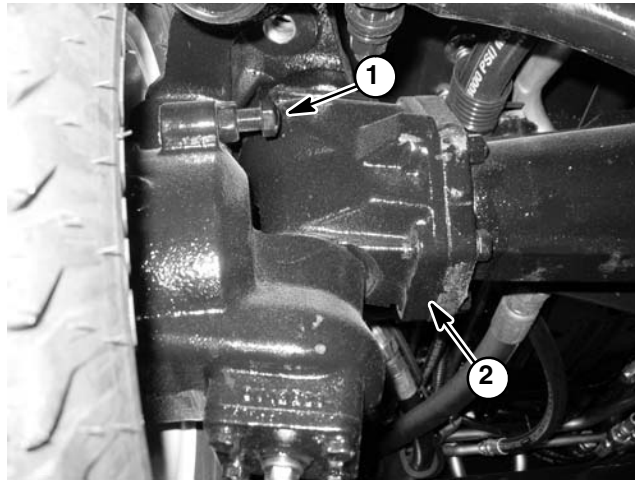


g276505

Figure 261

1. Rear axle check plug
2. Rear axle fill plug

Installation ([Figure 256](#)) (continued)



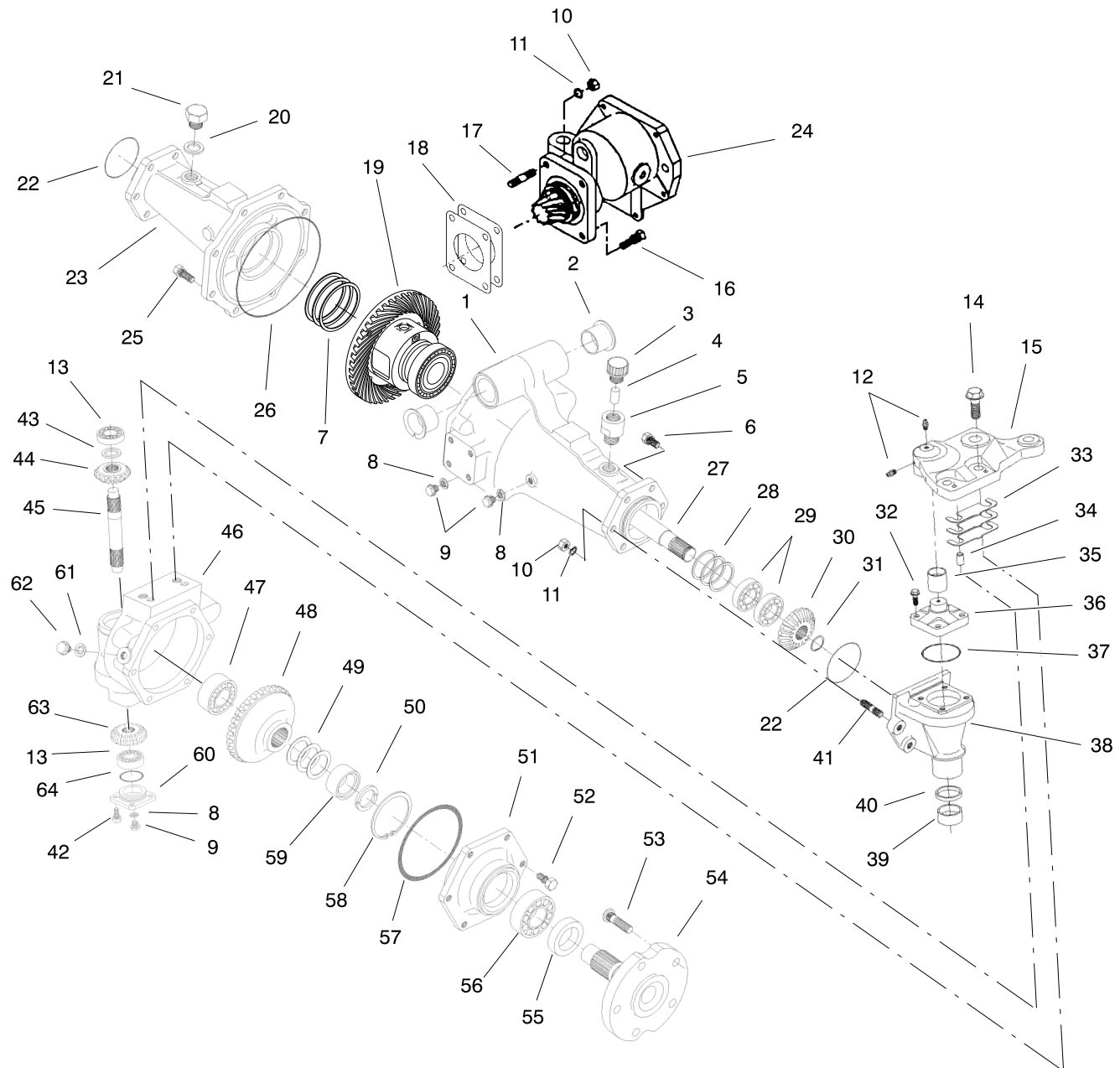
g276506

Figure 262

- | | |
|-----------------------|-------------------------|
| 1. Steering stop bolt | 2. Bevel gear case (LH) |
|-----------------------|-------------------------|

-
11. Fill gearbox and rear axle with SAE 85W-140 weight gear lube ([Figure 258](#) and [Figure 261](#)). 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 262](#) shows stop bolt location.

Rear Axle Service



g276507

Figure 263

Rear Axle Service (continued)

Figure 263 (continued)

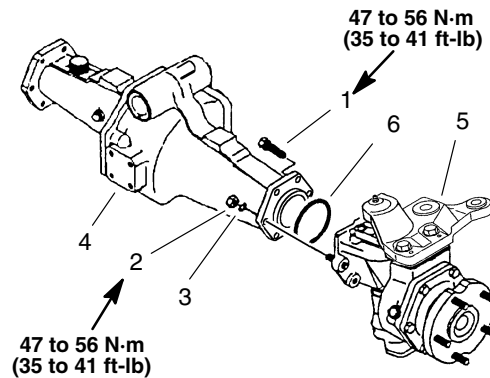
1. LH axle support	23. RH axle support	45. Bevel gear shaft
2. Flange bushing (2 used)	24. Input shaft assembly	46. Axle case (LH shown)
3. Axle vent	25. Bolt (8 used)	47. Ball bearing
4. Filter	26. O-ring	48. Bevel gear (29 tooth)
5. Vent extension	27. Differential shaft (LH shown)	49. Shim set
6. Cap screw (4 used per gear case)	28. Shim set	50. Clip (2 used per axle case)
7. Shim set	29. Ball bearing	51. Axle cover
8. Seal washer	30. Bevel gear (15 tooth)	52. Screw (6 used per cover)
9. Plug	31. Retaining ring	53. Wheel stud (5 used per axle)
10. Lock nut	32. Bolt (4 used per knuckle)	54. Axle
11. Lock washer	33. Shim set	55. Oil seal
12. Grease fitting	34. Dowel pin (2 used per axle case)	56. Ball bearing
13. Ball bearing	35. Bushing	57. O-ring
14. Screw (2 used per steering arm)	36. Knuckle pin	58. Retaining ring
15. Axle case support (LH shown)	37. O-ring	59. Spacer
16. Bolt (2 used)	38. Bevel gear case (LH shown)	60. Axle case cover
17. Stud (2 used)	39. Bushing	61. Seal washer
18. Shim set	40. Shaft seal	62. Plug
19. Differential assembly	41. Stud (2 used per gear case)	63. Bevel gear (17 tooth)
20. O-ring	42. Bolt (4 used per cover)	64. O-ring
21. Plug	43. Collar	
22. O-ring	44. Bevel gear (17 tooth)	

Note: Figure 263 illustrates the rear axle used on the Groundsmaster 4000 and 4010. 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



g276508

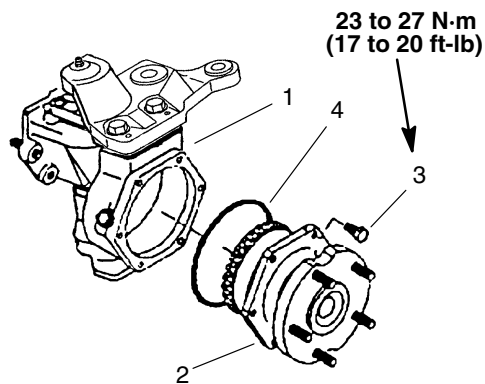
Figure 264

- | | |
|-------------------------|---------------------------------------|
| 1. Cap screw (4 used) | 4. Axle support |
| 2. Lock nut (2 used) | 5. Bevel gear case/axle case assembly |
| 3. Lock washer (2 used) | 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 264](#)).
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.



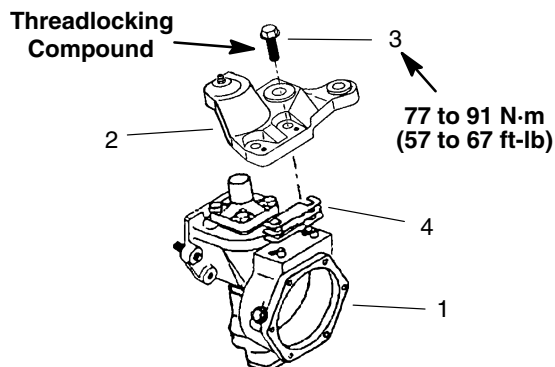
g276510

Figure 265

- | | |
|------------------------|-------------------|
| 1. Axle case | 3. Screw (6 used) |
| 2. Axle cover assembly | 4. O-ring |

3. Remove the axle cover mounting screws. Remove the axle cover from the axle case as an assembly ([Figure 265](#)).

Removal (continued)

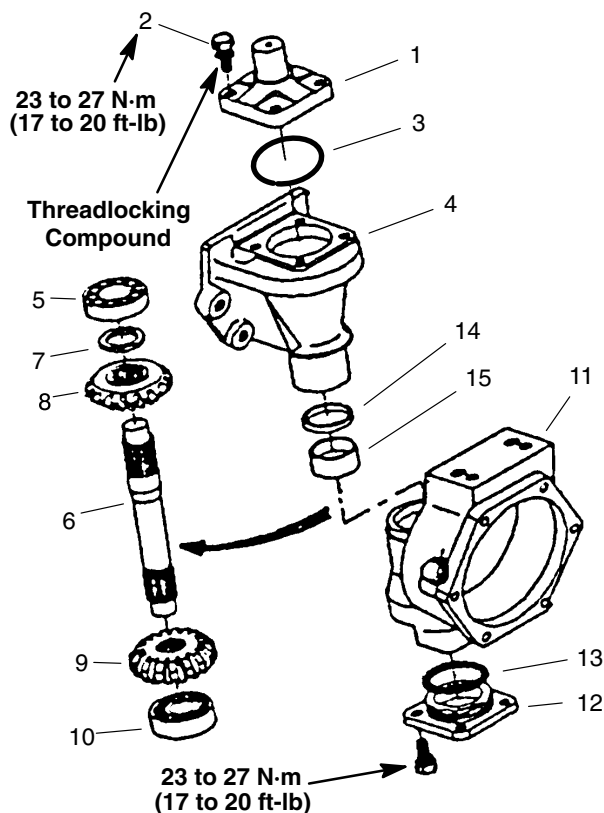


g276511

Figure 266

- | | |
|----------------------|-------------------|
| 1. Axle case | 3. Screw (2 used) |
| 2. Axle case support | 4. Support shim |

4. Remove the axle case support mounting screws, the axle case support and the support shims ([Figure 266](#)).



g276512

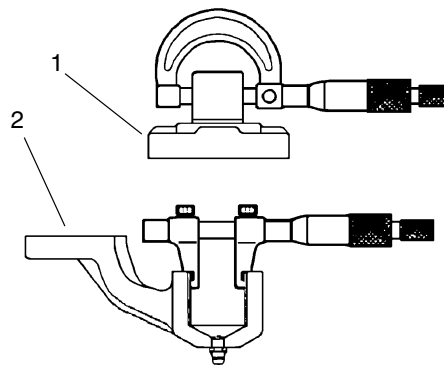
Figure 267

- | | |
|----------------------------|---------------------|
| 1. Knuckle pin | 9. Lower bevel gear |
| 2. Mounting screw (4 used) | 10. Lower bearing |
| 3. O-ring | 11. Axle case |
| 4. Bevel gear case | 12. Axle case cover |
| 5. Upper bearing | 13. O-ring |
| 6. Bevel gear shaft | 14. Shaft seal |
| 7. Collar | 15. Bushing |
| 8. Upper bevel gear | |

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 267).
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 267).

Inspection



g276513

Figure 268

1. Knuckle pin
2. Axle case support

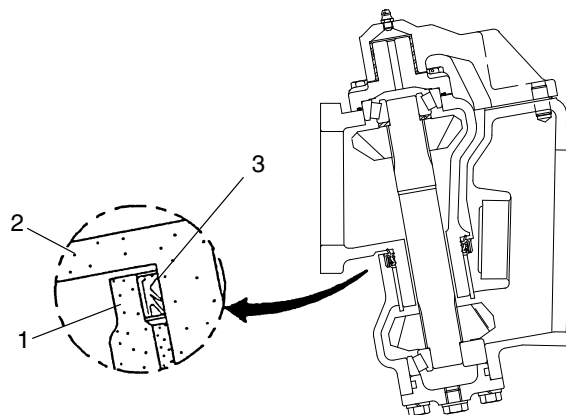
1. Measure the knuckle pin O.D. and the axle case support bushing I.D. to determine the bushing to pin clearance (Figure 268). Replace components as necessary.

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.

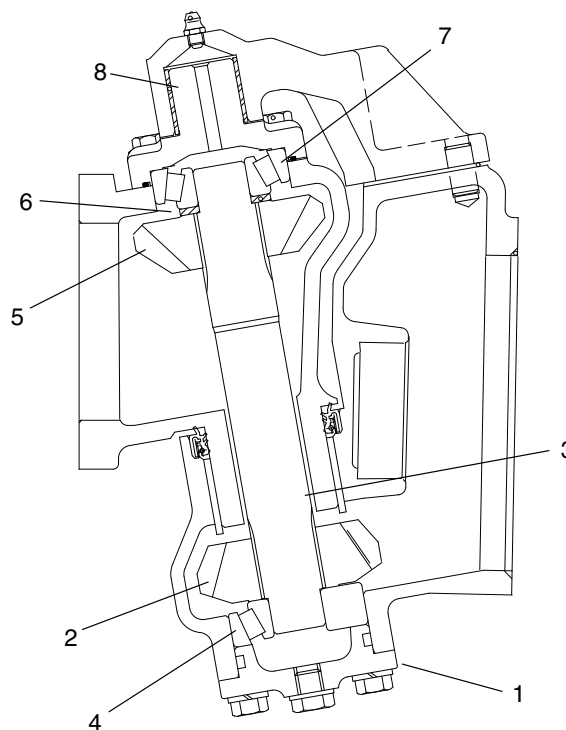


g276514

Figure 269

- | | |
|--------------------|---------------|
| 1. Axle case | 3. Shaft seal |
| 2. Bevel gear case | |

1. Coat new shaft seal with grease and install in axle case as shown ([Figure 269](#)).



g276515

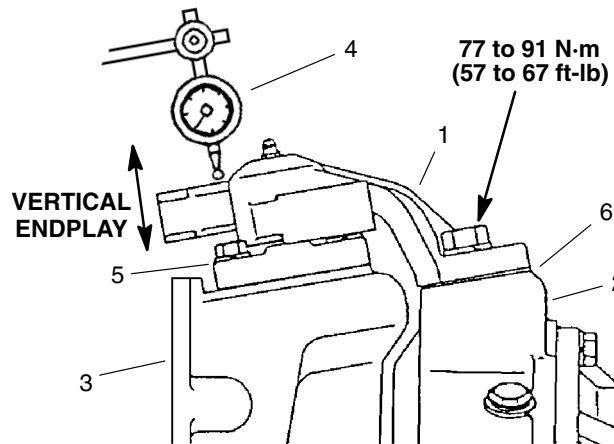
Figure 270

- | | |
|---------------------|---------------------|
| 1. Axle case cover | 5. Upper bevel gear |
| 2. Lower bevel gear | 6. Collar |
| 3. Bevel gear shaft | 7. Upper bearing |
| 4. Lower 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 270](#)). Tighten cover screws from **23 to 27 N·m (17 to 20 ft-lb)**.
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 270](#)).

Installation (continued)

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)**.



g276516

Figure 271

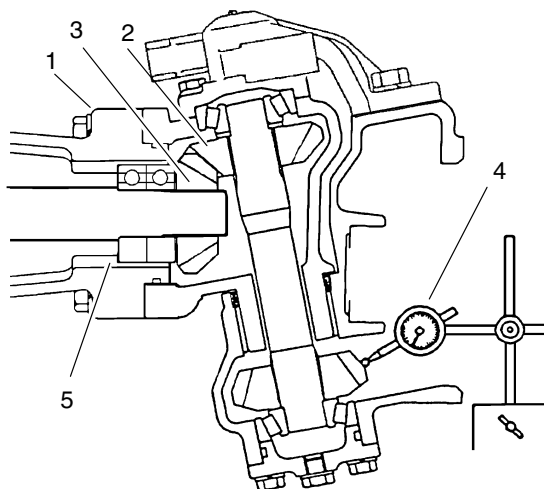
- | | |
|----------------------|--------------------------|
| 1. Axle case support | 4. Dial indicator |
| 2. Axle case | 5. Knuckle pin |
| 3. Bevel gearcase | 6. Support shim location |

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 271).
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)



g276517

Figure 272

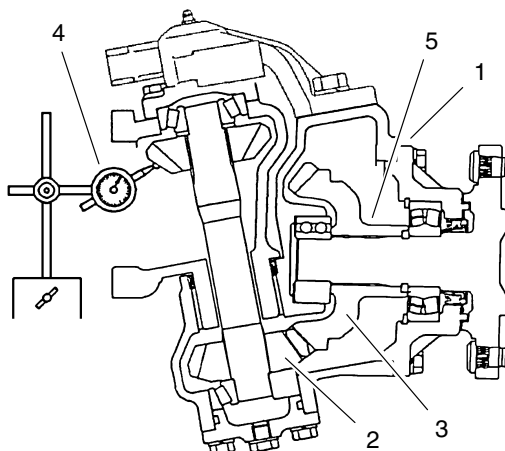
- | | |
|----------------------------|-----------------------|
| 1. Axle support | 4. Dial indicator |
| 2. Upper bevel gear | 5. Axle bearing shims |
| 3. Differential shaft gear | |

-
7. Temporarily install the bevel gear case/axle case assembly on the axle support. Position a dial indicator at the teeth center. Prevent the axle from turning and measure the upper bevel gear to differential shaft gear backlash ([Figure 272](#)).

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.



g276518

Figure 273

- | | |
|------------------------|-----------------------|
| 1. Axle cover assembly | 4. Dial indicator |
| 2. Lower bevel gear | 5. Axle bearing shims |
| 3. Axle gear | |

-
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 tooth's center. Prevent the axle from turning and measure the lower bevel gear to axle gear backlash ([Figure 273](#)).

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 274](#)).

Differential Shafts

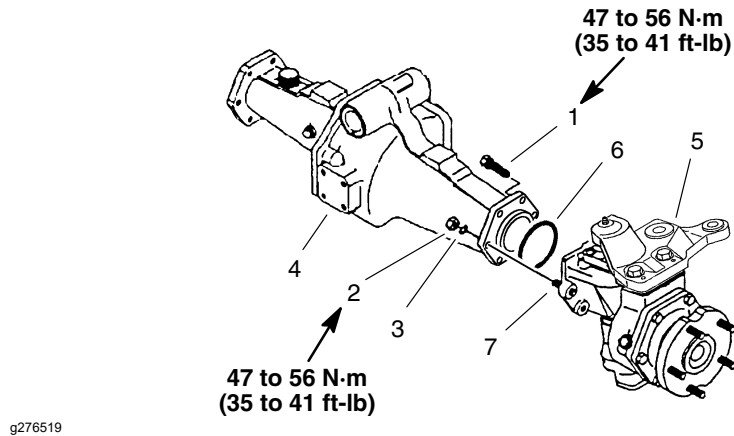


Figure 274

- | | |
|-------------------------|----------------------------------|
| 1. Cap screw (4 used) | 5. Bevel gear/axle case assembly |
| 2. Lock nut (2 used) | 6. O-ring |
| 3. Lock washer (2 used) | 7. Stud (2 used) |
| 4. Axle support | |

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 274](#)).
2. Mark and pull the differential shaft assembly from the axle support.

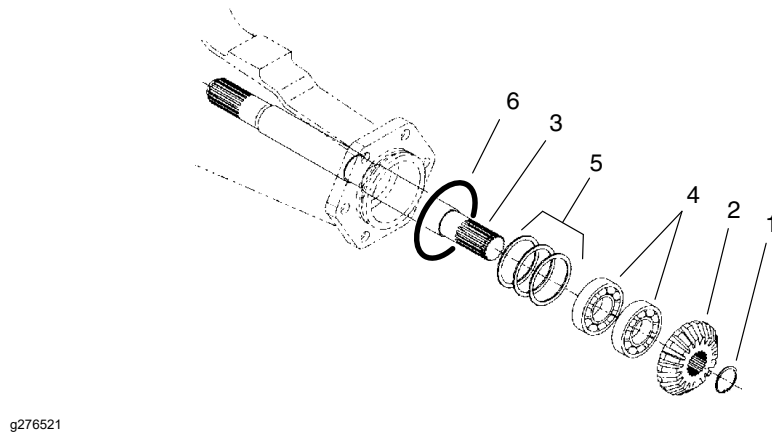


Figure 275

- | | |
|-----------------------|------------------|
| 1. Retaining ring | 4. Bearing |
| 2. Bevel gear | 5. Bearing shims |
| 3. Differential shaft | 6. O-ring |

3. Remove the retaining ring and bevel gear ([Figure 275](#)).
4. Drive the differential shaft out of the bearings. Remove the bearings and bearing shims.

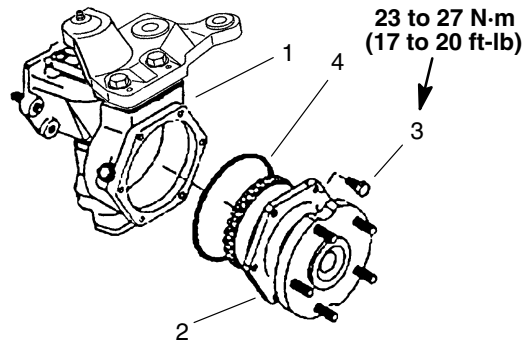
Removal (continued)

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 \(page 7-28\)](#)).

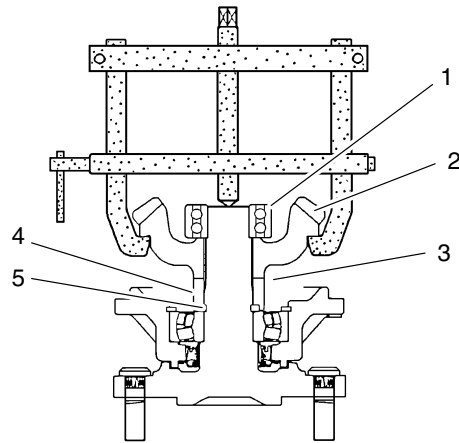
Axle Shafts



g276522

Figure 276

- | | |
|------------------------|-------------------|
| 1. Axle case | 3. Screw (6 used) |
| 2. Axle cover assembly | 4. O-ring |



g276523

Figure 277

- | | |
|---------------|-------------------|
| 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 276](#)).
2. Use a bearing puller to remove the bearing and bevel gear as shown ([Figure 277](#)).
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

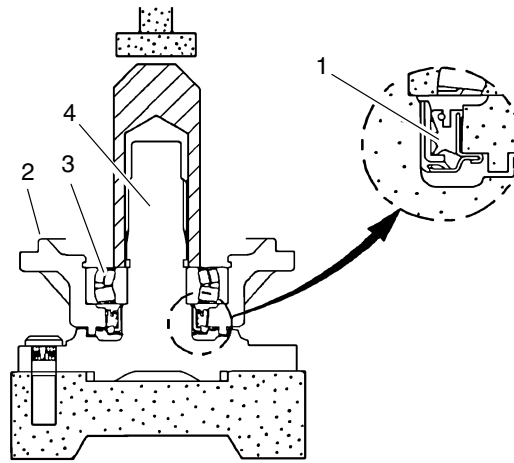


Figure 278

- | | |
|--------------------|---------------|
| 1. Axle shaft seal | 3. Bearing |
| 2. Axle cover | 4. Axle shaft |

-
1. Coat new axle shaft seal with grease and install in axle cover as shown (Figure 278).
 2. Press the axle cover and bearing assembly onto the axle shaft. Press only on the inner race of the cover bearing (Figure 278).
 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

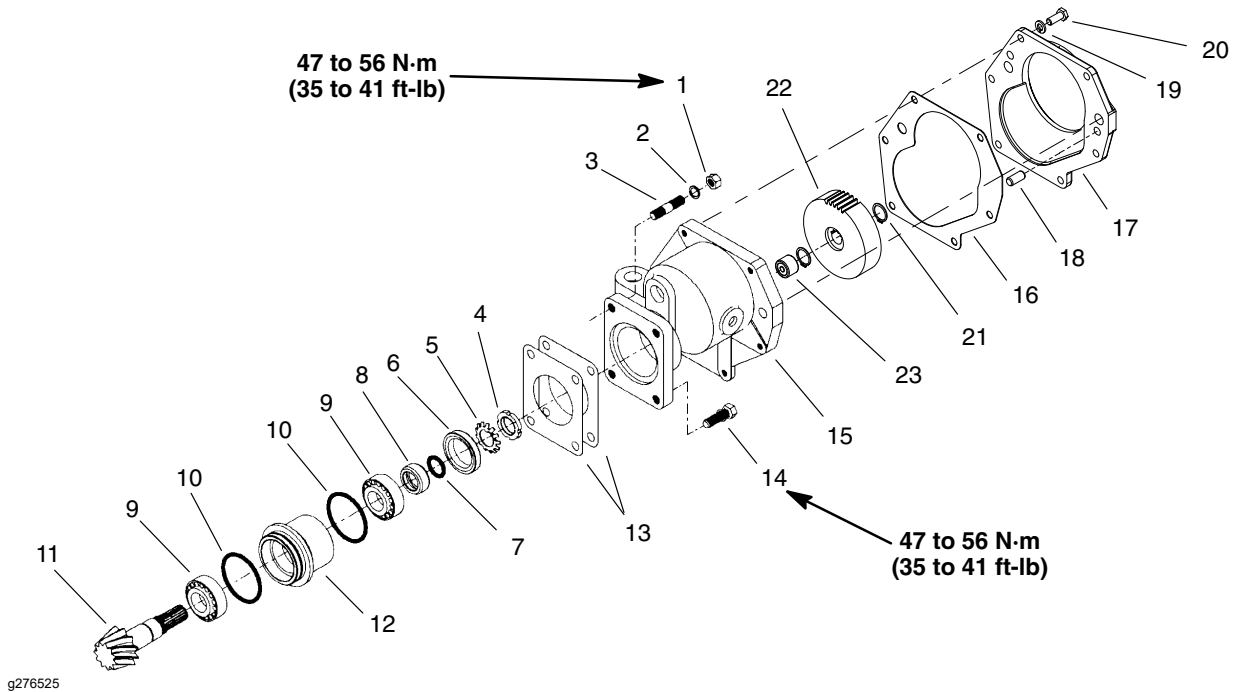


Figure 279

- | | | |
|-------------------------|-----------------------------|-----------------------------|
| 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 279)

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 279)

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.

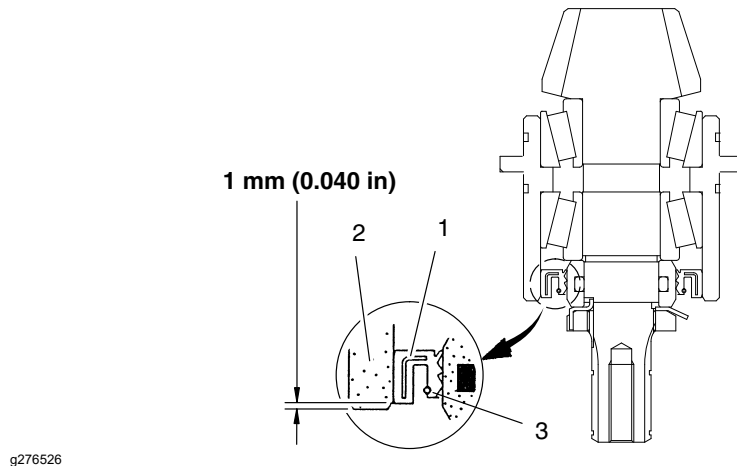


Figure 280

- | | |
|-----------------|-----------------------|
| 1. Oil seal | 3. Seal garter spring |
| 2. Bearing case | |

3. Coat a new oil seal with grease and install as shown in [Figure 280](#). 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.

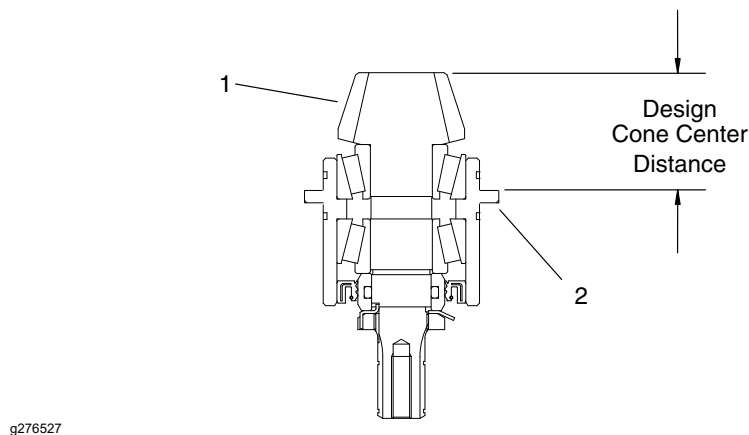


Figure 281

- | | |
|----------------------------|-----------------|
| 1. Input shaft/pinion gear | 2. Bearing case |
|----------------------------|-----------------|

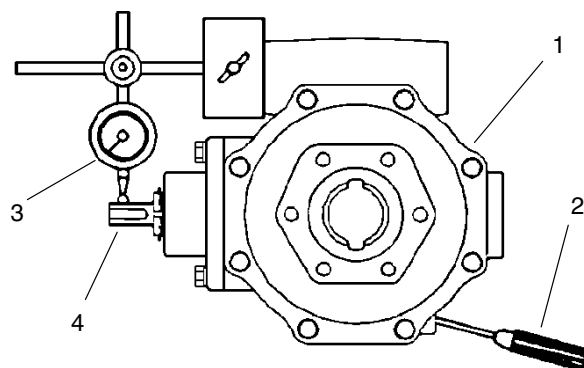
Installation (Figure 279) (continued)

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 281).

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)**.



g276528

Figure 282

- | | |
|----------------|----------------------------|
| 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 282).

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

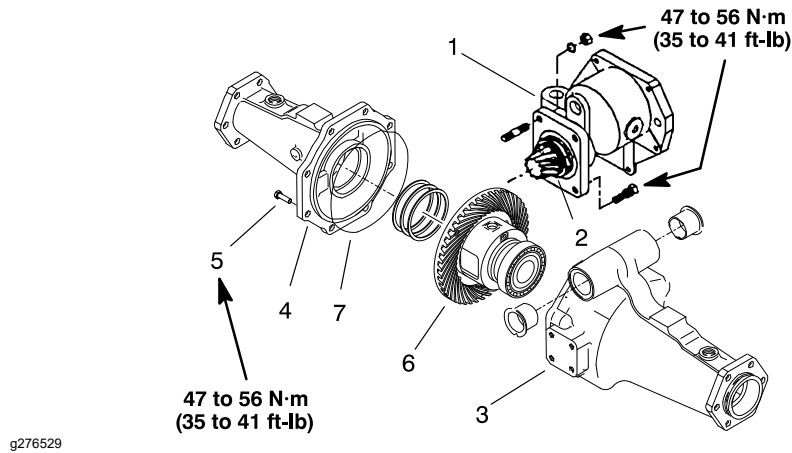


Figure 283

- | | |
|-------------------------|------------------------|
| 1. Gear case | 5. Case screw (8 used) |
| 2. Pinion gear | 6. Differential gear |
| 3. Axle support (left) | 7. O-ring |
| 4. Axle support (right) | |

The following procedures assume the rear axle assembly has been removed from the machine.

Removal

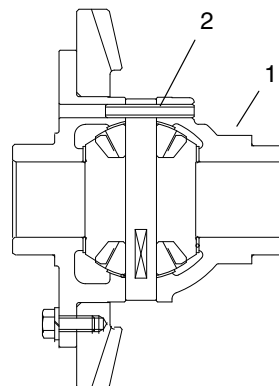
1. Remove bevel gear case/axle case assemblies (see [Bevel Gear Case and Axle Case \(page 7–28\)](#)).

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 283](#)).
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)



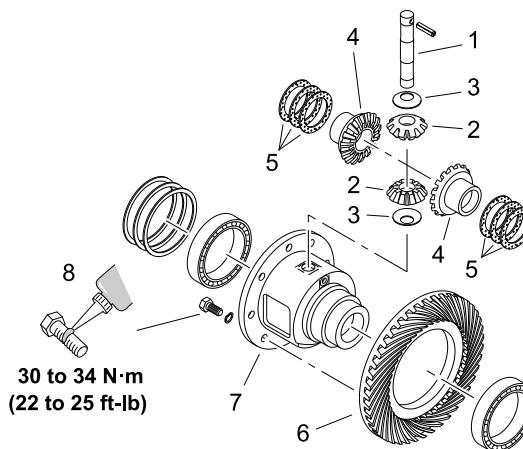
g276530

Figure 284

- | | |
|----------------------|---------------|
| 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 284](#)).

Note: Mark and arrange all components so they can be reassembled in their original position.



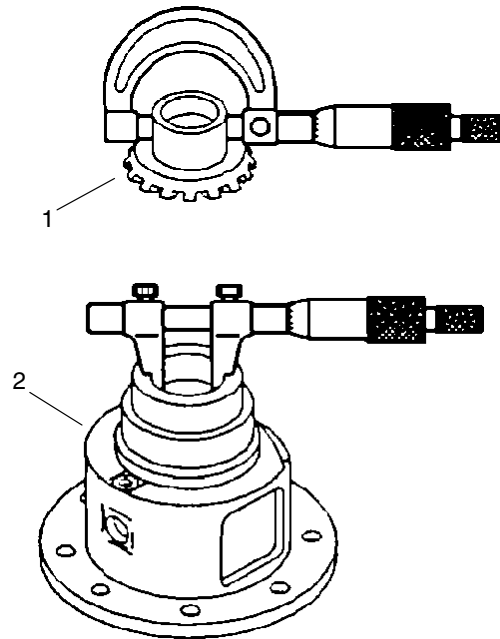
g276532

Figure 285

- | | |
|------------------------------|-------------------------|
| 1. Differential pinion shaft | 5. Side gear shims |
| 2. Pinion gear | 6. Ring gear |
| 3. Pinion washer | 7. Differential case |
| 4. Side gear | 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 285](#)).

Note: Replacement ring gears are only available in matched ring and pinion sets.



g276533

Figure 286

1. Side gear
2. Differential case

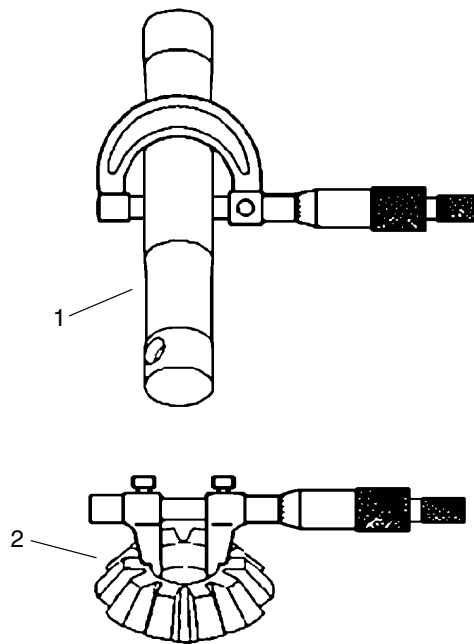
-
1. Measure the differential side gear O.D. and the differential case I.D. to determine the side gear to case clearance ([Figure 286](#)). Replace components as necessary.

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)



g276534

Figure 287

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 287](#)). 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)

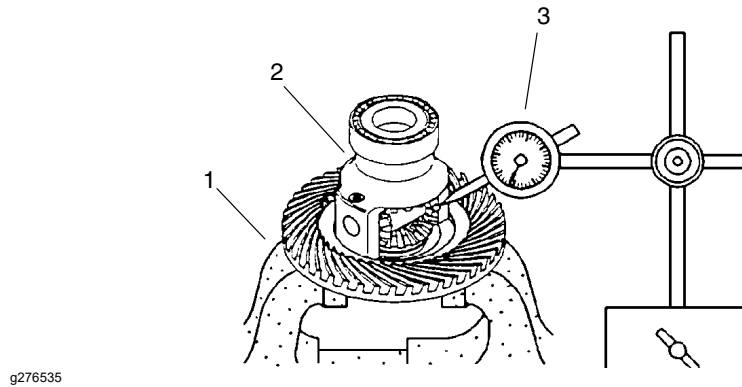


Figure 288

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 288).

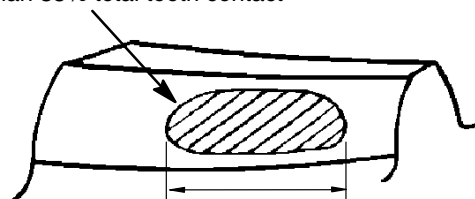
PINION GEAR TO SIDE GEAR BACKLASH: 0.10 to 0.40 mm (0.004 to 0.016 in)

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.

More than 35% total tooth contact



1/3 to 1/2 of entire width
from small end of tooth

g276536

Figure 289

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 289).
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.
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)**.

Installation (continued)

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

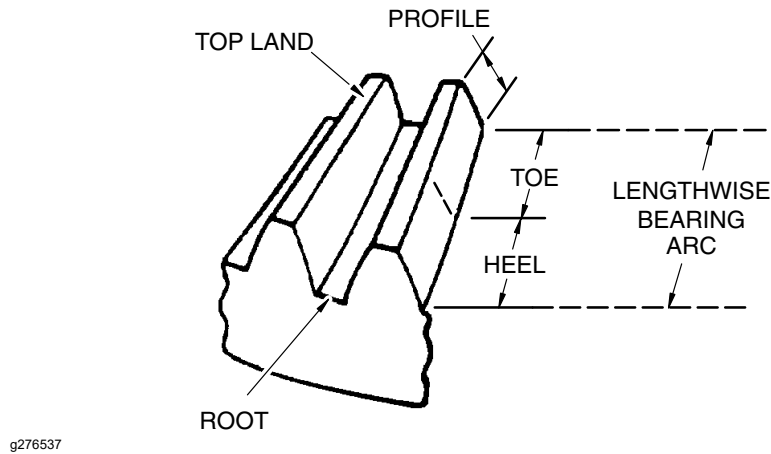


Figure 290

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 290):

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.

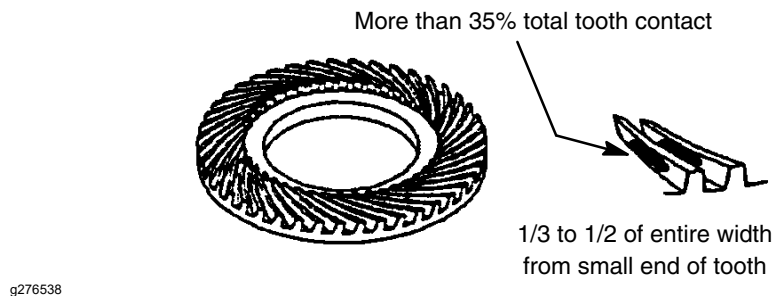
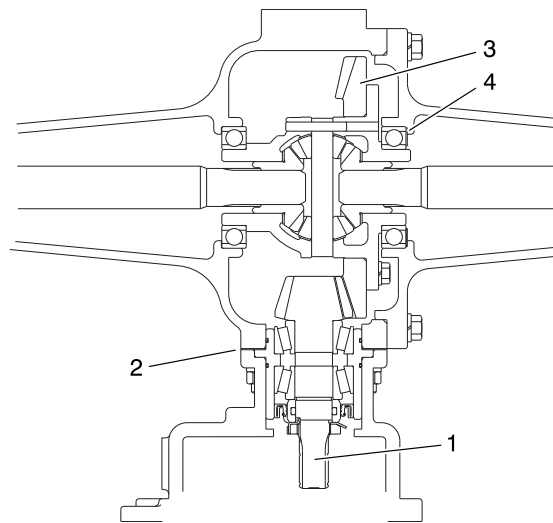


Figure 291

Pinion Gear to Ring Gear Engagement (continued)



g276539

Figure 292

- | | |
|----------------------------|-------------------------------|
| 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 291](#)).

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 292](#)).

Note: Bearing case shims are available in **0.10 mm (0.004 in)** and **0.20 mm (0.008 inch)** thickness.

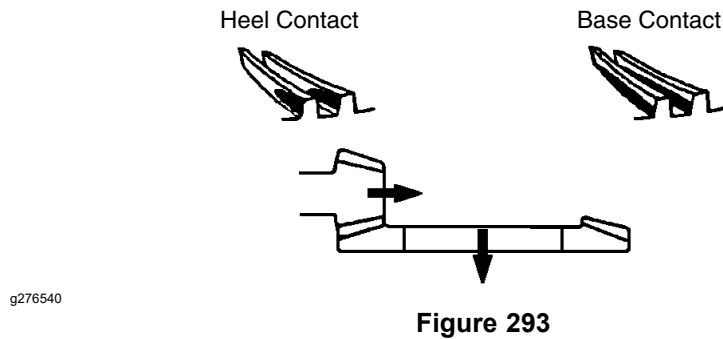
Note: Differential bearing shims are available in **0.10 mm (0.004 in)**, **0.20 mm (0.008 in)** and **0.40 mm (0.016 in)** thickness.

Study the different contact patterns ([Figure 293](#) and [Figure 294](#)) and correct gear engagement as necessary.

Note: When making changes, note that two variables are involved (see [Gear Pattern Movement Summary \(page 7–50\)](#)).

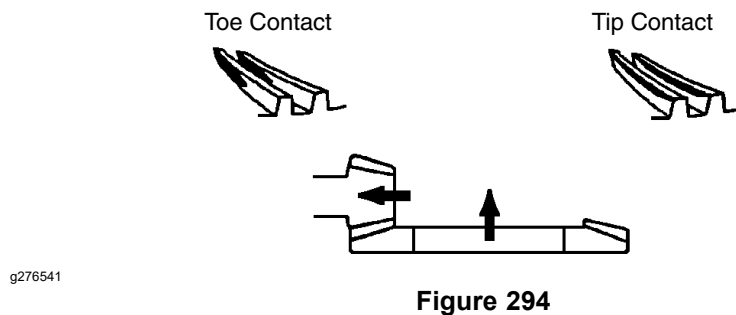
Example: If the pinion gear to ring gear backlash is set correctly to specifications and the bearing case shim is changed to adjust tooth contact, it may be necessary to readjust backlash to the correct specification before checking the contact pattern.

Gear Pattern Movement Summary



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 293](#)):
 - 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.



2. If contact is toward the toe or tip of the gear ([Figure 294](#)):
 - 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.



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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)

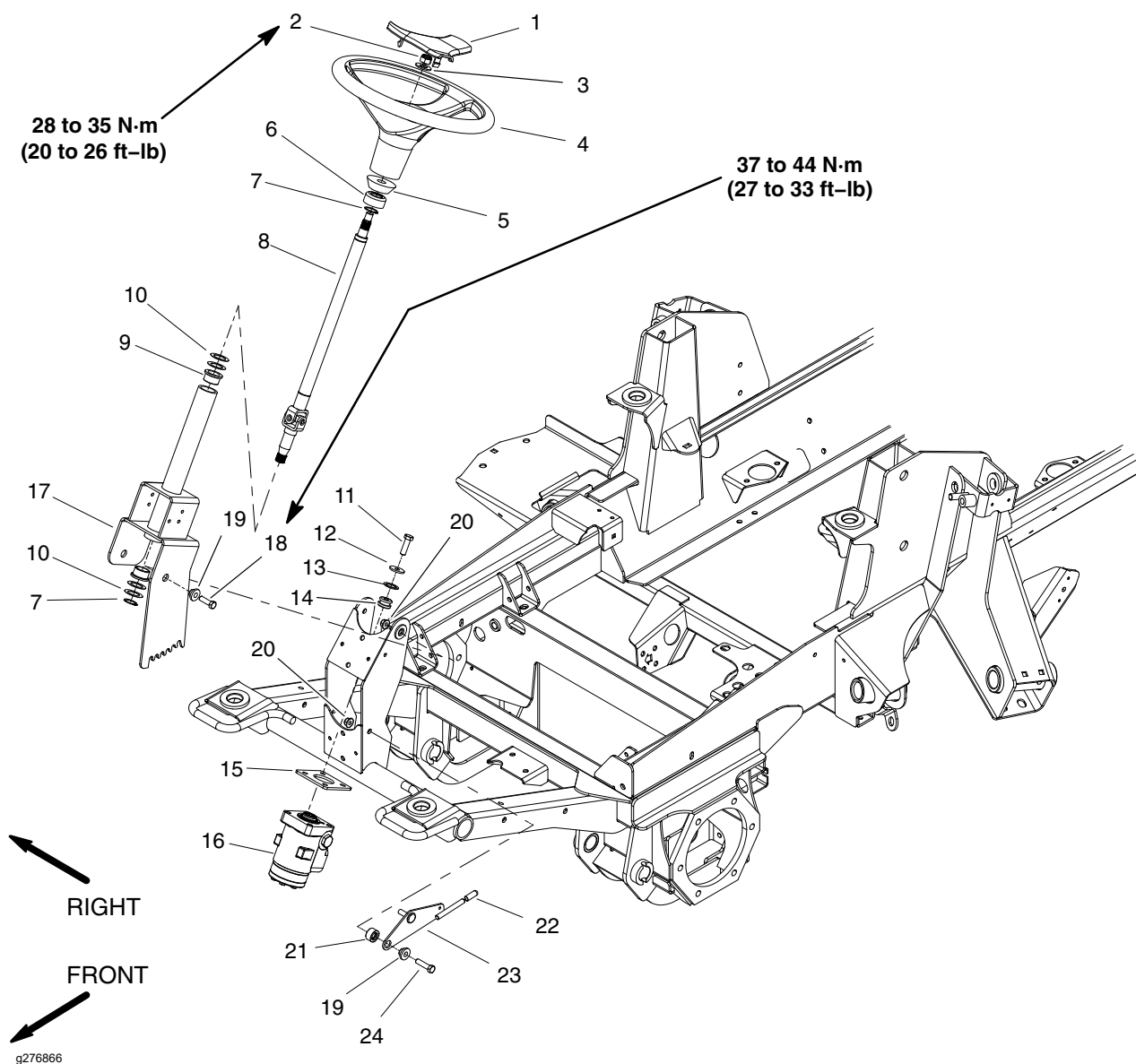


Figure 295

- | | | |
|--------------------------------|-------------------------------|-------------------------|
| 1. Steering wheel cover | 9. Flange bushing | 17. Steering column |
| 2. Hex nut | 10. Thrust washer (as needed) | 18. Cap screw (2 used) |
| 3. Flat washer | 11. Cap screw (4 used) | 19. Pivot hub (3 used) |
| 4. Steering wheel | 12. Washer (4 used) | 20. Flange nut (3 used) |
| 5. Foam collar | 13. Washer (4 used) | 21. Spacer |
| 6. Steering seal | 14. Mount (4 used) | 22. Cap |
| 7. External snap ring (2 used) | 15. Valve mount plate | 23. Tilt lever |
| 8. Steering shaft | 16. Steering control valve | 24. Cap screw |

Disassembly (Figure 295)

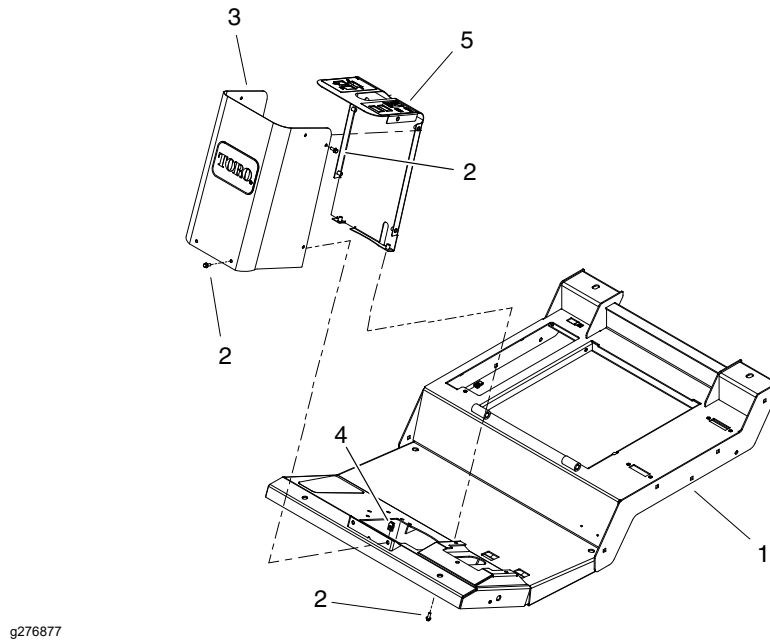


Figure 296

- | | |
|---------------------------|------------------|
| 1. Operator platform | 4. Clip (2 used) |
| 2. Flange screw (10 used) | 5. Rear cover |
| 3. Front cover | |

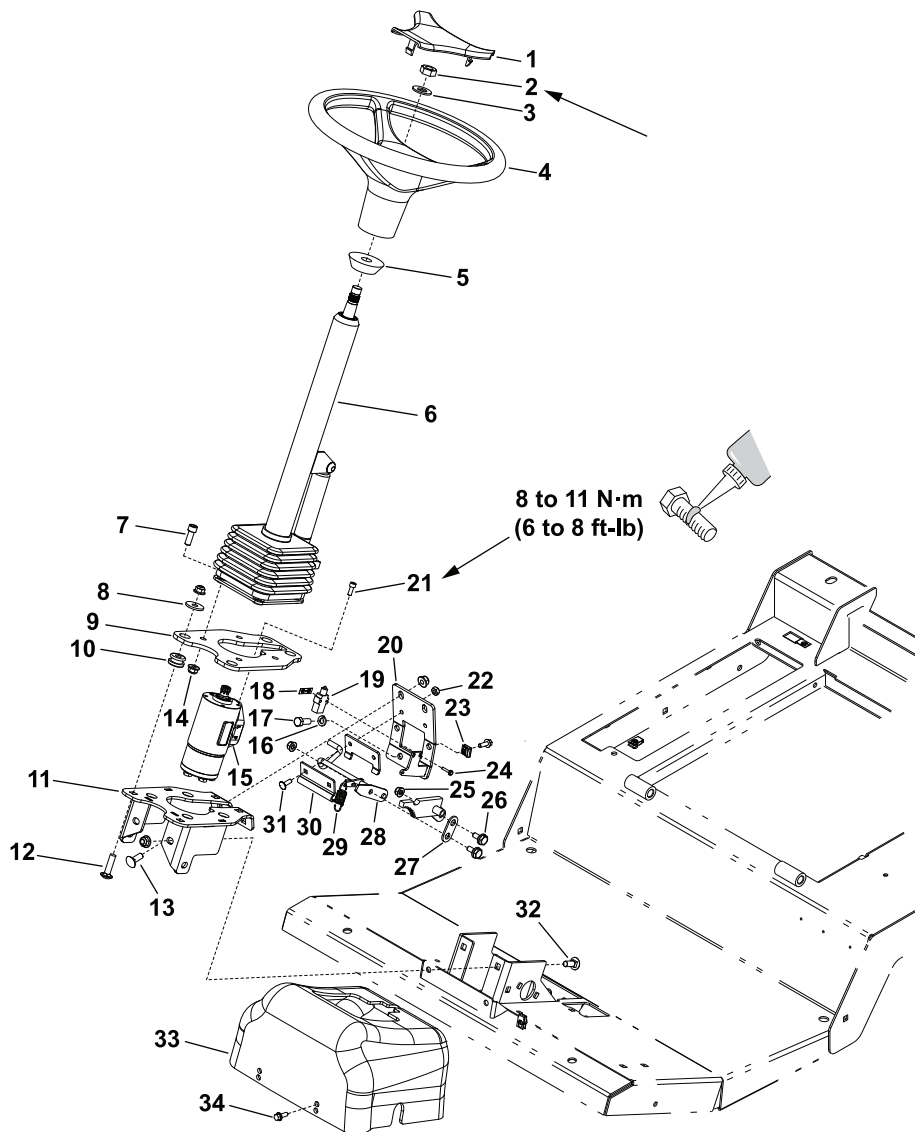
1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the ignition switch.
2. Remove steering tower covers to access steering tower components (Figure 296).
3. Disassemble steering tower as needed using Figure 295 as a guide.

Assembly (Figure 295)

Assemble steering tower using Figure 295 and Figure 296 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 295) 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)



g278210

Figure 297

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

Removal (Figure 297)

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 297) (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 297](#) as a guide.

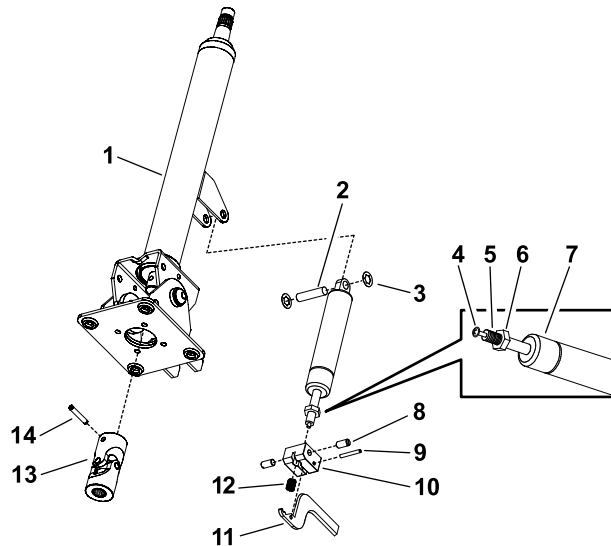


Figure 298

1. Steering tower
2. Pin
3. Lock washer (2 each)
4. Release pin
5. Cylinder shaft
6. Jam nut
7. Cylinder
8. Bolt (2 each)
9. Pin
10. Pedal block
11. Pedal
12. Spring
13. Universal joint
14. Pin

8. Disassemble the steering tower assembly as necessary; refer to [Figure 298](#).

Installation (Figure 297)

1. Assemble the steering tower; refer to [Figure 298](#).
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 297](#) as a guide.
4. Secure the steering wheel to the 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

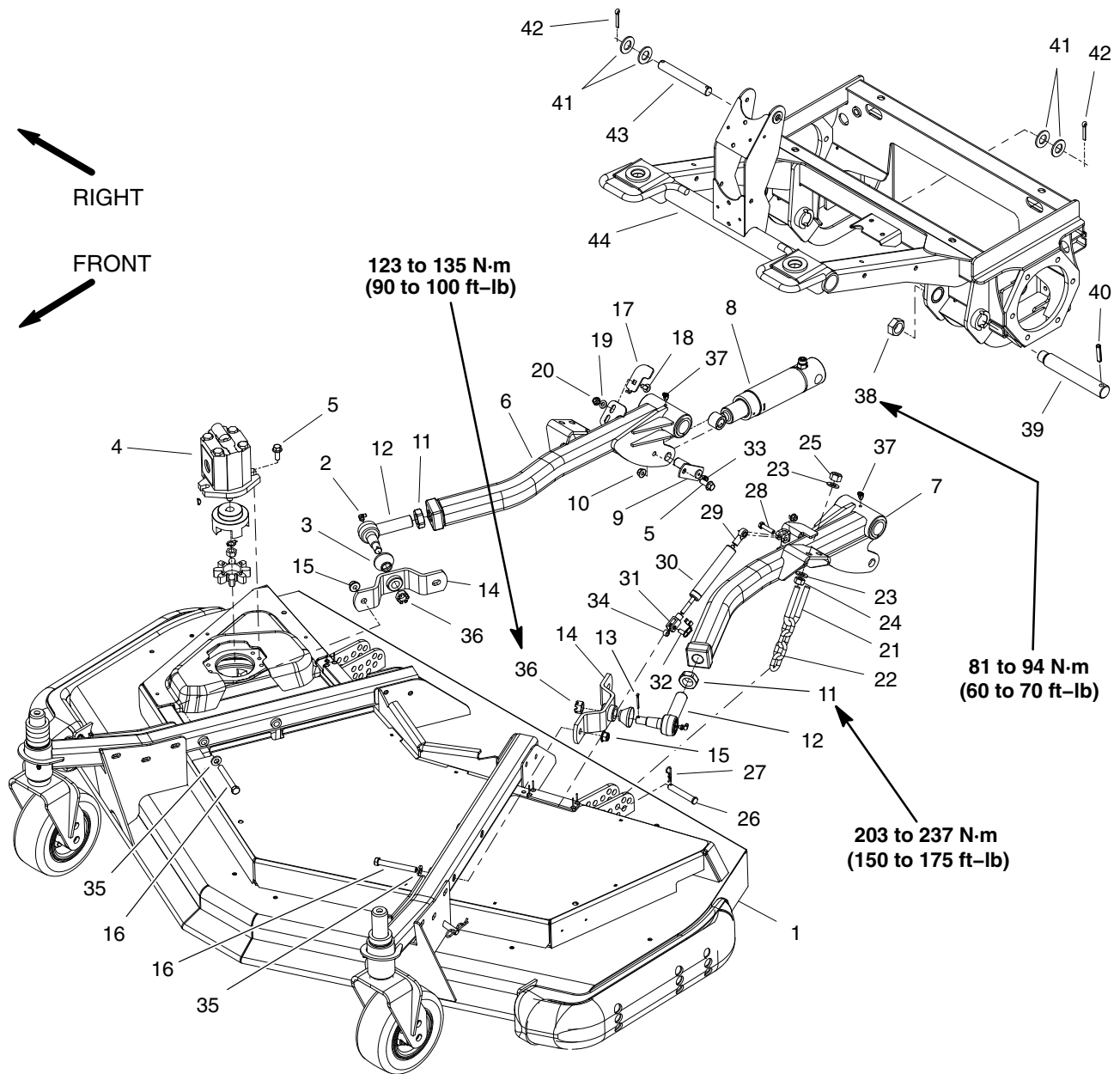


Figure 299

- | | | |
|--------------------------------------|----------------------------------|----------------------------------|
| 1. Center deck assembly | 16. Cap screw (2 per mount) | 31. Clevis rod end |
| 2. Grease fitting | 17. Sensor plate | 32. Spring pin |
| 3. Ball joint seal | 18. Carriage screw | 33. Grease fitting (2 used) |
| 4. Hydraulic deck motor | 19. Flat washer | 34. Spacer |
| 5. Flange head screw | 20. Flange nut | 35. Flat washer (2 used) |
| 6. RH lift arm | 21. U-bolt (2 used) | 36. Slotted hex nut |
| 7. LH lift arm | 22. Height-of-cut chain (2 used) | 37. Grease fitting |
| 8. Lift cylinder (2 used) | 23. Flat washer (4 per u-bolt) | 38. Lock nut (2 used) |
| 9. Pin (2 used) | 24. Hex nut (2 per u-bolt) | 39. Lift arm pin (2 used) |
| 10. Flange nut (2 used) | 25. Lock nut (2 per u-bolt) | 40. Spring pin (2 used) |
| 11. Jam nut (LH threads) (2 used) | 26. Clevis pin (2 used) | 41. Flat washer (4 used per pin) |
| 12. Ball joint (LH threads) (2 used) | 27. Hair pin (2 used) | 42. Cotter pin (2 used per pin) |
| 13. Cotter pin (2 used) | 28. Cap screw | 43. Clevis pin (2 used) |
| 14. Ball joint mount (2 used) | 29. Spherical rod end | 44. Front frame |
| 15. Flange nut (2 per mount) | 30. Damper | |

Removal (Figure 299)

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the ignition switch.
2. Remove center cutting deck (see [Center Cutting Deck \(page 9–4\)](#)).



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.
4. Remove front wheel next to lift arm that is to be removed.
5. Remove cap screw, washers and lock nut that secure lift cylinder pin to lift arm. Remove pin and separate lift cylinder and lift arm.
6. Remove lock nut that secures lift arm pin. Support lift arm and slide pin from frame and lift arm. Remove lift arm from frame.

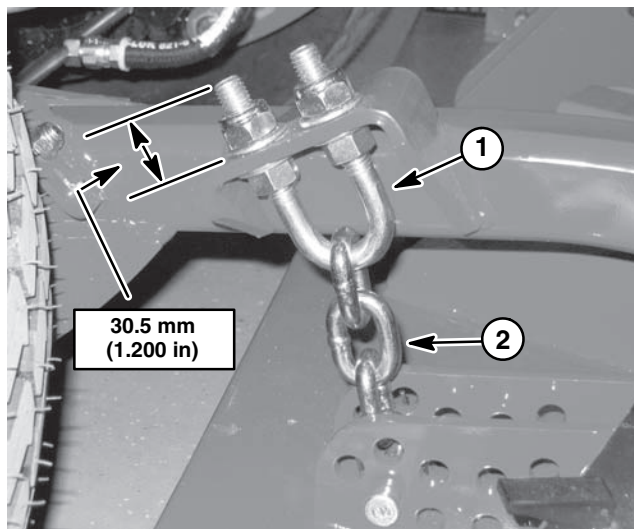
Note: The lift arm ball joint (item 12) and jam nut (item 11) have left hand threads.

7. Remove height-of-cut chain, ball joint mount and ball joint from removed lift arm as required.

Installation (Figure 299)

1. Position lift arm to frame and insert lift arm pin. Engage roll pin into frame slots and install lock nut on pin. Torque lock nut from **81 to 94 N·m (60 to 70 ft-lb)**. Make sure that lift arm pivots freely after installation.
2. Align lift cylinder with lift arm. Slide pin through lift arm and cylinder end. Secure pin with cap screw, washers and lock nut.
3. Install front wheel assembly and lower machine to the ground. Make sure that wheel lug nuts are torqued from **115 to 135 N·m (85 to 100 ft-lb)** in a crossing pattern.
4. If sensing plate (item 32) was removed from lift arm, secure plate fully forward in lift arm slot.

Installation (Figure 299) (continued)



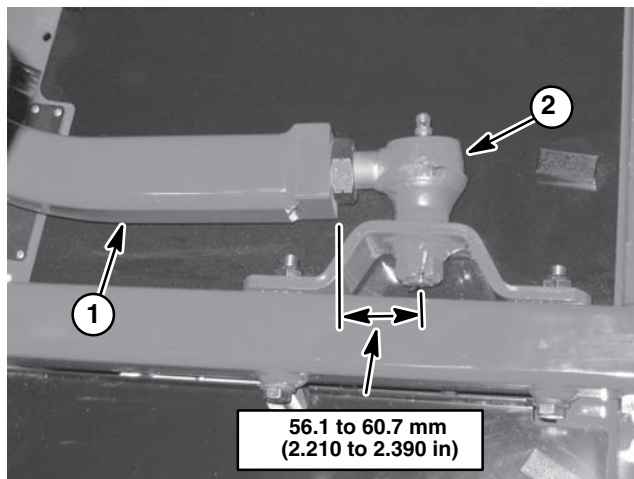
g276894

Figure 300

1. U-bolt
2. Height of cut chain

5. If height-of-cut chain u-bolt was removed from lift arm, assemble u-bolt so that threaded portion extends **30.5 mm (1.200 in)** above lift arm mounting plate (Figure 300). This dimension is a starting point that might need additional adjustment for deck pitch correction (see step 12 below).

Note: The lift arm ball joint (item 12) and jam nut (item 11) have left hand threads.



g276895

Figure 301

1. Lift arm
2. Ball joint

6. If removed, install ball joint to lift arm. Distance from end of lift arm to center of ball joint should be from **56.1 to 60.7 mm (2.210 to 2.390 in)** (Figure 301). Make sure that ball joint is horizontal and that stud is centered in ball joint. Install deck before torquing ball joint jam nut (item 24).
7. Install ball joint mount to ball joint with slotted hex nut. Torque nut from **123 to 135 N·m (90 to 100 ft-lb)** while aligning cotter pin holes. Install cotter pin.
8. Install center cutting deck (see [Center Cutting Deck \(page 9-4\)](#)).
9. If ball joint was removed from lift arm, torque ball joint jam nut from **203 to 237 N·m (150 to 175 ft-lb)**.

Installation (Figure 299) (continued)

10. Lubricate lift arm grease fittings.
11. After assembly is completed, raise and lower the cutting deck to verify that hydraulic hoses and fittings do not contact anything.
12. Check height-of-cut and deck pitch adjustment (refer to *Operator's Manual*).

Side Deck Lift Arms

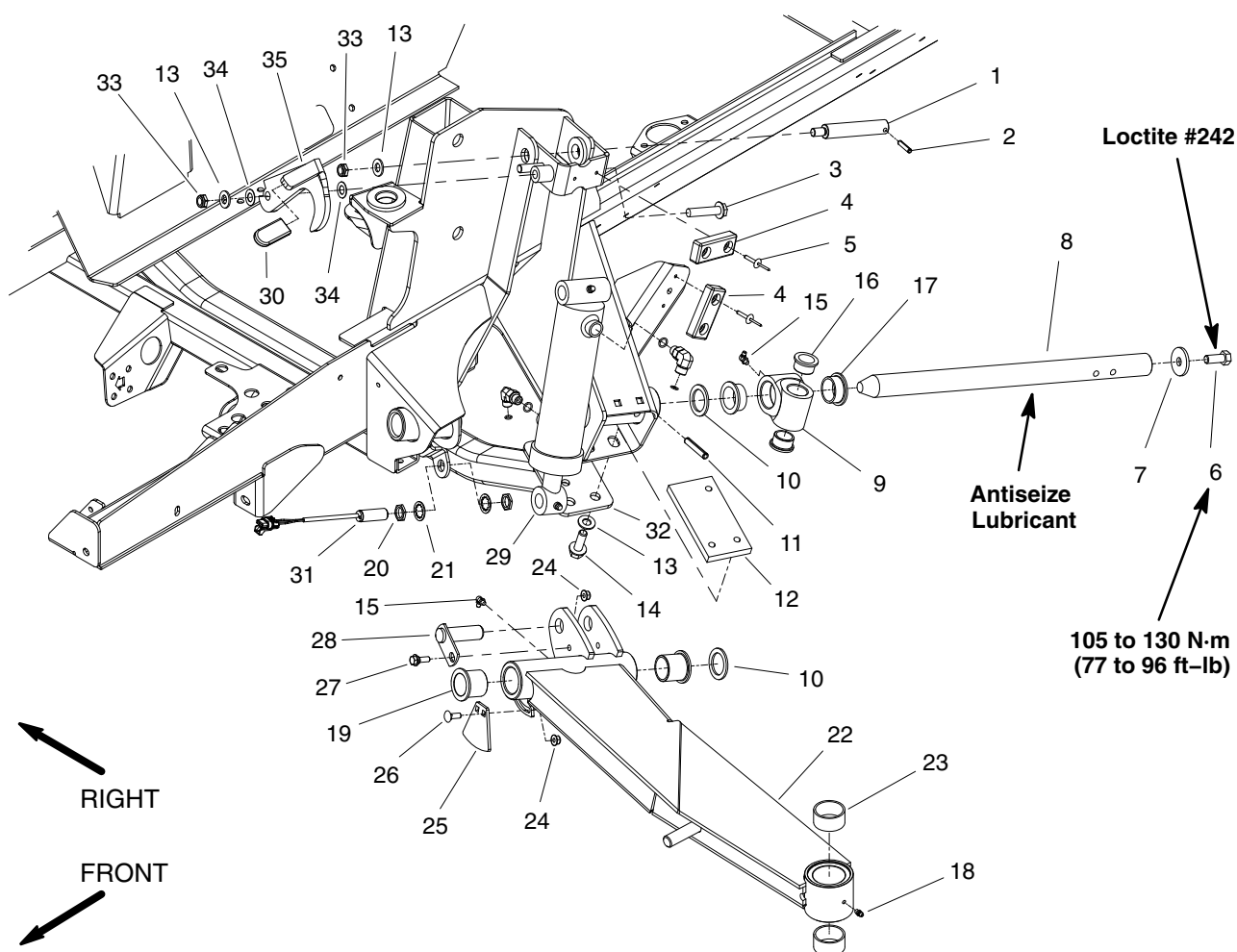
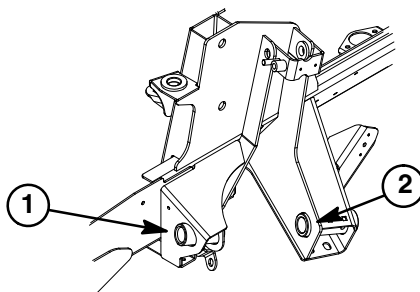


Figure 302

- | | | |
|-------------------------------|--|----------------------------------|
| 1. Lift cylinder pin | 13. Flat washer (5 used per side) | 25. Sensing plate |
| 2. Slotted roll pin | 14. Flange head screw (3 used per block) | 26. Carriage screw (2 per plate) |
| 3. Flange head screw | 15. Grease fitting | 27. Shoulder screw |
| 4. Rubber bumper | 16. Flange bushing (2 per hub) | 28. Cylinder pin |
| 5. Rivet (2 per bumper) | 17. Flange bushing (2 per hub) | 29. Lift cylinder |
| 6. Cap screw | 18. Grease fitting | 30. Plastic grip |
| 7. Thrust washer | 19. Flange bushing (2 per lift arm) | 31. Proximity switch |
| 8. Lift arm pivot shaft | 20. Jam nut (2 per switch) | 32. Crossmember |
| 9. Pivot hub | 21. Washer (2 per switch) | 33. Lock nut (2 per side) |
| 10. Thrust washer (as needed) | 22. Lift arm (LH shown) | 34. Washer (2 per latch) |
| 11. Spring pin | 23. Bushing (2 per lift arm) | 35. Latch (LH shown) |
| 12. Tapped block | 24. Flange nut (3 used per side) | |

Note: There are not bushings in the frame to support the lift arm pivot shaft (item 8) because the shaft is fixed in place by a roll pin (item 11). The lift arm (item 22) and pivot hub (item 9) rotate on the pivot shaft and have bushings that can be serviced.



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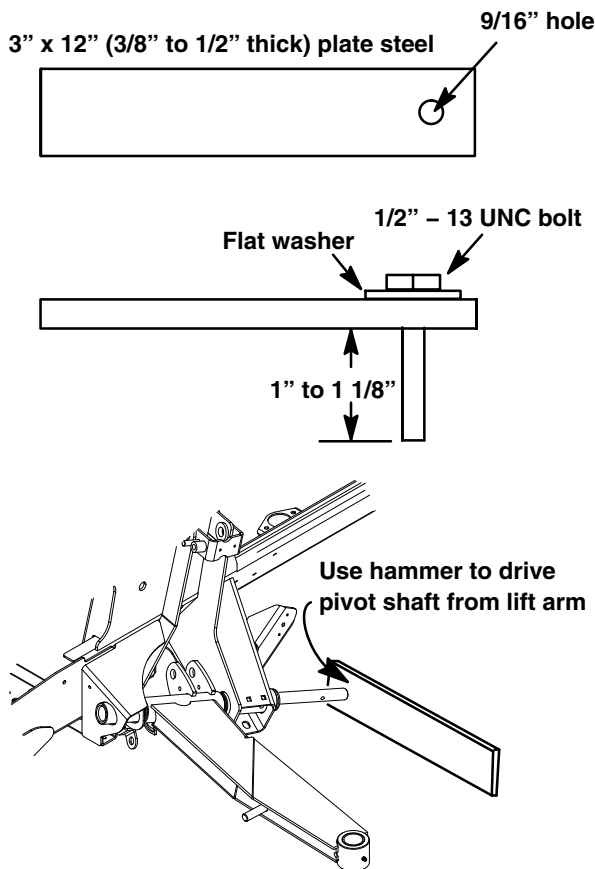
Figure 303

1. Front frame bore
2. Rear frame bore

Note: Allowable clearance between lift arm pivot shaft (item 8) and front frame bore (Figure 303) is up to **0.64 mm (0.025 in)**. Allowable clearance between lift arm pivot shaft and rear frame bore is up to **1.78 mm (0.070 in)**.

Removal (Figure 302)

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the ignition switch.
2. Remove side deck from lift arm (see [Side Cutting Decks \(page 9–7\)](#)).
3. Remove side deck rear arm assembly from pivot hub (see [Side Deck Rear Arm Assembly \(page 8–14\)](#)).
4. Remove lift cylinder pin (item 28) that secures lift cylinder to lift arm.
5. Drive out slotted roll pin (item 11) that retains lift arm pivot shaft. Discard roll pin.



g276898

Figure 304

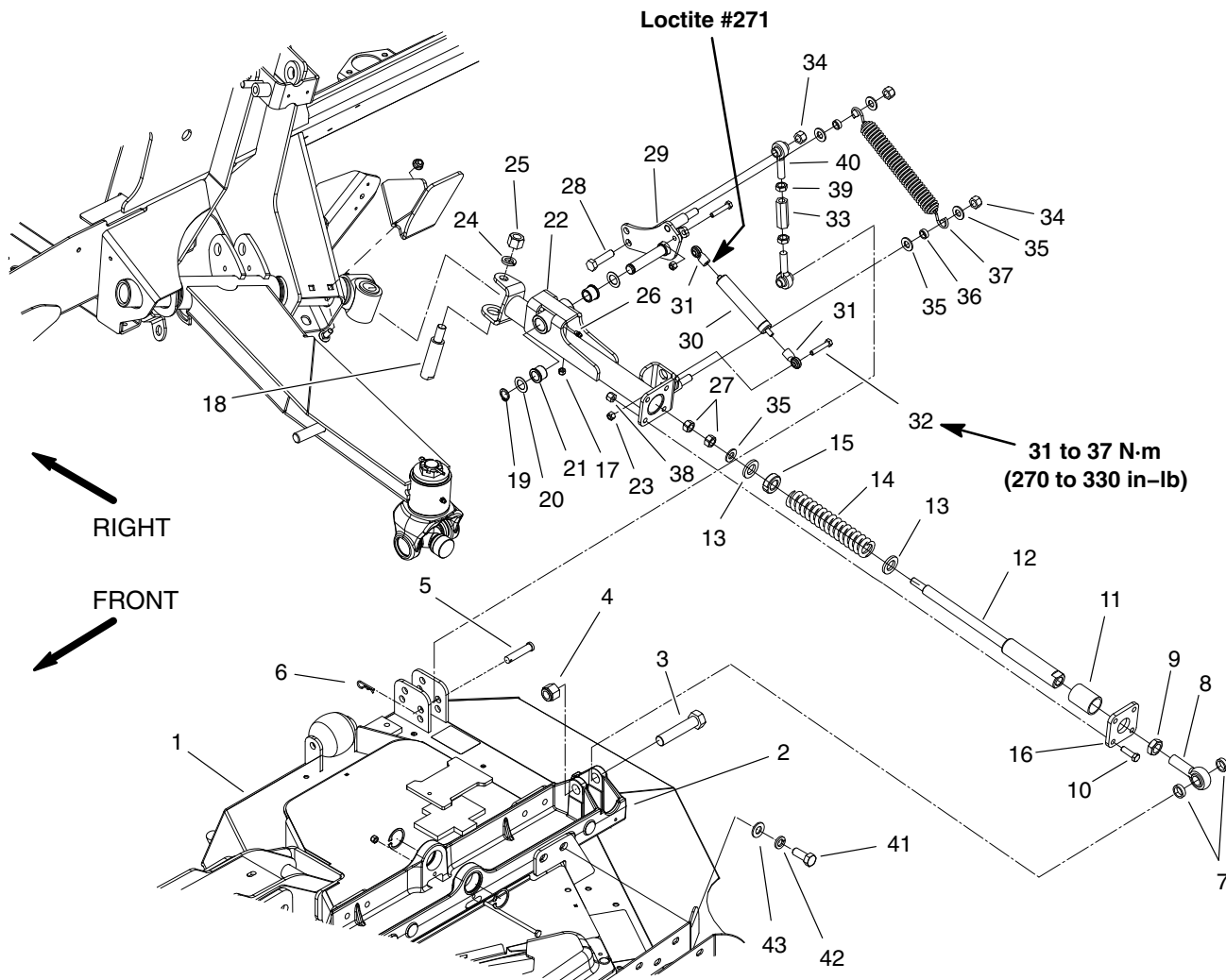
Removal ([Figure 302](#)) (continued)

6. Support lift arm and pull lift arm pivot shaft from lift arm and frame. Locate and remove thrust washers (item 10) during pivot shaft removal. Note location of thrust washers for assembly purposes.
 - A. If pivot shaft is difficult to remove, fabricate a puller as shown in [Figure 304](#).
 - B. Attach puller to end of pivot shaft using bolt and flat washer.
 - C. Drive pivot shaft from lift arm and frame with hammer.
7. Remove lift arm from machine.

Installation ([Figure 302](#))

1. Apply anti-seize lubricant to lift arm pivot shaft.
2. Position lift arm to frame with thrust washers properly placed ([Figure 302](#)). Make sure that there is a thrust washer placed between the rear of the lift arm and frame. Additional thrust washers can be used to remove end play of lift arm.
3. Slide pivot shaft into frame and lift arm until roll pin holes in shaft and frame align. Make sure that lift arm pivots freely after installation.
4. Install new slotted roll pin (item 11) to secure lift arm pivot shaft.
5. If pivot hub (item 9) was removed from pivot shaft, slide pivot hub onto shaft. Apply Loctite #242 (or equivalent) to cap screw threads and secure pivot hub with washer and cap screw. Torque cap screw from **105 to 130 N·m (77 to 96 ft-lb)**.
6. Align lift cylinder with lift arm. Secure lift cylinder to lift arm with lift cylinder pin (item 28). After lift cylinder is secured, make sure that upper hydraulic fitting on lift cylinder does not contact frame.
7. Install side deck rear arm assembly (see [Side Deck Rear Arm Assembly \(page 8–14\)](#)).
8. If sensing plate (item 25) was removed from lift arm, secure plate so it is rotated as far as possible toward center of machine.
9. Position and install side cutting deck to machine (see [Side Cutting Decks \(page 9–7\)](#)).
10. Lubricate lift arm grease fittings after assembly is complete.
11. After assembly is completed, raise and lower the cutting deck to verify that hydraulic hoses and fittings do not contact anything.

Side Deck Rear Arm Assembly

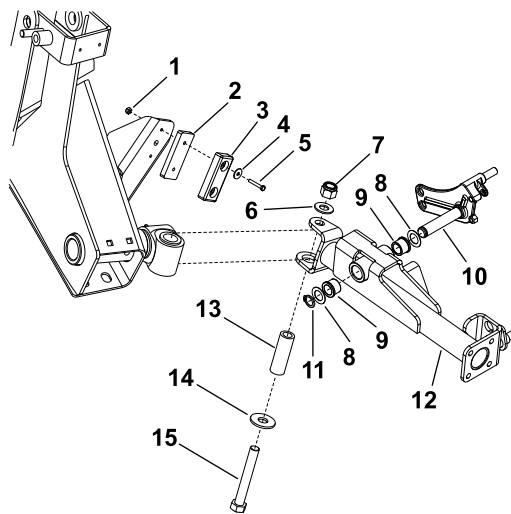


g276899

Figure 305

For machines serial number below 400000000

- | | | |
|----------------------------|-------------------------------|-----------------------------------|
| 1. Cutting deck (LH shown) | 16. Plate | 31. Damper rod end (2 per damper) |
| 2. Deck mount (LH shown) | 17. Lock nut (2 per arm) | 32. Cap screw (2 per damper) |
| 3. Cap screw | 18. Pivot shaft | 33. Link tube |
| 4. Lock nut | 19. Retaining ring | 34. Lock nut |
| 5. Clevis pin | 20. Thrust washer (2 per arm) | 35. Flat washer |
| 6. Hair pin | 21. Flange bushing | 36. Bushing |
| 7. Spacer | 22. Rear arm (LH shown) | 37. Damper spring |
| 8. Rod end | 23. Lock nut (2 per damper) | 38. Lock nut (4 per arm) |
| 9. Jam nut | 24. Lock washer | 39. Jam nut (2 per arm) |
| 10. Cap screw (4 per arm) | 25. Lock nut | 40. Rod end (2 per arm) |
| 11. Straight bushing | 26. Grease fitting | 41. Cap screw (8 used) |
| 12. Spring shaft | 27. Jam nut | 42. Lock washer (8 used) |
| 13. Flat washer | 28. Cap screw | 43. Flat washer (8 used) |
| 14. Compression spring | 29. Bell crank (LH shown) | |
| 15. Plastic bearing | 30. Damper | |



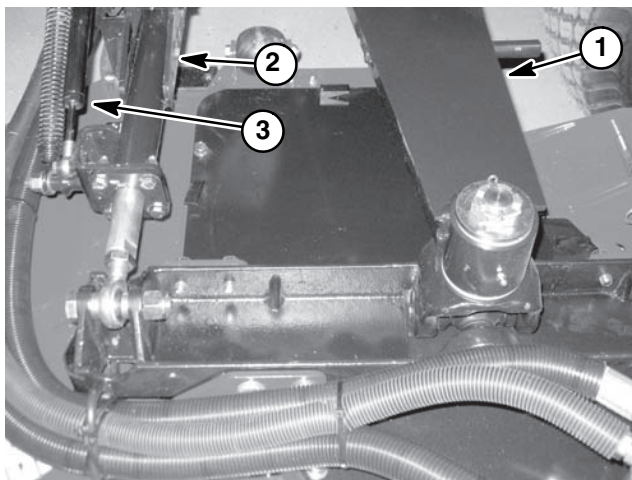
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Figure 306

For machines serial number above 400000000

- | | |
|---------------------------|----------------------------|
| 1. Lock nut (2 each) | 9. Flange bushing (2 each) |
| 2. Plate | 10. Bell crank (LH shown) |
| 3. Bumper | 11. Retaining ring |
| 4. Flat washer (2 each) | 12. LH rear arm |
| 5. Bolt (2 each) | 13. Spacer tube |
| 6. Flat washer | 14. Flat washer |
| 7. Lock nut | 15. Bolt |
| 8. Thrust washer (2 each) | |

Rear Arm Removal (**Figure 305**)



g276867

Figure 307

- | | |
|------------------------|-----------|
| 1. Lift arm (RH shown) | 3. Damper |
| 2. Rear arm | |

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the ignition switch.
2. Remove hair pin (item 6) and clevis pin (item 5) that connect damper link to cutting deck.
3. Remove cap screw (item 3) and lock nut (item 4) that secures rod end of rear arm to cutting deck. Locate and remove spacer from each side of rod end.

Rear Arm Removal (Figure 305) (continued)

4. Remove lock nut (item 25) and lock washer (item 24) that secures rear arm pivot shaft. Slide pivot shaft from hub and rear arm. Remove rear arm assembly from machine.

Rear Arm Disassembly (Figure 305)

Disassemble rear arm assembly using Figure 305 as a guide.

Rear Arm Assembly (Figure 305)

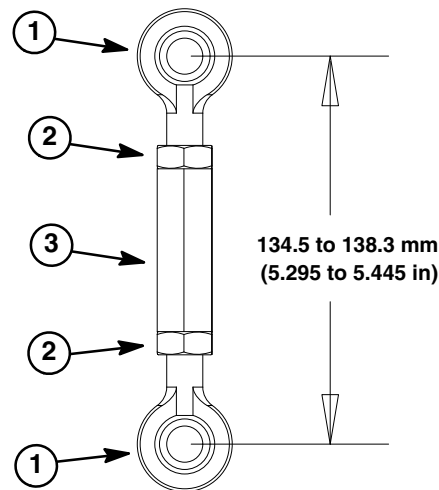
1. Slide large flat washer, spring, plastic bearing, second large flat washer and small flat washer onto spring shaft. Thread one jam nut onto shaft and tighten so that spring is compressed to a length of **195.3 mm (7.690 in)**.
2. Slide the straight bushing and plate onto spring shaft.
3. Insert assembly into rear arm housing.
4. Secure plate to rear arm housing with two (2) cap screws and lock nuts.

IMPORTANT

All free play must be removed from assembly to allow proper operation and ensure long life.

5. Grasp end of spring shaft. Push inward and pull outward on shaft to determine free play in assembly. Loosen jam nut, 1/2 turn at a time, until there is no free play in spring assembly.
6. Remove two (2) cap screws and nuts securing plate to rear arm housing. Remove spring shaft assembly from housing.
7. Thread remaining jam nut onto end of spring shaft and, while retaining inner jam nut to prevent it from moving, torque outer jam nut from **30 to 37 N·m (22 to 28 ft-lb)** to lock adjustment.
8. Thoroughly pack spring with grease. Install spring shaft assembly into housing and secure plate with four (4) cap screws and lock nuts.
9. Thread rod end (item 8) with jam nut (item 9) into end of spring shaft. Do not tighten jam nut at this time.
10. If rod ends (item 31) were removed from damper (item 30), apply Loctite #271 (or equivalent) to damper shaft threads before installing rod ends. Secure damper to bellcrank and rear arm with cap screws and lock nuts.

Rear Arm Assembly (Figure 305) (continued)



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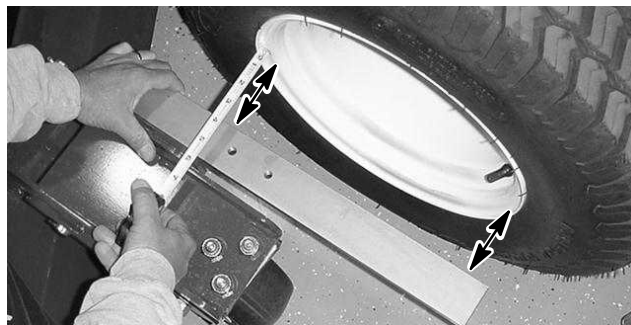
Figure 308

- 1. Rod end (2 used)
- 2. Jam nut (2 used)
- 3. Link tube

11. If damper link was disassembled, adjust the length of the link from **134.5 to 138.3 mm (5.295 to 5.445 in)** (Figure 308).
12. If damper springs (item 37) were removed, tighten lock nuts so that bushings (item 36) are free to rotate.

Rear Arm Installation (Figure 305)

1. Position rear arm assembly to cutting deck and frame.
2. Slide pivot shaft through rear arm clevis and hub. Secure pivot shaft with lock washer (item 24) and lock nut (item 25).
3. Connect damper link to cutting deck with clevis pin (item 5) and hair pin (item 6).
4. Position spacers on both sides of rod end of rear arm assembly. Secure rod end of rear arm assembly to deck mount with cap screw (item 3) and lock nut (item 4).
5. Lubricate rear arm grease fittings.



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Figure 309

6. Align cutting deck to traction unit as follows:
 - A. Make sure the machine is on a level, hard surface.
 - B. Place a square or straight edge against the deck weldment that contains the castor fork assembly (Figure 309). Do not use the castor fork assembly itself.

Rear Arm Installation ([Figure 305](#)) (continued)

- C. Measure from the inset bead of the rim (not the outer edge of the rim) to the straight edge at two locations as indicated in [Figure 309](#). Rim and paint irregularities make the rim outer edge an unreliable point of measure. These two measurements should be the same within a tolerance of **3 mm (1/8 in)**.
- D. Rotate spring shaft (item 12) in rear arm assembly until correct dimension is attained. Shaft should rotate freely inside the assembly. All adjustments must be made with the rod end of the rear arm bolted to the deck.
- E. Raise and lower the deck and recheck dimensions for correct alignment.
- F. When deck is properly aligned to traction unit, tighten rod end jam nut (item 9).

Note: Due to differences in turf conditions and the counterbalance setting of traction unit, it is advised that turf be cut and appearance checked before formal cutting is started. Refer to *Operator's Manual* for correcting cutting deck mismatch procedures.

Lift Arm Joint Yoke

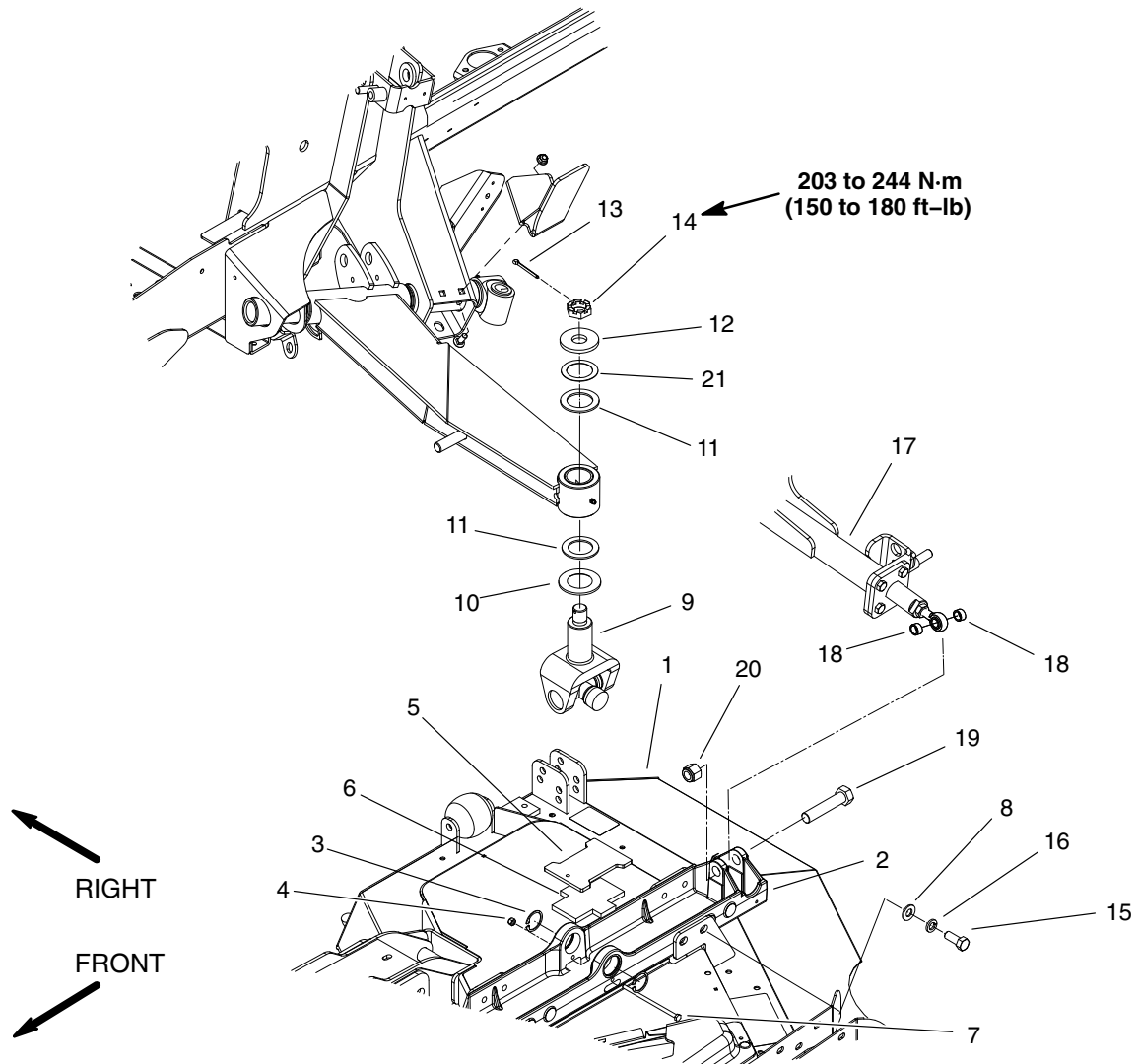


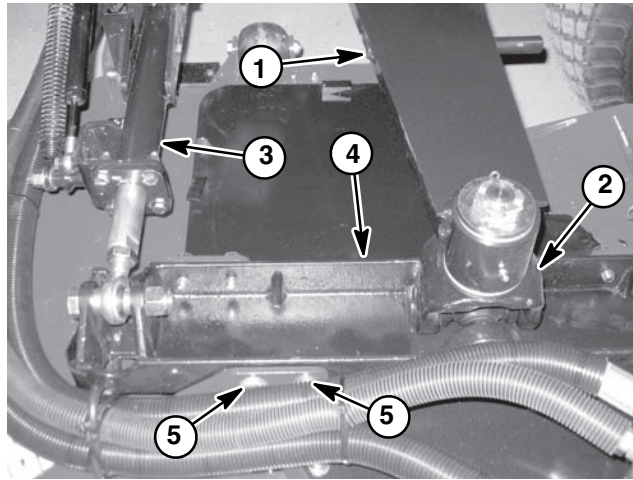
Figure 310

- | | | |
|-------------------------------------|--------------------------------------|--------------------------------------|
| 1. Side cutting deck (LH shown) | 8. Flat washer (8 used per mount) | 15. Cap screw (8 used per mount) |
| 2. Deck mount (LH shown) | 9. Joint yoke | 16. Lock washer (8 used per mount) |
| 3. Retaining ring (2 used per deck) | 10. Spacer | 17. Rear arm assembly |
| 4. Lock nut | 11. Thrust washer (0.125" thickness) | 18. Spacer |
| 5. Plate | 12. Hardened washer | 19. Cap screw |
| 6. Rubber plate | 13. Cotter pin | 20. Lock nut |
| 7. Cap screw | 14. Slotted hex nut | 21. Thrust washer (0.032" thickness) |

Removal (Figure 310)

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the ignition switch.
2. Remove cap screw (item 19) and lock nut (item 20) that secures rod end of rear arm assembly to cutting deck. Locate and remove spacer (item 18) from each side of rod end.

Removal (Figure 310) (continued)



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Figure 311

- | | |
|------------------------|----------------------|
| 1. Lift arm (RH shown) | 4. Deck mount |
| 2. Joint yoke | 5. Cap screw/washers |
| 3. Rear arm assembly | |
-
3. Remove eight (8) cap screws, lock washers and flat washers that secure deck mount to cutting deck (Figure 311).
 4. Remove cotter pin from joint yoke shaft. Make sure that deck mount is supported and remove slotted hex nut that secures joint yoke to lift arm. Take hardened washer (item 12) and thrust washers (items 21 and 11) from joint yoke shaft. Slowly raise lift arm enough to free joint yoke from lift arm. Remove thrust washer (item 11) and spacer (item 10) from yoke shaft.
 5. Lift joint yoke and deck mount from lift arm and cutting deck.

Joint Yoke Disassembly

1. Remove retaining rings from yoke and deck mount.

IMPORTANT

Support yoke when removing cross and bearings to prevent yoke damage.

2. Use a press to remove yoke from deck mount:
 - A. Place a small socket against one bearing in the deck mount and a large socket on the opposite side of the mount.
 - B. While supporting the large socket, apply pressure on small socket to partially push the opposite bearing into the large socket.
 - C. Remove assembly from press, grasp partially removed bearing and tap on yoke to completely remove the bearing.
 - D. Repeat process for remaining bearing.
 - E. Remove yoke from mount.
3. Use a press and the above process to remove bearings and cross from yoke.
4. Thoroughly clean and inspect all components.

Joint Yoke Assembly

1. Make sure that rubber plate (item 6) and plate (item 5) are positioned in bottom of deck mount.
2. Apply a coating of grease to bearing bores of yoke and deck mount. Also, apply grease to bearings and seal of bearing assembly. Make sure that all bearing rollers are properly seated in bearing cage.
3. Use a press to install cross and bearings into yoke.
 - A. Press one bearing partially into yoke.

IMPORTANT

Take care when installing cross into bearing to avoid damaging bearing seal.

- B. Carefully insert cross into bearing and yoke.
 - C. Hold cross in alignment and press bearing in until it hits the yoke.
 - D. Carefully place second bearing into yoke bore and onto cross shaft. Press bearing into yoke.
4. Use a press and the above process to install deck mount to yoke.
 5. Install retaining rings to yoke and deck mount to secure bearings in place.
 6. Make sure that assembled joint yoke moves without binding. Slight binding can usually be eliminated by lightly rapping the yoke lugs with a soft faced hammer. If binding continues, disassemble joint yoke and deck mount to identify and eliminate source of binding.

Installation (Figure 310)

1. Position joint yoke with deck mount to cutting deck.
2. Secure deck mount to deck with eight (8) cap screws, lock washers and flat washers (Figure 311).
3. Place spacer washer (chamfered ID side down) and then thrust washer (item 11) onto joint yoke shaft. Insert yoke shaft up through lift arm bushings. Place additional thrust washers (items 11 and 21) and then hardened washer (item 12) on yoke shaft and secure with slotted hex nut. Torque nut from **203 to 244 N·m (150 to 180 ft-lb)** while aligning hole in shaft with slot in nut. Install cotter pin.
4. Position spacers on both sides of rod end of rear arm assembly. Secure rod end of rear arm assembly to deck mount with cap screw and lock nut.
5. Grease joint yoke and lift arm bushings after installation on machine.
6. After assembly is completed, raise and lower the cutting deck to verify that hydraulic hoses and fittings do not contact anything.

Control Arm

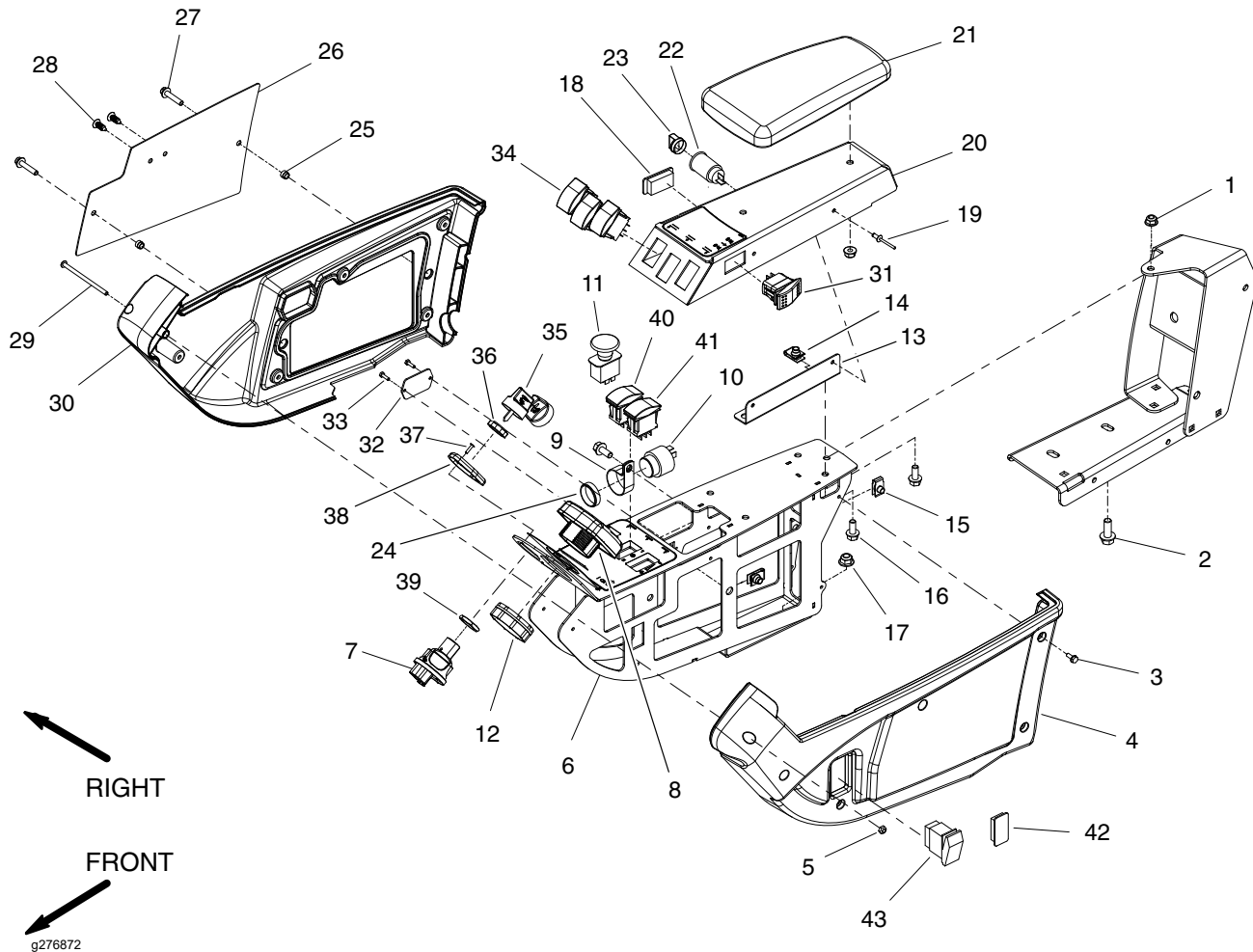


Figure 312

- | | | |
|--------------------------------|--------------------------------|---------------------------------|
| 1. Flange nut (3 used) | 16. Flange head screw (6 used) | 31. Cruise control switch |
| 2. Flange head screw (2 used) | 17. Flange nut (2 used) | 32. Cover plate |
| 3. Washer head screw (10 used) | 18. Hole plug | 33. Cap screw (2 used) |
| 4. LH cover | 19. Rivet (2 used) | 34. Lift/lower switch (3 used) |
| 5. Lock nut | 20. Switch panel | 35. Ignition key |
| 6. Control arm panel | 21. Arm rest | 36. Nut |
| 7. Ignition switch | 22. Power point | 37. Screw (2 used) |
| 8. InfoCenter display | 23. Cap | 38. Switch step |
| 9. R-clamp | 24. Nut | 39. Hex nut |
| 10. Audio alarm | 25. Flange spacer (2 used) | 40. Hi-low speed switch |
| 11. PTO switch | 26. Cover plate | 41. Engine speed switch |
| 12. Nut | 27. Flange head screw (2 used) | 42. Hole plug (GM4000-D) |
| 13. Bracket | 28. Plug (2 used) | 43. Headlight switch (GM4010-D) |
| 14. U-nut (5 used) | 29. Screw | |
| 15. Clip (2 used) | 30. RH cover | |

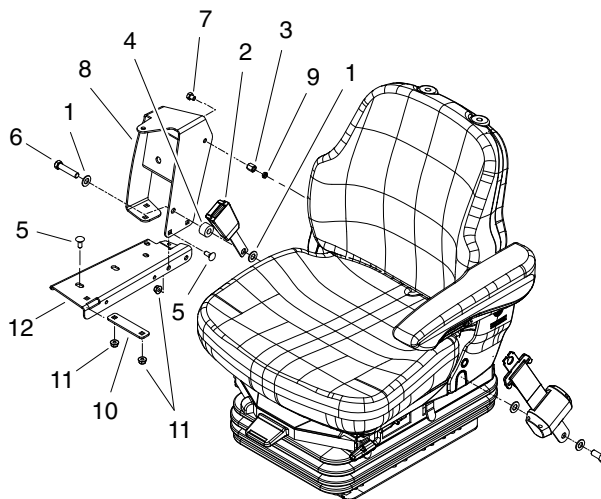
Disassembly (Figure 312)

1. Park machine on a level surface, lower cutting units, stop engine and engage parking brake. Remove key from ignition 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 312) (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 312 as a guide.
7. If necessary, remove control arm panel and supports from machine using Figure 312 and Figure 313 as guides.

Assembly (Figure 313)



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Figure 313

- | | |
|----------------------------|-------------------------|
| 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 312 and Figure 313 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

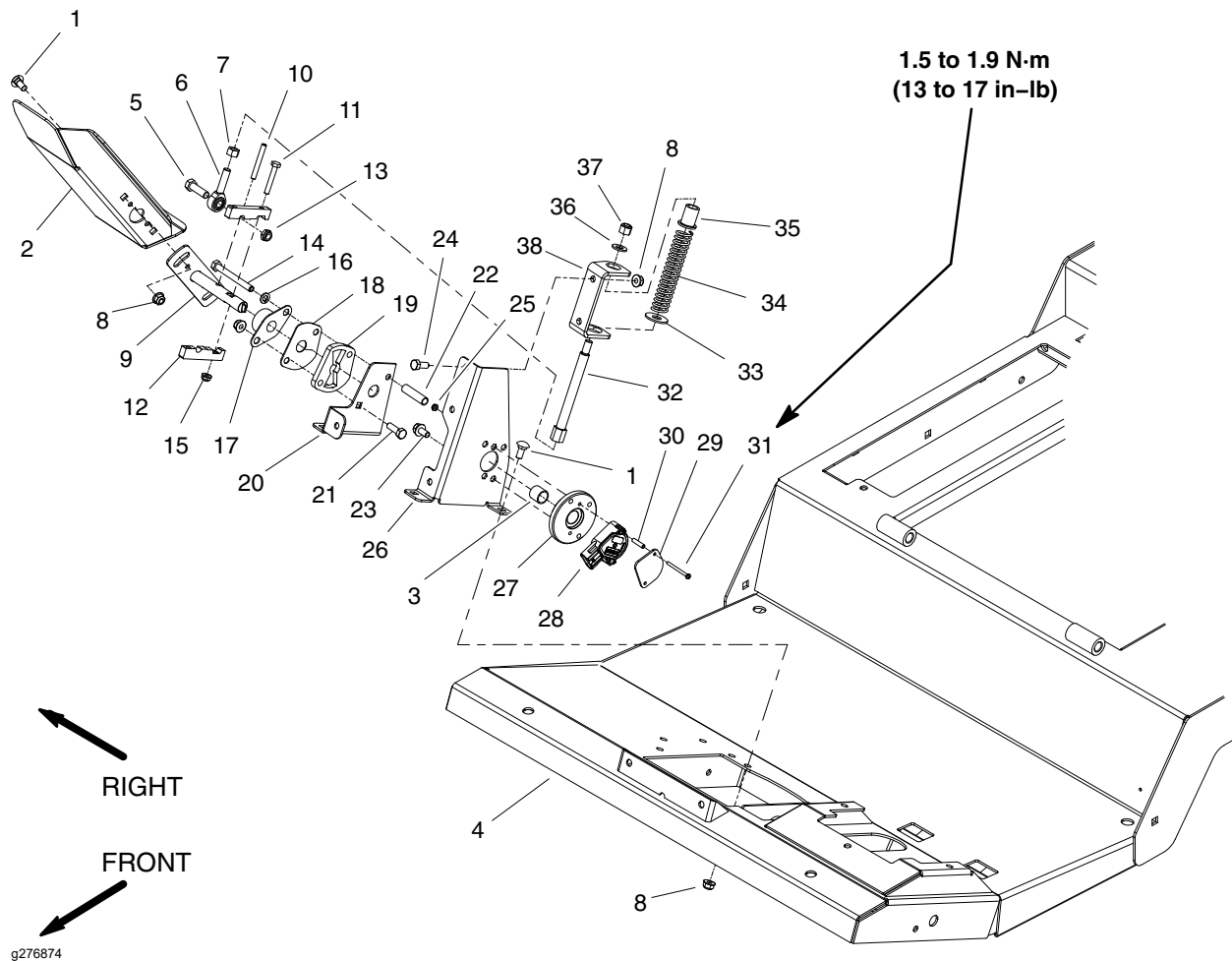
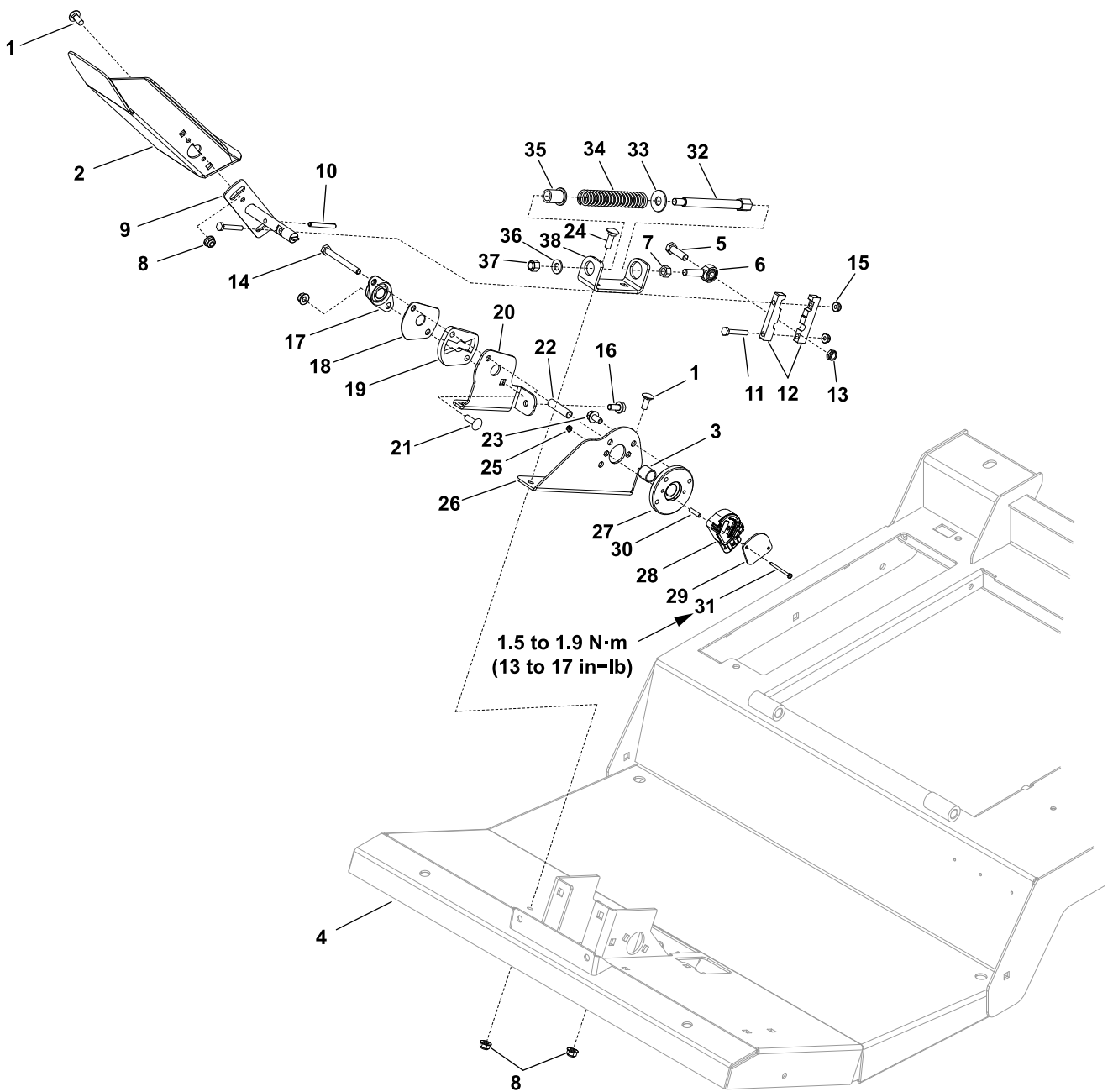


Figure 314

(For machines serial numbers below 400000000)

- | | | |
|---------------------------|-------------------------------|------------------------------|
| 1. Carriage bolt (6 used) | 14. Cap screw | 27. Bushing hub |
| 2. Traction pedal | 15. Flange nut (2 used) | 28. Position sensor |
| 3. Bushing | 16. Lock washer | 29. Capture plate |
| 4. Operator platform | 17. Flange mount bearing | 30. Standoff spacer (2 used) |
| 5. Cap screw | 18. Cover plate | 31. Screw (2 used) |
| 6. Rod end bearing | 19. Butterfly plate | 32. Spring shaft |
| 7. Hex nut | 20. Butterfly bracket | 33. Flat washer |
| 8. Flange nut (10 used) | 21. Carriage screw | 34. Compression spring |
| 9. Traction pedal shaft | 22. Spacer | 35. Spring retainer |
| 10. Roll pin | 23. Threadlock screw (2 used) | 36. Flat washer |
| 11. Cap screw (2 used) | 24. Cap screw (5 used) | 37. Lock nut |
| 12. Clamp block (2 used) | 25. Lock nut (6 used) | 38. Spring bracket |
| 13. Lock nut | 26. Sensor bracket | |



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Figure 315

(For machines serial numbers above 400000000)

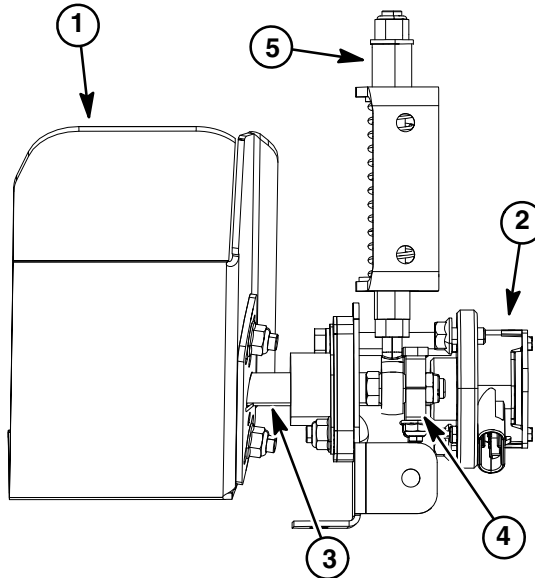
- | | | |
|---------------------------|-------------------------------|------------------------------|
| 1. Carriage bolt (6 used) | 14. Cap screw | 27. Bushing hub |
| 2. Traction pedal | 15. Flange nut (2 used) | 28. Position sensor |
| 3. Bushing | 16. Lock washer | 29. Capture plate |
| 4. Operator platform | 17. Flange mount bearing | 30. Standoff spacer (2 used) |
| 5. Cap screw | 18. Cover plate | 31. Screw (2 used) |
| 6. Rod end bearing | 19. Butterfly plate | 32. Spring shaft |
| 7. Hex nut | 20. Butterfly bracket | 33. Flat washer |
| 8. Flange nut (10 used) | 21. Carriage screw | 34. Compression spring |
| 9. Traction pedal shaft | 22. Spacer | 35. Spring retainer |
| 10. Roll pin | 23. Threadlock screw (2 used) | 36. Flat washer |
| 11. Cap screw (2 used) | 24. Cap screw (5 used) | 37. Lock nut |
| 12. Clamp block (2 used) | 25. Lock nut (6 used) | 38. Spring bracket |
| 13. Lock nut | 26. Sensor 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 314)

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



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Figure 316

- | | |
|--------------------------|--------------------------|
| 1. Traction pedal | 4. Clamp block (2 used) |
| 2. Pedal position sensor | 5. Spring shaft assembly |
| 3. Traction pedal shaft | |

-
5. Disassemble traction pedal as needed using [Figure 1](#) and [Figure 316](#) as guides. When removing roll pin (item 10 in [Figure 314](#)), make sure to support shaft to prevent component damage.

Assembly (Figure 314)

1. Assemble traction pedal using [Figure 314](#) and [Figure 316](#) 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 314) (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 \(page 6–20\)](#) and [Traction Pedal Position Sensor Calibration \(page 6–22\)](#)).
 - 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

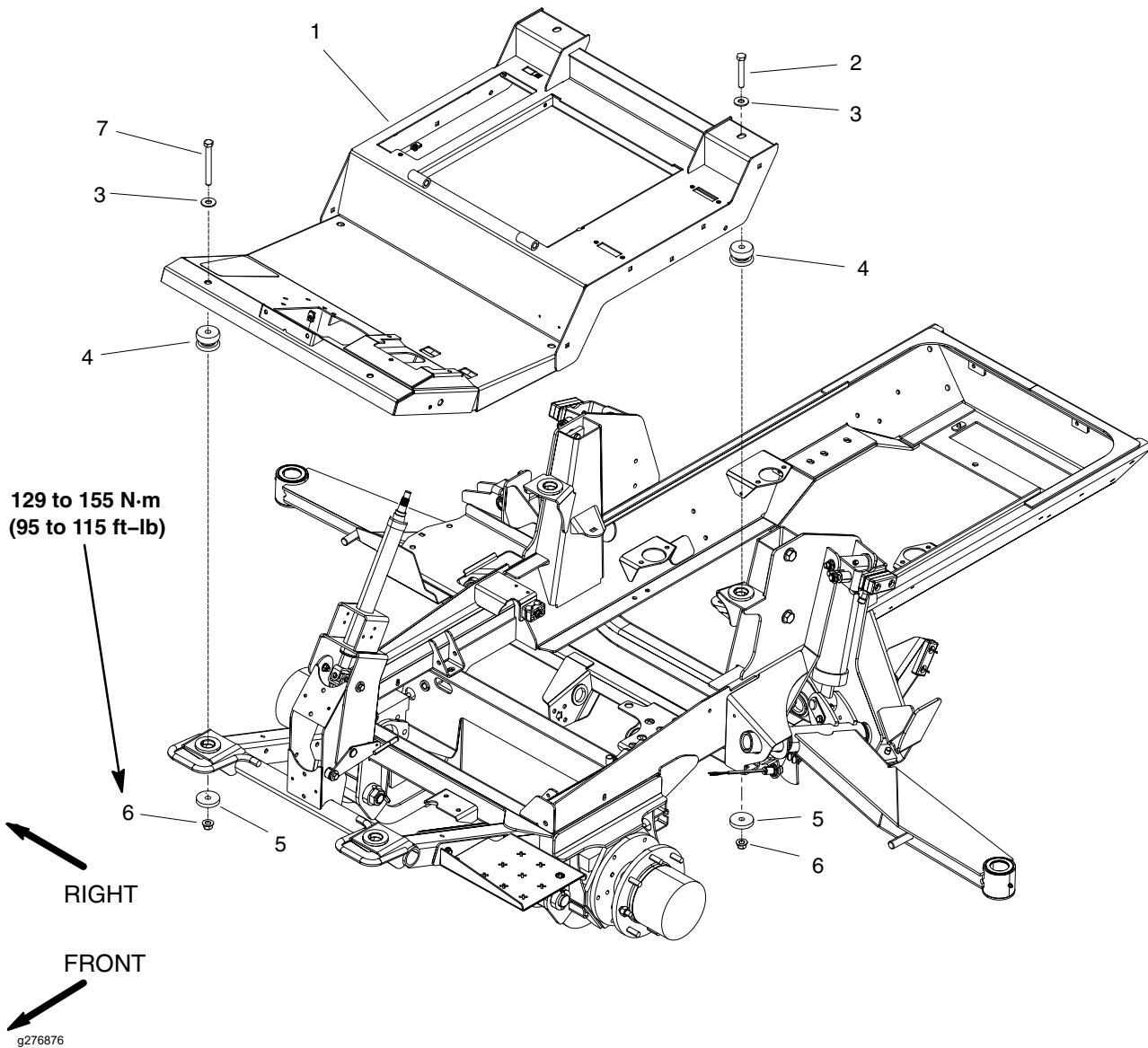
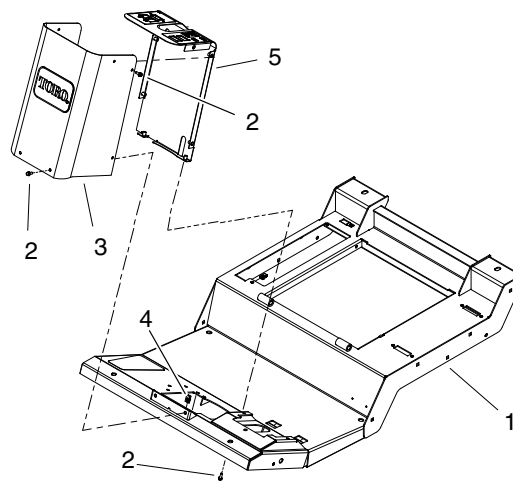


Figure 317

- | | | |
|-------------------------|--------------------------|-----------------------|
| 1. Operator platform | 4. Center mount (4 used) | 7. Cap screw (2 used) |
| 2. Cap screw (2 used) | 5. Plain washer (4 used) | |
| 3. Flat washer (4 used) | 6. Lock nut (4 used) | |



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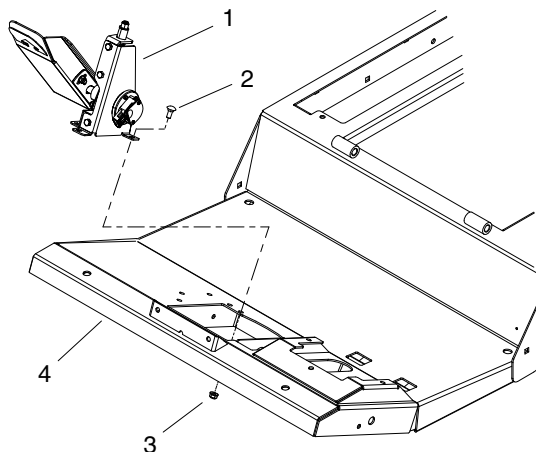
Figure 318

- | | |
|---------------------------|------------------|
| 1. Operator platform | 4. Clip (2 used) |
| 2. Flange screw (10 used) | 5. Rear cover |
| 3. Front 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 317)

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

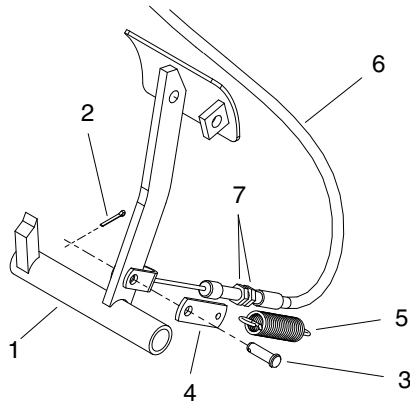


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Figure 319

- | | |
|----------------------------|------------------------|
| 1. Traction pedal assembly | 3. Flange nut (4 used) |
| 2. Carriage screw (4 used) | 4. Operator platform |

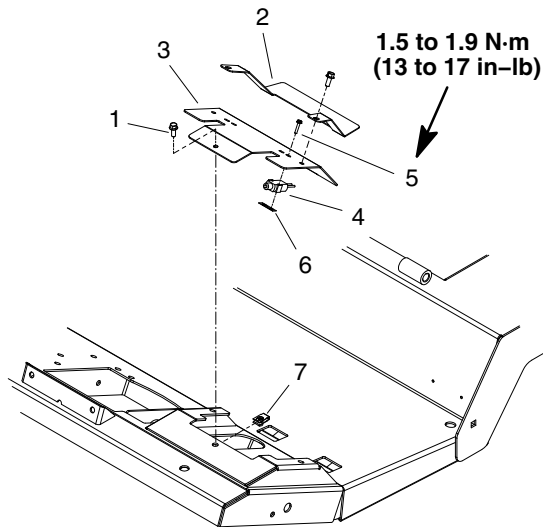
Disassembly ([Figure 317](#)) (continued)



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Figure 320

- | | |
|---------------------------|---------------------------|
| 1. Brake pedal (RH shown) | 5. Spring |
| 2. Cotter pin | 6. Brake cable (RH shown) |
| 3. Clevis pin | 7. Brake cable jam nuts |
| 4. Brake strap | |



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Figure 321

- | | |
|--------------------------|-------------------------|
| 1. Flange screw (3 used) | 5. Screw (2 per switch) |
| 2. Adjustment cover | 6. Switch nut (2 used) |
| 3. Switch bracket | 7. Clip (3 used) |
| 4. Brake switch (2 used) | |

5. Remove fasteners that secure traction pedal assembly to operator platform and then remove traction pedal assembly from platform ([Figure 319](#)).
6. Disconnect both brake cables from brake pedals and operator frame ([Figure 320](#)). Access to brake cable jam nuts can be obtained by removing adjustment cover on operator platform ([Figure 321](#)). 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 4010 machines:

Disassembly (Figure 317) (continued)

- 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 \(page 8–32\)](#)).

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 317)

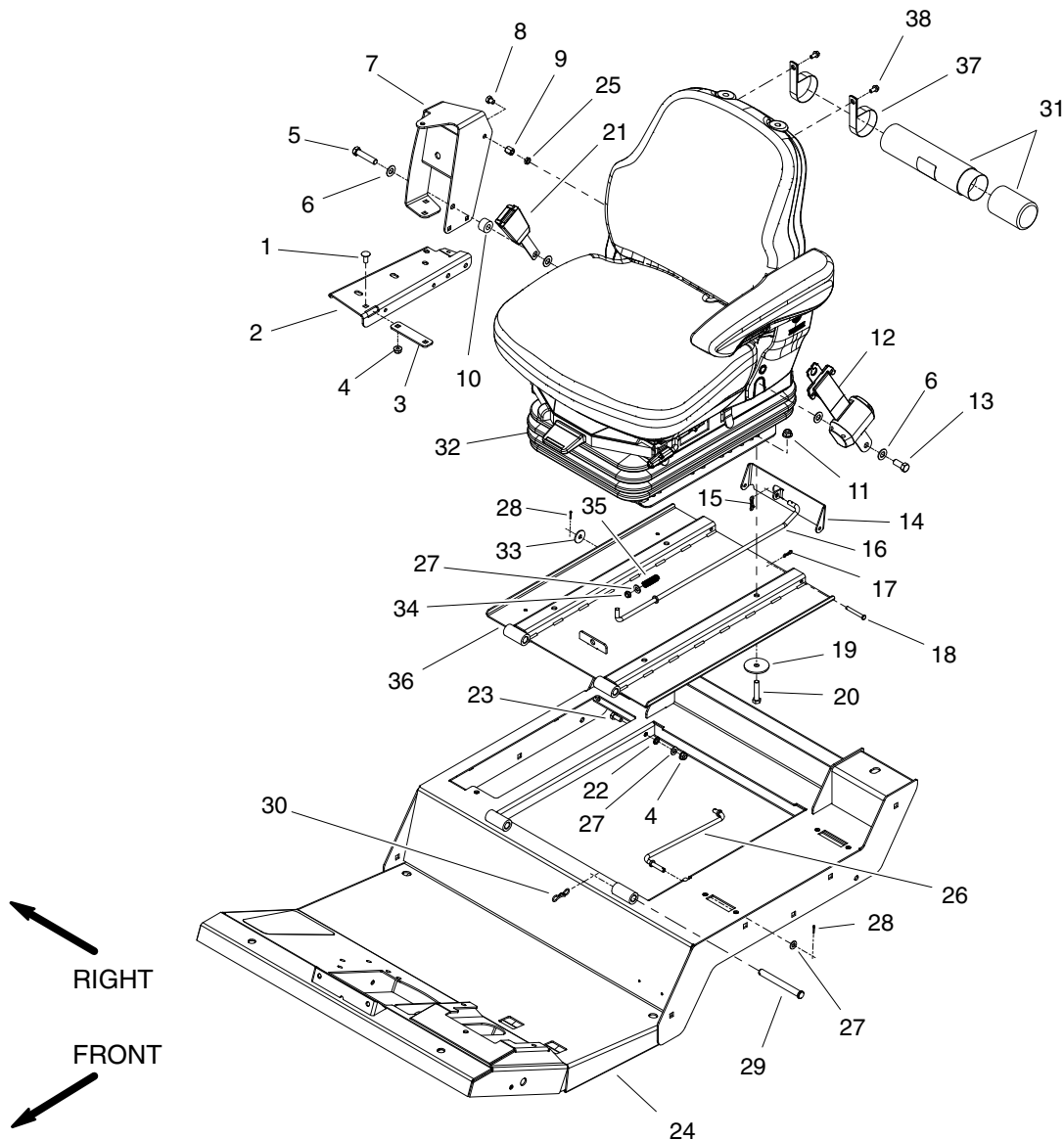
1. Make sure that all machine components are installed below operator platform before platform is lowered to frame.

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 4010 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.
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 319](#)). 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 \(page 6–91\)](#)).

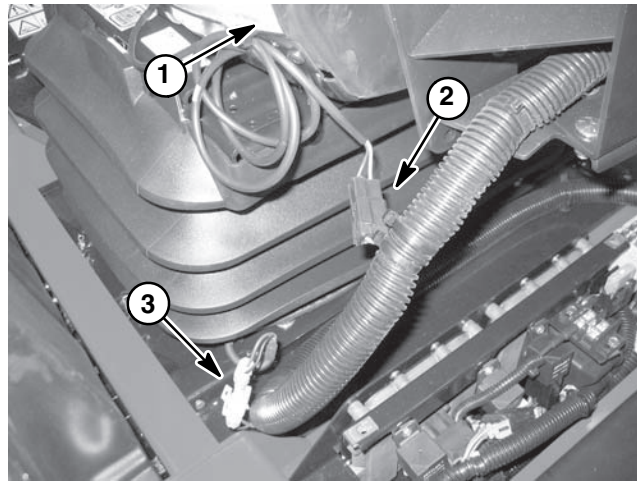
Operator Seat



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Figure 322

- | | | |
|----------------------------|---------------------------------|----------------------------------|
| 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 323

- | | |
|--------------------------|-------------------------|
| 1. Operator seat | 3. Suspension connector |
| 2. Seat switch connector | |

Removal (Figure 322)

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the ignition switch.
2. Disconnect seat electrical connector from machine wire harness (Figure 323).
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 322) (continued)

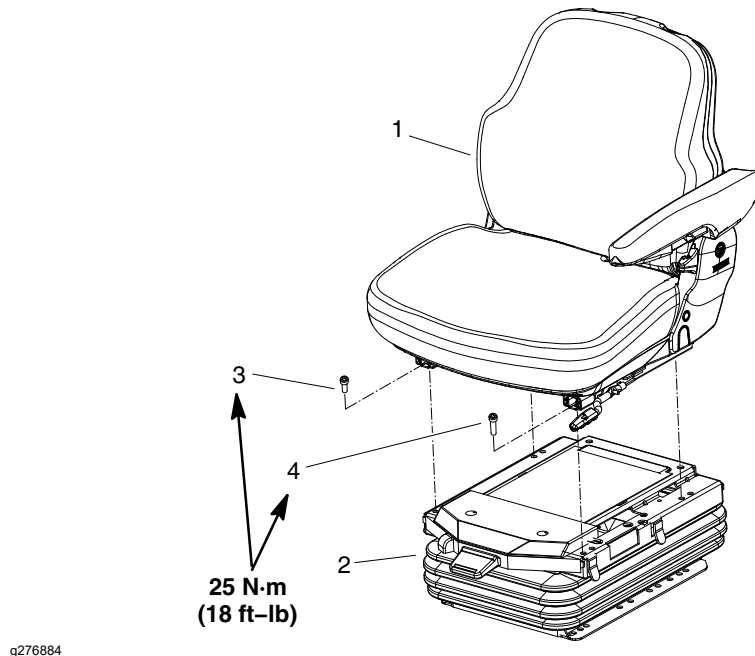


Figure 324

- | | |
|------------------------|---------------------------|
| 1. Seat | 3. Screw (M8x12) (3 used) |
| 2. Suspension assembly | 4. Screw (M8x16) |

8. Remove four (4) torx head screws that secure seat to seat suspension (Figure 324). 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 \(page 8–38\)](#) in this section if seat suspension service is necessary.

Installation (Figure 322)

1. Carefully position seat to seat suspension.
2. Secure seat to seat suspension with four (4) torx head screws (Figure 324). Make sure that longer screw is positioned near the seat adjustment handle. Torque screws **25 N·m (18 ft-lb)**.

IMPORTANT

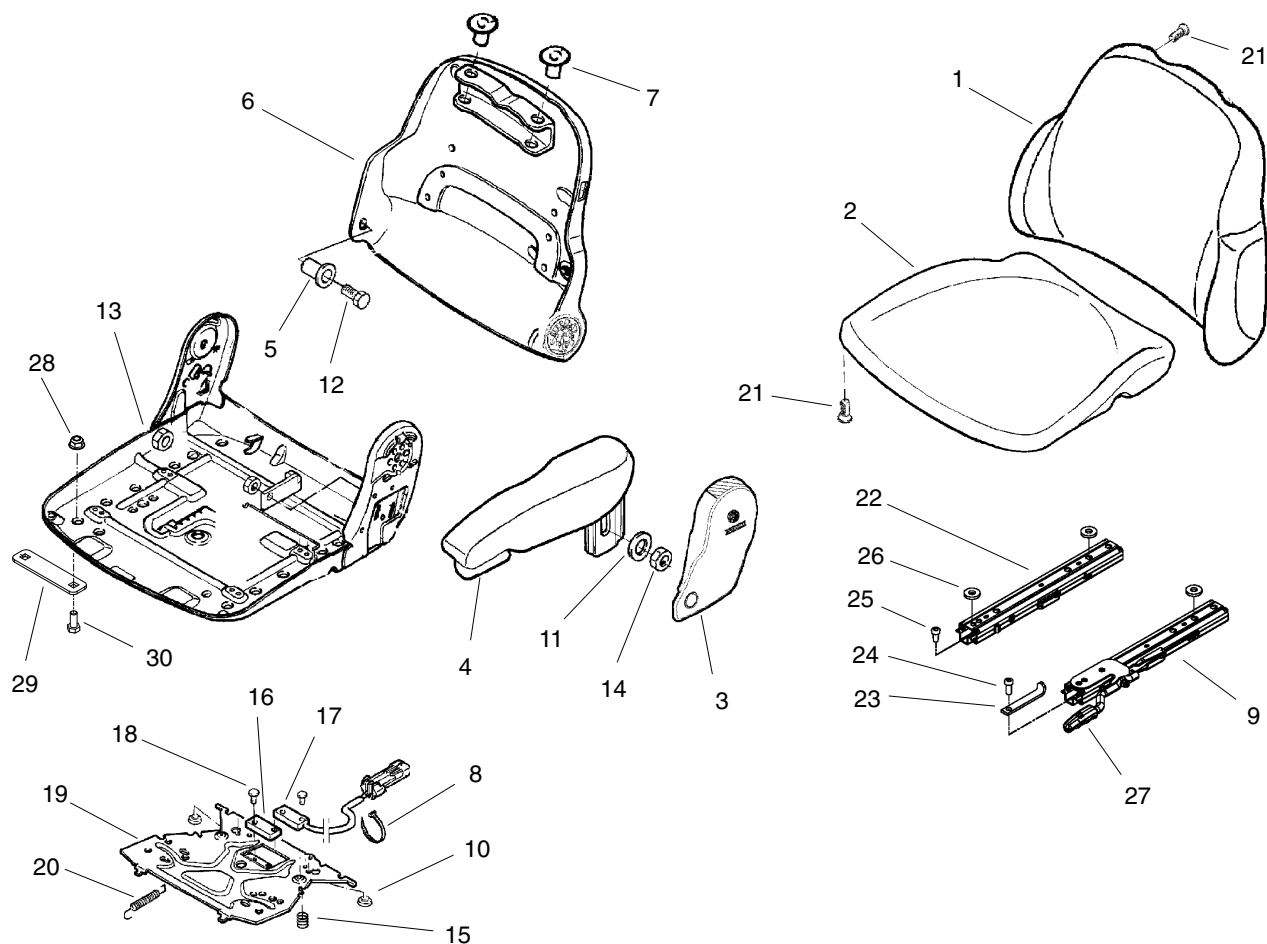
Make sure to not damage the electrical harness, control cable or other parts while moving the control arm assembly.

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).
 - 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).

Installation ([Figure 322](#)) (continued)

- D. Fully tighten all fasteners to secure control arm assembly to seat.
- 4. Connect seat electrical connector to machine wire harness ([Figure 323](#)).

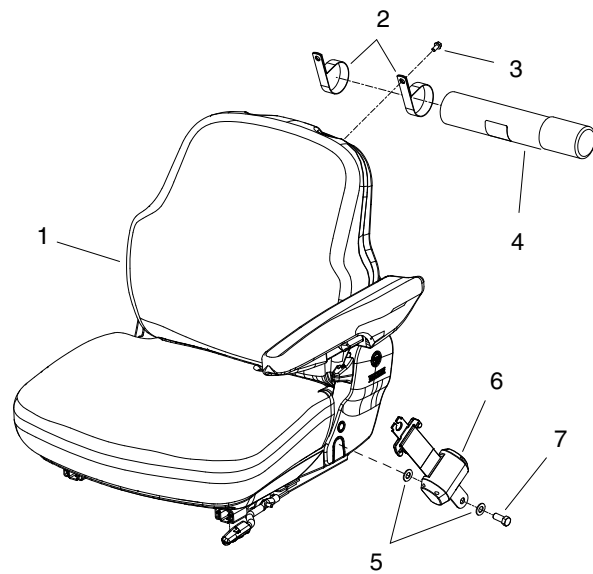
Operator Seat Service



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Figure 325

- | | | |
|-----------------------|------------------------|-------------------------|
| 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 |



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Figure 326

- | | |
|---------------------|----------------|
| 1. Operator seat | 5. Flat washer |
| 2. R-clamp (2 used) | 6. Seat belt |
| 3. Screw (2 used) | 7. Cap screw |
| 4. Manual tube | |

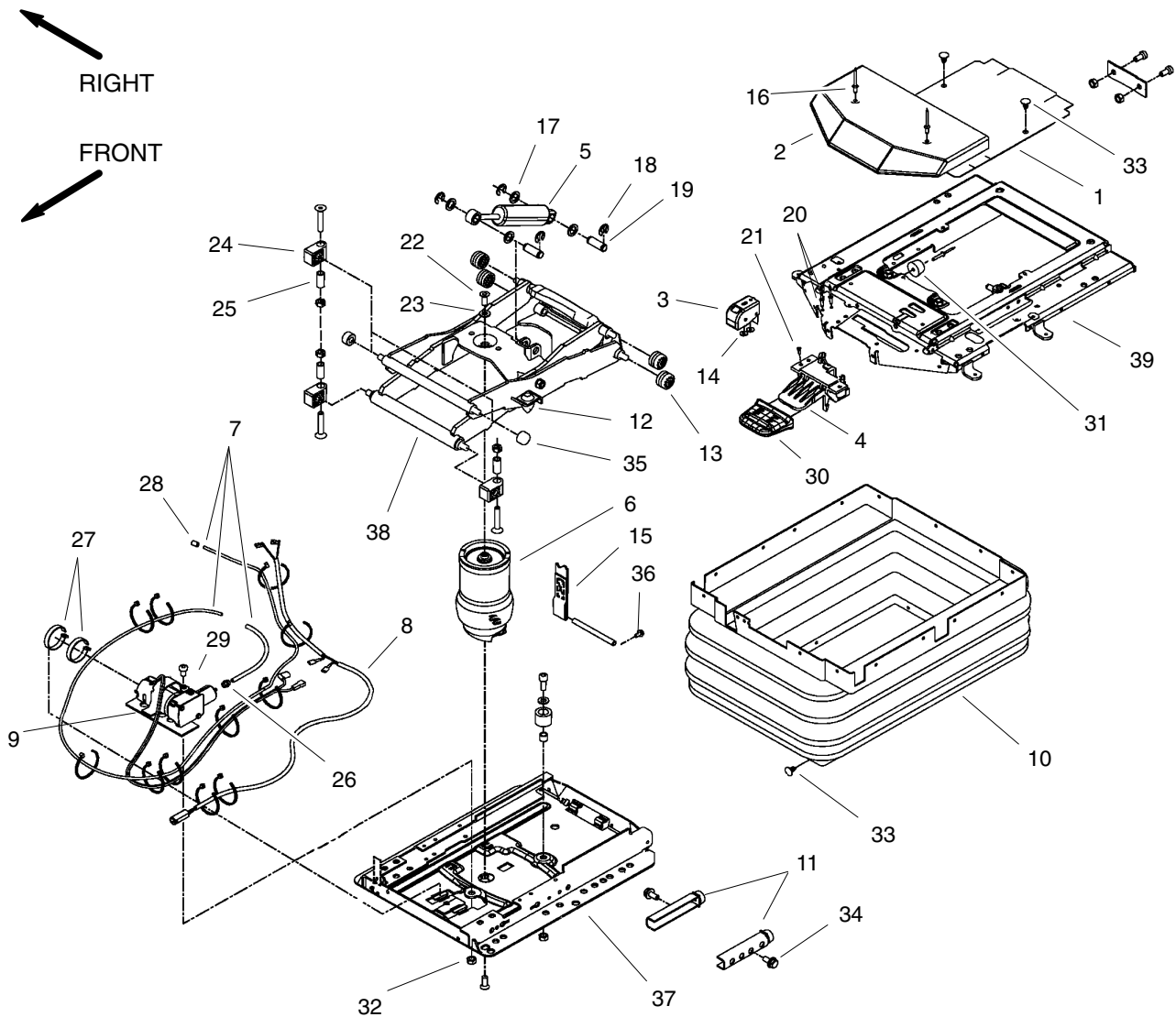
Disassembly ([Figure 325](#))

Disassemble operator seat as necessary using [Figure 325](#) and [Figure 326](#) as guides.

Assembly ([Figure 325](#))

Assemble operator seat using [Figure 325](#) and [Figure 326](#) as guides.

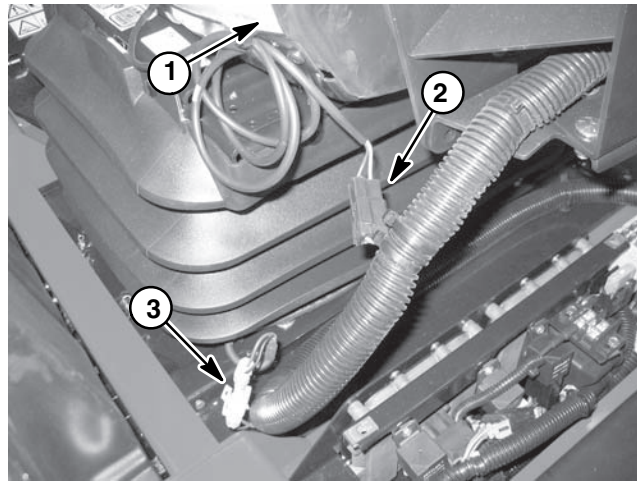
Operator Seat Suspension



g276887

Figure 327

- | | | |
|-------------------------|------------------------------|----------------------------|
| 1. Cover | 14. Washer (2 used) | 27. Clamp (2 used) |
| 2. Cover | 15. Tether | 28. Hose nipple |
| 3. Level control | 16. Rivet (2 used) | 29. Screw |
| 4. Air control valve | 17. Washer (4 used) | 30. Handle |
| 5. Shock absorber | 18. C-clip (4 used) | 31. Bumper |
| 6. Air spring | 19. Pin (2 used) | 32. Nut |
| 7. Air tube assembly | 20. Rivet (2 used) | 33. Plastic plug (23 used) |
| 8. Wire harness | 21. Washer (3 used) | 34. Screw (2 used) |
| 9. Compressor | 22. Screw (2 used) | 35. Roller (2 used) |
| 10. Bellows | 23. Washer | 36. Screw (4 used) |
| 11. Stop | 24. Housing support (4 used) | 37. Base plate |
| 12. Bumper set (2 used) | 25. Spacer (4 used) | 38. Suspension frame |
| 13. Roller (4 used) | 26. Hose nipple | 39. Upper plate |



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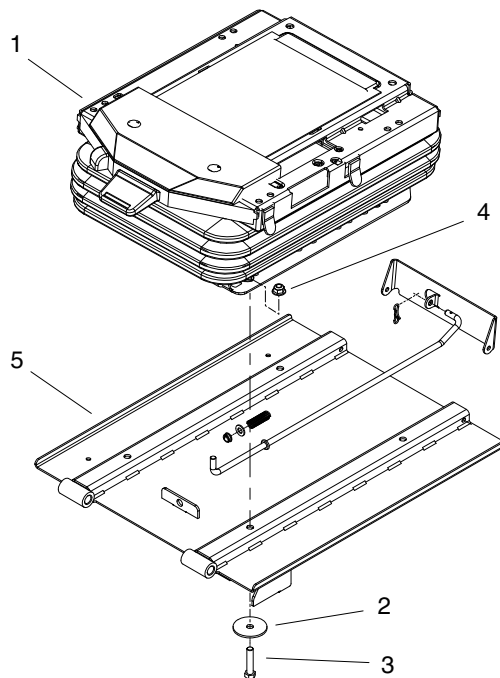
Figure 328

- | | |
|--------------------------|-------------------------|
| 1. Operator seat | 3. Suspension connector |
| 2. Seat switch 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 327)

1. Remove operator seat from seat suspension (see [Operator Seat \(page 8–32\)](#)).
2. Disconnect seat suspension connector from machine wire harness ([Figure 328](#)).



g276890

Figure 329

- | | |
|-------------------------|------------------------|
| 1. Seat suspension | 4. Flange nut (4 used) |
| 2. Flat washer (4 used) | 5. Seat plate |
| 3. Cap screw (4 used) | |

Disassembly ([Figure 327](#)) (continued)

3. If the air spring assembly (item 6) or base plate (item 37) requires removal, remove seat suspension from seat plate ([Figure 329](#)):
 - 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 327](#) as a guide.

Assembly ([Figure 327](#))

1. Install all removed seat suspension components using [Figure 327](#) as a guide.
2. If seat suspension was removed from seat plate, secure suspension to seat plate ([Figure 329](#)):
 - 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 \(page 8–32\)](#)).
4. Make sure that seat electrical connectors are connected to machine wire harness ([Figure 328](#)).

Hood

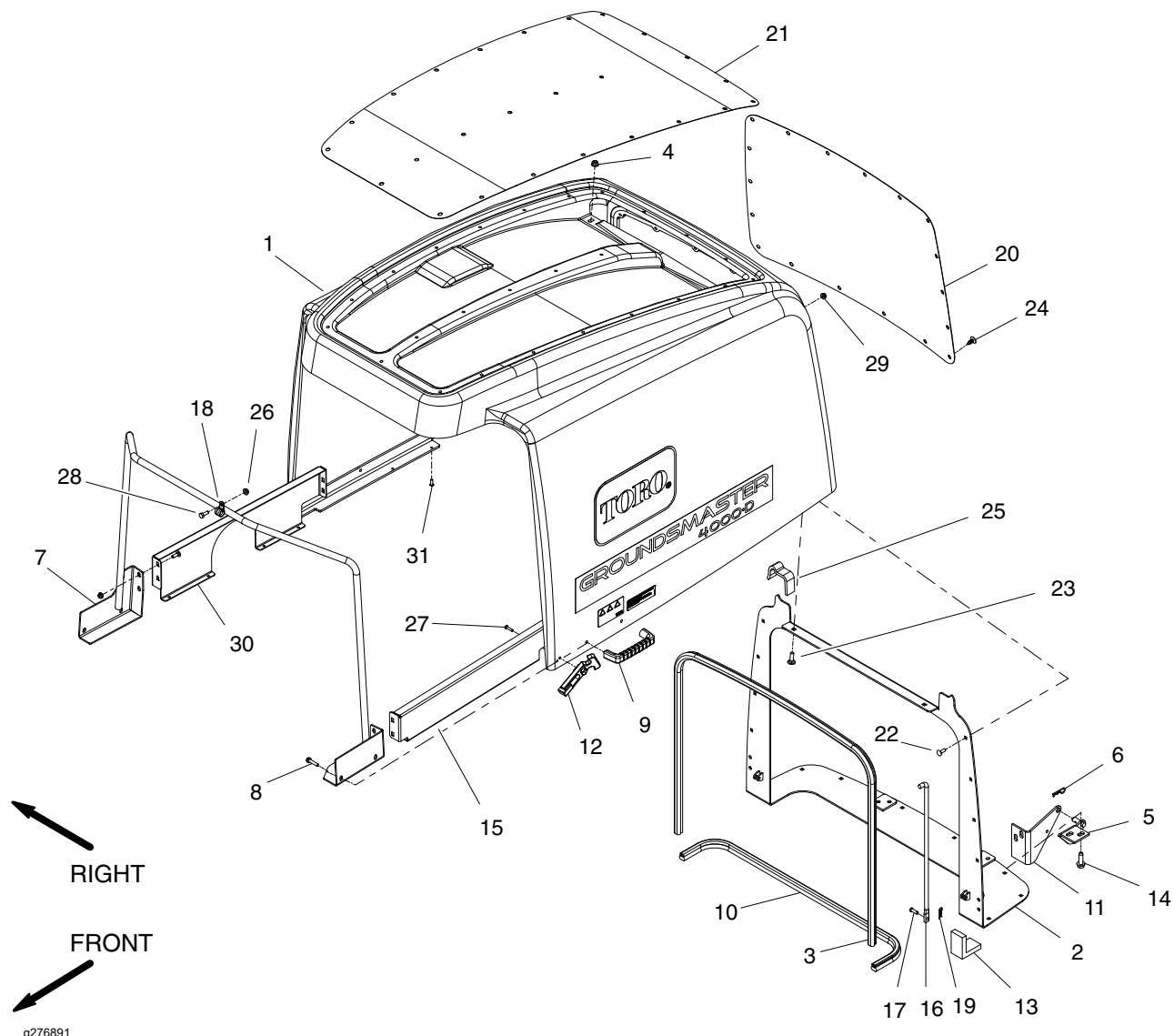


Figure 330

- | | | |
|----------------------------|----------------------------------|----------------------------|
| 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

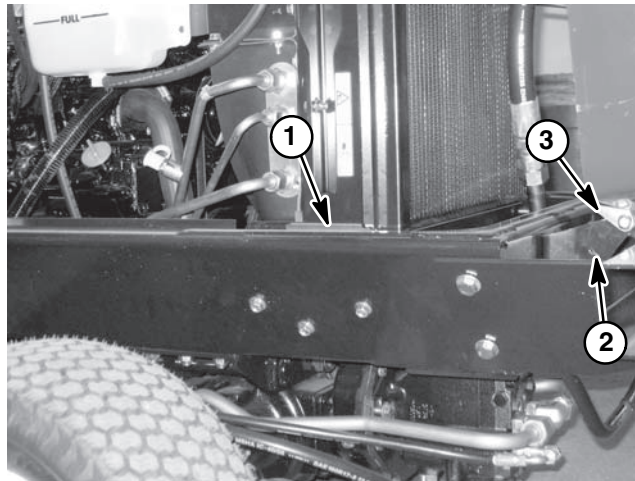
1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the ignition switch.
2. Remove hood assembly from machine:

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 330](#) as a guide.

Installation

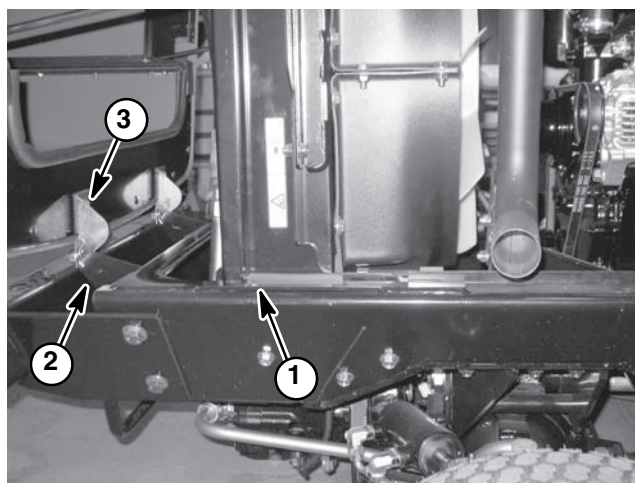
1. Assemble hood using [Figure 330](#) as a guide.
2. Install hood to machine:
 - A. Position hood to machine and engage screen pivots to hood pivots.
 - B. Install hair pins (item 6) to secure screen pivots to hood pivots.
3. Align hood to machine to allow correct operation of hood latch and dust seals:



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Figure 331

- | | |
|---------------------|--------------------|
| 1. LH shim location | 3. LH screen pivot |
| 2. LH hood pivot | |



g276893

Figure 332

- | | |
|---------------------|--------------------|
| 1. RH shim location | 3. RH screen pivot |
| 2. RH hood 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 331](#) and [Figure 332](#)).
 - 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.



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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

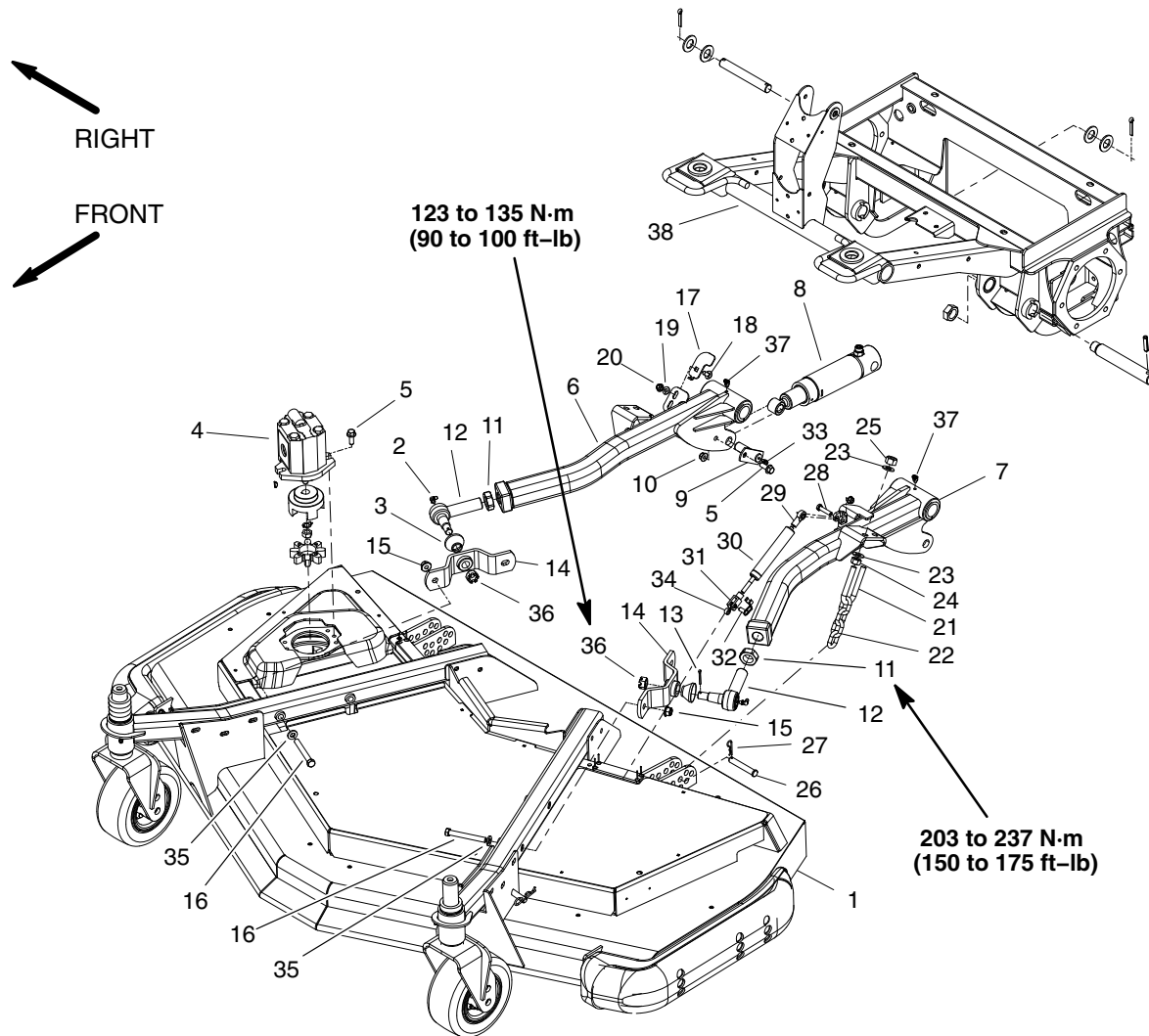


CAUTION



Never install or work on the cutting decks or lift arms with the engine running. Always stop engine and remove key from ignition switch first.

Center Cutting Deck



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Figure 333

- | | | |
|--------------------------------------|----------------------------------|-----------------------------|
| 1. Center deck assembly | 14. Ball joint mount (2 used) | 27. Hair pin (2 used) |
| 2. Grease fitting | 15. Flange nut (2 per mount) | 28. Cap screw |
| 3. Ball joint seal | 16. Cap screw (2 per mount) | 29. Spherical rod end |
| 4. Hydraulic deck motor | 17. Sensor plate | 30. Damper |
| 5. Flange head screw | 18. Carriage screw | 31. Clevis rod end |
| 6. RH lift arm | 19. Flat washer | 32. Spring pin |
| 7. LH lift arm | 20. Flange nut | 33. Grease fitting (2 used) |
| 8. Lift cylinder (2 used) | 21. U-bolt (2 used) | 34. Spacer |
| 9. Pin (2 used) | 22. Height-of-cut chain (2 used) | 35. Flat washer (2 used) |
| 10. Flange nut (2 used) | 23. Flat washer (4 per u-bolt) | 36. Slotted hex nut |
| 11. Jam nut (LH threads) (2 used) | 24. Hex nut (2 per u-bolt) | 37. Grease fitting |
| 12. Ball joint (LH threads) (2 used) | 25. Lock nut (2 per u-bolt) | 38. Front frame |
| 13. Cotter pin (2 used) | 26. Clevis pin (2 used) | |

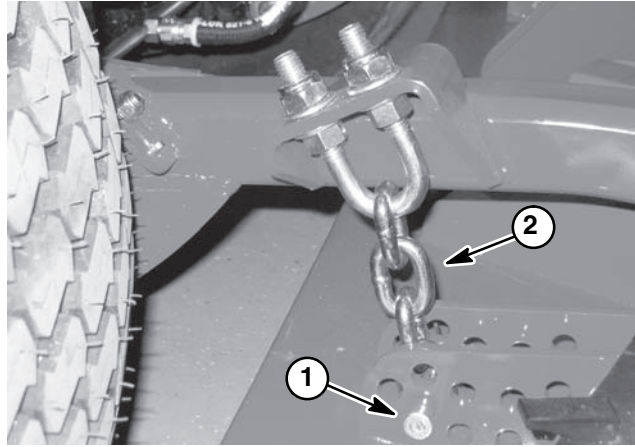
Removal (Figure 333)

1. Position machine on a clean, level surface. Lower cutting decks, stop engine, apply parking brake and remove key from the ignition switch.

Removal (Figure 333) (continued)

2. Remove spring pin (item 32) that secures damper (item 30) to cutting deck. Position damper away from cutting deck.

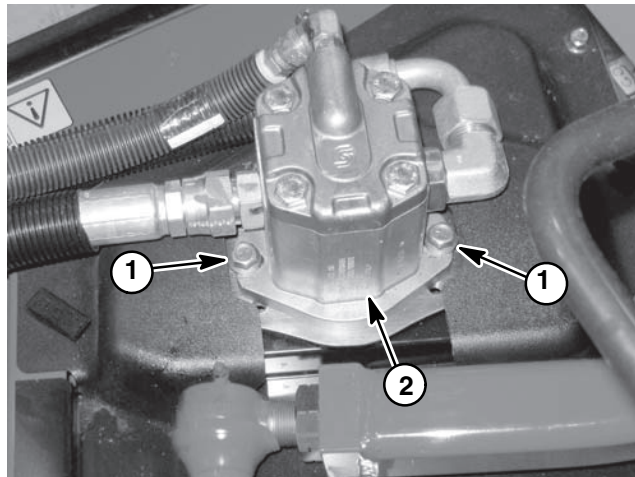
Note: Removal of clevis pin from deck and height-of-cut chain is easier if deck is lifted slightly.



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Figure 334

1. Hairpin and clevis pin
2. Height-of-cut chain

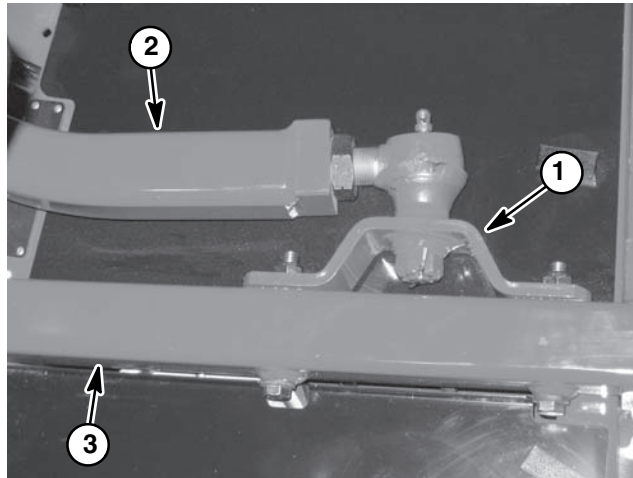


g277089

Figure 335

1. Flange head screw
2. Hydraulic motor

Removal (Figure 333) (continued)



g277090

Figure 336

- | | |
|---------------------|---------------|
| 1. Ball joint mount | 3. Castor arm |
| 2. Lift arm | |
-
3. Remove hairpin and clevis pin that secure the height-of-cut chain to the rear of the cutting deck (Figure 334).
 4. Remove hydraulic motor from cutting deck (see [Cutting Deck Motors \(page 5-155\)](#)).
 5. Remove cap screws, washers and lock nuts securing ball joint mounts (item 14) to center deck castor arms (Figure 336).
 6. Slide the center cutting deck away from the traction unit.

Installation (Figure 333)

1. Position machine on a clean, level surface. Lower lift arms, stop engine, apply parking brake and remove key from the ignition switch.
2. Position the center deck to the lift arms.
3. Align ball joint mounts (item 14) to center deck castor arms and secure with cap screws, washers and lock nuts (Figure 336).
Note: Installation of clevis pin to deck and height-of-cut chain is easier if deck is lifted slightly.
4. Install clevis pin and hairpin that secure the height-of-cut chain to the rear of the cutting deck (Figure 334).
5. Install hydraulic motor to cutting deck (see [Cutting Deck Motors \(page 5-155\)](#)).
6. Position damper (item 30) to cutting deck bracket and secure with spring pin (item 32).
7. Lubricate grease fittings on cutting deck and lift arm assemblies.

Side Cutting Decks

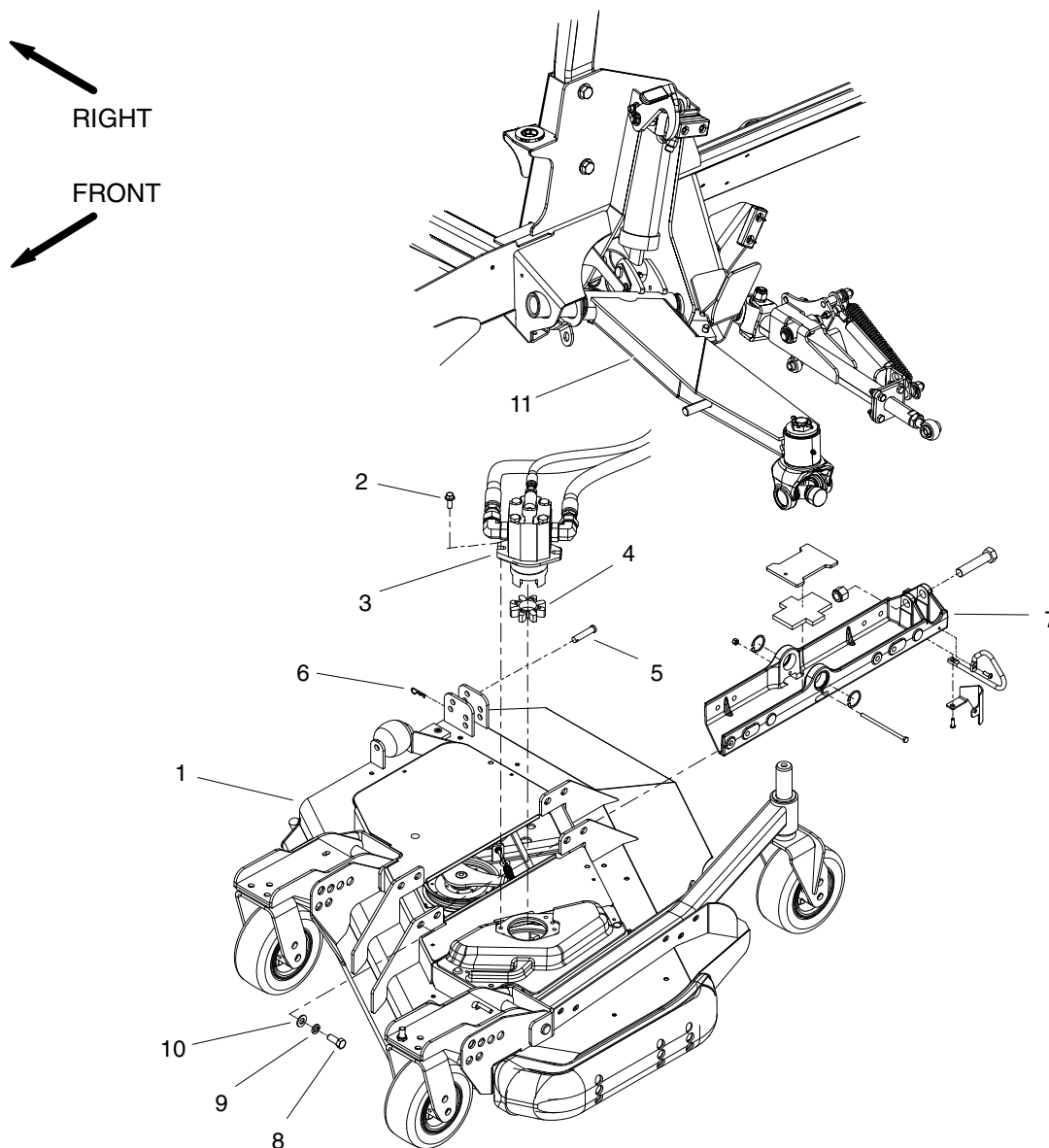


Figure 337

- | | | |
|-------------------------------|---------------------------------|------------------------------------|
| 1. Cutting deck (LH shown) | 5. Clevis pin | 9. Lock washer (8 used per mount) |
| 2. Flange head screw (2 used) | 6. Hair pin | 10. Flat washer (8 used per mount) |
| 3. Hydraulic deck motor | 7. Deck mount (LH shown) | 11. Lift arm (LH shown) |
| 4. Spider | 8. Cap screw (8 used per mount) | |

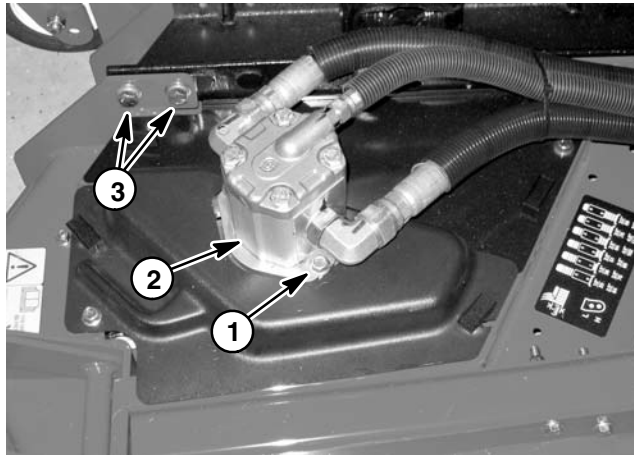
Removal (Figure 337)

1. Position machine on a clean, level surface. Lower cutting decks, stop engine, apply parking brake and remove key from the ignition switch.
2. Remove hydraulic motor from cutting deck (see [Cutting Deck Motors \(page 5-155\)](#)).

IMPORTANT

Do not change the length of the damper link (Figure 340).

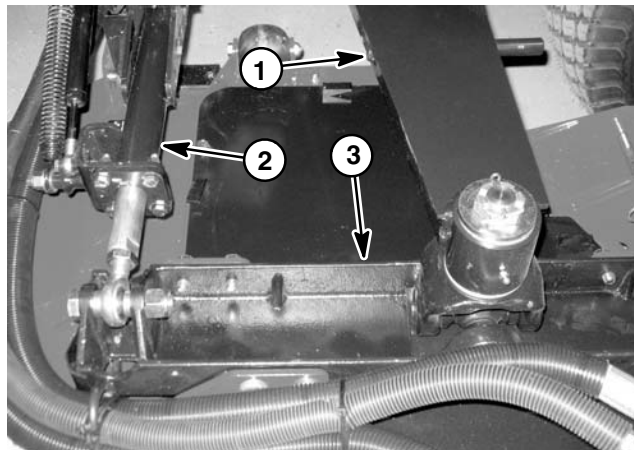
Removal (Figure 337) (continued)



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Figure 338

- | | |
|----------------------|---------------------|
| 1. Flange head screw | 3. Deck mount screw |
| 2. Hydraulic motor | |
-



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Figure 339

- | | |
|------------------------|---------------|
| 1. Lift arm (RH shown) | 3. Deck mount |
| 2. Rear arm assembly | |
-

Removal (Figure 337) (continued)

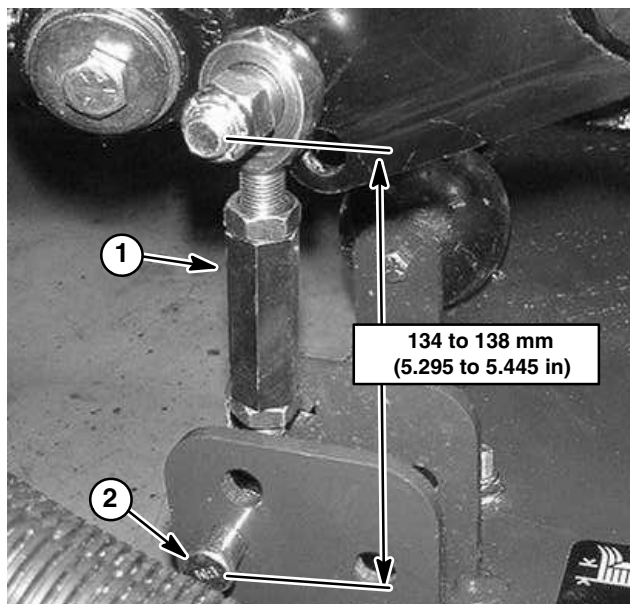


Figure 340

1. Damper link
2. Clevis pin

3. Remove hairpin and clevis pin that secure the damper link to the rear of the cutting deck (Figure 340).
4. Remove eight (8) cap screws, lock washers and flat washers that secure deck mount to cutting deck (Figure 338).
5. Raise lift arm enough to separate deck mount from cutting deck (Figure 339).
6. Slide the cutting deck away from the traction unit.

Installation (Figure 337)

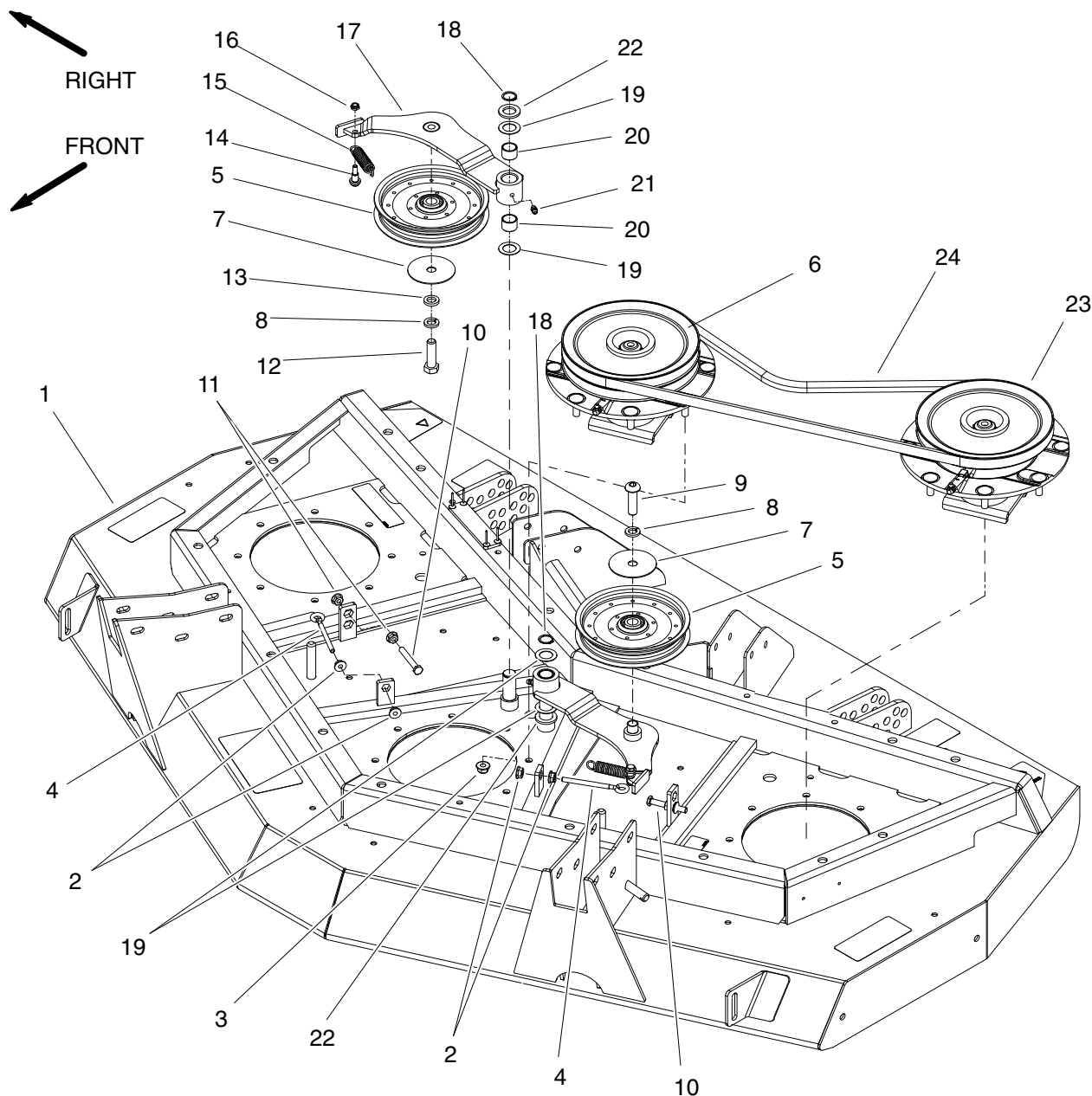
1. Position machine on a clean, level surface. Stop engine, apply parking brake and remove key from the ignition switch.
2. Position the side cutting deck to the lift arm and deck mount.
3. Lower lift arm while aligning deck mount to cutting deck.
4. Install deck mount to cutting deck with (8) cap screws, lock washers and flat washers (Figure 338). Tighten fasteners.

IMPORTANT

The length of the damper link should be from 134 to 138 mm (5.295 to 5.445 in) measured between rod end centers.

5. Install clevis pin and hairpin that secure the damper link to the rear of the cutting deck ([Figure 340](#)).
6. Install hydraulic motor to cutting deck (see [Cutting Deck Motors \(page 5–155\)](#)).
7. Lubricate grease fittings on cutting deck and lift arm assembly.

Idler Assembly



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Figure 341

- | | | |
|---|----------------------|------------------------------------|
| 1. Cutting deck (front shown) | 9. Socket head screw | 17. Idler arm |
| 2. Flange nut | 10. Idler stop bolt | 18. Retaining ring |
| 3. Flange nut | 11. Flange nut | 19. Thrust washer |
| 4. Adjusting screw | 12. Cap screw | 20. Bushing (2 used per idler) |
| 5. Idler pulley | 13. Spacer | 21. Grease fitting |
| 6. Driven spindle (double pulley shown) | 14. Shoulder bolt | 22. Washer |
| 7. Flat washer | 15. Idler spring | 23. Driven spindle (single pulley) |
| 8. Lock washer | 16. Lock nut | 24. Drive belt |

Note: The front deck is shown in [Figure 341](#). The idler assemblies used on the side decks use the same idler components.

Removal (Figure 341)

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.



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 341 as a guide. Note location of washers, idler spacer and screw as idler assemblies are being removed.

Installation (Figure 341)

1. Install removed idler components using Figure 341 as a guide.
 - A. Make sure that one (1) thrust washer (item 19) is placed above and below the idler arm. Location of additional washer (item 22) depends on whether the idler pulley mounts on the bottom side of the idler arm or on the top of the idler arm.
 - 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.



CAUTION



Be careful when installing the idler spring. The spring is under heavy load and may cause personal injury.

3. Use spring hook tool to attach the idler spring (item 15) onto the adjusting screw (item 4) and shoulder bolt on idler arm.

Installation (Figure 341) (continued)

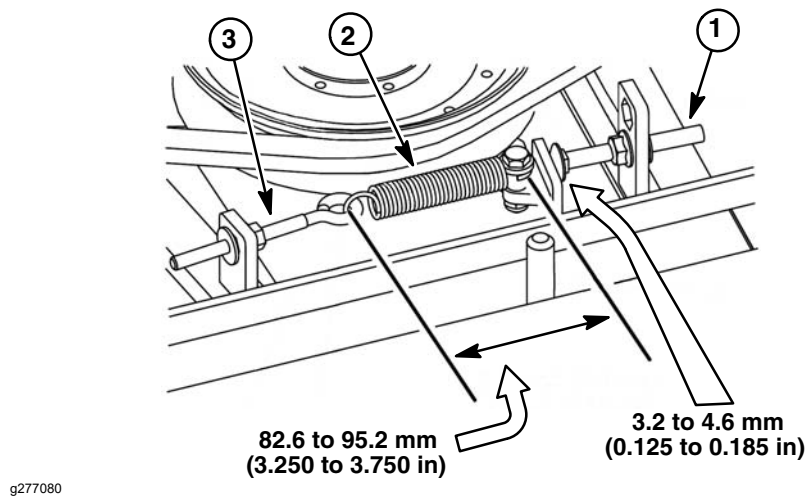
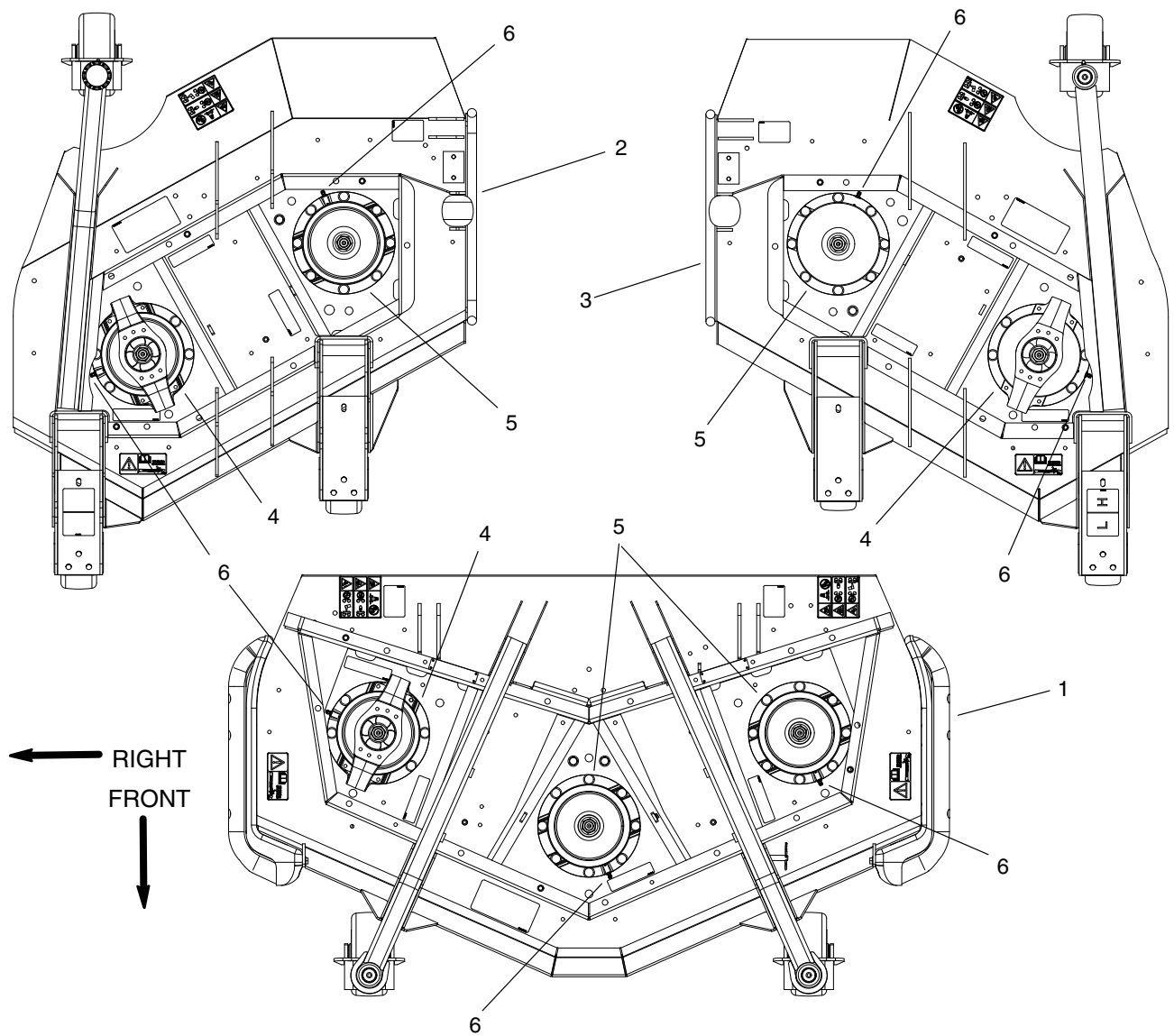


Figure 342

1. Idler stop bolt
 2. Idler spring
 3. Adjusting screw
-
4. With the idler arm tensioning the drive belt, the idler spring hook to hook length should be from **82.6 to 95.2 mm (3.250 to 3.750 in)** (Figure 342). If necessary, disconnect spring and change position of adjusting screw. When idler spring is the correct length, tighten second flange nut to secure idler adjustment.
 5. Adjust location of idler stop bolt 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 342).
 6. Lubricate idler arm grease fitting.
 7. Install deck covers to cutting deck.

Blade Spindle Assemblies



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Figure 343

- | | | |
|------------------------|---------------------------|----------------------------|
| 1. Center cutting deck | 3. LH cutting deck | 5. Driven spindle assembly |
| 2. RH cutting deck | 4. Drive spindle assembly | 6. Grease fitting location |

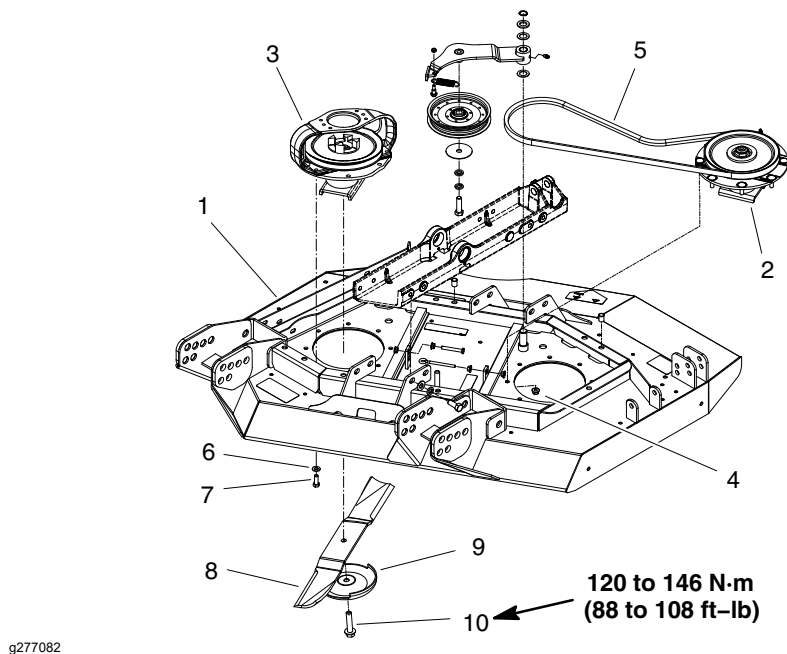


Figure 344

- | | |
|----------------------------|-------------------|
| 1. Deck (RH shown) | 6. Washer |
| 2. Driven spindle assembly | 7. Cap screw |
| 3. Drive spindle assembly | 8. Blade |
| 4. Flange nut | 9. Anti-scalp cup |
| 5. Drive belt | 10. Blade bolt |

Removal (Figure 343 and Figure 344)

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the ignition switch.
2. Remove covers from cutting deck to allow access to spindle assemblies.
3. If drive spindle assembly is to be serviced, remove hydraulic motor from cutting deck (see [Cutting Deck Motors \(page 5–155\)](#)). Position motor away from spindle.
4. Loosen idler assembly to release drive belt tension (see [Idler Assembly \(page 9–10\)](#)). Remove drive belt from spindle assembly that is to be serviced.
5. 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.
6. Remove cutting blade, anti-scalp cup and blade bolt from spindle assembly that is to be serviced.
7. Remove spindle assembly from deck.
 - A. For driven spindle assemblies, remove eight (8) flange nuts that secure spindle assembly to deck.
 - B. For drive spindle assemblies, remove four (4) cap screws with washers that secure spindle assembly and hydraulic motor mount to deck. Remove motor mount. Then, remove four (4) flange nuts that secure spindle assembly to deck.
 - C. Lift spindle assembly from deck.
8. If necessary, press screws from spindle housing.

Installation ([Figure 343](#) and [Figure 344](#))

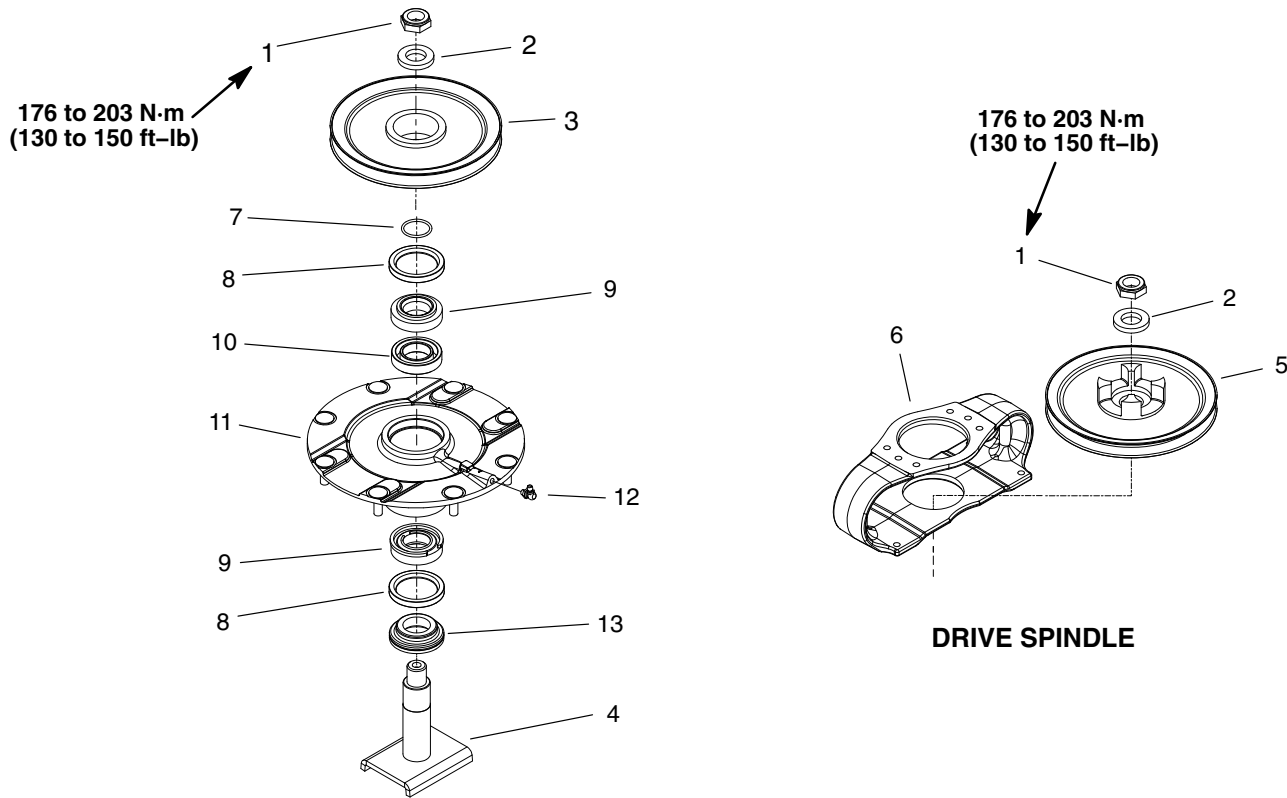
1. If screws were removed from spindle housing, press new screws into housing. Make sure that screw head is squarely seated against housing after installation.
2. Position spindle assembly on cutting deck noting orientation of grease fitting ([Figure 343](#)). Secure spindle assembly to deck with removed fasteners.
3. Install cutting blade, anti-scalp cup and blade bolt to spindle. Tighten blade bolt from **120 to 146 N·m (88 to 108 ft-lb)**.
4. Slowly rotate cutting blades to verify that blades do not contact any deck components.
5. Install drive belt to spindle pulleys and idler pulley. Adjust drive belt tension (see [Idler Assembly \(page 9–10\)](#)).
6. If drive spindle assembly was removed, install hydraulic motor to cutting deck (see [Cutting Deck Motors \(page 5–155\)](#)).

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 covers to cutting deck.

Blade Spindle Service



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Figure 345

- | | | |
|---------------------------------|--------------------------|--------------------------|
| 1. Lock nut | 6. Hydraulic motor mount | 11. Spindle housing |
| 2. Hardened washer | 7. O-ring | 12. Grease fitting |
| 3. Driven pulley (single shown) | 8. Oil seal | 13. Spindle shaft spacer |
| 4. Spindle shaft | 9. Bearing cup and cone | |
| 5. Drive pulley | 10. Spacer set | |

Disassembly (Figure 345)

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 345) (continued)

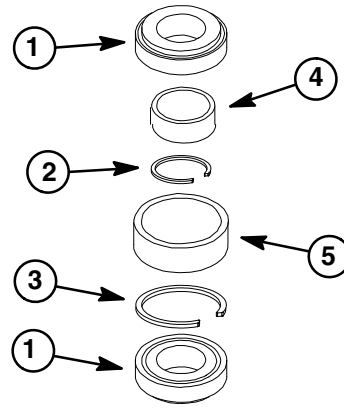


Figure 346

- | | |
|--------------------|-------------------------|
| 1. Bearing | 4. Inner bearing spacer |
| 2. Spacer ring | 5. Outer bearing spacer |
| 3. Large snap ring | |
-
4. Allow the bearing cones, inner bearing spacer and spacer ring to drop out of the spindle housing (Figure 346).
 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 345)

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 346). 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 346). 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 345) (continued)

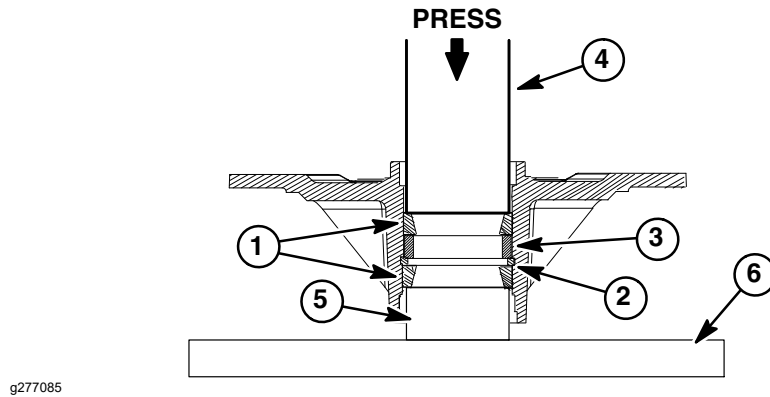


Figure 347

- | | |
|-------------------------|---------------------|
| 1. Bearing cups | 4. Arbor press |
| 2. Large snap ring | 5. Support |
| 3. Outer bearing spacer | 6. Arbor press base |

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 347).
4. Pack the bearing cones with grease. Apply a film of grease on lips of oil seals and O-ring.

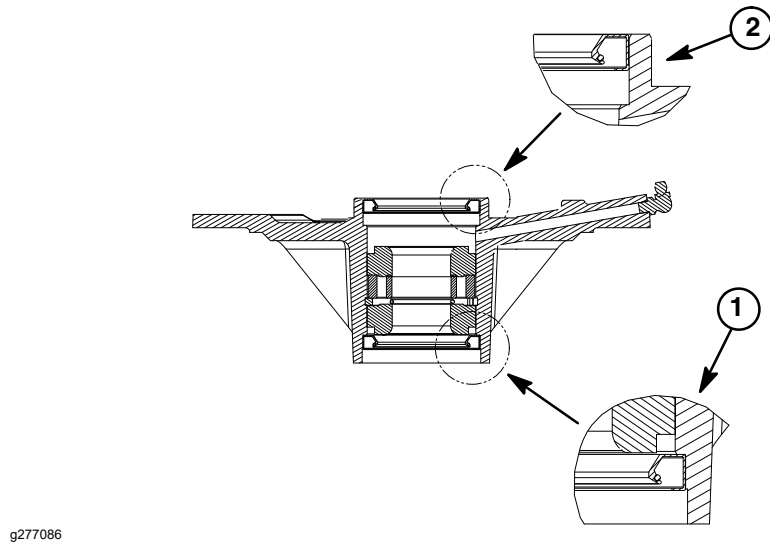


Figure 348

- | | |
|-----------------------------|----------------------------|
| 1. Bottom seal installation | 2. Upper seal installation |
|-----------------------------|----------------------------|

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 348). 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 346).

Assembly (Figure 345) (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 348). 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.

Castor Forks and Wheels

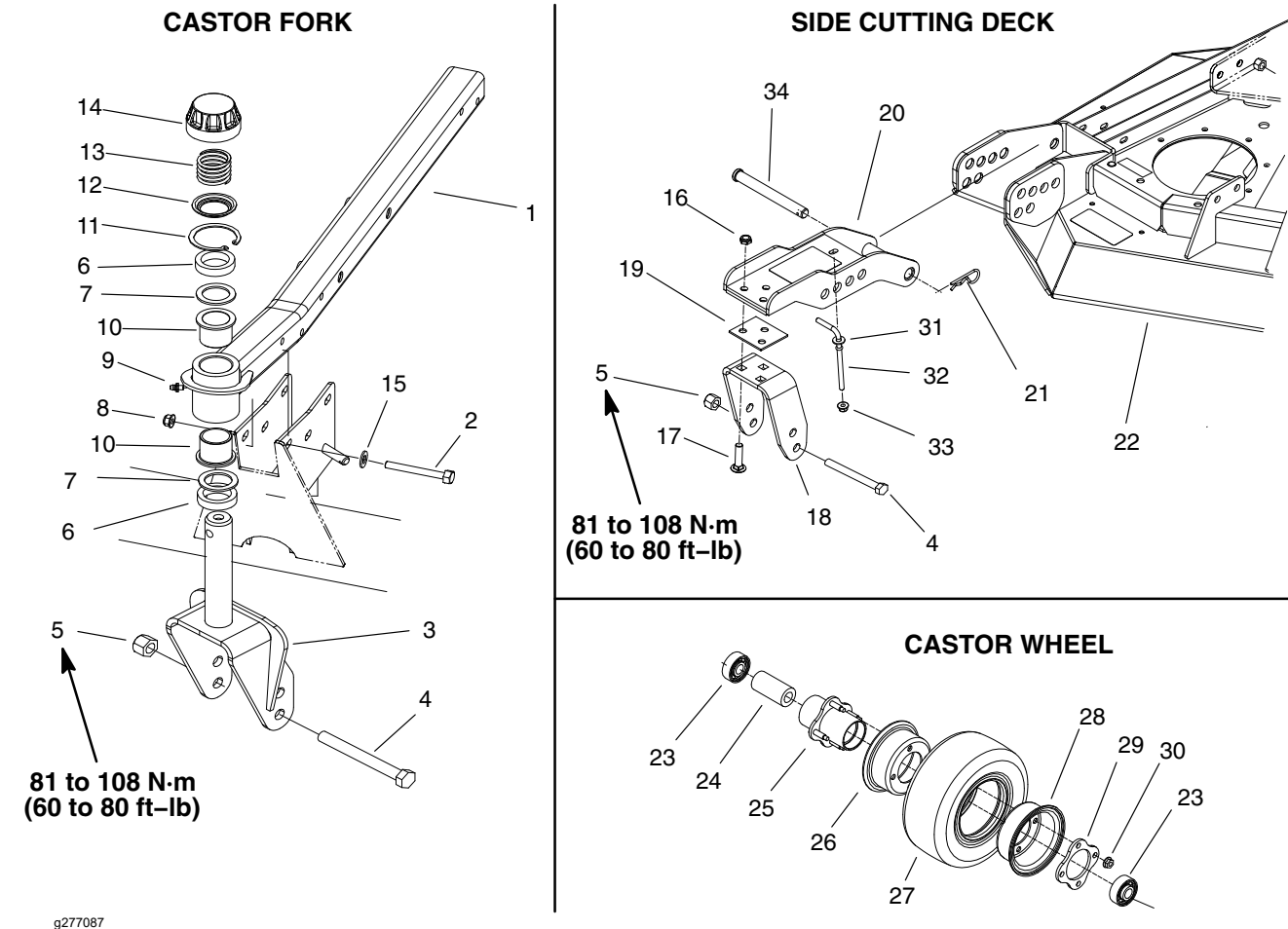


Figure 349

- | | | |
|-----------------------------------|---|--------------------|
| 1. Castor arm (center deck shown) | 13. Compression spring | 25. Wheel hub |
| 2. Cap screw (5 used) | 14. Cap | 26. Wheel rim half |
| 3. Castor fork | 15. Flat washer | 27. Castor tire |
| 4. Cap screw | 16. Lock nut (3 used per bracket) | 28. Wheel rim half |
| 5. Lock nut | 17. Carriage screw (3 used per bracket) | 29. Plate |
| 6. Castor spacer | 18. Castor fork bracket | 30. Flange nut |
| 7. Thrust washer | 19. Shim | 31. Flat washer |
| 8. Flange nut (5 used) | 20. Castor bracket | 32. Tension rod |
| 9. Grease fitting | 21. Hairpin | 33. Flange nut |
| 10. Flange bushing | 22. Cutting deck (RH shown) | 34. Clevis pin |
| 11. Retaining ring | 23. Bearing | |
| 12. Cap washer | 24. Inner bearing spacer | |

Disassembly

Disassemble castor wheel as needed using [Figure 349](#) as a guide.

Assembly

1. Assemble castor wheel using [Figure 349](#) as a guide.
2. If castor fork was removed, lubricate grease fitting.
3. Torque castor wheel lock nut (item 5) from **81 to 108 N·m (60 to 80 ft-lb)**.



Operator Cab (For models 30603 and 30607)

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Additional Reference Materials

[Sanden SD Compressor Service Guide](#)

General Information

The information in this chapter pertains to the operator cab on the Groundsmaster 4010-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 4010-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 4010-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 4010-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.

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 (3.43 lb) of R134a refrigerant.

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

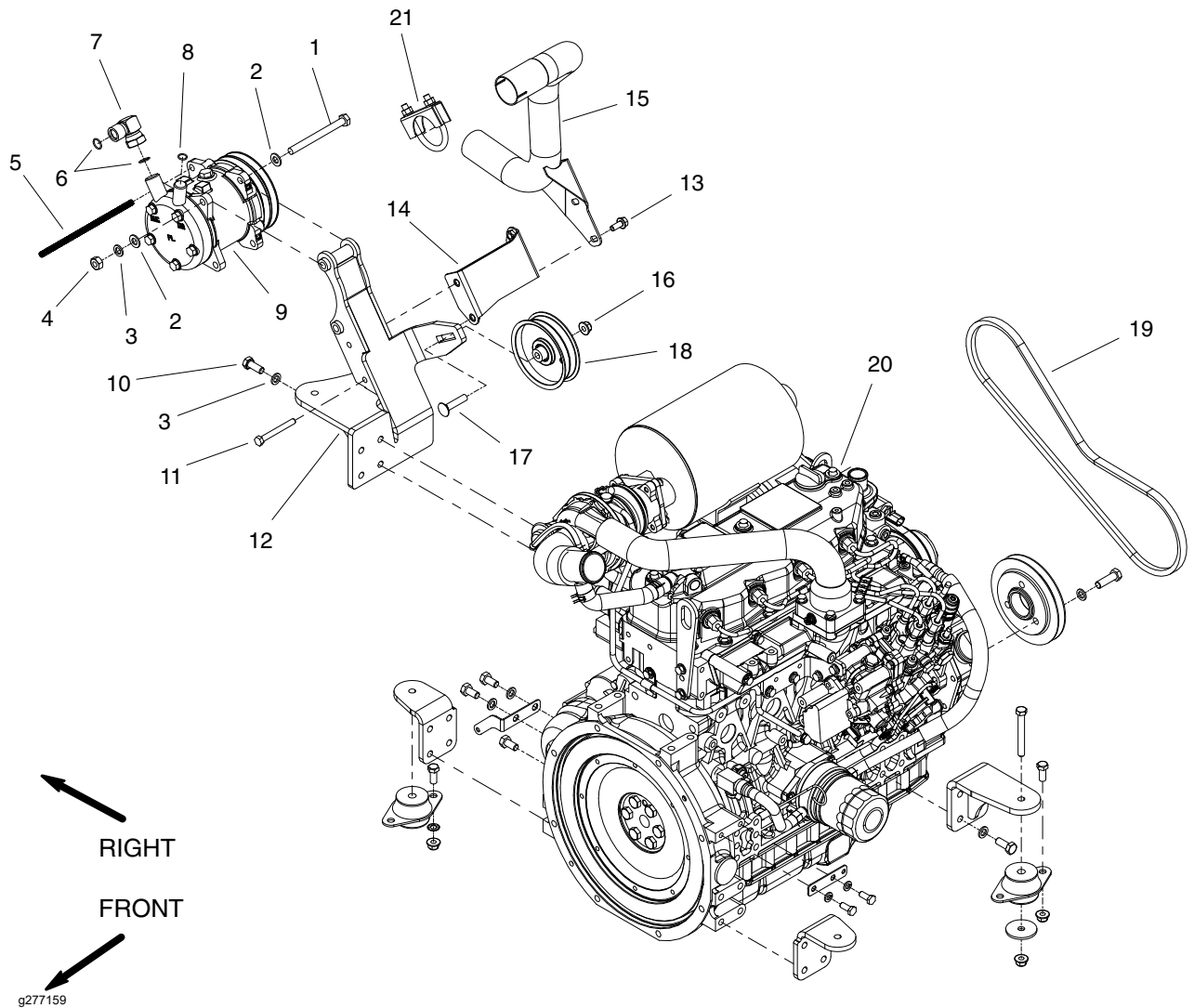


Figure 350

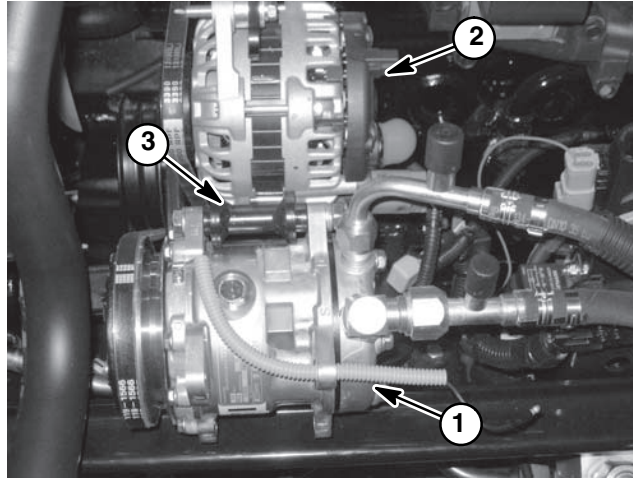
- | | | |
|-------------------------|--------------------------------|--------------------------------|
| 1. Cap screw (2 used) | 8. O-ring | 15. Exhaust pipe |
| 2. Flat washer (4 used) | 9. A/C compressor | 16. Flange nut |
| 3. Lock washer (6 used) | 10. Cap screw (4 used) | 17. Carriage screw |
| 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 30603 shown) |
| 7. 90° fitting | 14. Exhaust bracket | 21. Clamp assembly |

Removal (Figure 350)

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition 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 350) (continued)

6. Disconnect compressor electrical connector from machine wire harness.



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Figure 351

- | | |
|-------------------|-------------------------|
| 1. A/C compressor | 3. A/C compressor mount |
| 2. Alternator | |

7. 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.

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 350) (continued)

Note: The air conditioning compressor used on the Groundsmaster 4010-D is a Sanden model SD5H09. For air conditioning compressor repair procedures, see the [Sanden SD Compressor Service Guide](#).

Installation (Figure 350)

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.

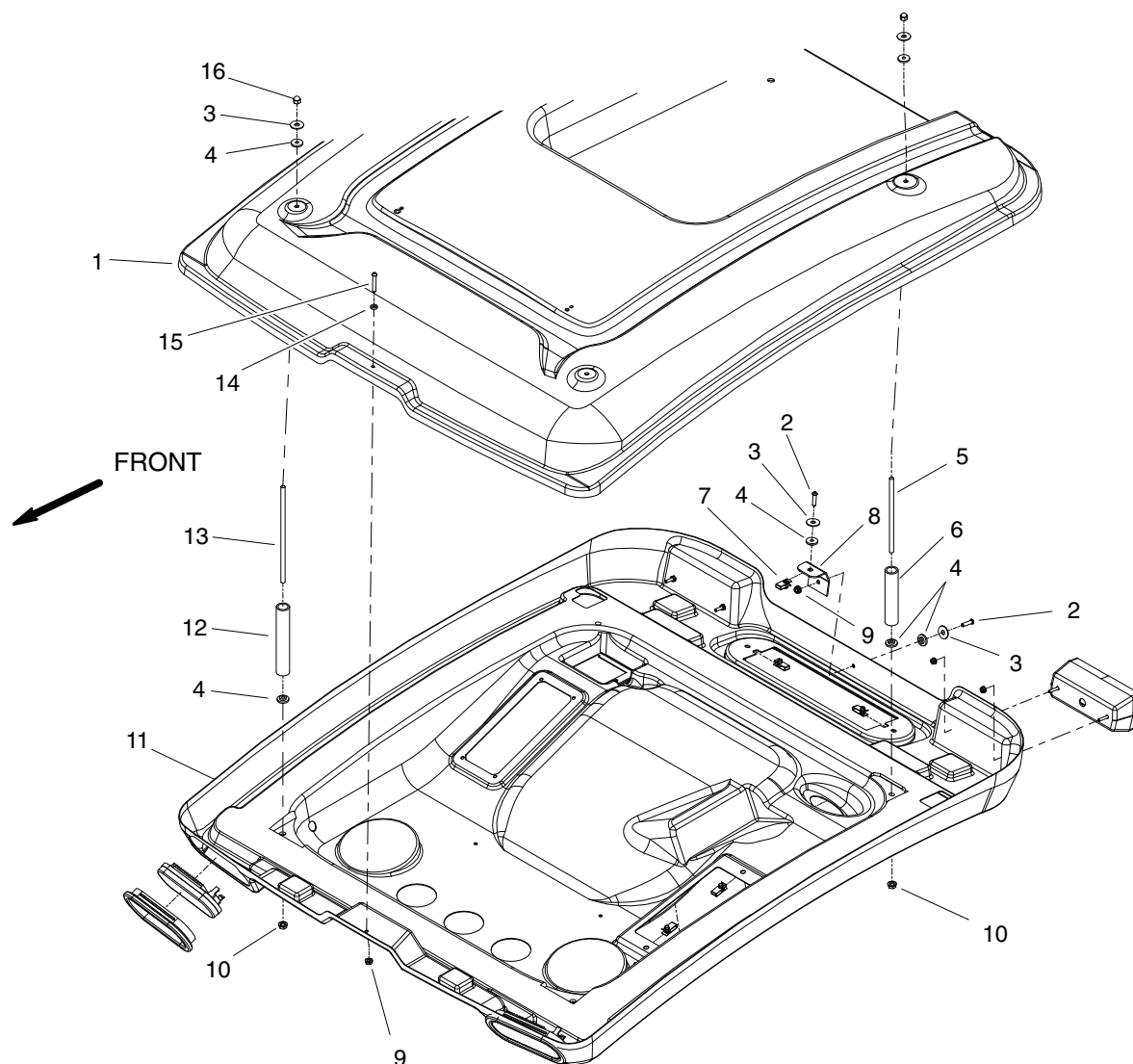
Note: The clearance between the compressor mounting flanges and compressor mount must be less than **0.10 mm (0.004 in)**. If necessary, install shims between compressor flanges and mount to adjust clearance. See Compressor Parts Catalog for shim kit.

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 1.35 pounds of R134a refrigerant.
10. Lower and secure hood.

Roof Assembly



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Figure 352

- | | | |
|---------------------------|---------------------------|-----------------------------|
| 1. Roof | 7. Panel nut | 13. Front fastener (2 used) |
| 2. Screw (2 used) | 8. Roof mount | 14. Rubber washer |
| 3. Flat washer (6 used) | 9. Flange nut (2 used) | 15. Cap screw |
| 4. Bushing (10 used) | 10. Flange nut (4 used) | 16. Hex nut (4 used) |
| 5. Rear fastener (2 used) | 11. Headliner | |
| 6. Rear spacer (2 used) | 12. Front spacer (2 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 352)

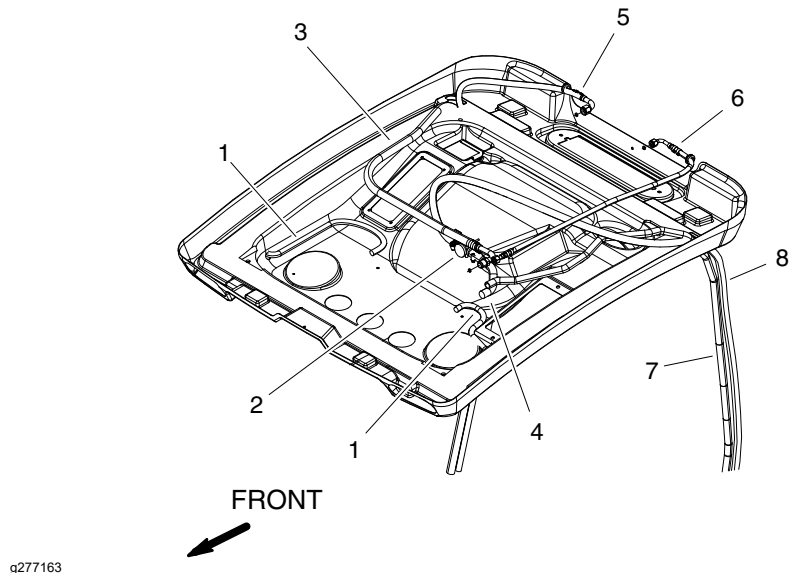


Figure 353

- | | |
|---|--|
| 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 ignition 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 352)

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

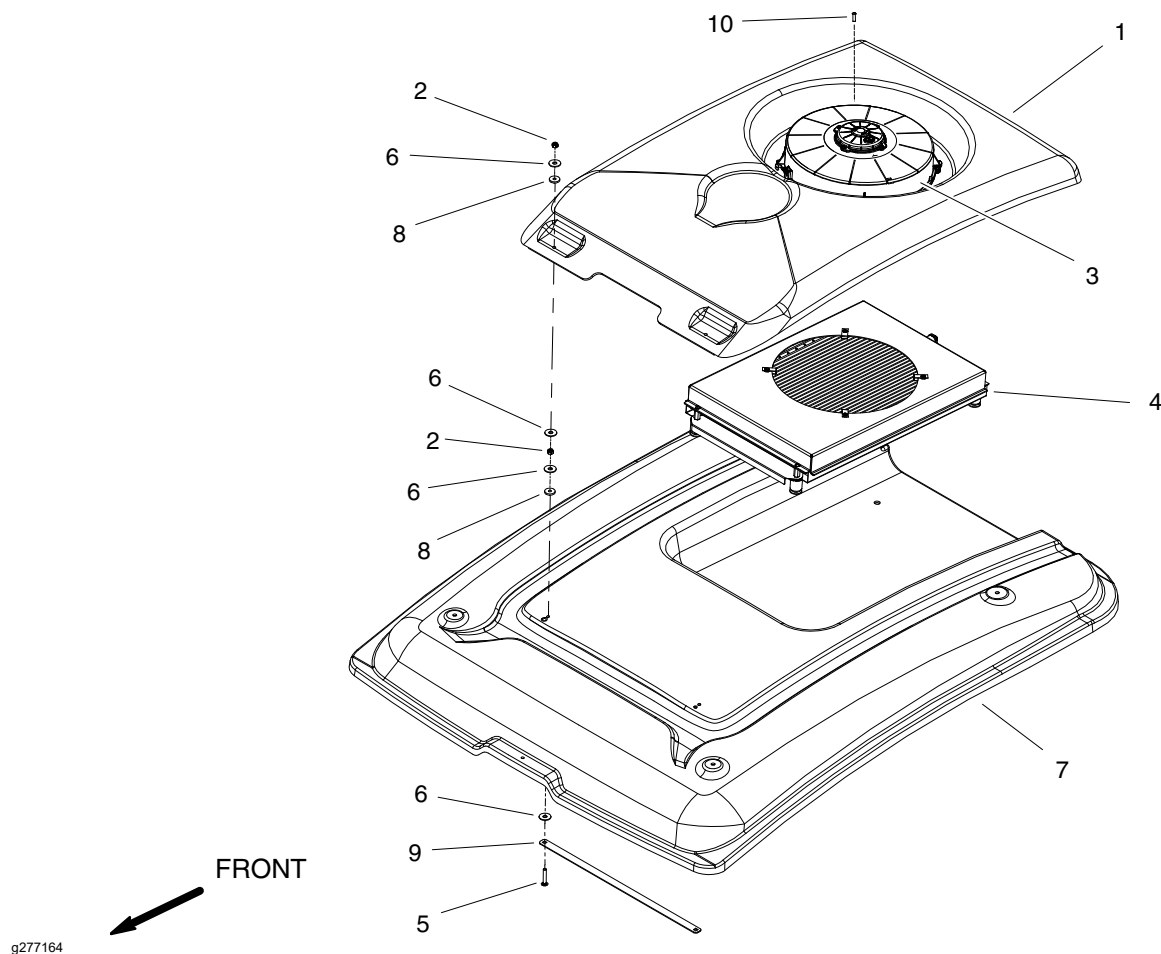


Figure 354

- | | | |
|----------------------------|----------------------------|--------------------------------|
| 1. Condenser cover | 5. Carriage screw (2 used) | 9. Mounting strap |
| 2. Lock nut (4 used) | 6. Flat washer (8 used) | 10. Button head screw (4 used) |
| 3. Condenser fan | 7. Roof | |
| 4. Condenser coil assembly | 8. Bushing (4 used) | |

Removal ([Figure 354](#))

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.
2. Remove fasteners that secure roof in place. Raise and support roof to allow access to condenser assembly (see [Roof Assembly \(page 10–8\)](#)).
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 \(page 10–3\)](#).

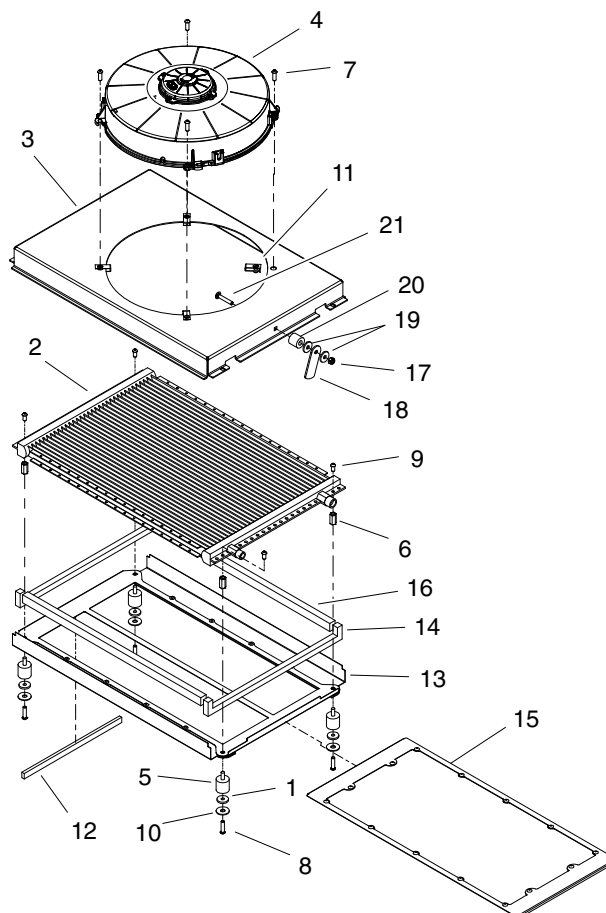


CAUTION



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.



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Figure 355

- | | |
|----------------------------|------------------------------|
| 1. Bushing (4 used) | 12. Tray foam |
| 2. Condenser coil | 13. Screen frame |
| 3. Fan shroud | 14. End foam (2 used) |
| 4. Condenser fan | 15. Screen |
| 5. Isolator mount (4 used) | 16. Side foam (2 used) |
| 6. Coupler nut (4 used) | 17. Lock nut |
| 7. Screw (4 used) | 18. Latch plate |
| 8. Screw (4 used) | 19. Friction washer (2 used) |
| 9. Screw (4 used) | 20. Latch spacer |
| 10. Flat washer (4 used) | 21. Carriage screw |
| 11. Clip (4 used) | |

Removal ([Figure 354](#)) (continued)

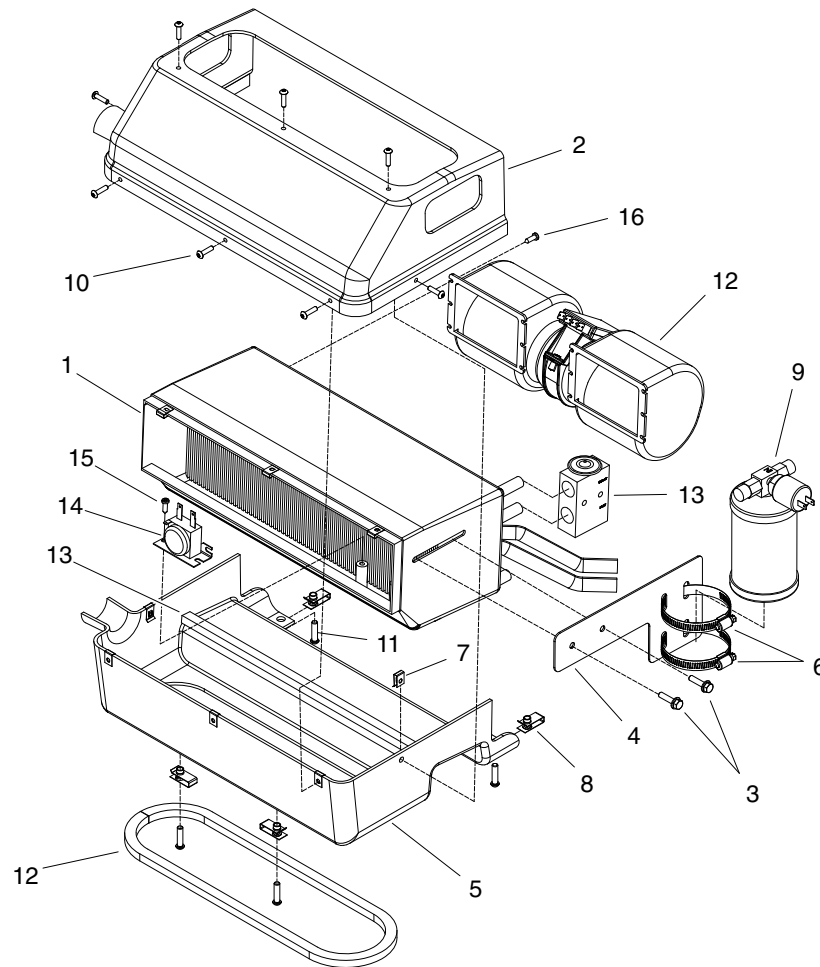
9. Remove condenser coil from roof using [Figure 355](#) as a guide.

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 354](#))

1. Install condenser coil to roof using [Figure 355](#) 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 1.35 pounds of R134a refrigerant.
8. Lower and secure roof assembly (see [Roof Assembly \(page 10–8\)](#)).

Heater/Evaporator Assembly



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Figure 356

- | | | |
|-------------------------------|----------------------------|---------------------|
| 1. Heater/evaporator assembly | 7. Speed nut (8 used) | 13. Expansion valve |
| 2. Top cover | 8. Panel nut (4 used) | 14. Freeze switch |
| 3. Flange head screw (2 used) | 9. Drier-receiver assembly | 15. Screw (2 used) |
| 4. Drier-receiver mount | 10. Screw (8 used) | 16. Screw (12 used) |
| 5. Bottom cover | 11. Screw (4 used) | |
| 6. Hose clamp (2 used) | 12. Blower fan assembly | |

Removal (Figure 356)

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition 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 356) (continued)

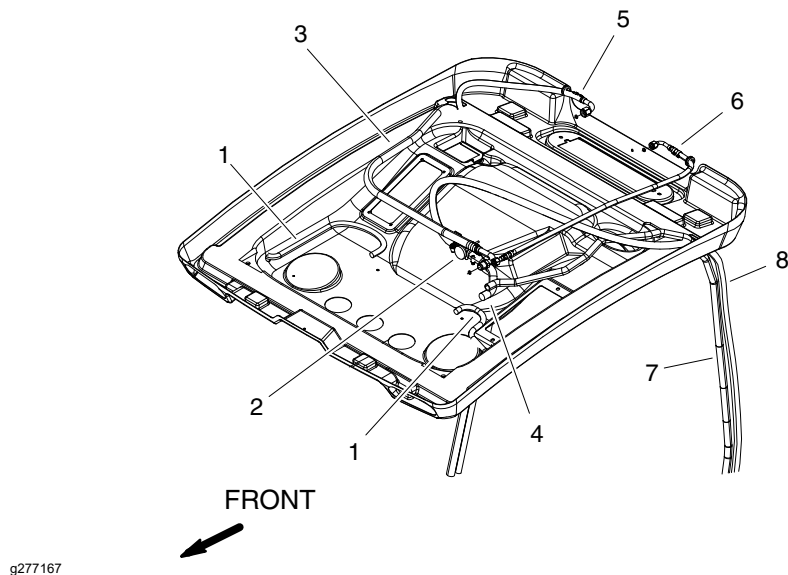


Figure 357

- | | |
|---|--|
| 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 |

-
4. Read the [General Precautions for Removing and Installing the Air Conditioning System Components](#) (page 10–3).



CAUTION



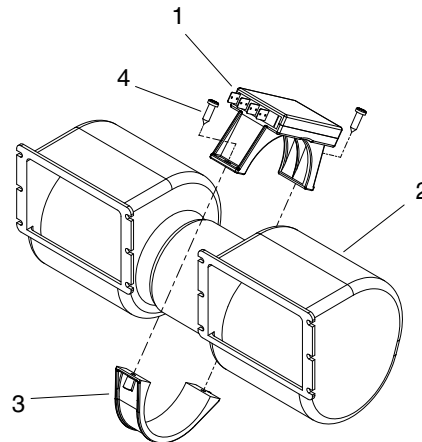
The air conditioning system is under high pressure. Do not loosen any system fitting or component until after the system has been completely discharged by a certified A/C service technician.

-
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 356](#) as a guide.
 10. If necessary, remove fan resistor from blower fan assembly ([Figure 358](#)).

Note: The replacement of the drier–receiver is recommended whenever the air conditioning system is opened.

Installation ([Figure 356](#))

1. Assemble heater/evaporator assembly using [Figure 356](#) as a guide. Make sure that expansion valve is covered with insulating tape to prevent condensation issues.

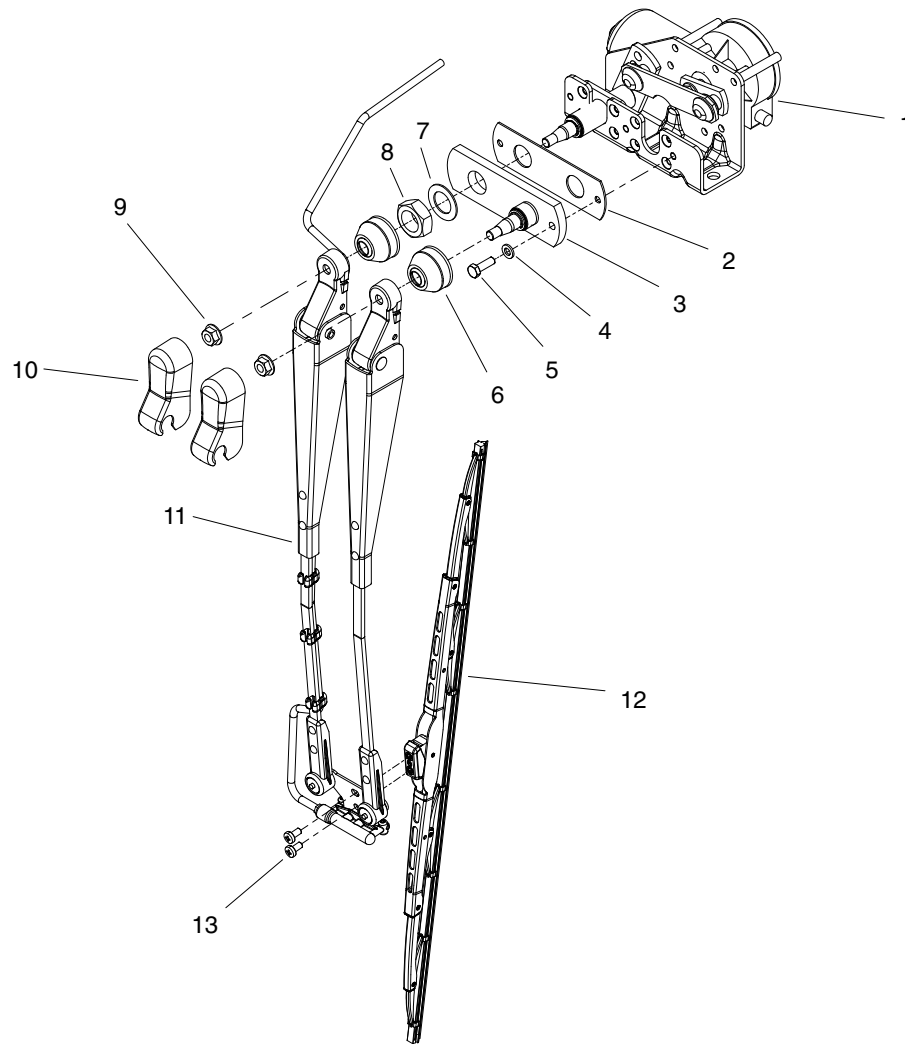


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Figure 358

- | | |
|------------------------|-------------------|
| 1. Fan resistor | 3. Clamp |
| 2. Blower fan assembly | 4. Screw (2 used) |
-
2. If removed, secure fan resistor to blower fan assembly ([Figure 358](#)).
 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 1.35 pounds 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



g277160

Figure 359

- | | | |
|--------------------|------------------------|------------------------|
| 1. Wiper motor | 6. Cap (2 used) | 11. Wiper arm assembly |
| 2. Gasket | 7. Washer | 12. Wiper blade |
| 3. Linkage bracket | 8. Nut | 13. Screw (2 used) |
| 4. Lock washer | 9. Flange nut (2 used) | |
| 5. Cap screw | 10. Cover (2 used) | |

Disassembly ([Figure 359](#))

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition 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 359](#) as a guide.

Assembly ([Figure 359](#))

1. Assemble windshield wiper components using [Figure 359](#) as a guide.
2. If roof was raised, lower and secure roof assembly (see [Roof Assembly \(page 10–8\)](#)).



Operator Cab (For models 30635 and 30636)

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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.

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.

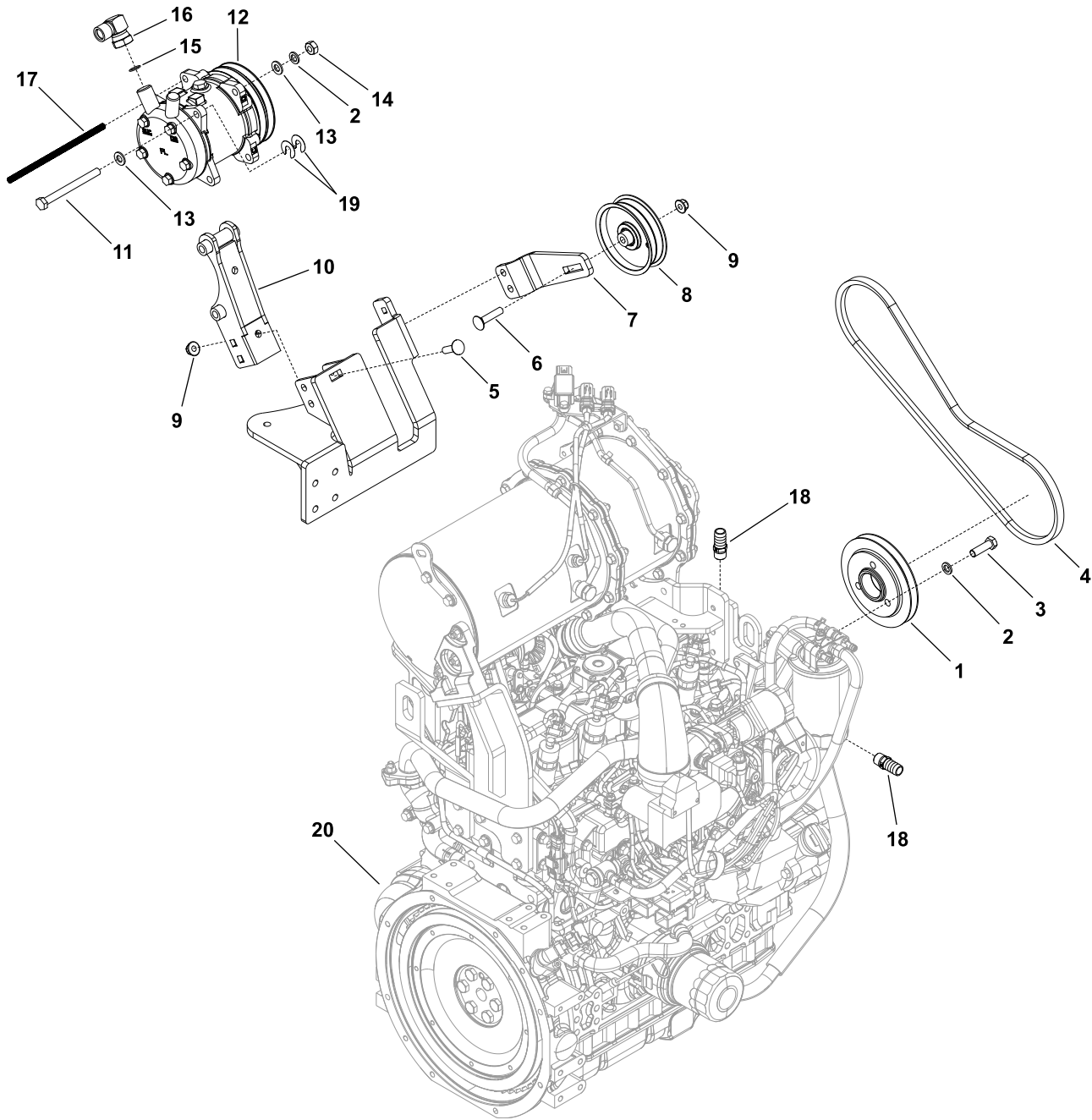
General Precautions for Removing and Installing the Air Conditioning System Components (continued)

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 (3.43 lb) of R134a refrigerant.

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



g278801

Figure 360

- | | | |
|---------------------------|----------------------|-------------------------------|
| 1. Pulley | 8. Idler pulley | 15. O-ring |
| 2. Lock washer (5 each) | 9. Nut (6 each) | 16. Elbow fitting |
| 3. Bolt (3 each) | 10. Compressor mount | 17. Convoluted conduit |
| 4. V-belt | 11. Bolt (2 each) | 18. Straight fitting (2 each) |
| 5. Carriage bolt (5 each) | 12. Compressor | 19. Shim (4 each) |
| 6. Carriage bolt | 13. Washer (4 each) | 20. Engine |
| 7. Pulley mount | 14. Nut (2 each) | |

Removing the Air Conditioning Compressor (Figure 360)

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.

Removing the Air Conditioning Compressor (**Figure 360**) (continued)

2. Raise the hood to get access to the engine and air conditioning compressor.
3. Remove the exhaust pipe; refer to [Exhaust System \(Models 30607, 30609 and 30636\)](#) (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 4010–D is a Badger Compressor. For air conditioning compressor repair procedures, see the [Badger Compressor Service Manual](#).

Installing the Air Conditioning Compressor (**Figure 360**)

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.

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 \(Models 30607, 30609 and 30636\) \(page 4–30\)](#).
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 1.35 pounds of R134a refrigerant.
10. Lower and secure hood.

Roof Assembly

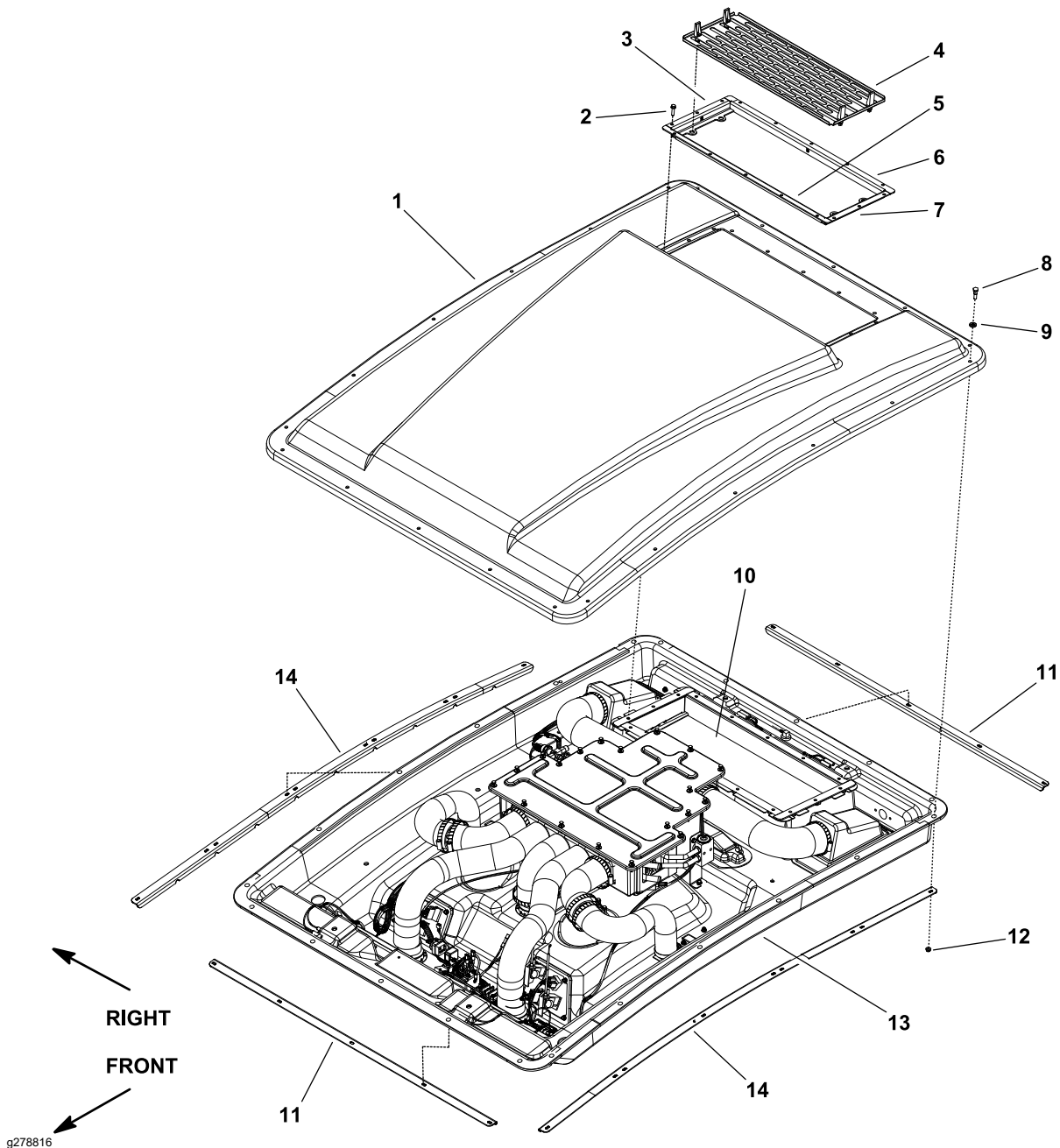


Figure 361

- | | | |
|--------------------------------|-----------------------------|-----------------------------------|
| 1. Roof panel | 6. Rear condenser seal | 11. Front/rear cab strap (2 each) |
| 2. Flange-head screw (16 each) | 7. Left condenser seal | 12. Flange nut (22 each) |
| 3. Right condenser seal | 8. Shoulder screw (22 each) | 13. Headliner assembly |
| 4. Condenser screen | 9. Flat washer (22 each) | 14. Side cab strap (2 each) |
| 5. Front condenser seal | 10. Condenser assembly | |

Get access to the heater core and air conditioning components by removing the roof panel.

Removing the Roof 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.

Removing the Roof Assembly (continued)

2. Release the 4 swell latches and lift the condenser screen (item 4 in [Figure 361](#)) from the roof assembly.
3. Remove the 16 flange-head screws (item 2 in [Figure 361](#)) 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 in [Figure 361](#)), 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

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 in [Figure 361](#)), 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

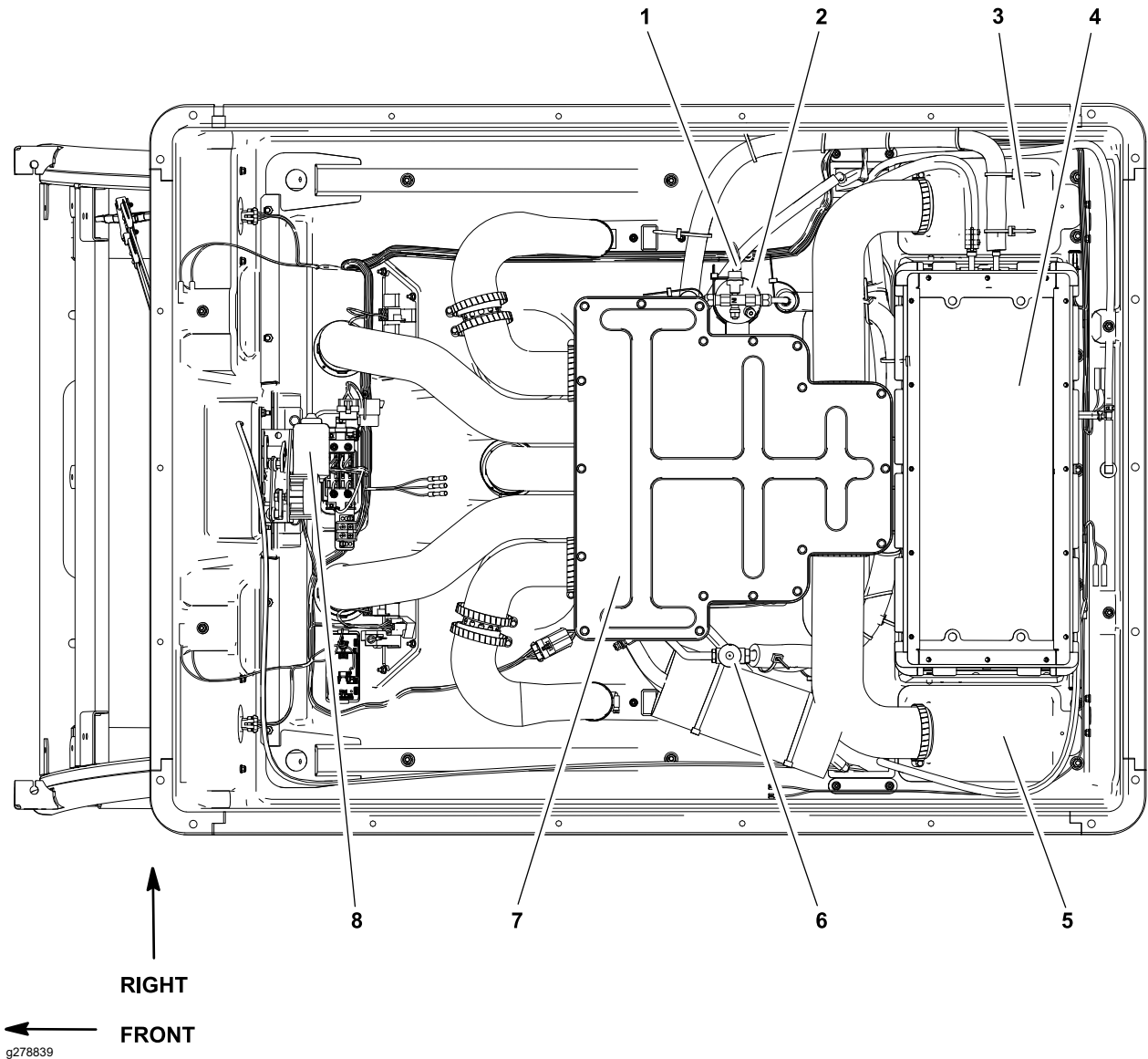


Figure 362

- | | | |
|------------------------------------|--|--|
| 1. Air conditioning binary switch | 4. Air conditioning condenser assembly | 7. Heat and air conditioning mixing box assembly |
| 2. Air conditioning drier-receiver | 5. Left intake air filter | 8. Wiper motor assembly |
| 3. Right intake air filter | 6. Air conditioning expansion valve | |

Heating and Air Conditioning Components (continued)

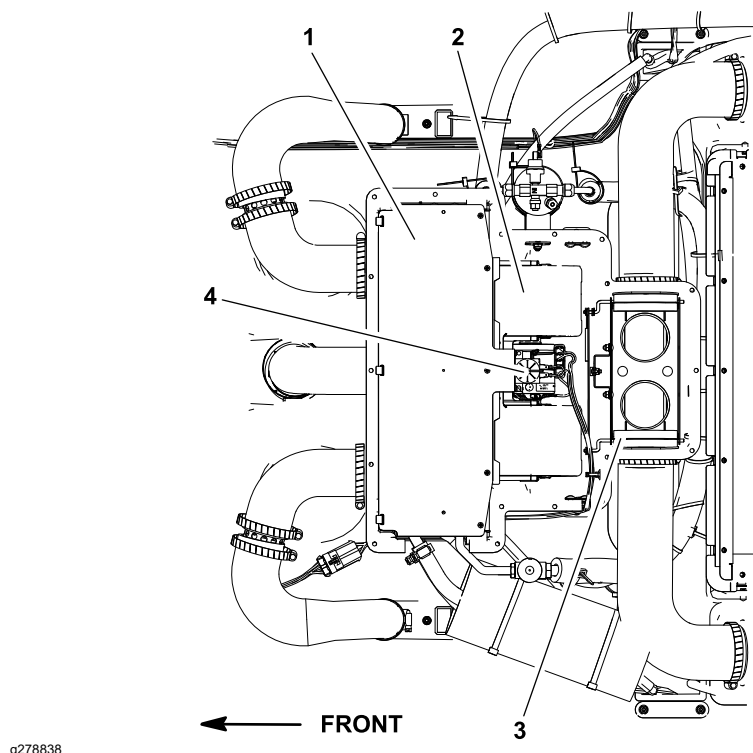


Figure 363

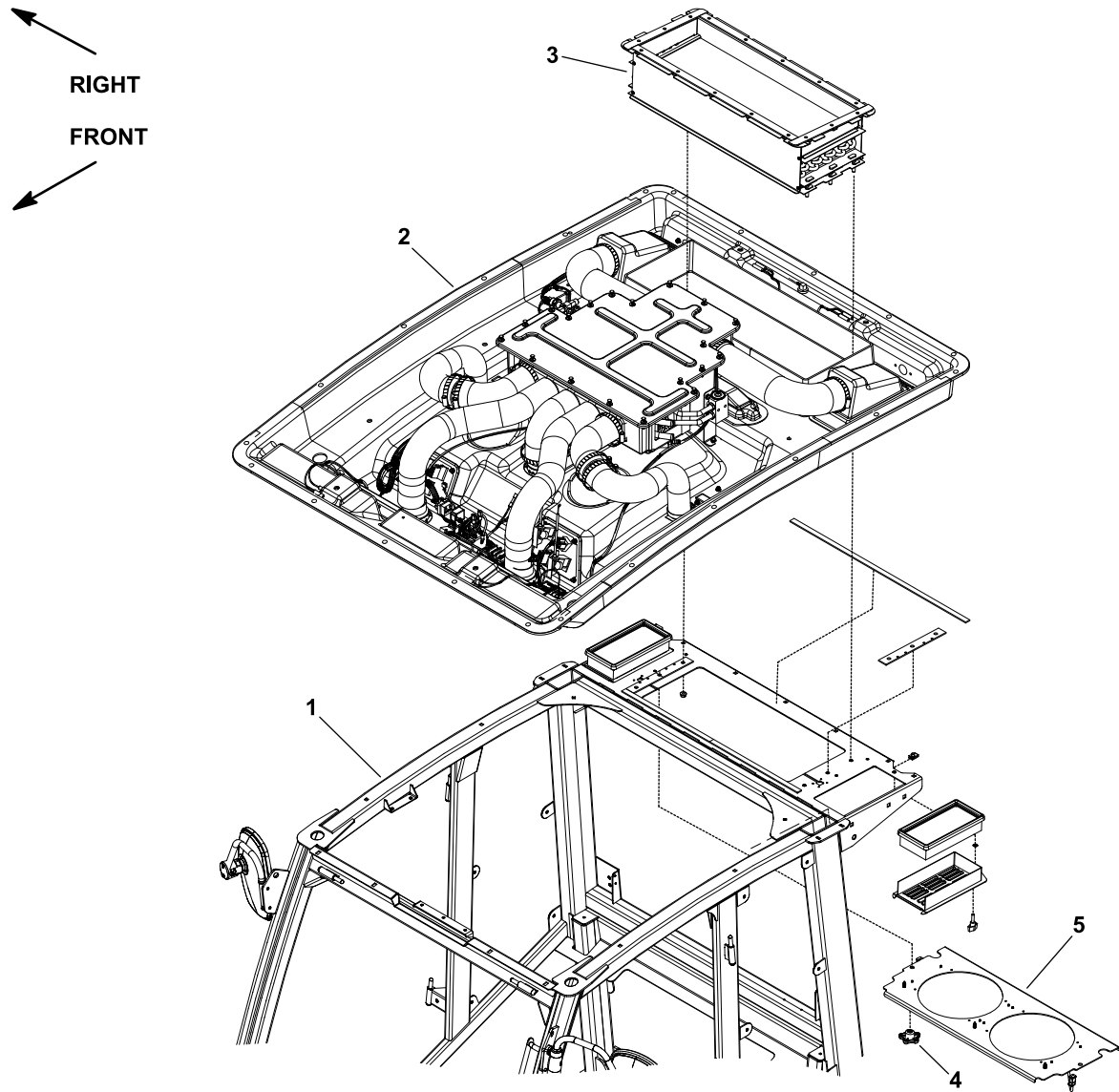
- | | |
|----------------------------|-----------------------------------|
| 1. Evaporator/heater cores | 3. Air diverter assembly |
| 2. Blower fan | 4. Air conditioning freeze switch |

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 362](#) and [Figure 363](#) to identify the components used for heating and cooling the operator cab.

Note: [Figure 363](#) 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 (3.43 lb)** of R134a refrigerant.

Air Conditioning Condenser Fan Assembly



g278864

Figure 364

- | | | |
|---------------------------|--|---------------------------|
| 1. Cab frame | 3. Air conditioning condenser assembly | 5. Condenser fan assembly |
| 2. Cab headliner assembly | 4. Knob (2 each) | |

Removing the Air Conditioning Condenser Fan Assembly

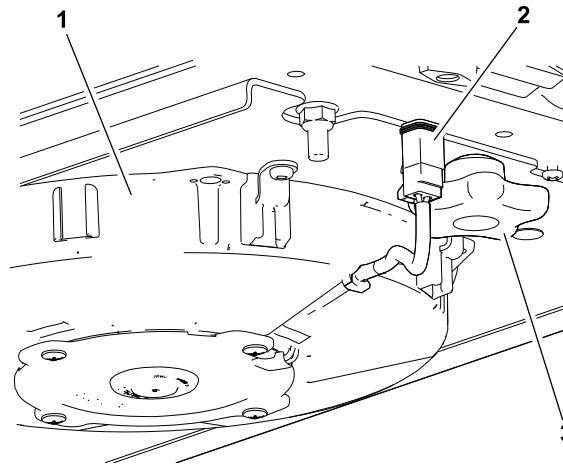


Figure 365

- | | |
|---------------------------|------------------|
| 1. Condenser fan (2 each) | 3. Knob (2 each) |
| 2. Fan plug (2 each) | |

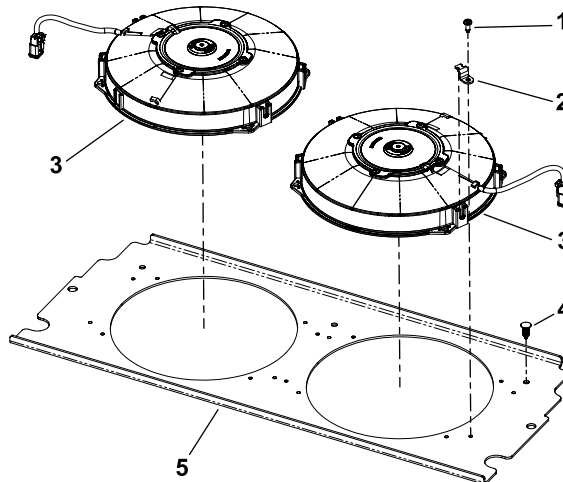


Figure 366

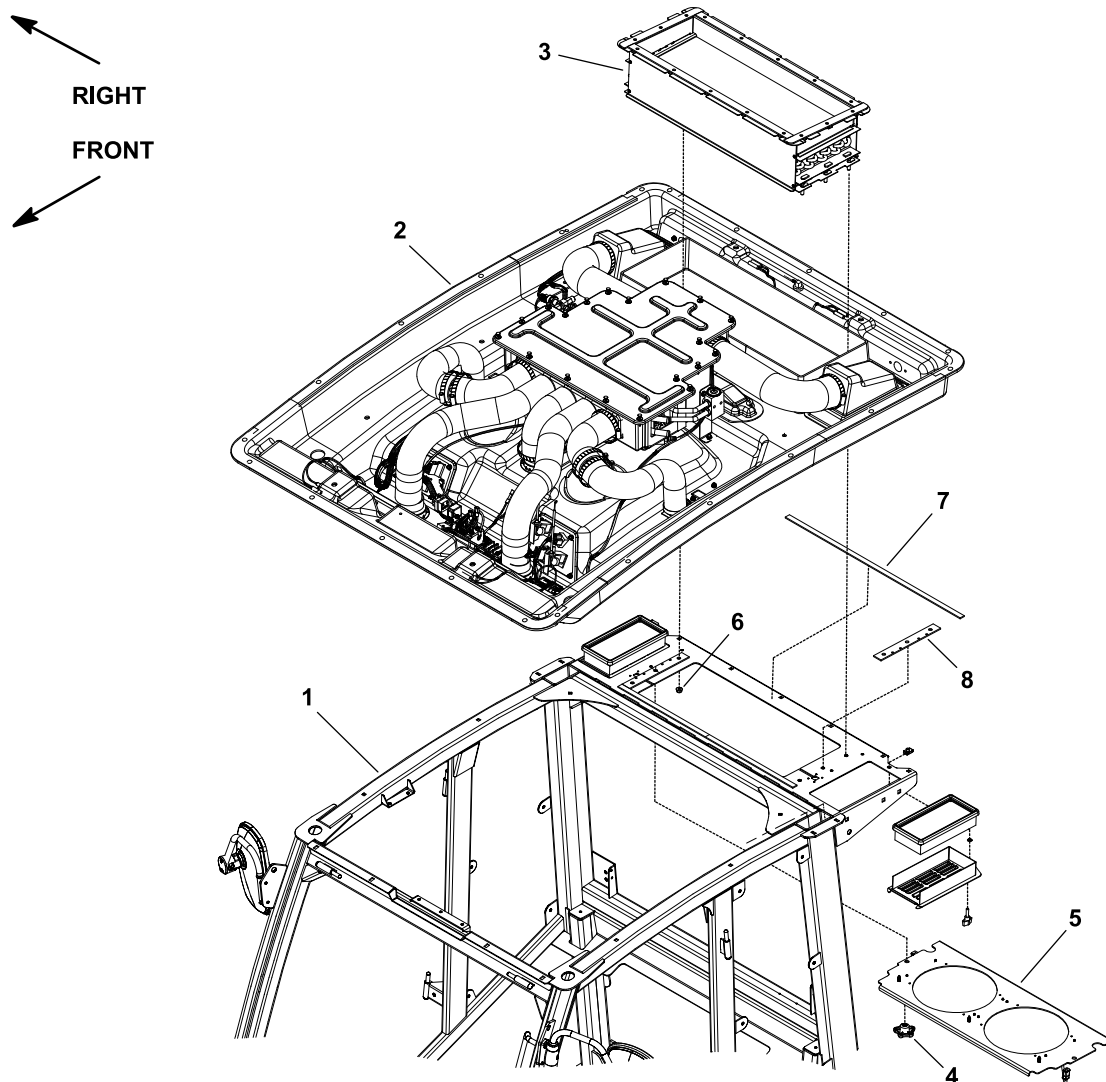
- | | |
|-----------------------------|--------------------|
| 1. Screw (4 each per fan) | 4. Plug (3 each) |
| 2. Fan tab (4 each per fan) | 5. Fan mount plate |
| 3. Condenser fan (2 each) | |

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 365](#)) 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 365](#)) 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 366](#)).

Installing the Air Conditioning Condenser Fan Assembly

1. If the condenser fan assembly was disassembled, secure the fans to the fan mount plate ([Figure 366](#)).
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



g278919

Figure 367

- | | |
|--|---------------------------|
| 1. Cab frame | 5. Condenser fan assembly |
| 2. Cab headliner assembly | 6. Flange nut (4 each) |
| 3. Air conditioning condenser assembly | 7. Strip seal (2 each) |
| 4. Knob (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 \(page 11–4\)](#).

Removing the Air Conditioning Condenser Assembly (continued)

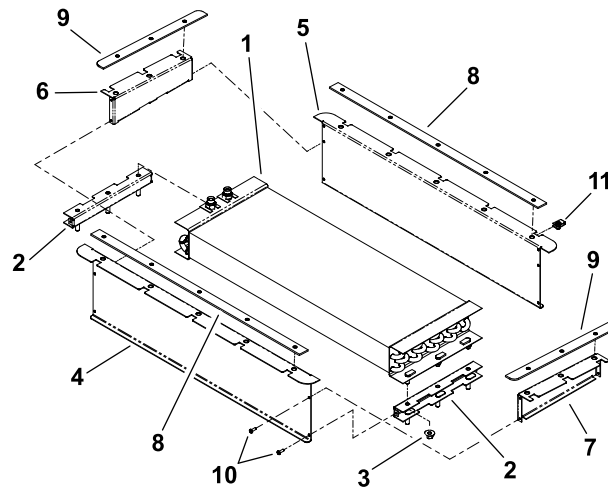


CAUTION



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.



g278920

Figure 368

- | | |
|-----------------------|------------------------|
| 1. Condenser core | 7. Left side wall |
| 2. Lower leg (2 each) | 8. Strip seal (2 each) |
| 3. Hex nut (6 each) | 9. Edge seal (2 each) |
| 4. Front wall | 10. Screw (12 each) |
| 5. Back wall | 11. Clip (16 each) |
| 6. Right side wall | |
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 367](#)) 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 367](#)) 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 368](#)).
 11. Inspect the seals (items 8 and 9 in [Figure 368](#)) 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 368](#).
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 (3.43 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 [Installing the Roof Assembly \(page 11–10\)](#).

Mixing Box Assembly

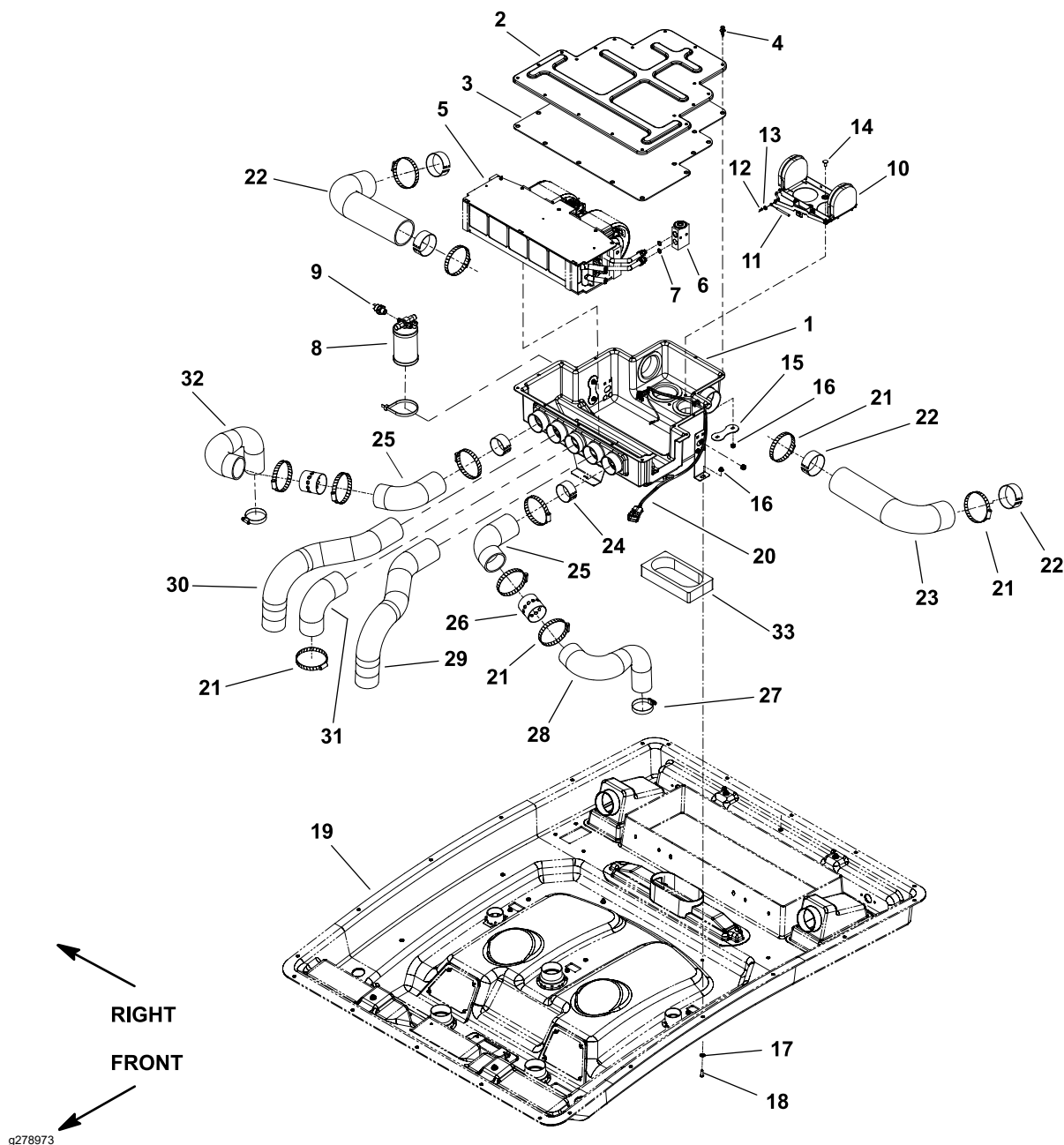


Figure 369

- | | | |
|--|--------------------------------|---------------------------|
| 1. Mixing box | 12. Hairpin | 23. Vent hose (2 each) |
| 2. Mixing box cover | 13. Flat washer | 24. Tube support (2 each) |
| 3. Cover insulation | 14. Carriage screw (2 each) | 25. Vent hose (2 each) |
| 4. Rivet (19 each) | 15. Support plate | 26. Adapter (2 each) |
| 5. Heater core/ air conditioning evaporator/fan assembly | 16. Flange nut (4 each) | 27. Hose clamp (2 each) |
| 6. Expansion valve | 17. Flat washer (2 each) | 28. Vent hose |
| 7. O-ring (2 each) | 18. Button-head screw (2 each) | 29. Vent hose |
| 8. Air conditioning drier-receiver | 19. Cab headliner | 30. Vent hose |
| 9. Binary switch | 20. Mixing box wire harness | 31. Vent hose |
| 10. Air diverter assembly | 21. Hose clamp (11 each) | 32. Vent hose |
| 11. Control cable | 22. Tube support (4 each) | 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 [Removing the 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 \(page 11–4\)](#). 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 369](#) and [Figure 370](#).

Note: Replace the air conditioning drier-receiver whenever you replace the expansion valve.

Installing the Mixing Box Assembly

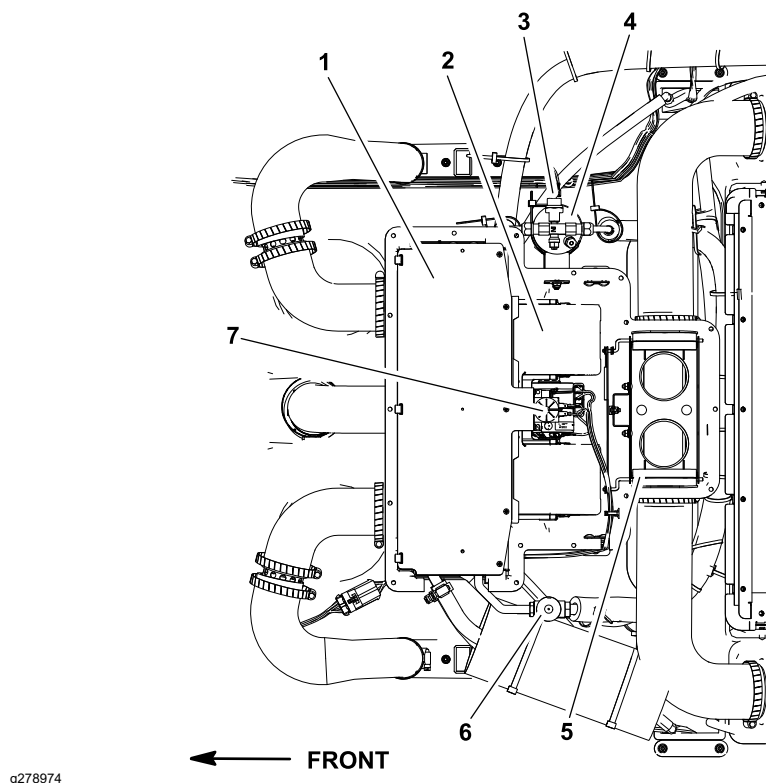


Figure 370

- | | |
|------------------------------------|-------------------------------------|
| 1. Evaporator and heater core | 5. Air diverter assembly |
| 2. Blower fan | 6. Air conditioning expansion valve |
| 3. Air conditioning binary switch | 7. Air conditioning freeze switch |
| 4. Air conditioning drier-receiver | |

-
1. Install all the mixing box components that were removed ([Figure 369](#) and [Figure 370](#)).

Note: Ensure that the expansion valve is covered with insulating tape to prevent condensation issues.

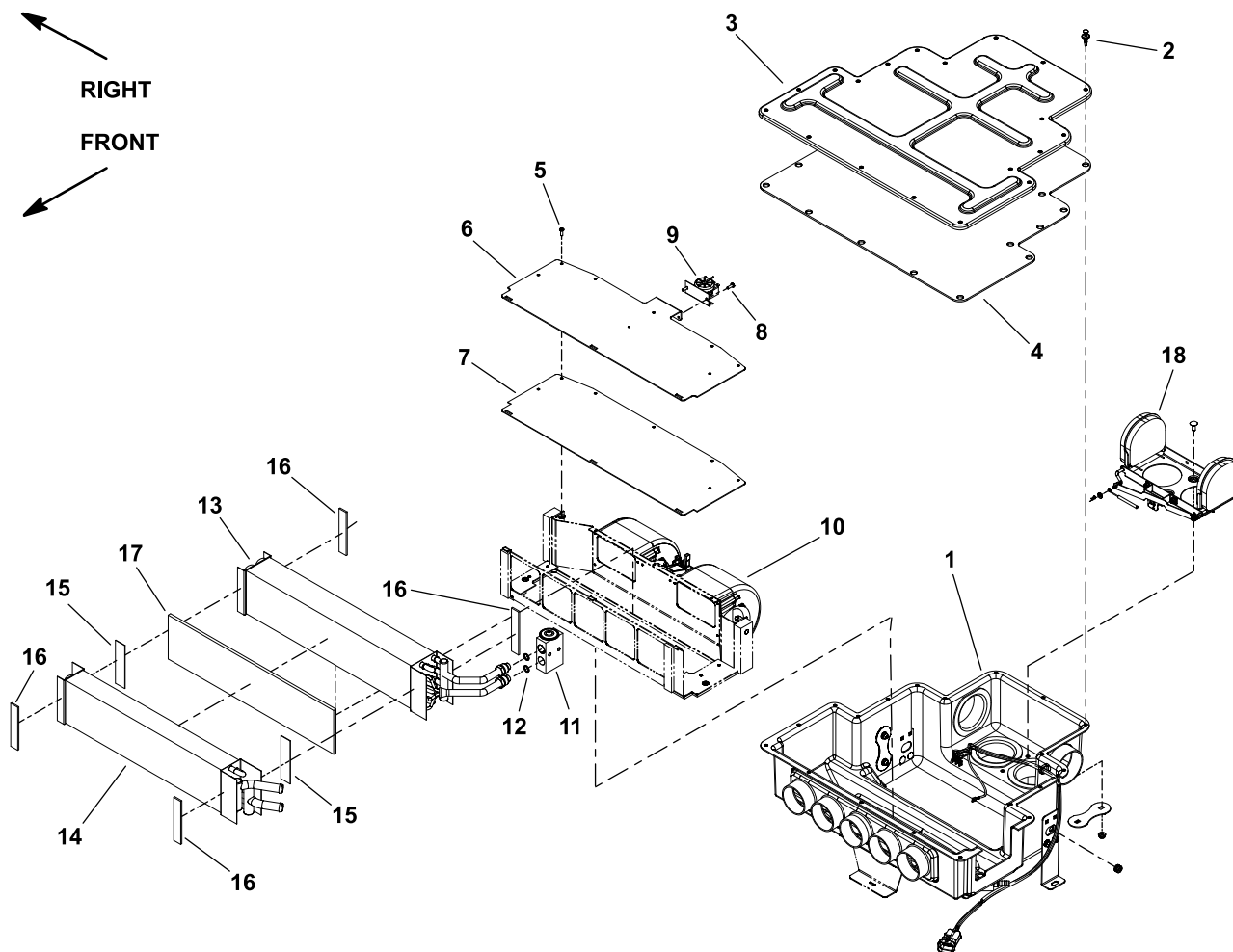
2. Ensure that the condensation hoses are secured to the drain fittings on the bottom of the mixing box assembly. Also, route the hoses to the cab frame for proper draining of the condensate.
3. Ensure to connect the electrical connectors from the mixing box wire harness and binary switch on the air 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 (3.43 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 [Installing the Roof Assembly \(page 11–10\)](#).

Heater and Air Conditioning Evaporator Cores



g278977

Figure 371

- | | |
|------------------------|--------------------------------------|
| 1. Mixing box | 10. Mount bracket (shown with fan) |
| 2. Rivet (19 each) | 11. Expansion valve |
| 3. Mixing box cover | 12. O-ring (2 each) |
| 4. Cover insulation | 13. Air conditioning evaporator core |
| 5. Screw (5 each) | 14. Heater core |
| 6. Mount bracket cover | 15. Double sided tape (2 each) |
| 7. Cover gasket | 16. Gasket (4 each) |
| 8. Screw (2 each) | 17. Condensation catch foam |
| 9. Freeze switch | 18. Air diverter assembly |

Note: The heater and evaporator cores can be removed and installed with the mixing box (item 1 in [Figure 371](#)) 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 [Removing the 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 371](#)) 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 371](#)). The cores are secured to each other with double sided tape (item 15 in [Figure 371](#)).
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 371](#)).
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 371](#)).
4. Insert the wire from the freeze switch into the air conditioning evaporator core through the mount bracket cover.

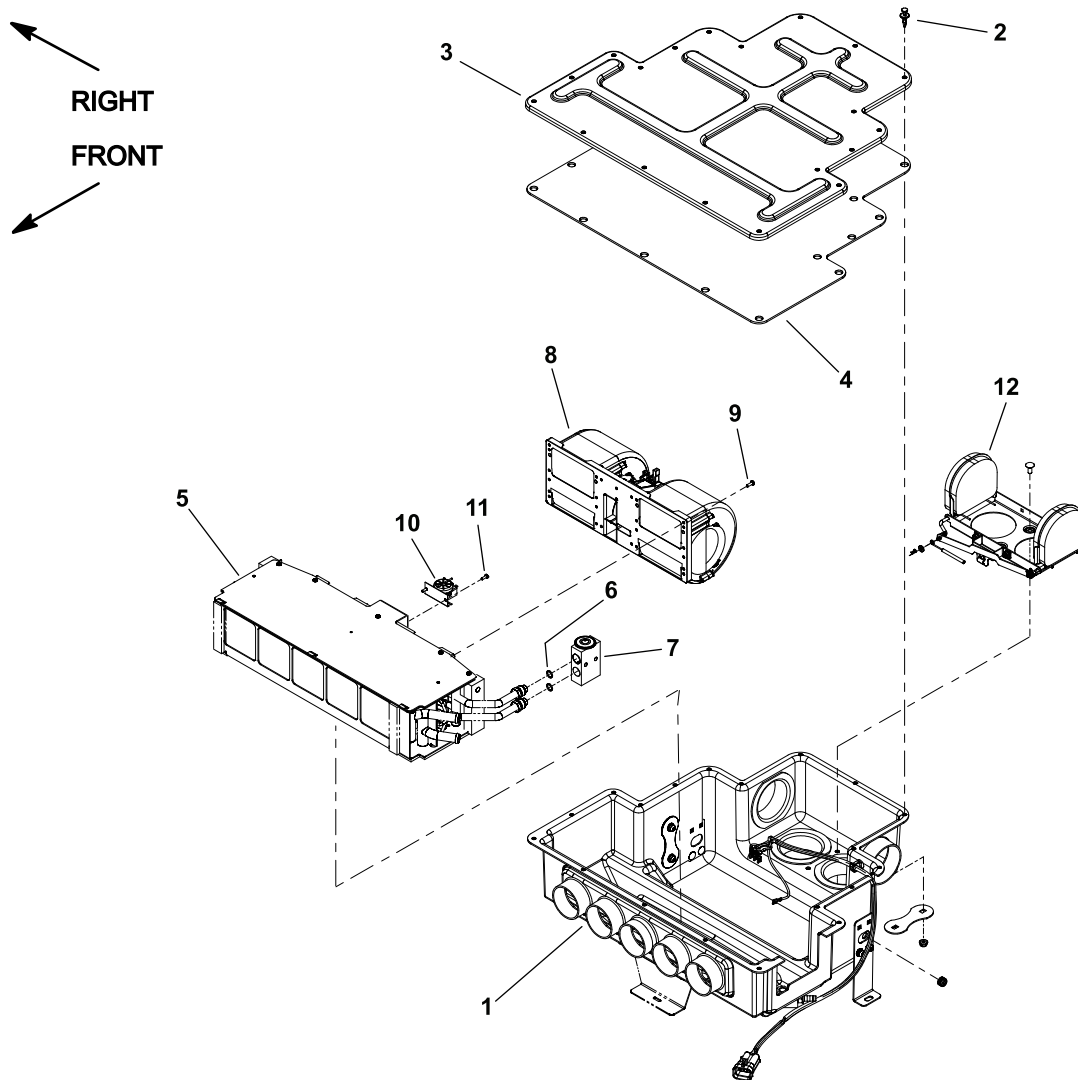
Note: The wire should be inserted **51 mm (2 in)** through the cover.

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 (3.43 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 [Installing the Roof Assembly \(page 11–10\)](#).

Blower Fan



g279105

Figure 372

- | | | |
|---------------------|---|---------------------------|
| 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 372](#)) 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 [Removing the Roof Assembly \(page 11–9\)](#).
3. Read the [General Precautions for Removing and Installing the Air Conditioning System Components \(page 11–4\)](#).



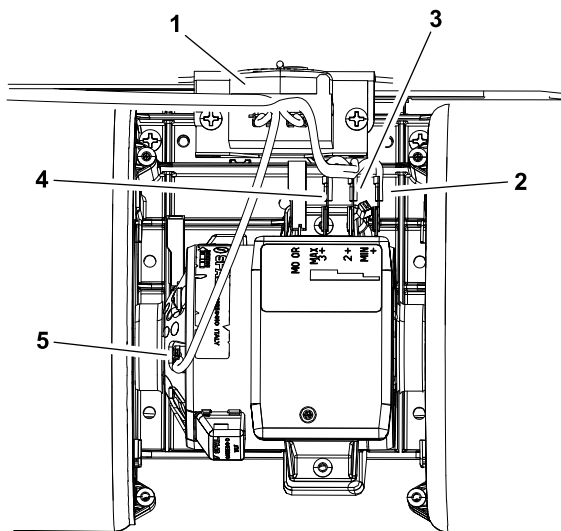
CAUTION



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.

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.



g279106

Figure 373

- | | |
|--------------------------|----------------------------|
| 1. Freeze switch | 4. Terminal 3 (orange) |
| 2. MIN terminal (violet) | 5. Ground terminal (black) |
| 3. Terminal 2 (brown) | |

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 373](#)), 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 372](#)) 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 373](#)).
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 (3.43 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 [Installing the Roof Assembly \(page 11–10\)](#).

Windshield Wiper Assembly

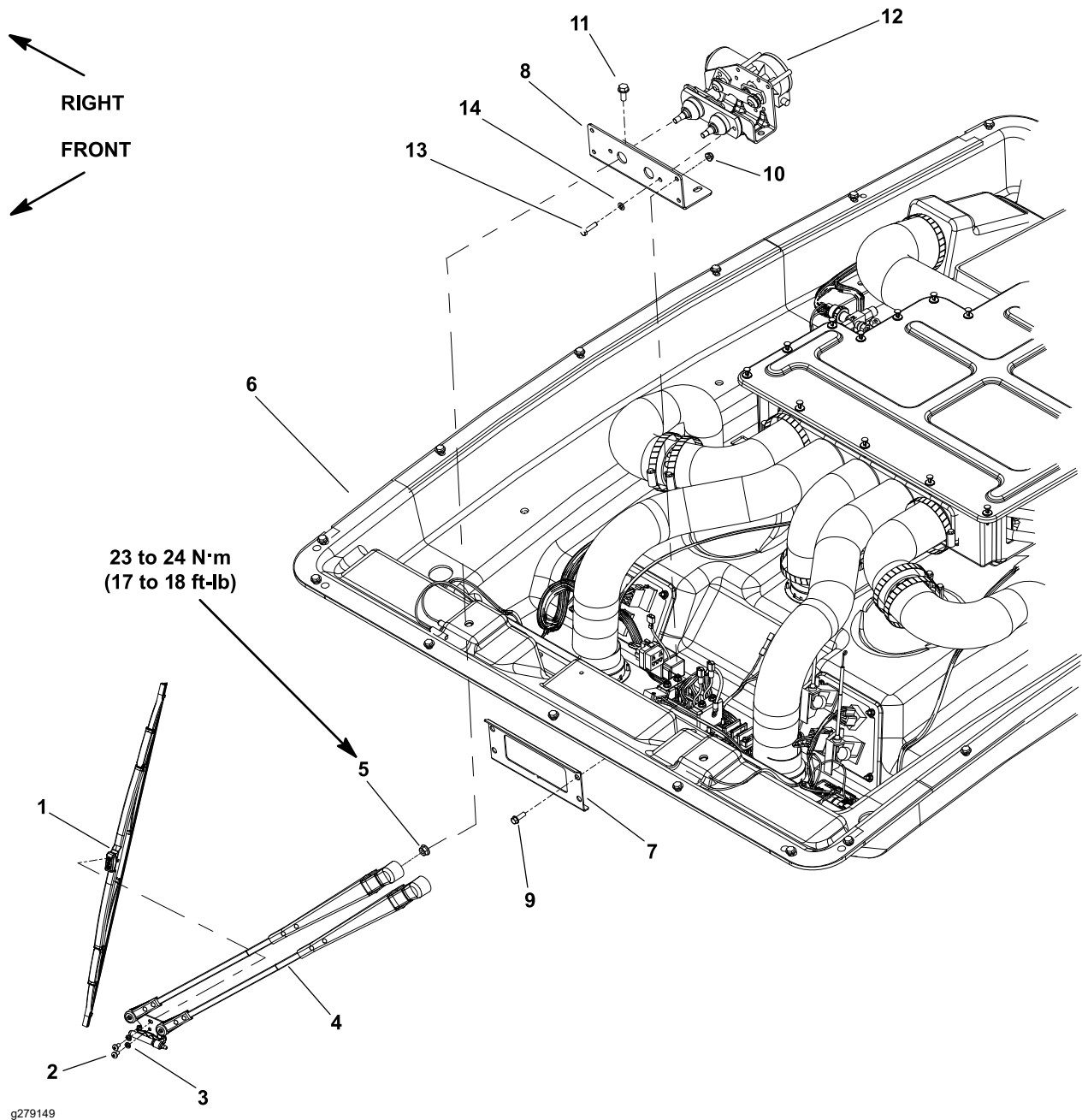


Figure 374

- | | | |
|-------------------------|-------------------------------|--------------------------------|
| 1. Wiper blade | 6. Cab headliner | 11. Washer-head screw (2 each) |
| 2. Bolt (2 each) | 7. Wiper plate | 12. Wiper motor |
| 3. Lock washer (2 each) | 8. Wiper bracket | 13. Bolt |
| 4. Wiper arm assembly | 9. Washer-head screw (4 each) | 14. Lock washer |
| 5. Flange nut (2 each) | 10. Flange nut (4 each) | |

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 374](#)) 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 [Removal \(Figure 352\) \(page 10–9\)](#).
5. Remove the wiper motor components as shown in [Figure 374](#).

Assembling the Windshield Wiper Assembly

1. If required, install the wiper motor components that were removed ([Figure 374](#)) and do the following:
 - A. If the wiper bracket (item 8 in [Figure 374](#)) 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 [Installation \(Figure 352\) \(page 10–9\)](#).
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.



Foldout Drawings

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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

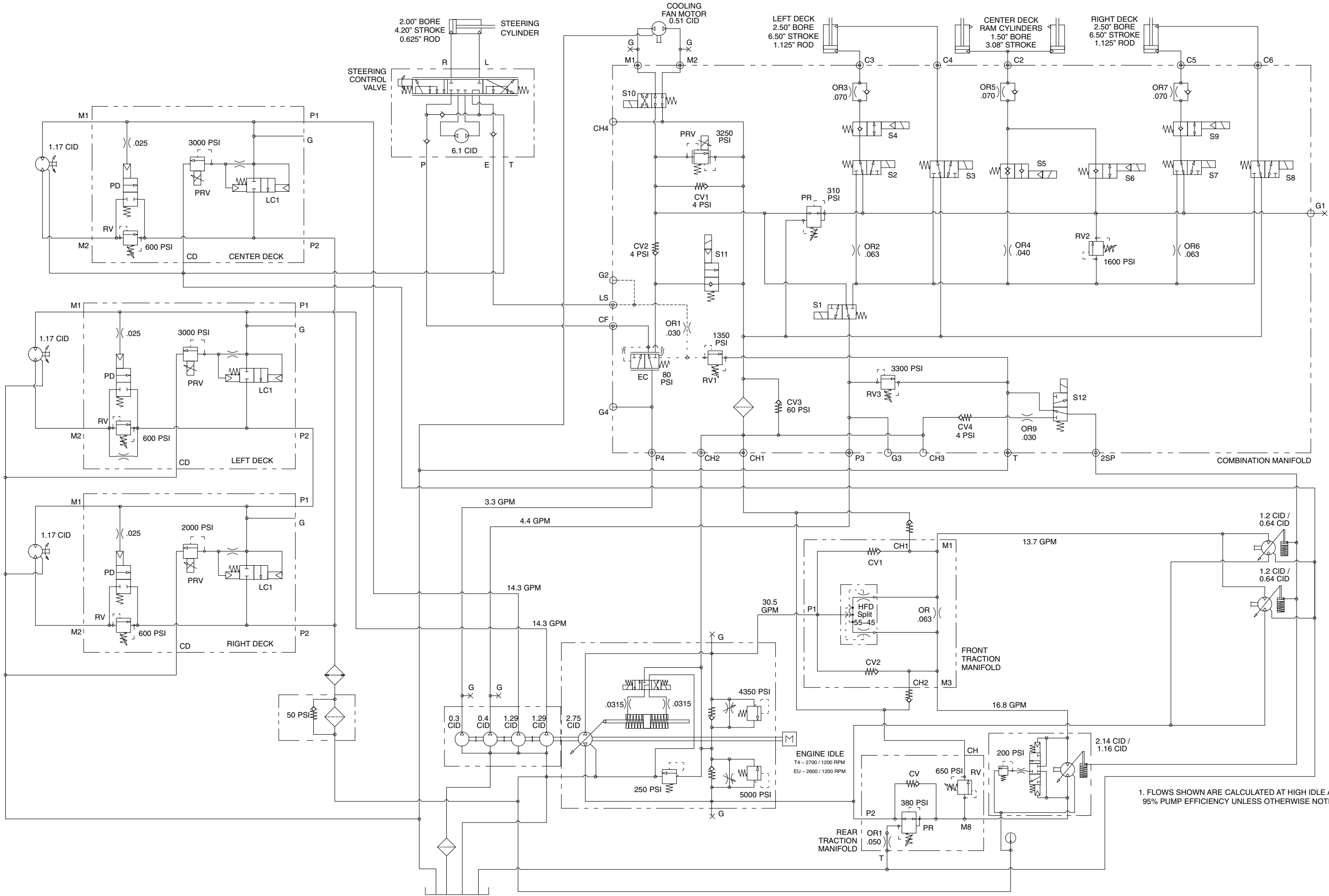
The individual wires of the electrical harness diagrams in this chapter identify both the wire color and the wire size.

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)

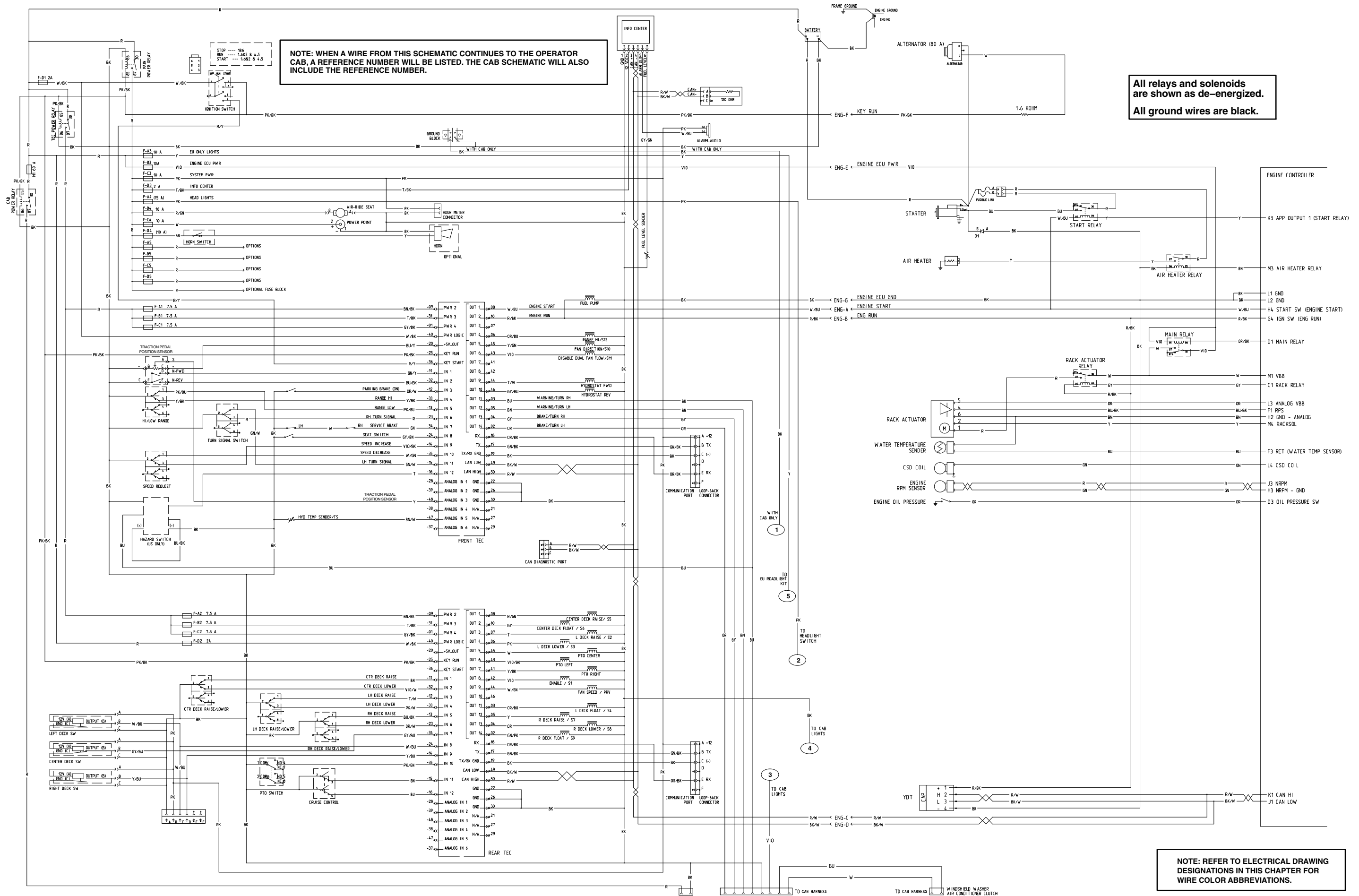
AWG Equivalents for Metric Wire		
Diagram Label	Metric Size	AWG Equivalent
050	0.5 mm	20 GA
175	0.75 mm	18 GA
100	1.0 mm	16 GA
150	1.5 mm	14 GA

Hydraulic Schematic

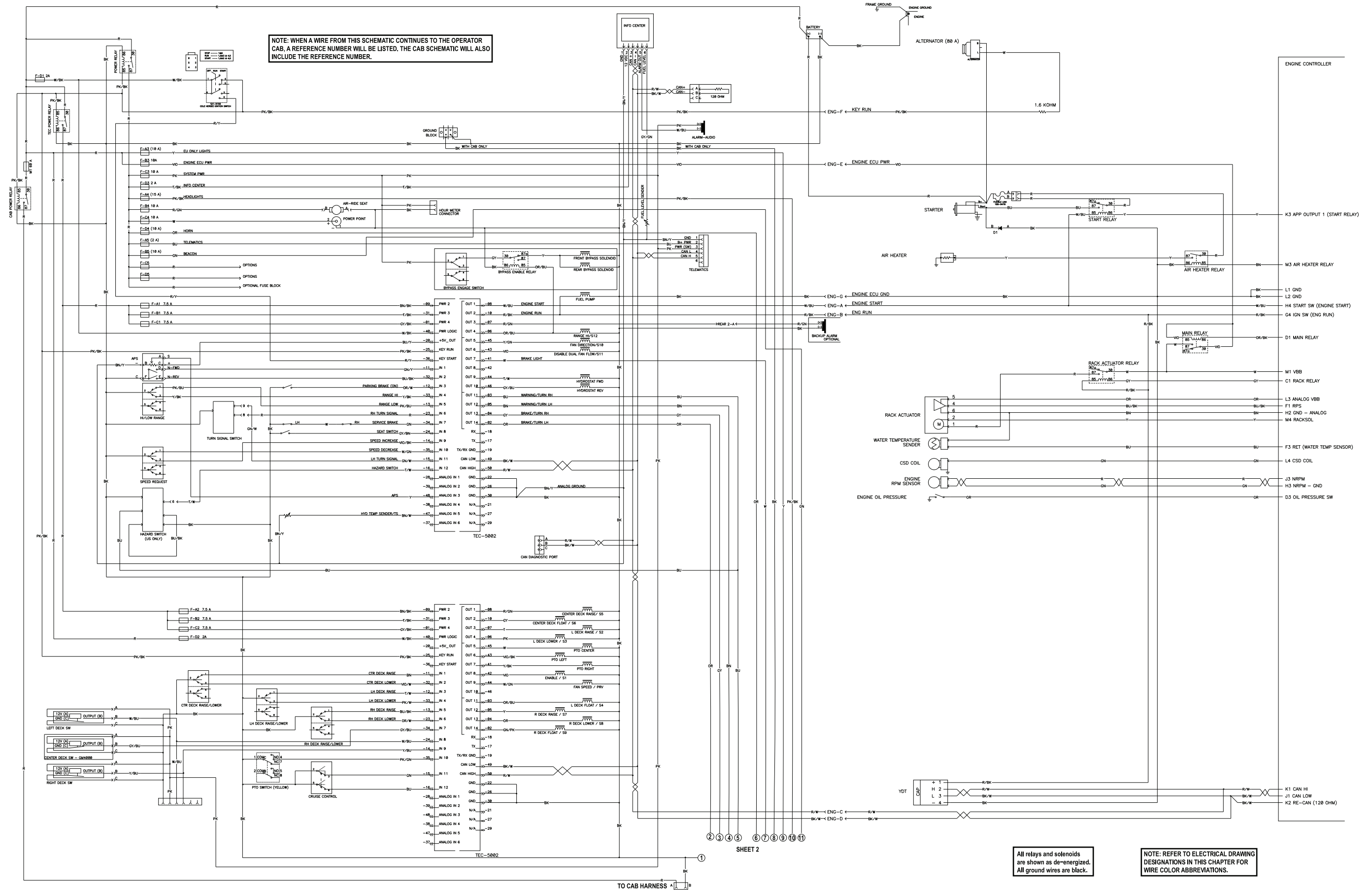


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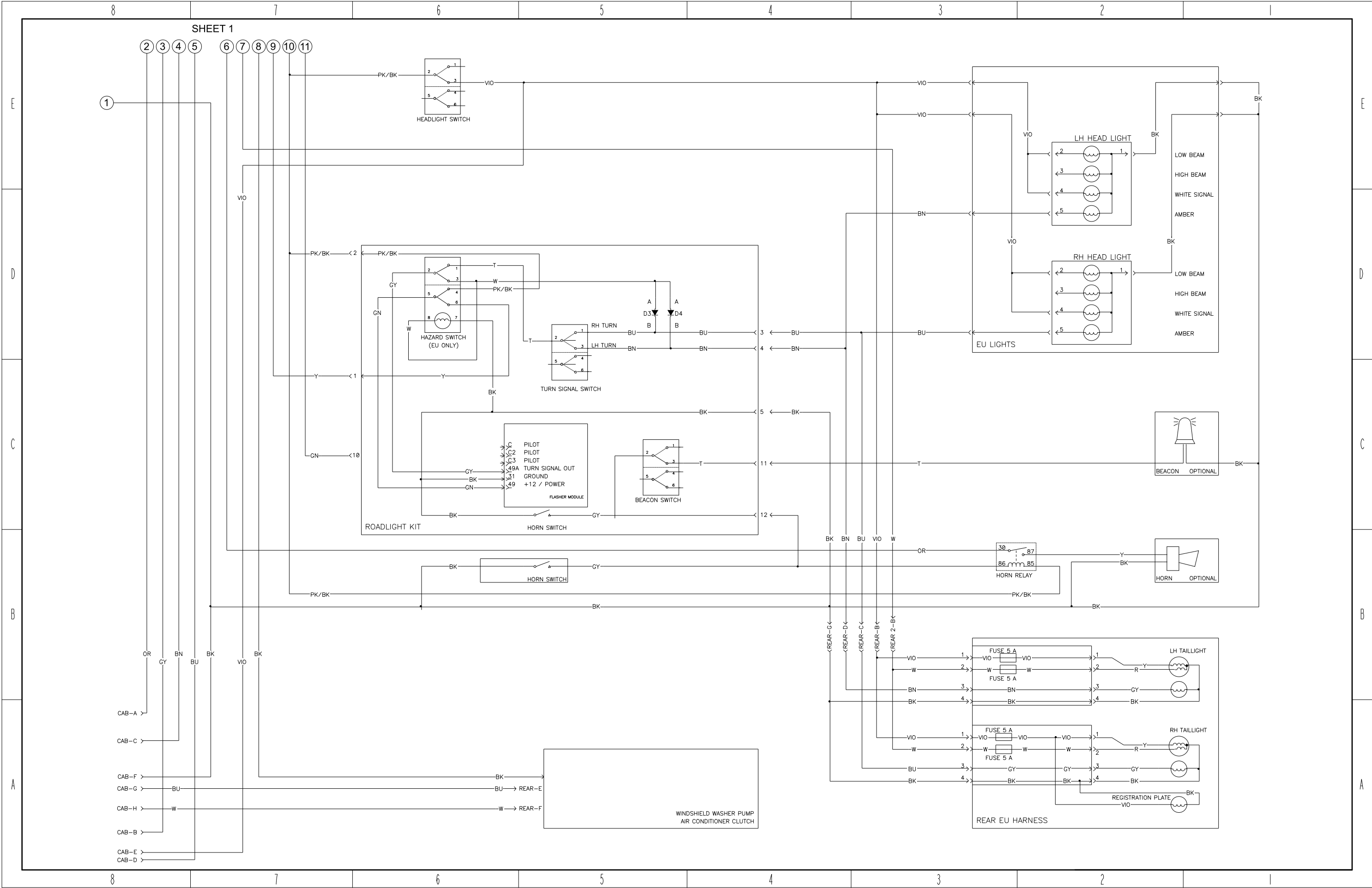
Electrical Schematic for Models 30605 and 30603/30635 (For machines serial number below 400000000)



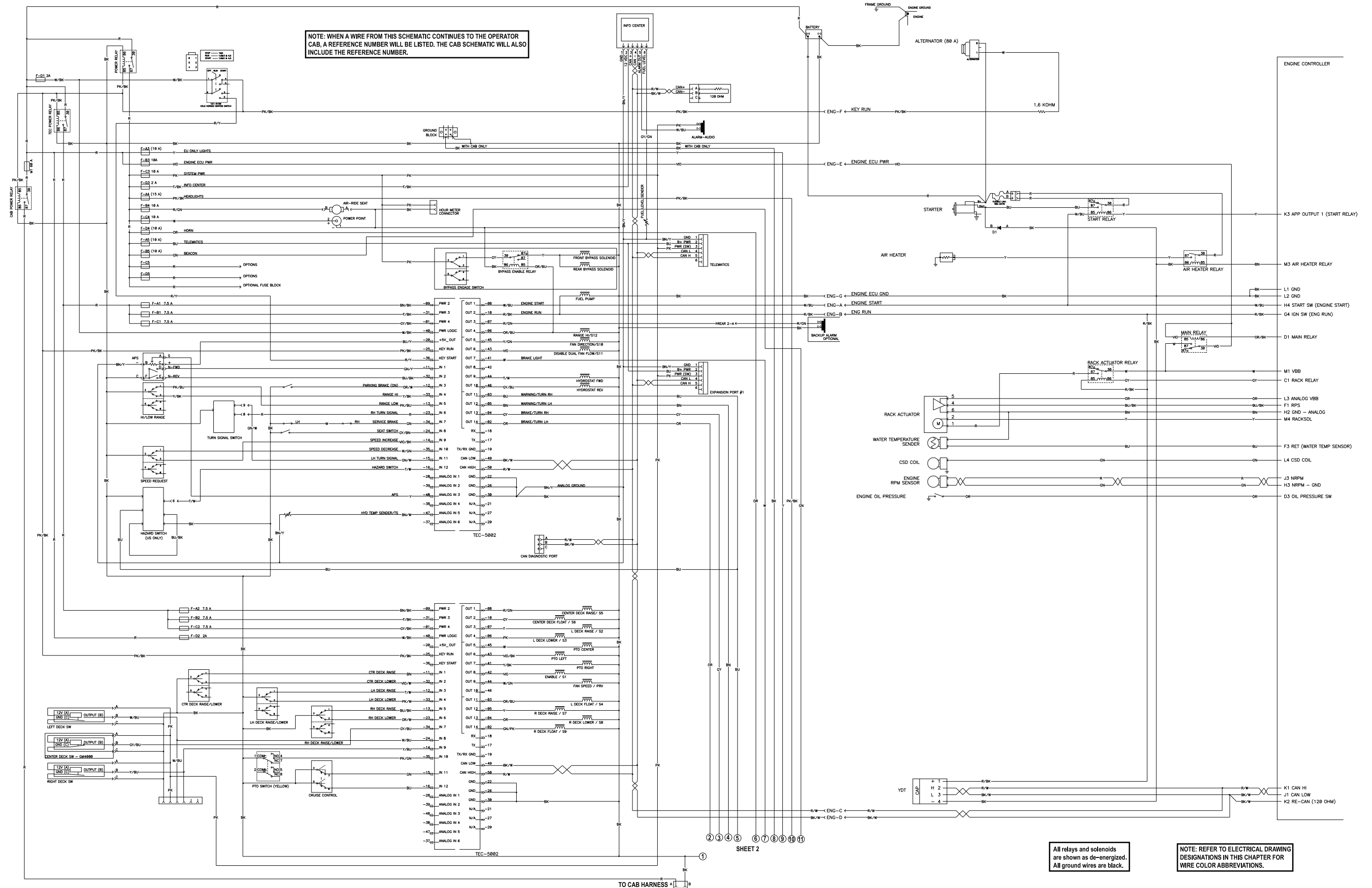
Electrical Schematic for Models 30605 and 30603/30635 (For machines serial number 400000001 to 403450000)



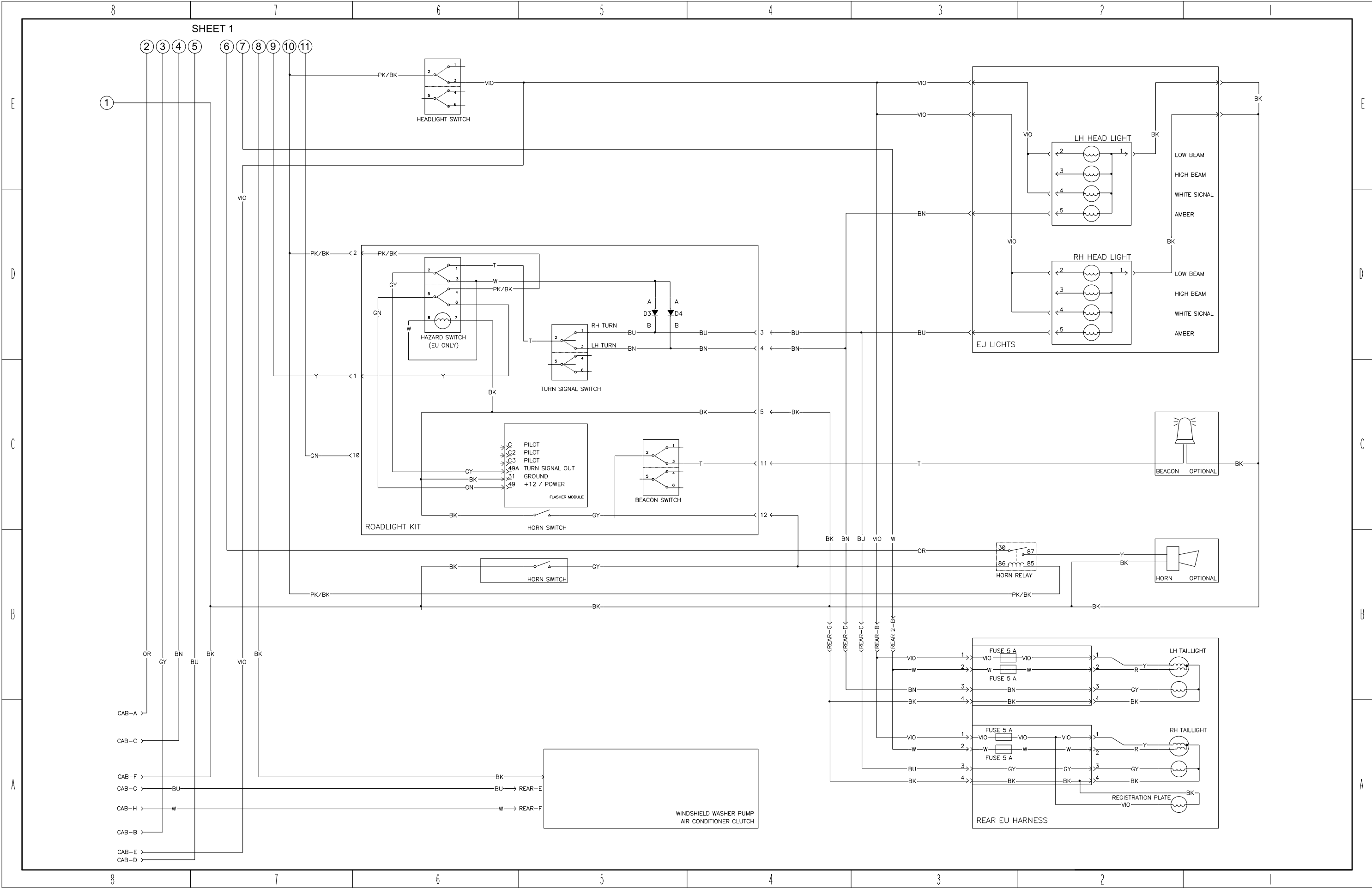
Electrical Schematic for Models 30605 and 30603/30635 (For machines serial number 400000001 to 403450000)



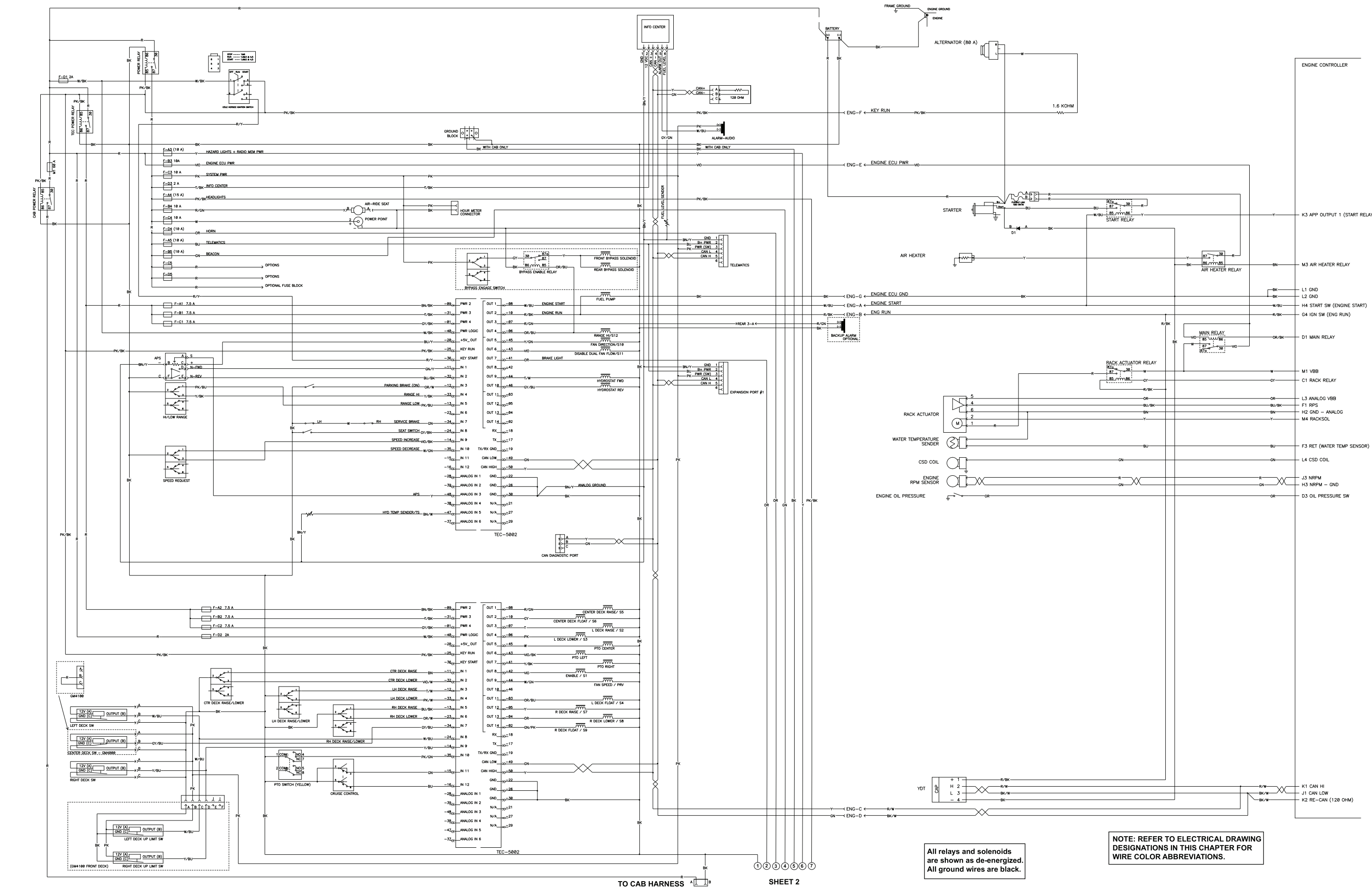
Electrical Schematic for Models 30605 and 30603/30635 (For machines serial number 403450001 to 408900000)



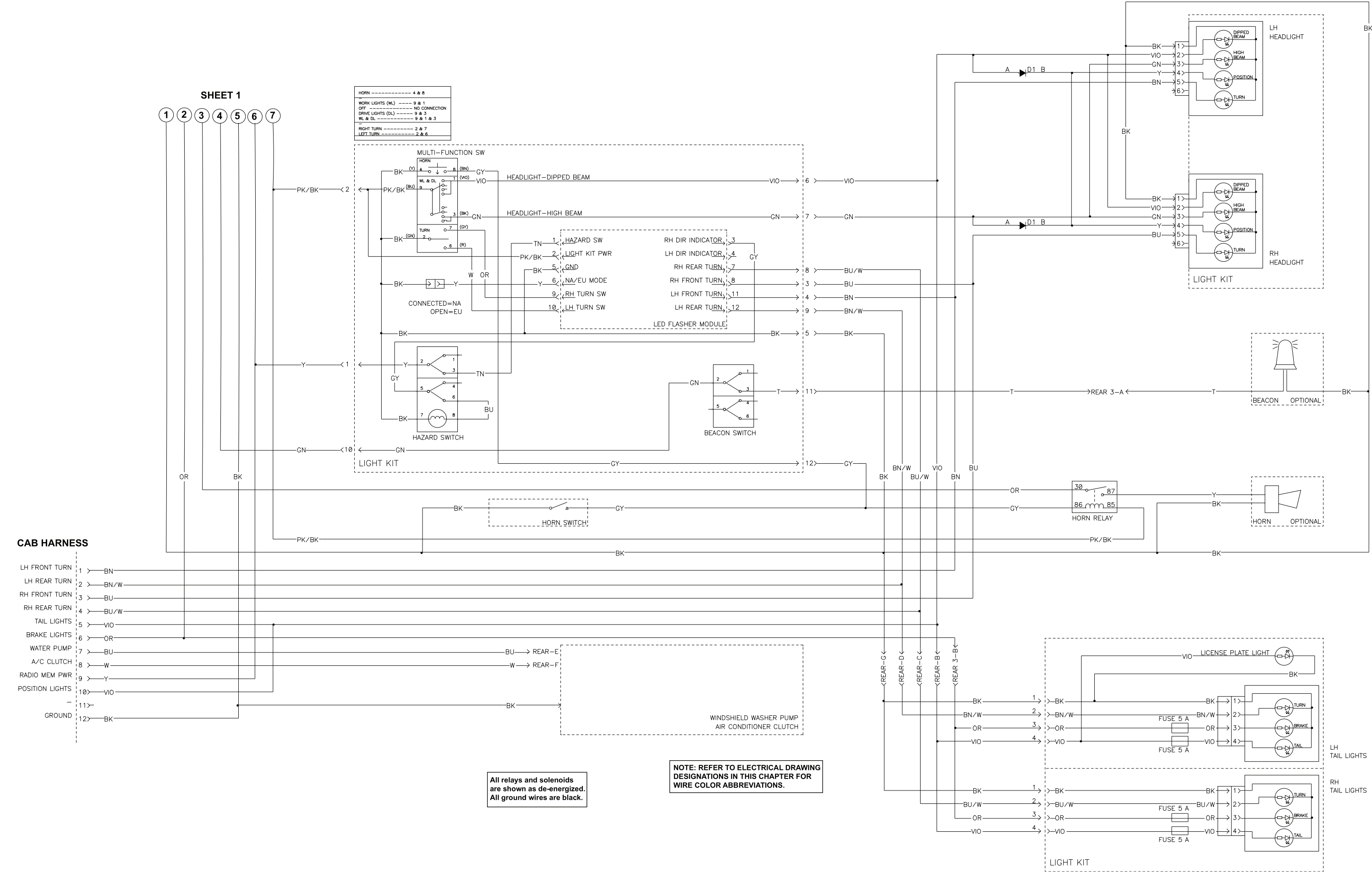
Electrical Schematic for Models 30605 and 30603/30635 (For machines serial number 403450001 to 408900000)



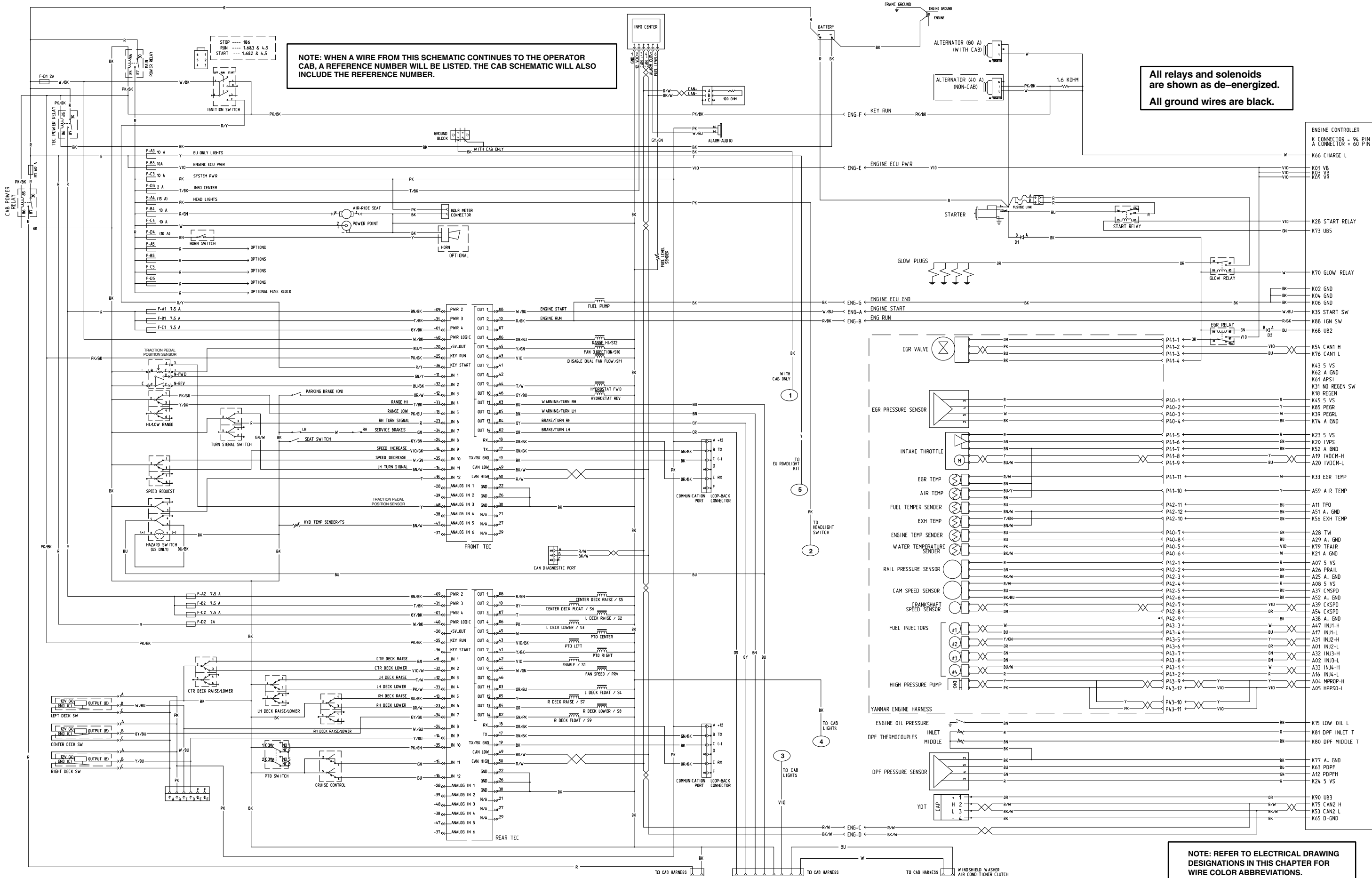
Electrical Schematic for Models 30605 and 30603/30635 (For machines serial number above 408900000)



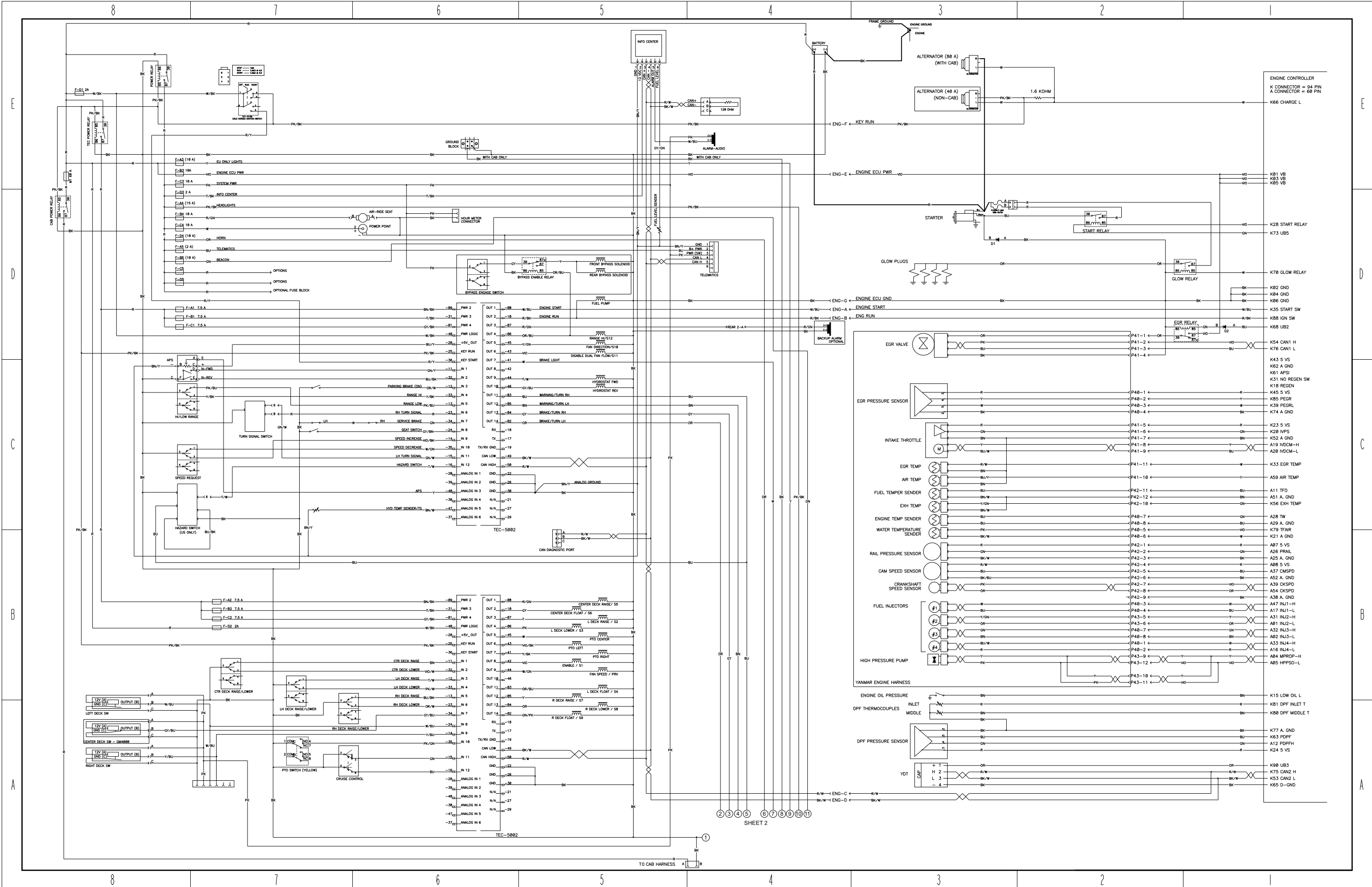
Electrical Schematic for Models 30605 and 30603/30635 (For machines serial number above 408900000)



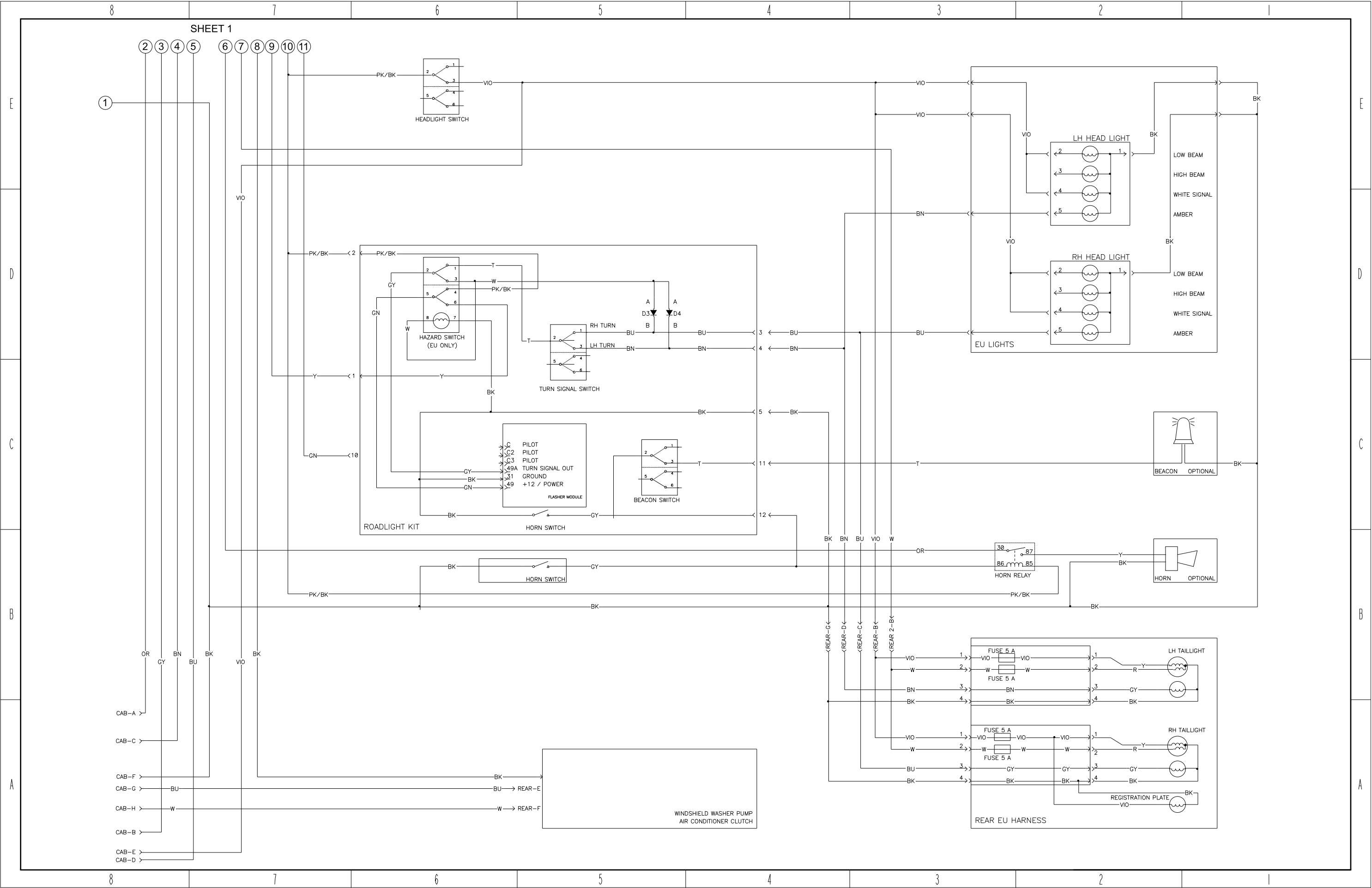
Electrical Schematic for Models 30609 and 30607/30636 (For machines serial number below 400000000)



Electrical Schematic for Models 30609 and 30607/30636 (For machines serial numbers 400000001 to 403450000)

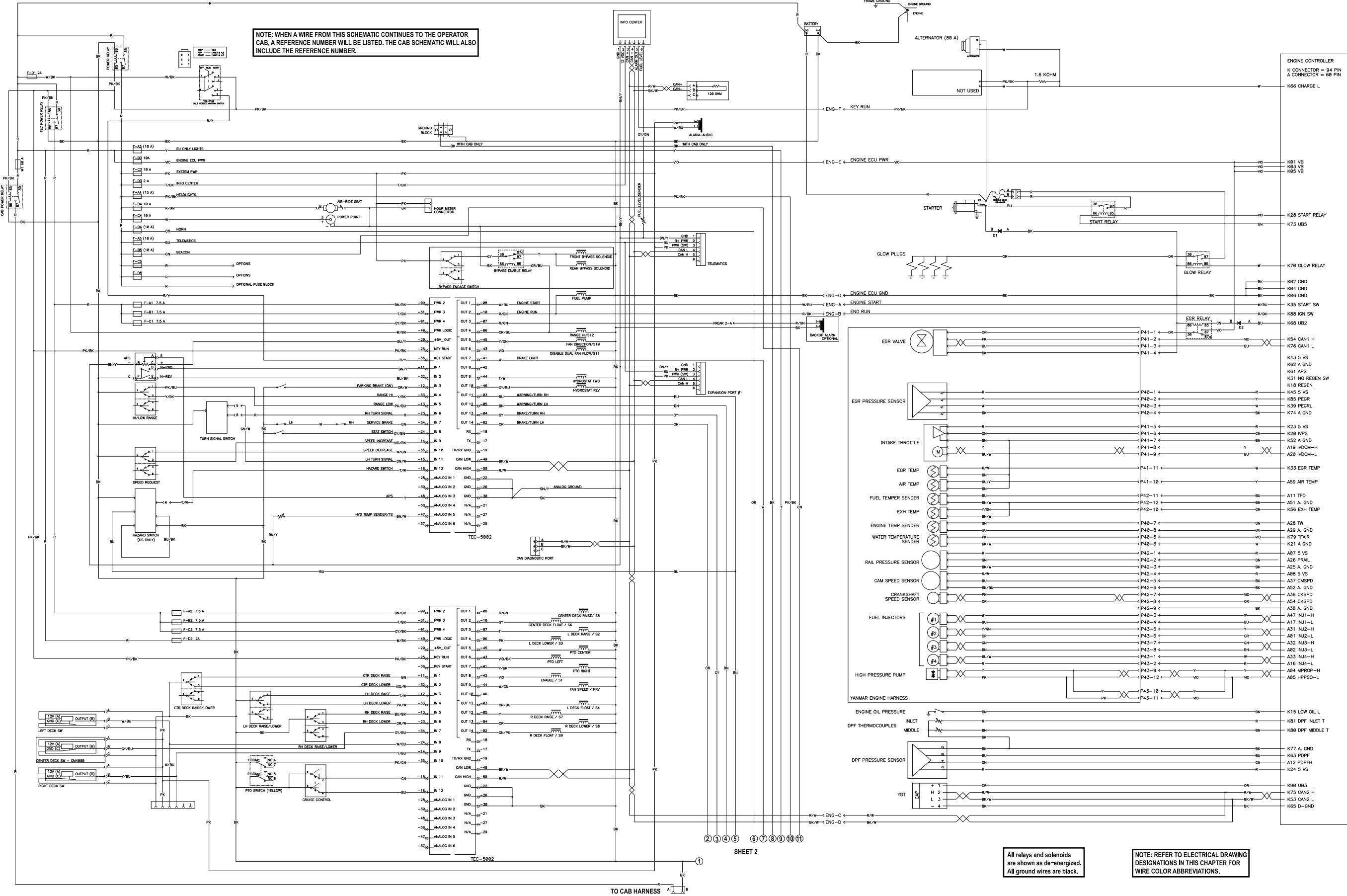


Electrical Schematic for Models 30609 and 30607/30636 (For machines serial numbers 400000001 to 403450000)



Electrical Schematic for Models 30609 and 30607/30636 (For machines serial numbers 403450001 to 408000000)

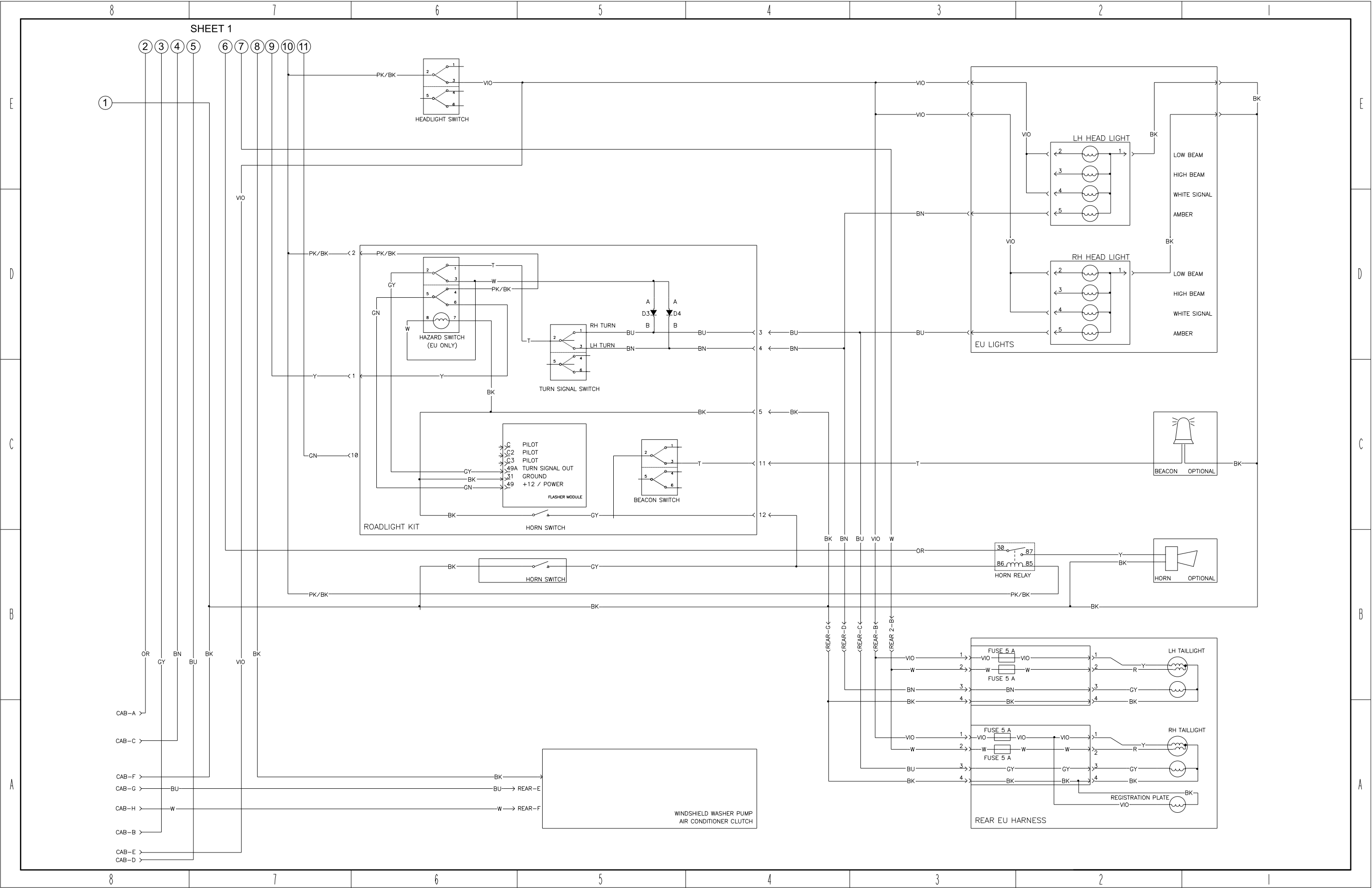
NOTE: WHEN A WIRE FROM THIS SCHEMATIC CONTINUES TO THE OPERATOR CAB, A REFERENCE NUMBER WILL BE LISTED. THE CAB SCHEMATIC WILL ALSO INCLUDE THE REFERENCE NUMBER.



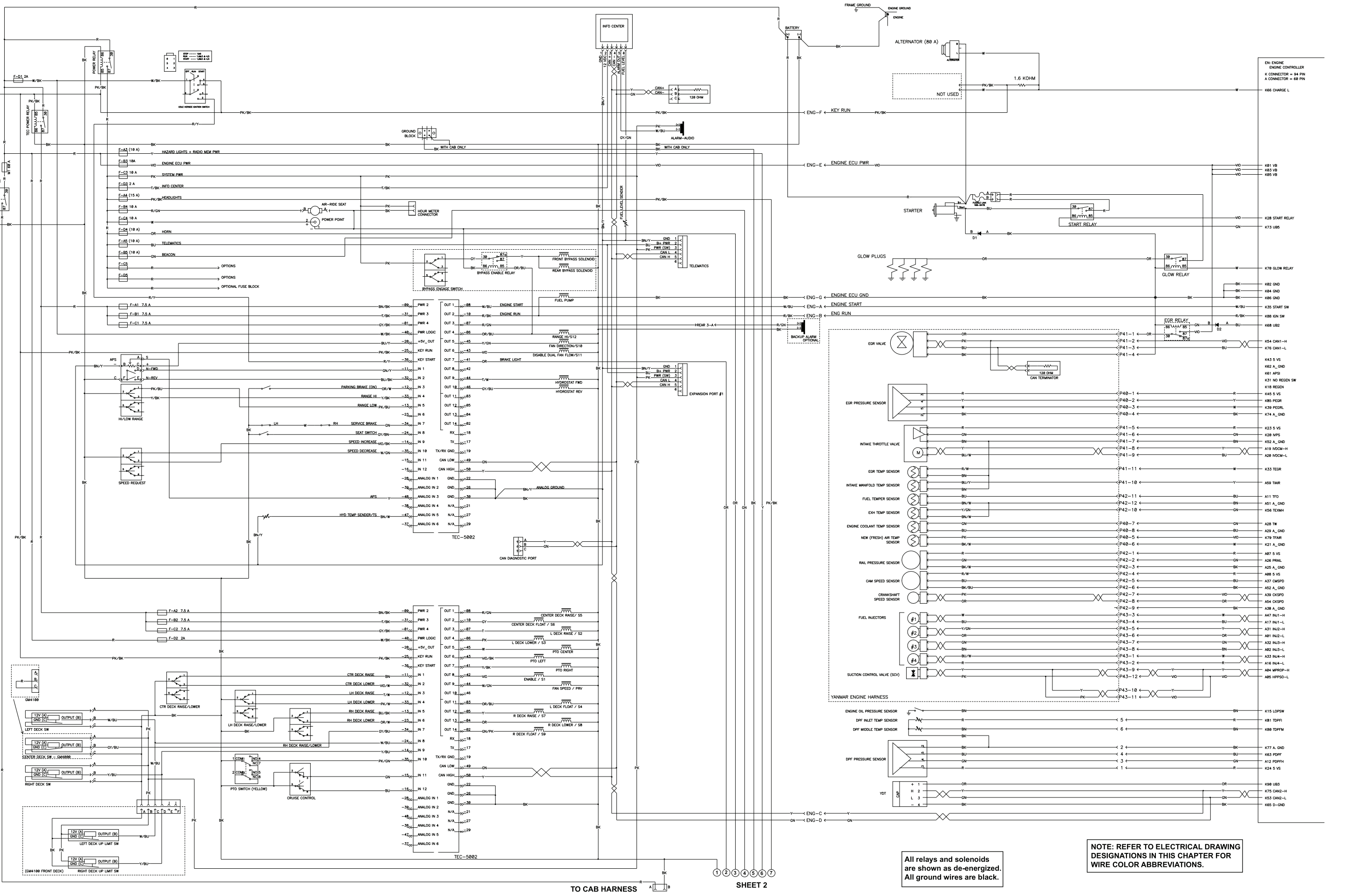
All relays and solenoids are shown as de-energized. All ground wires are black.

NOTE: REFER TO ELECTRICAL DRAWING DESIGNATIONS IN THIS CHAPTER FOR WIRE COLOR ABBREVIATIONS.

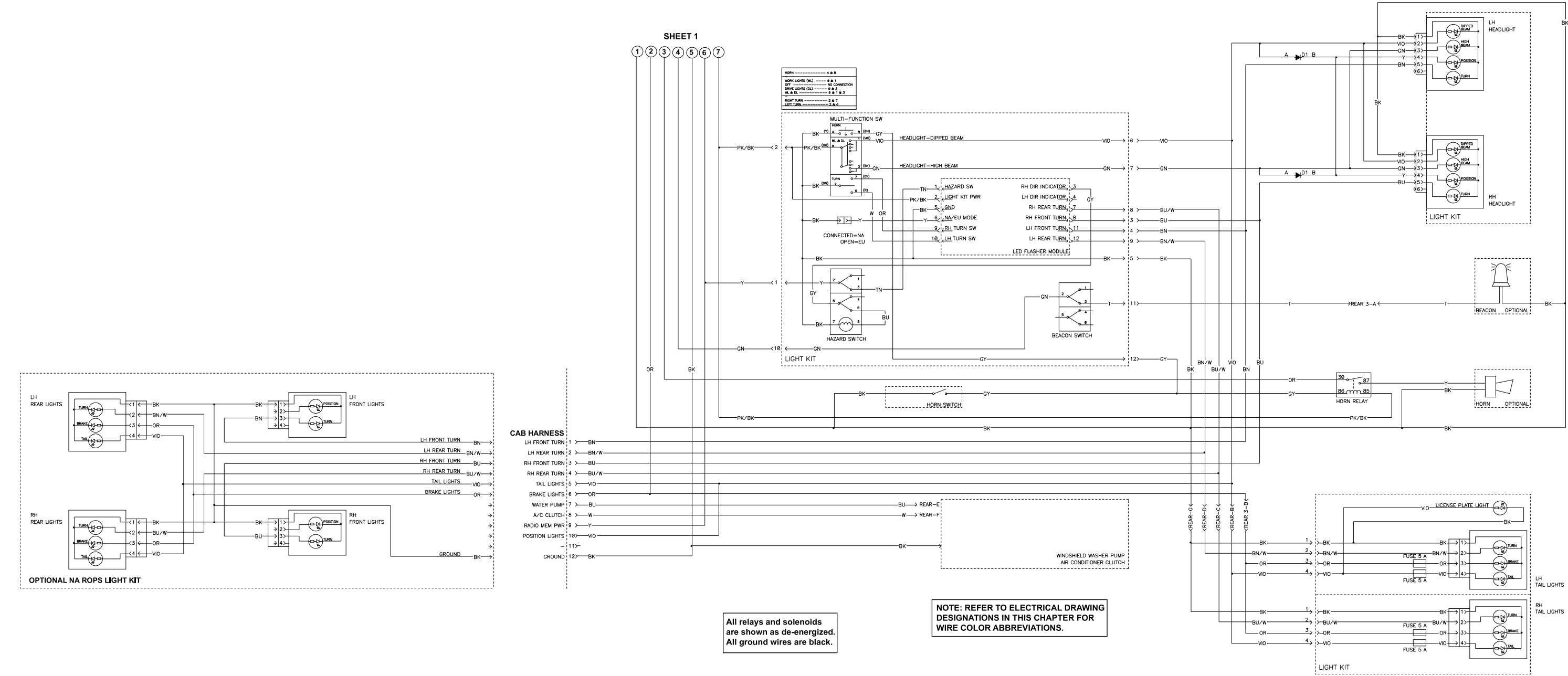
Electrical Schematic for Models 30609 and 30607/30636 (For machines serial numbers 403450001 to 408000000)



Electrical Schematic for Models 30609 and 30607/30636 (For machines serial numbers above 408000000)



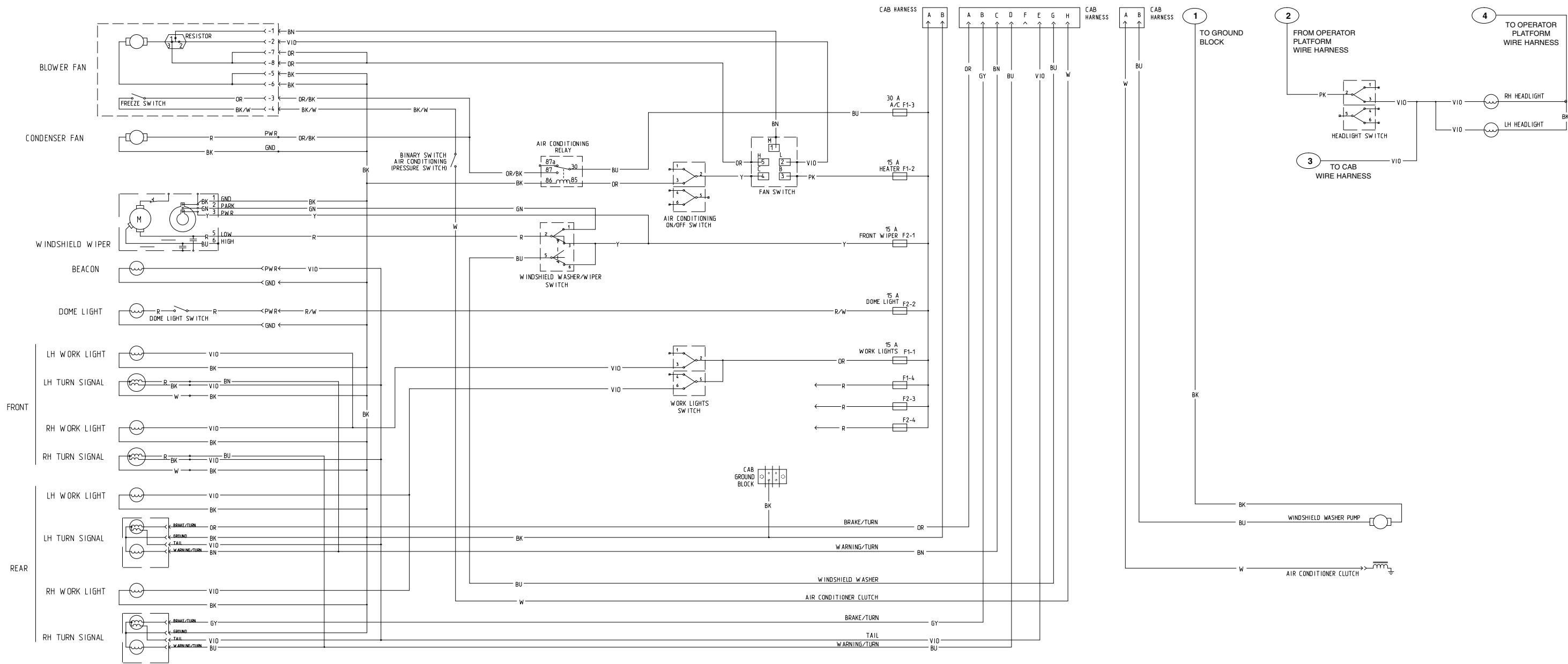
Electrical Schematic for Models 30609 and 30607/30636 (For machines serial numbers above 408000000)



g362031

Electrical Schematic - Operator Cab (shown with lights for models 30603 and 30607)

NOTE: REFER TO ELECTRICAL DRAWING DESIGNATIONS IN THIS CHAPTER FOR WIRE COLOR ABBREVIATIONS.

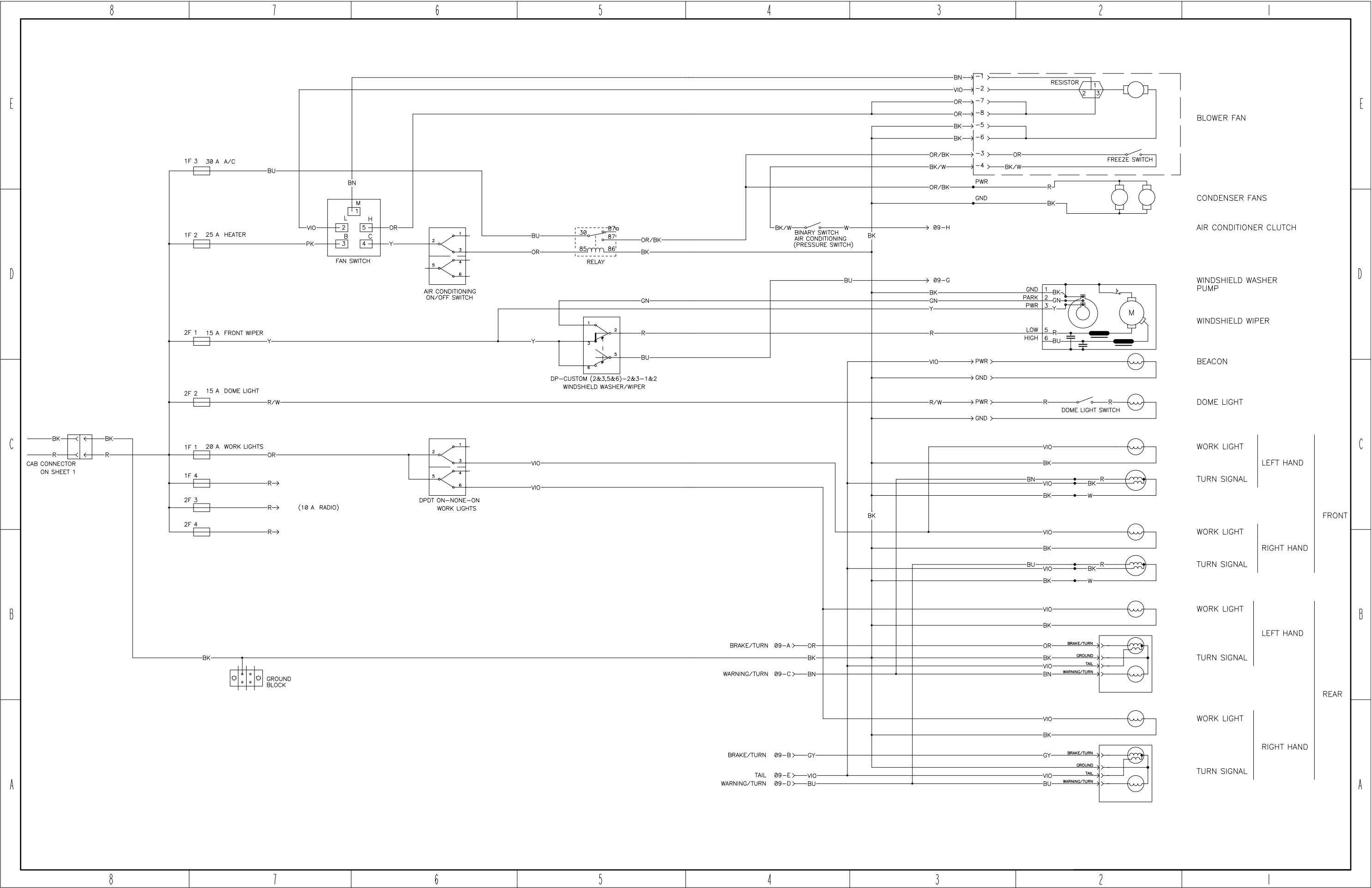


All relays and solenoids are shown as de-energized.
All ground wires are black.

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.

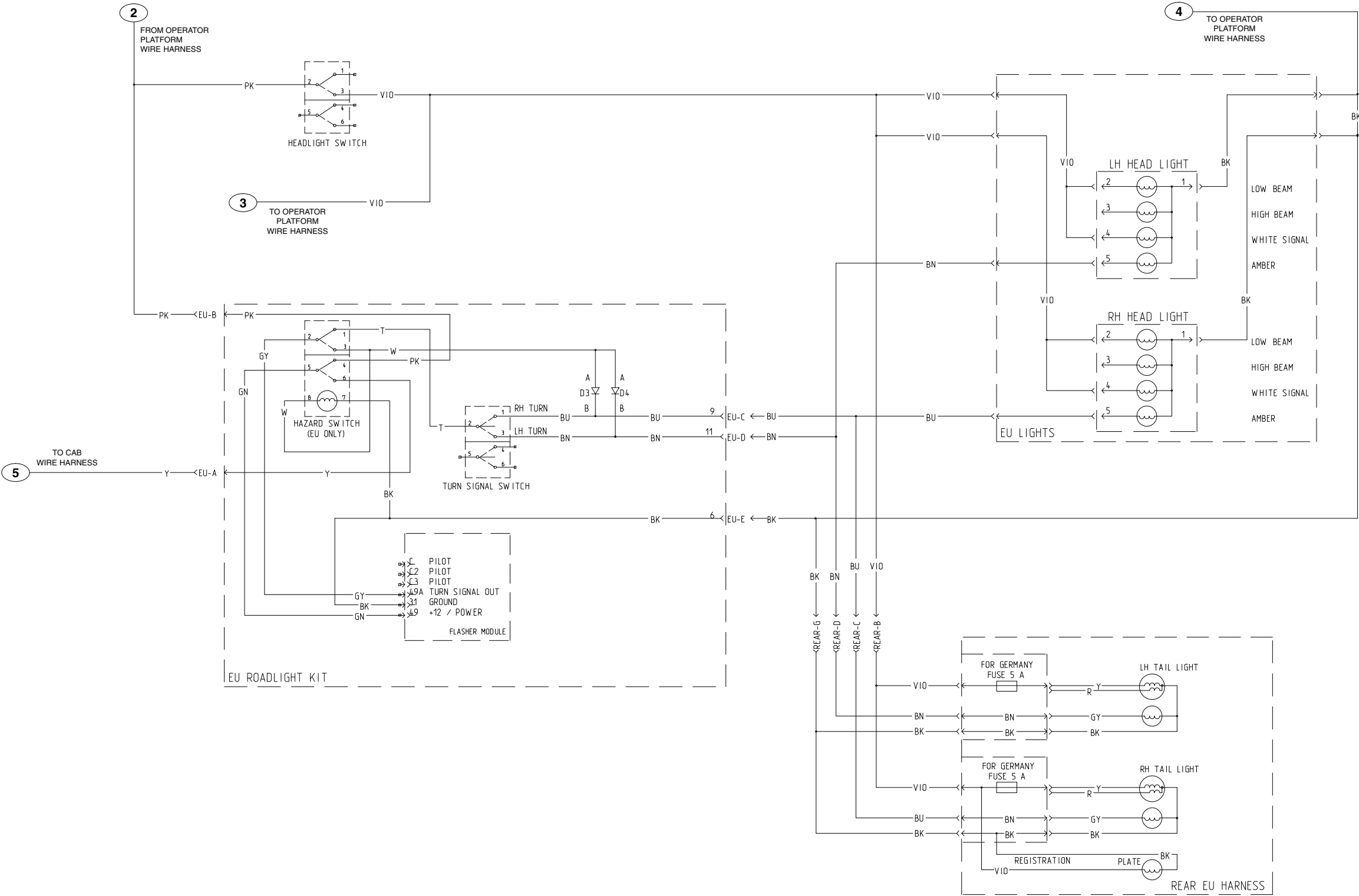
g277235

Electrical Schematic - Operator Cab (shown with lights for models 30635 and 30636)



Electrical Schematic - International Light Kits

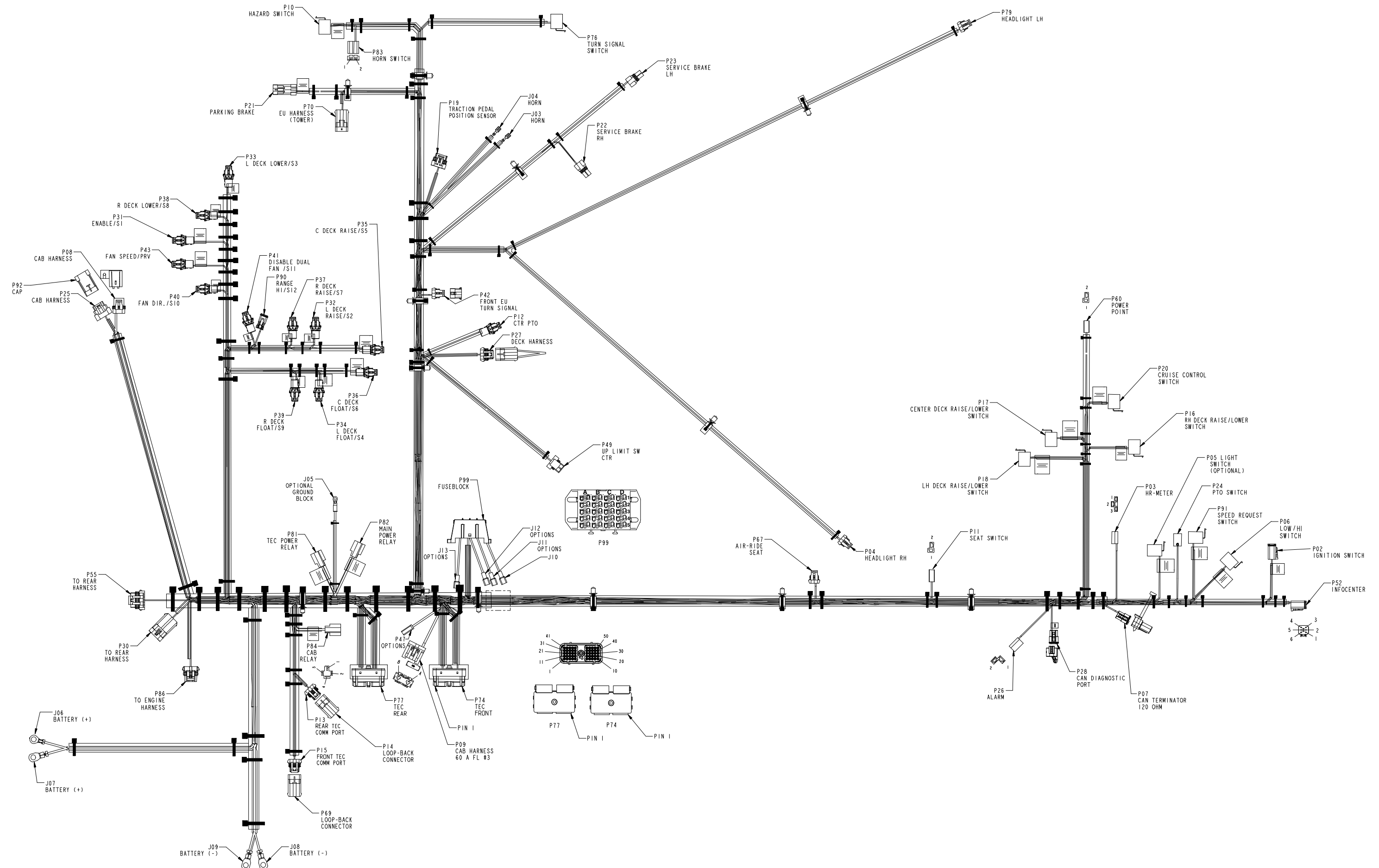
NOTE: REFER TO ELECTRICAL DRAWING DESIGNATIONS IN THIS CHAPTER FOR WIRE COLOR ABBREVIATIONS.



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.

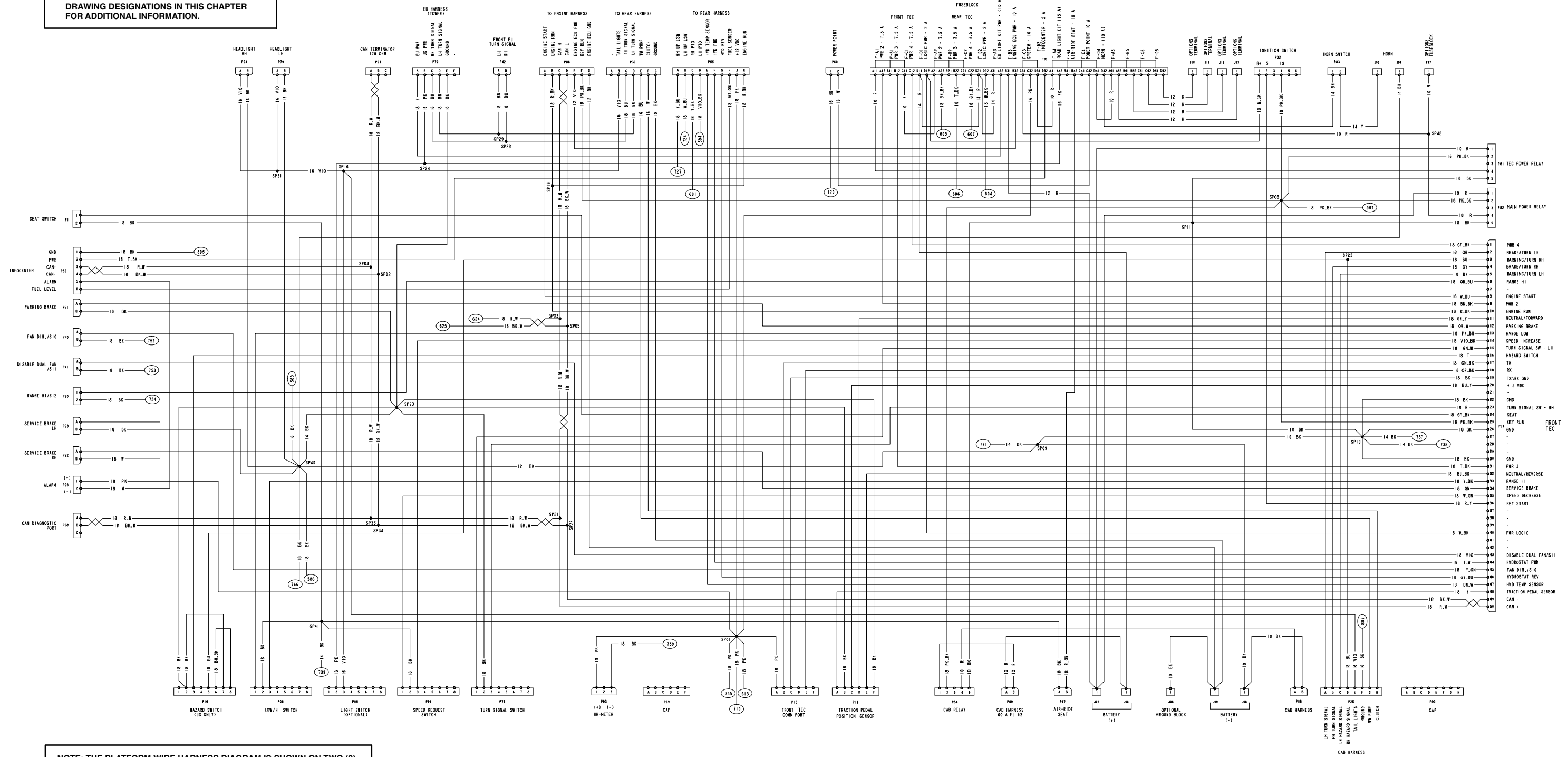
Platform Wire Harness Diagram (For machines serial number below 400000000)



g277237

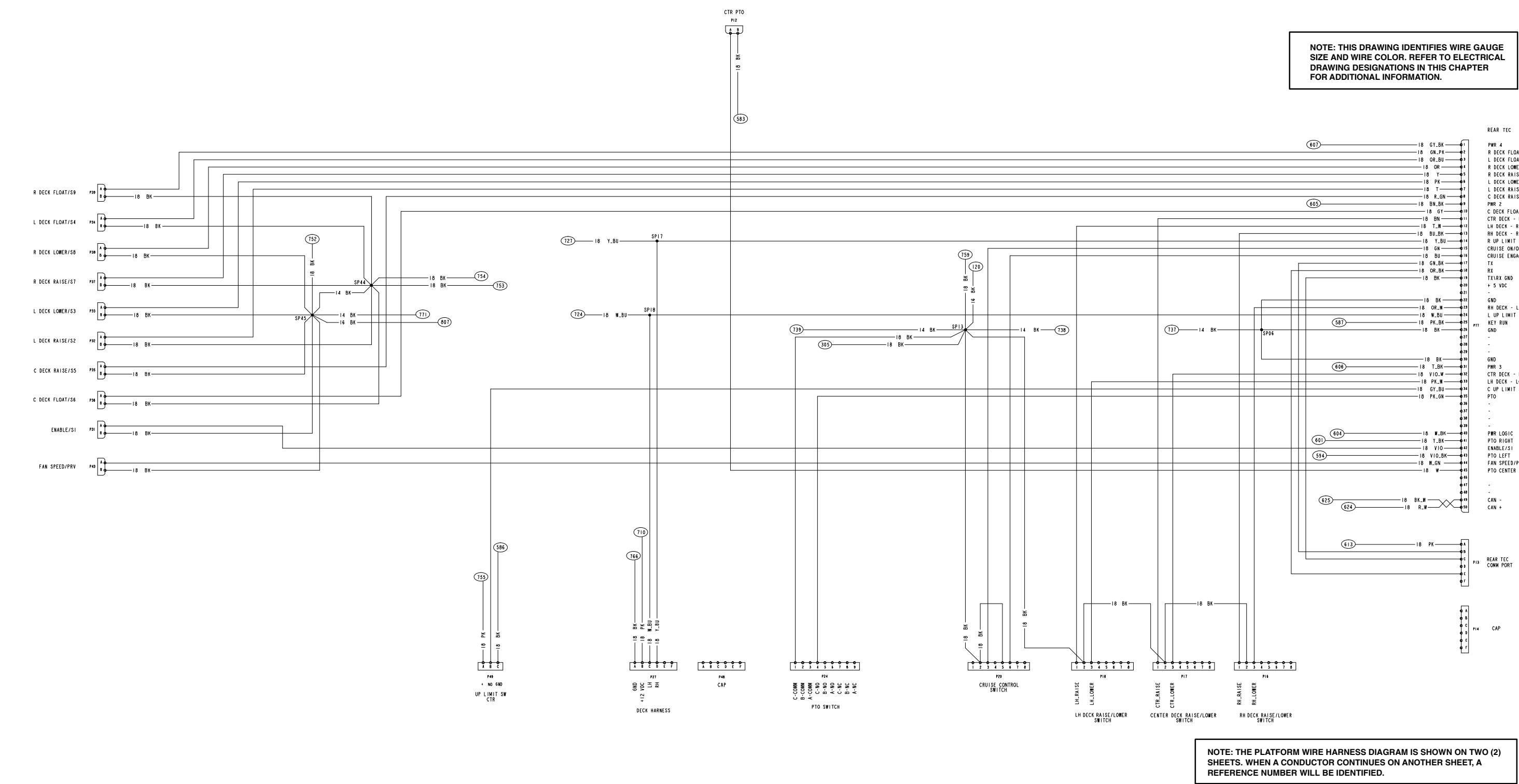
Platform Wire Harness Diagram (For machines serial number below 400000000)

NOTE: THIS DRAWING IDENTIFIES WIRE GAUGE SIZE AND WIRE COLOR. REFER TO ELECTRICAL DRAWING DESIGNATIONS IN THIS CHAPTER FOR ADDITIONAL INFORMATION.



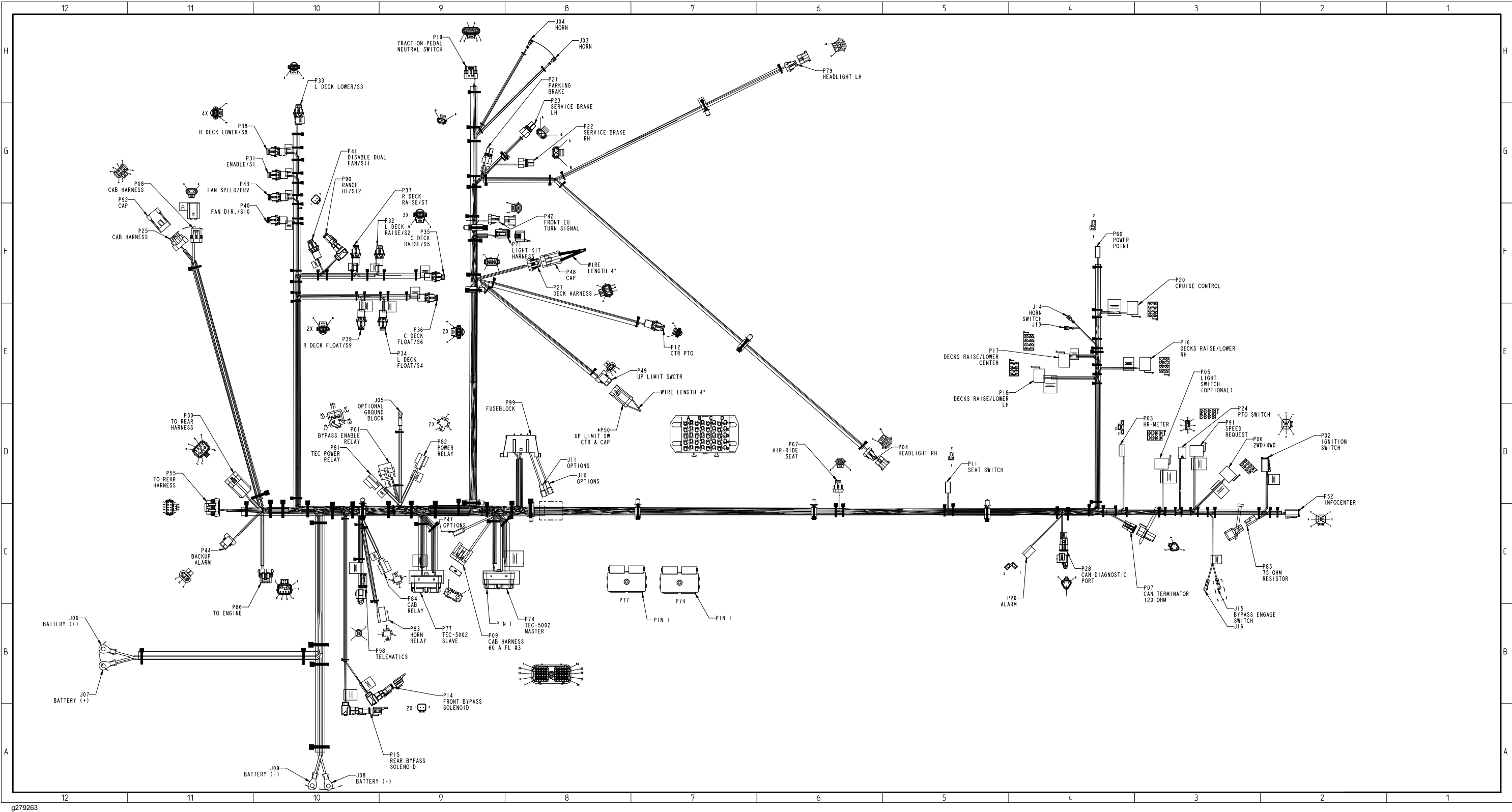
NOTE: THE PLATFORM WIRE HARNESS DIAGRAM IS SHOWN ON TWO (2) SHEETS. WHEN A CONDUCTOR CONTINUES ON ANOTHER SHEET, A REFERENCE NUMBER WILL BE IDENTIFIED.

Platform Wire Harness Diagram (For machines serial number below 400000000)



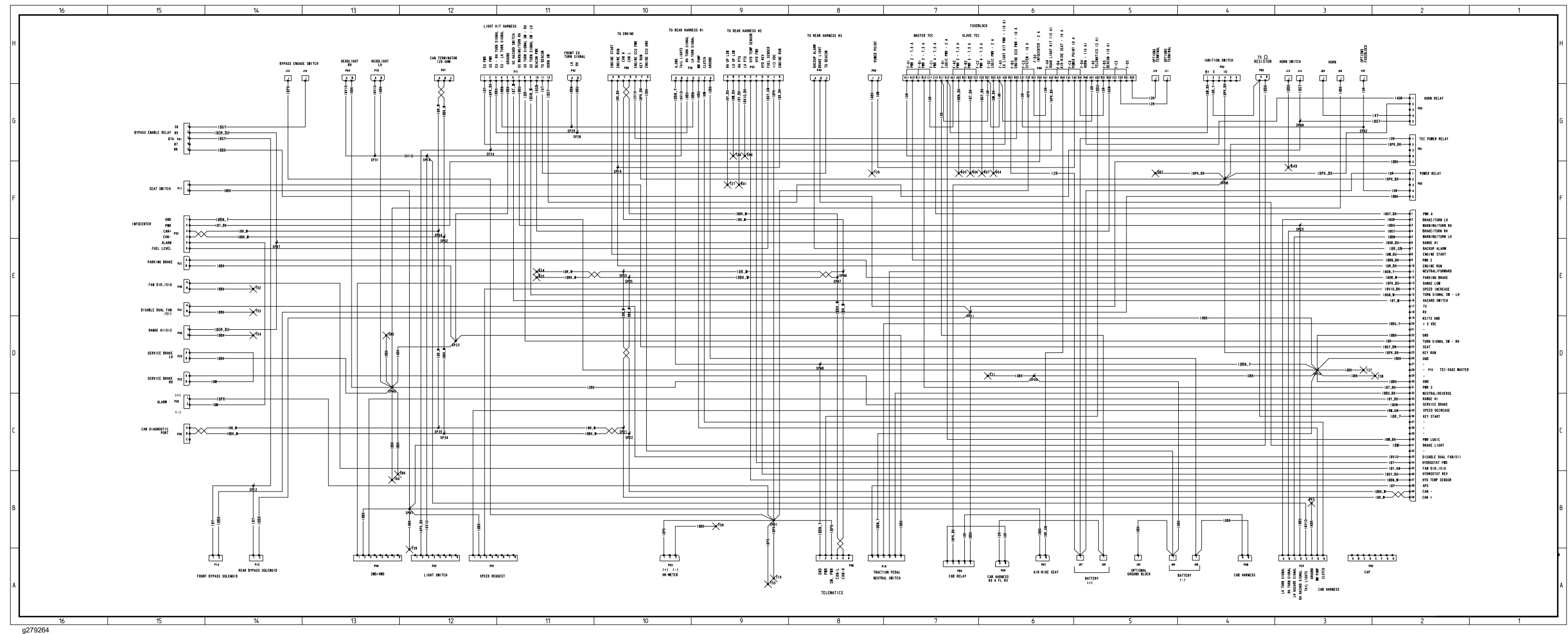
g277220

Platform Wire Harness Diagram (For machines serial numbers 400000000 to 403450000)

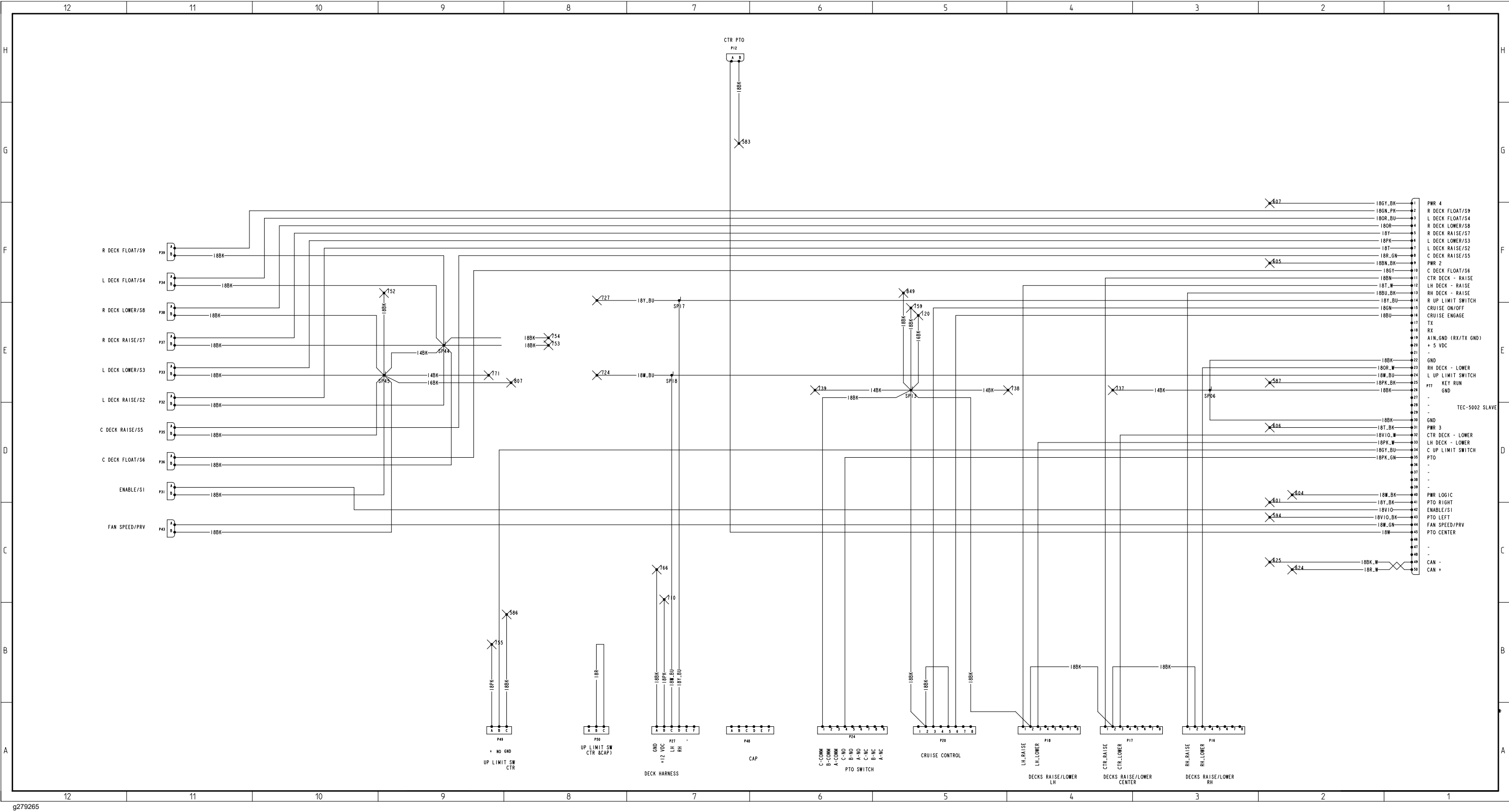


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Platform Wire Harness Diagram (For machines serial numbers 400000000 to 403450000)

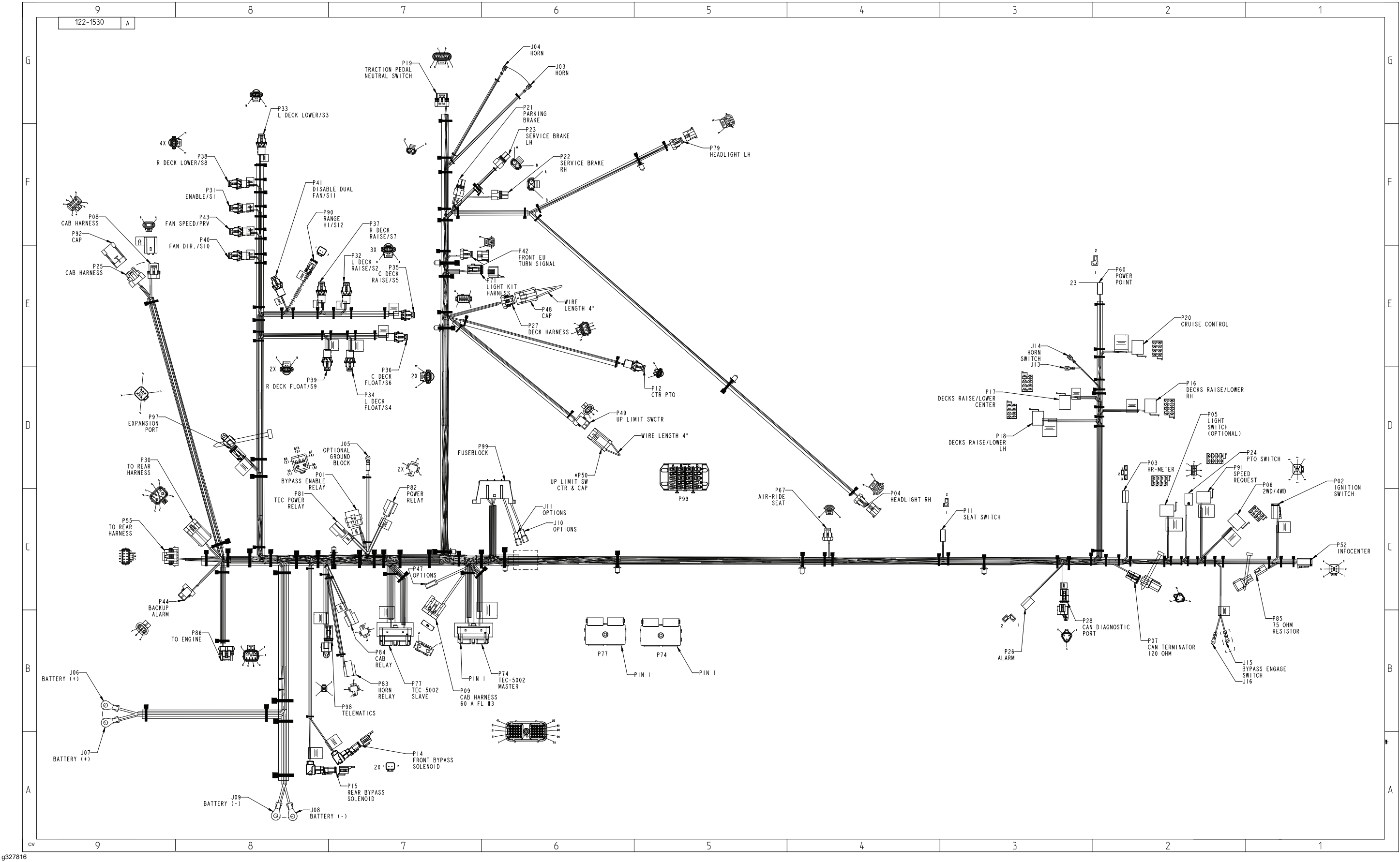


Platform Wire Harness Diagram (For machines serial numbers 400000000 to 403450000)

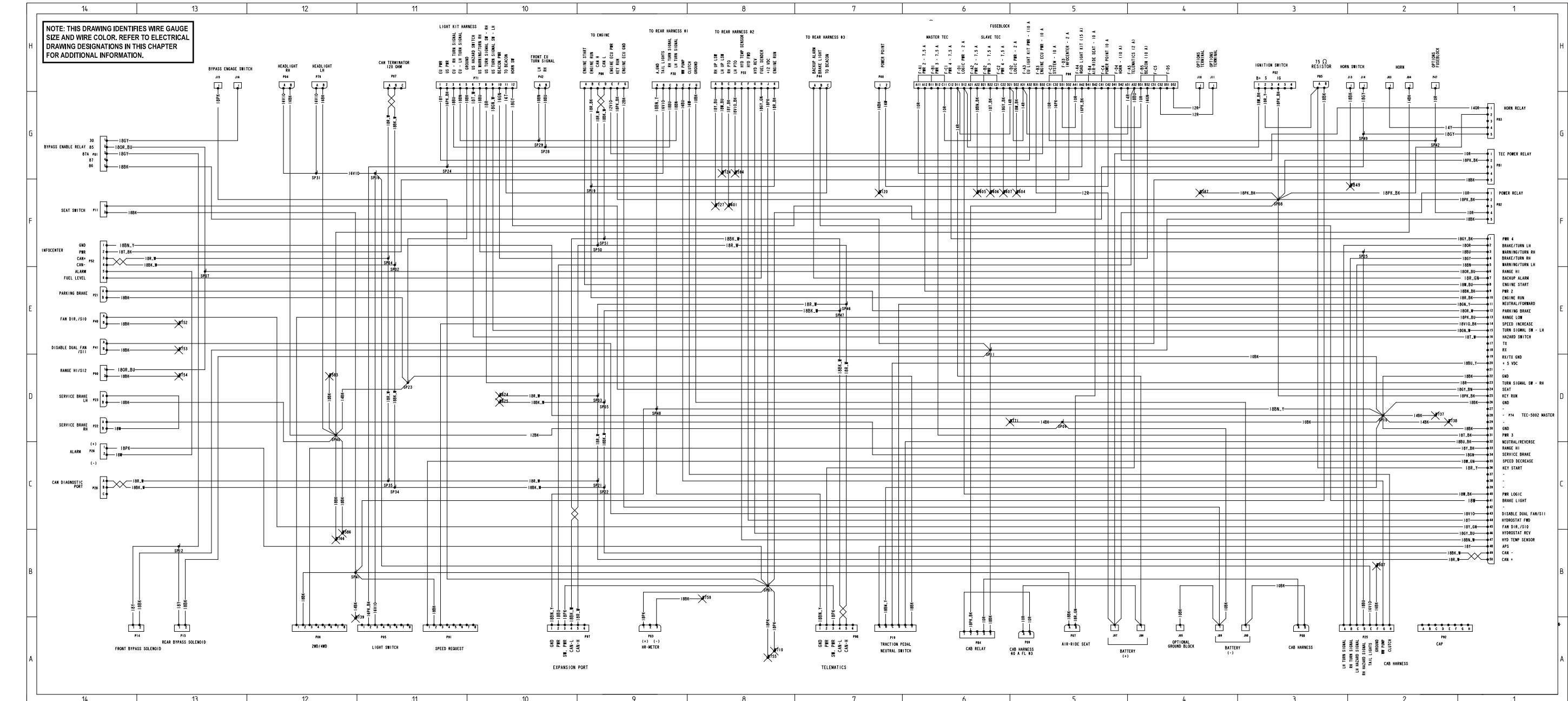


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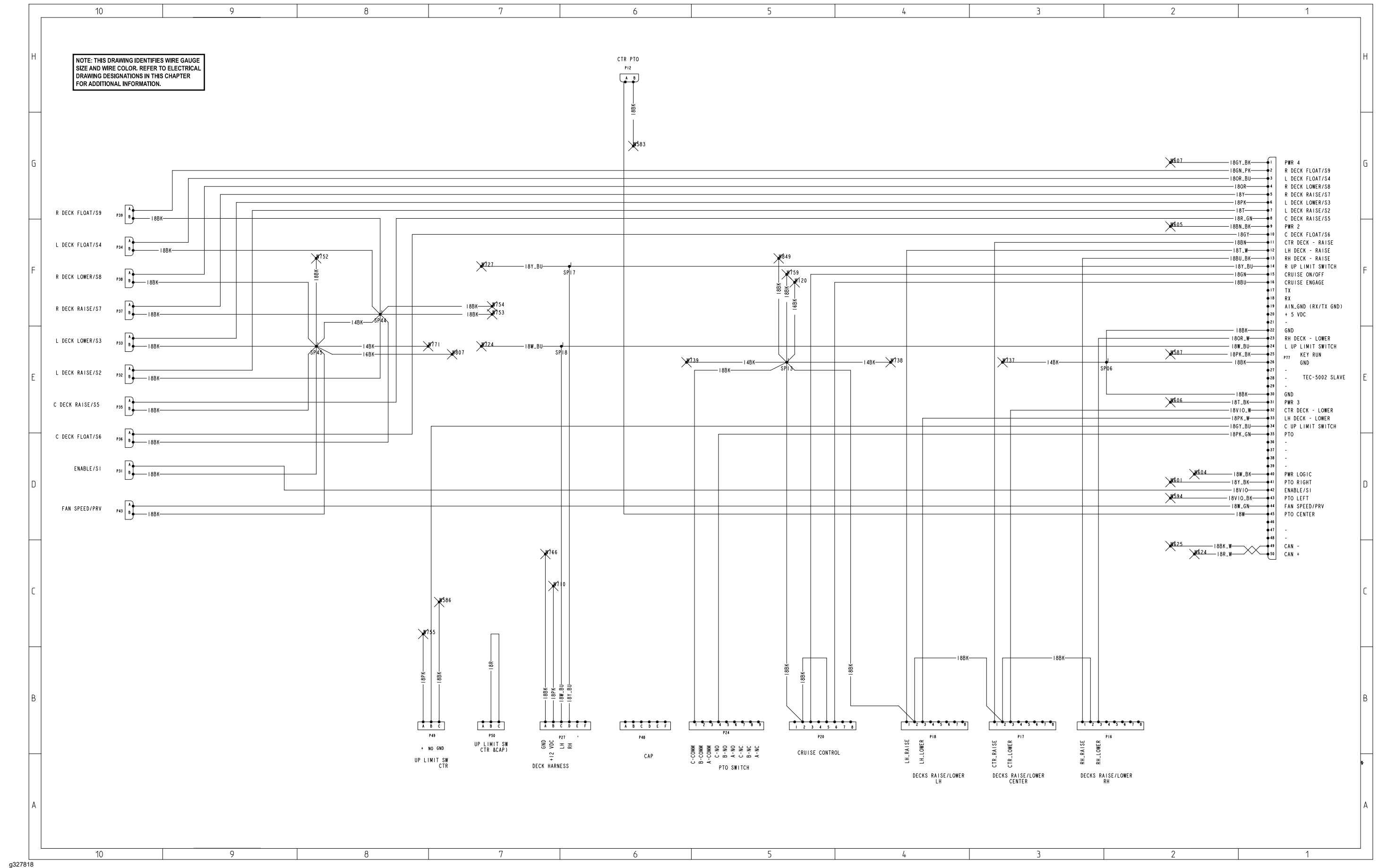
Platform Wire Harness Diagram (For machines serial numbers 403450001 to 408000000)



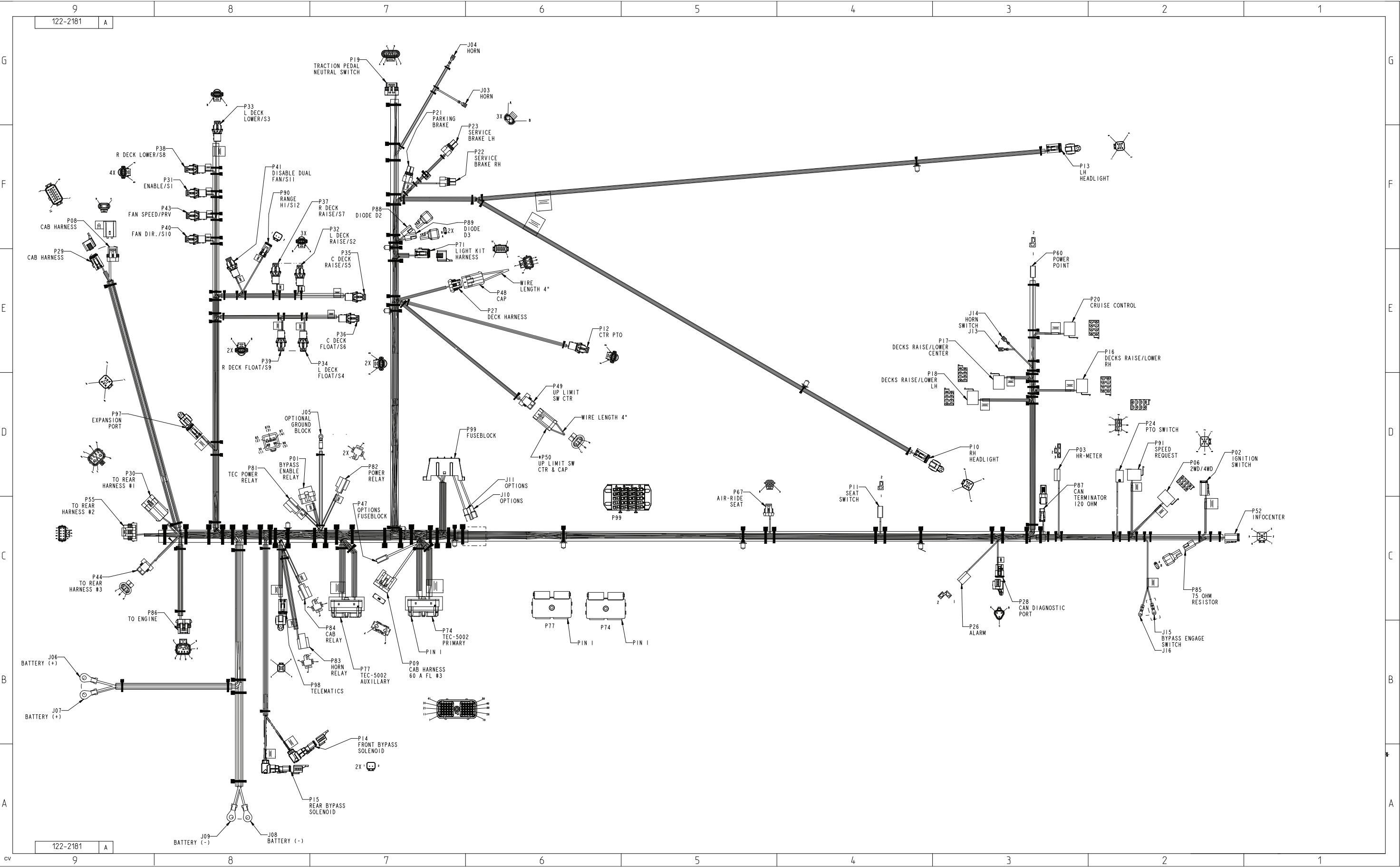
Platform Wire Harness Diagram (For machines serial numbers 403450001 to 408000000)



Platform Wire Harness Diagram (For machines serial numbers 403450001 to 408000000)

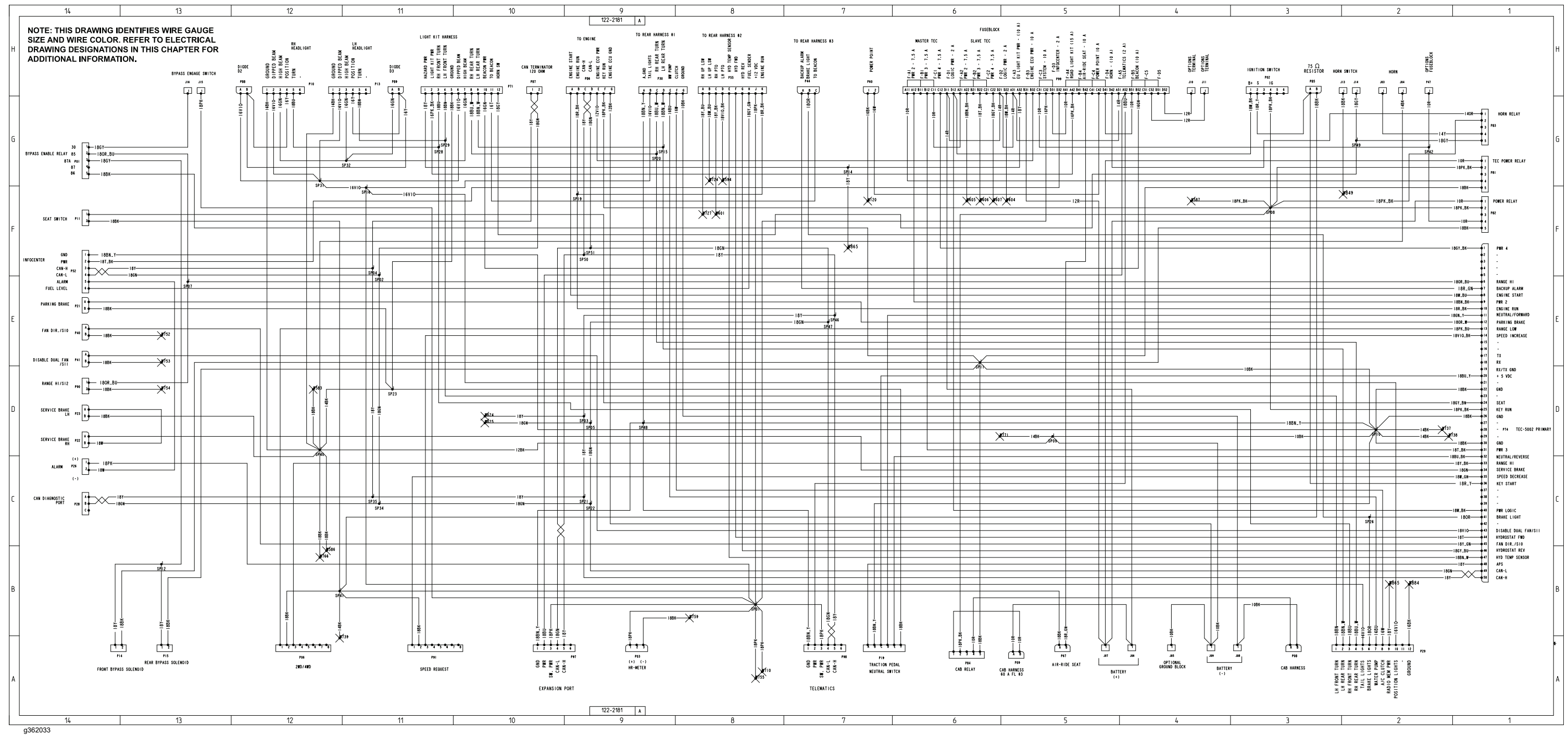


Platform Wire Harness Diagram (For machines serial numbers above 408000000)

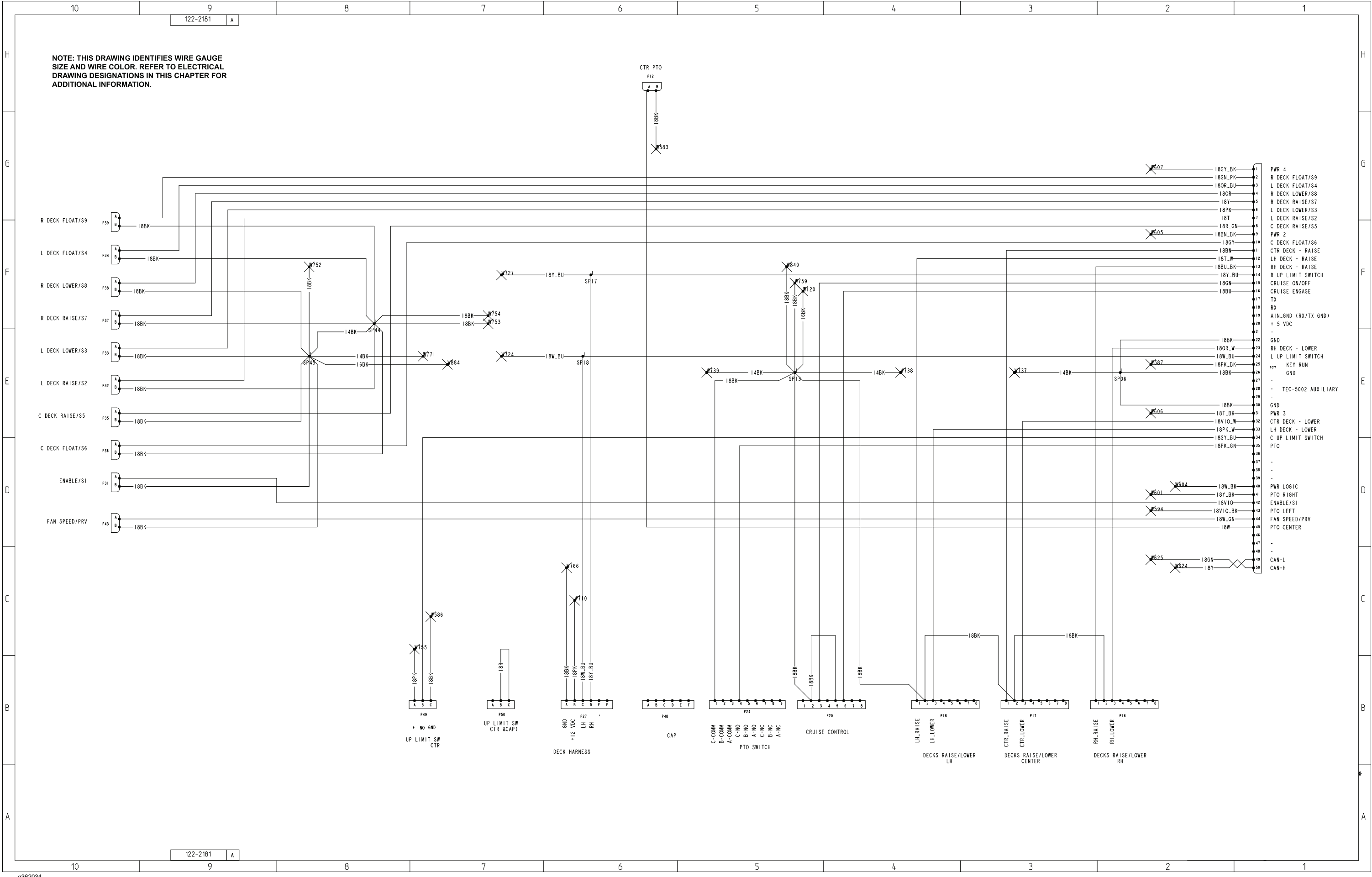


g362032

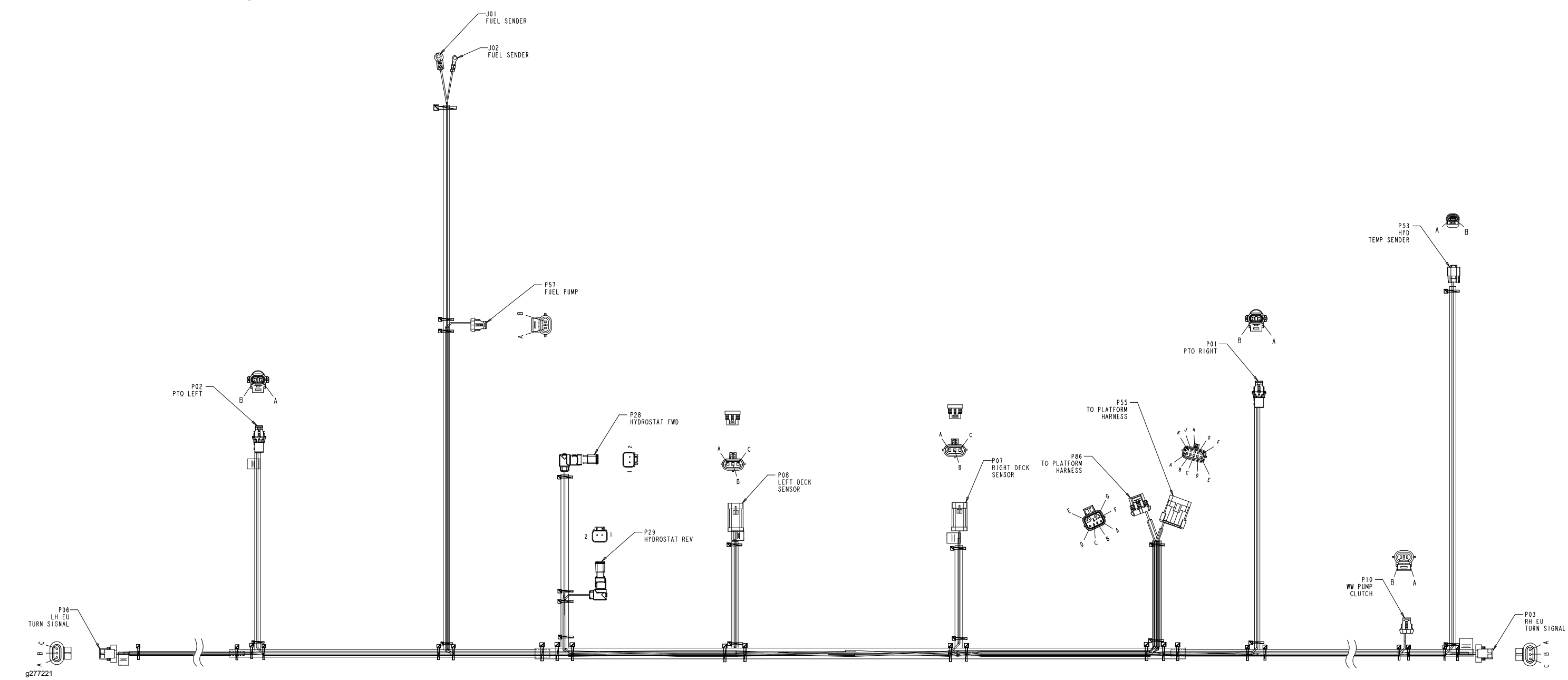
Platform Wire Harness Diagram (For machines serial numbers above 408000000)



Platform Wire Harness Diagram (For machines serial numbers above 408000000)

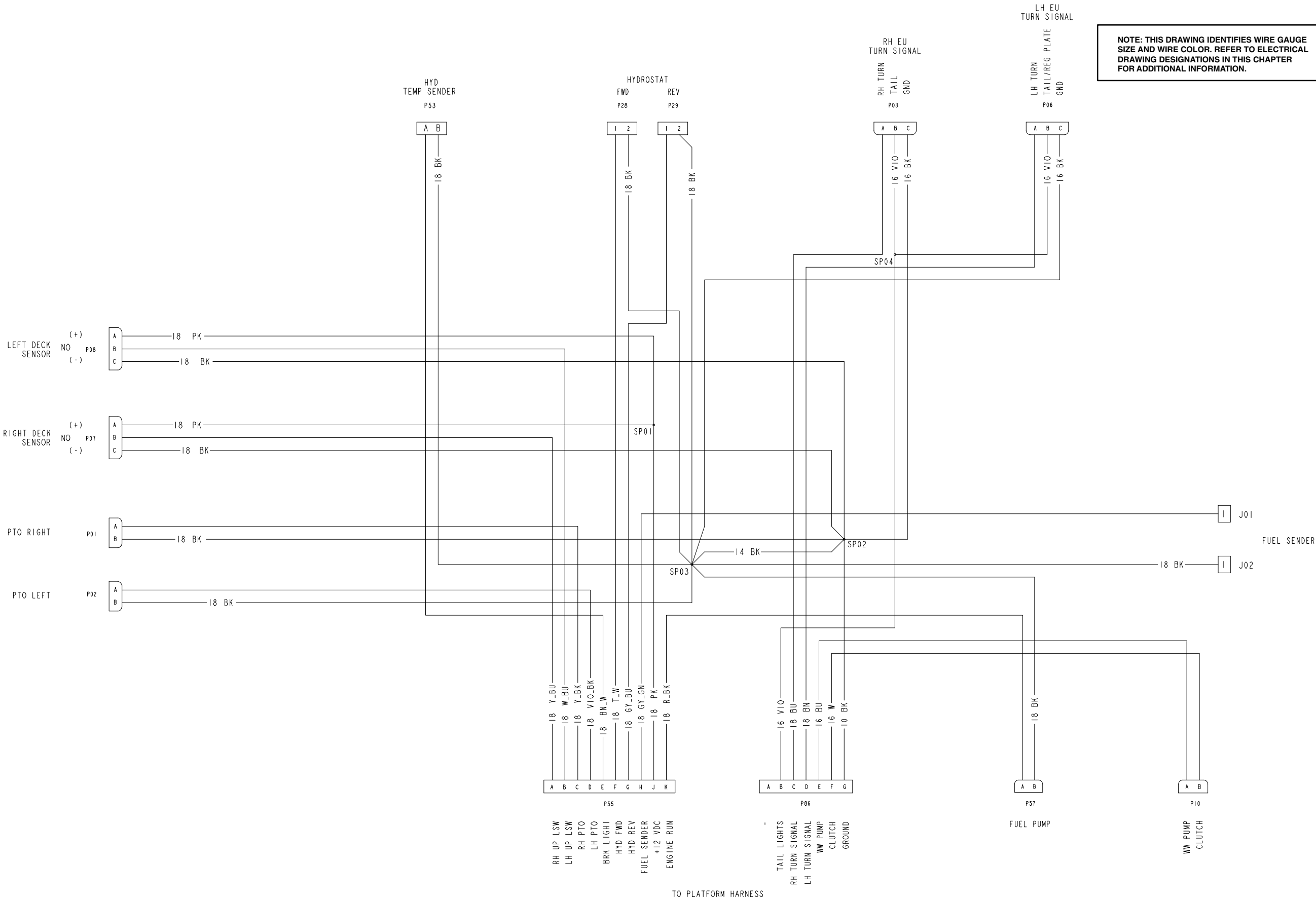


Rear Wire Harness Diagram (For machines serial number below 400000000)

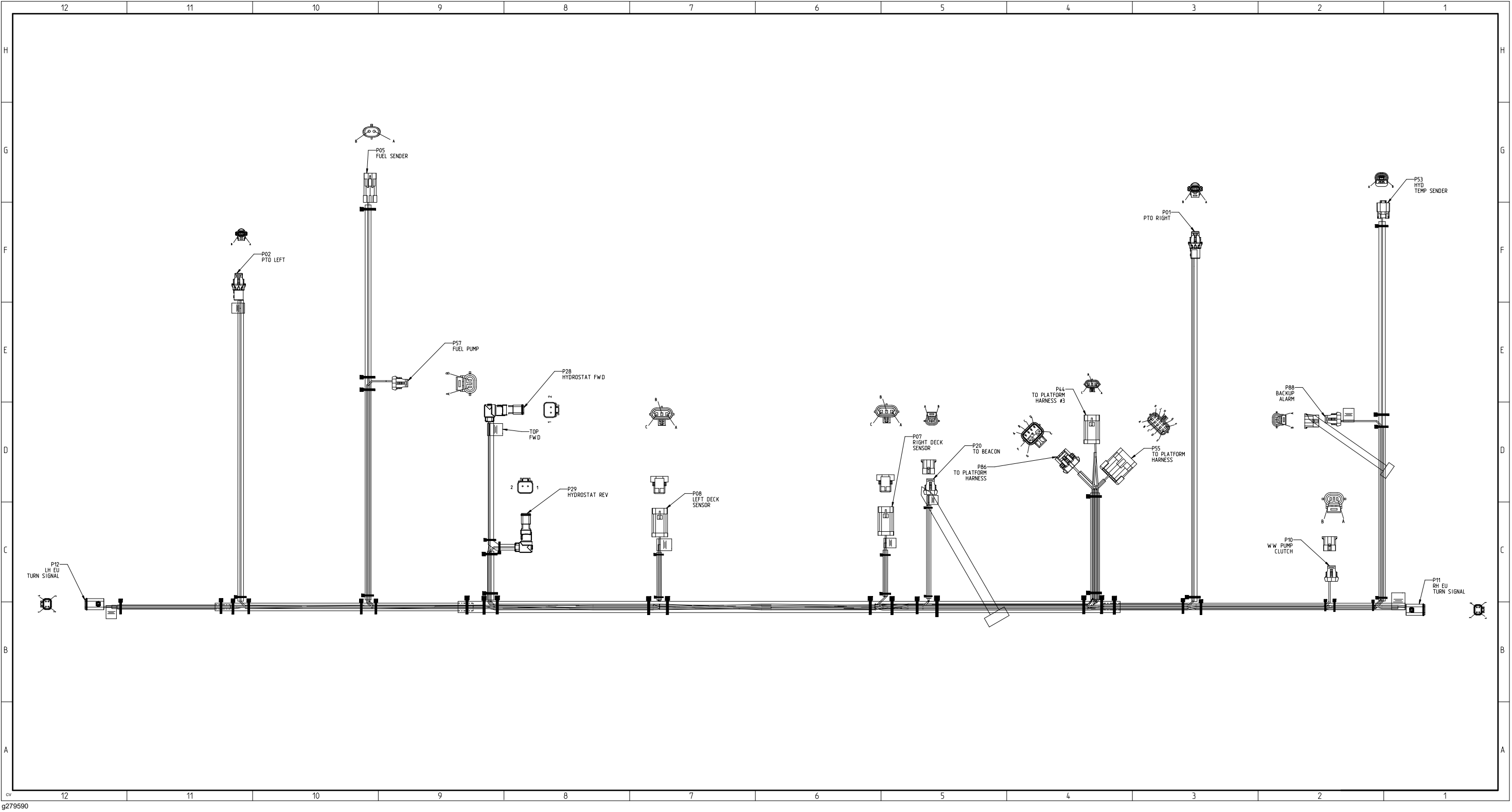


Rear Wire Harness Diagram (For machines serial number below 400000000)

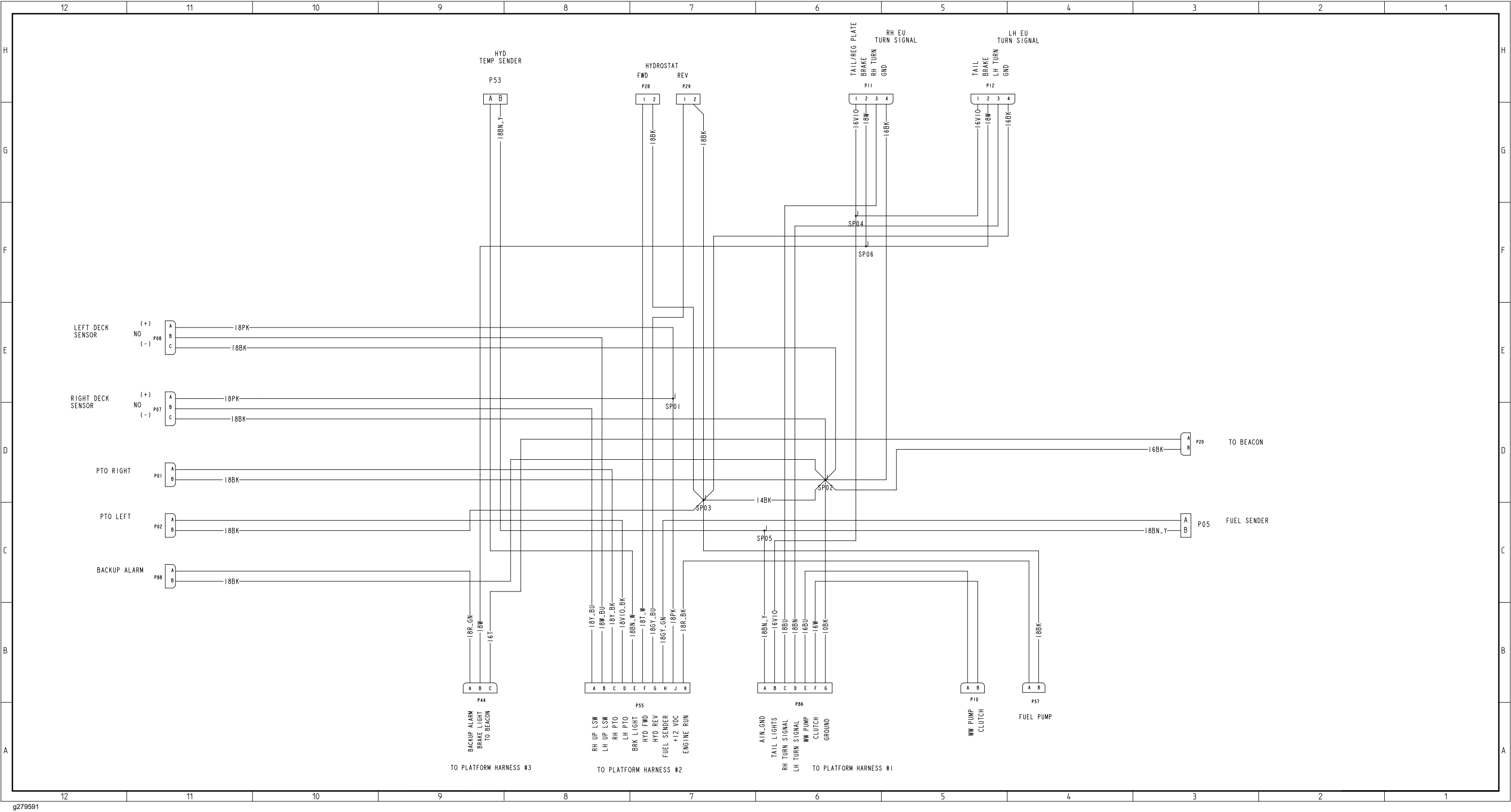
NOTE: THIS DRAWING IDENTIFIES WIRE GAUGE SIZE AND WIRE COLOR. REFER TO ELECTRICAL DRAWING DESIGNATIONS IN THIS CHAPTER FOR ADDITIONAL INFORMATION.



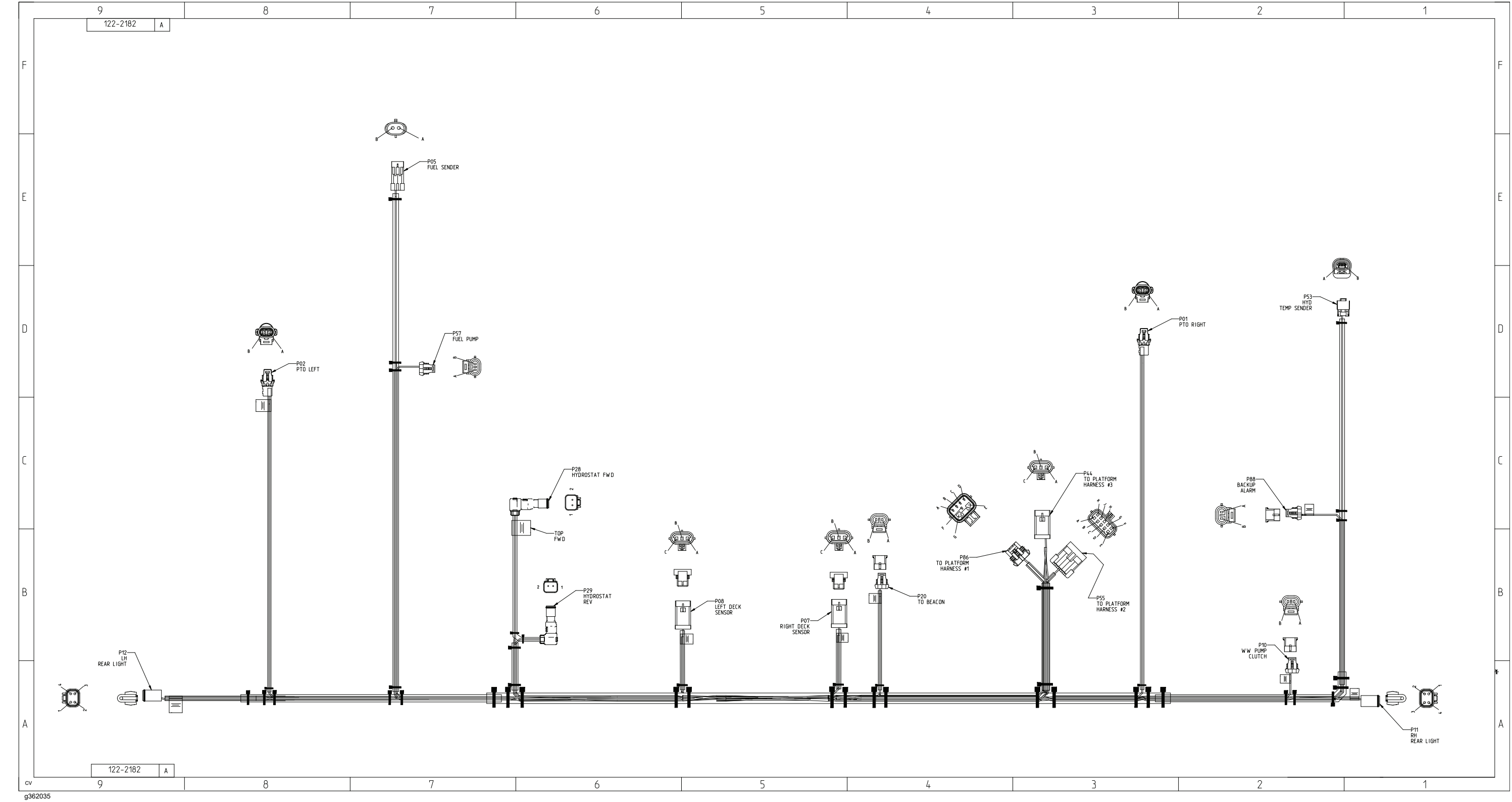
Rear Wire Harness Diagram (For machines serial number 400000000 to 408000000)



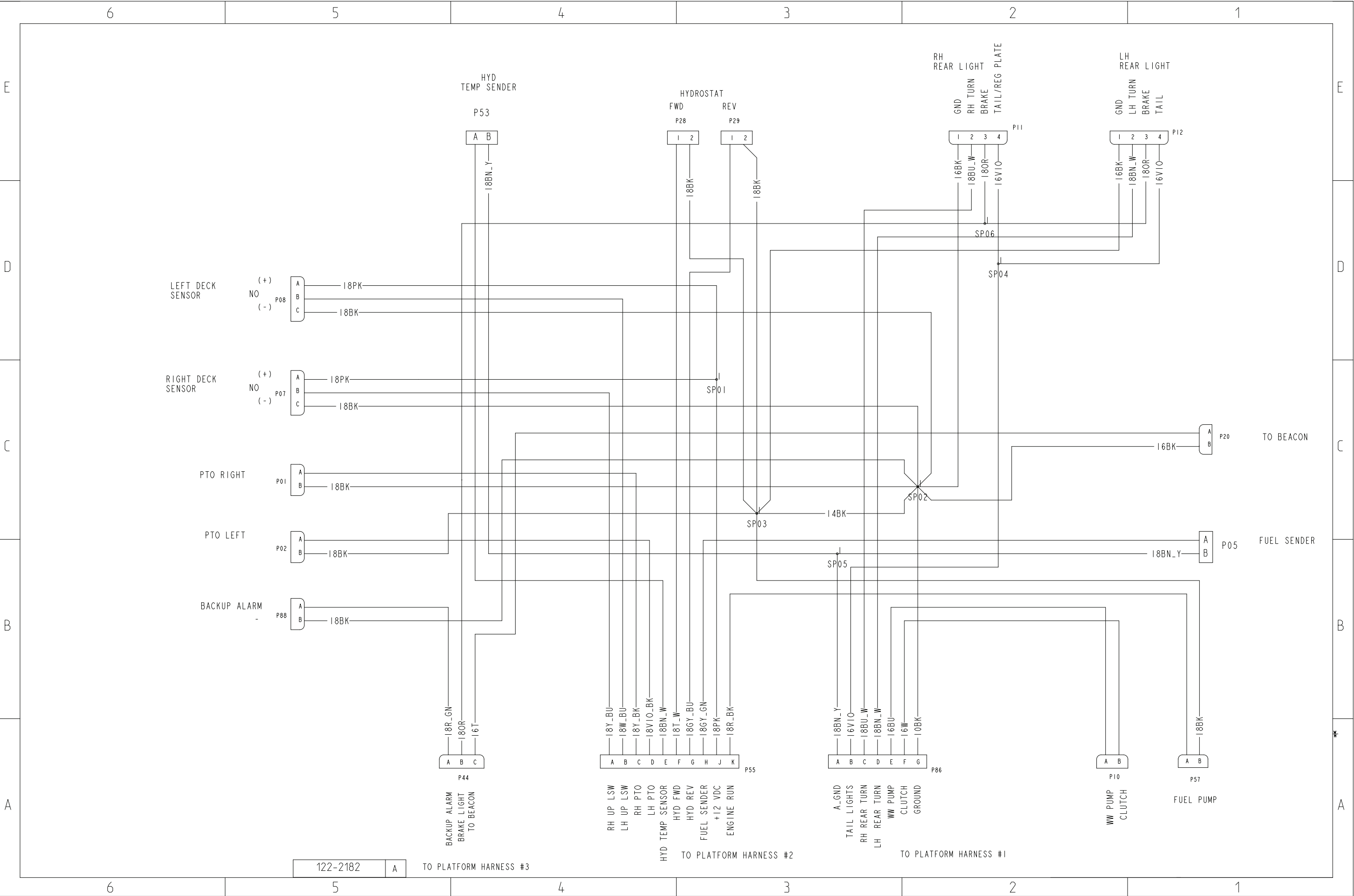
Rear Wire Harness Diagram (For machines serial number 400000000 to 408000000)



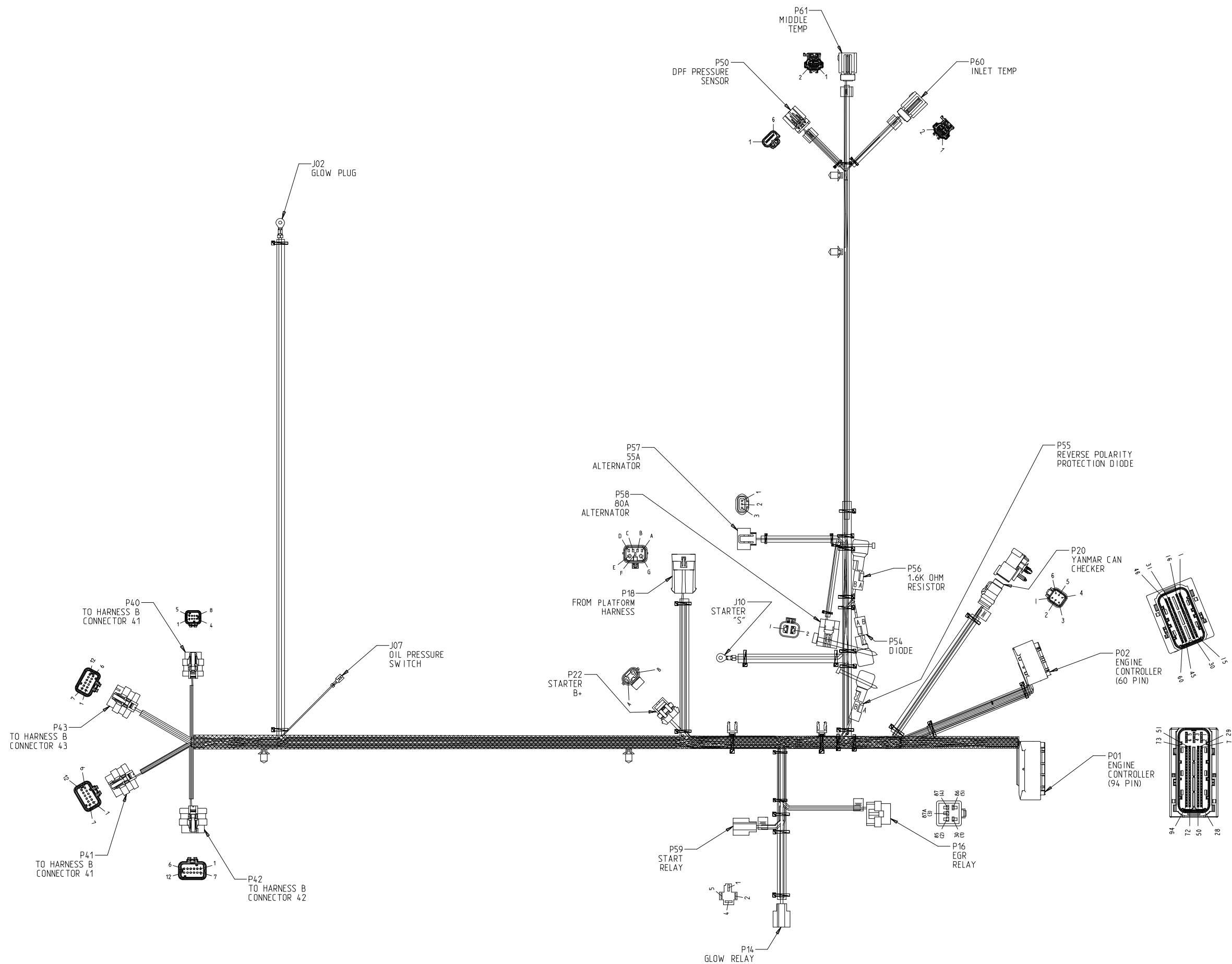
Rear Wire Harness Diagram (For machines serial number above 408000000)



Rear Wire Harness Diagram (For machines serial number above 408000000)

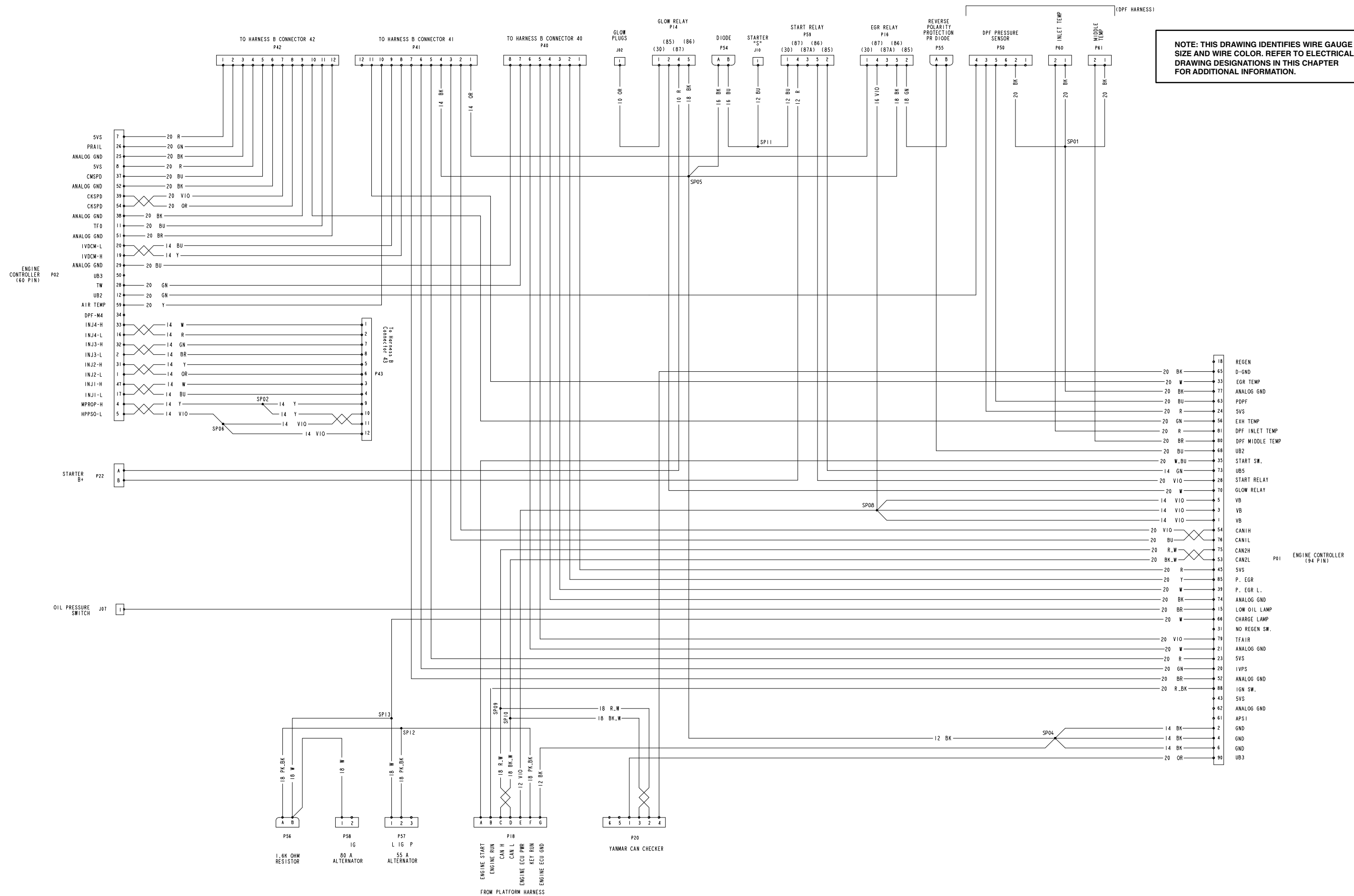


Engine Wire Harness Drawing for Models 30607, 30609, 30636 (For machines serial number below 400000000)

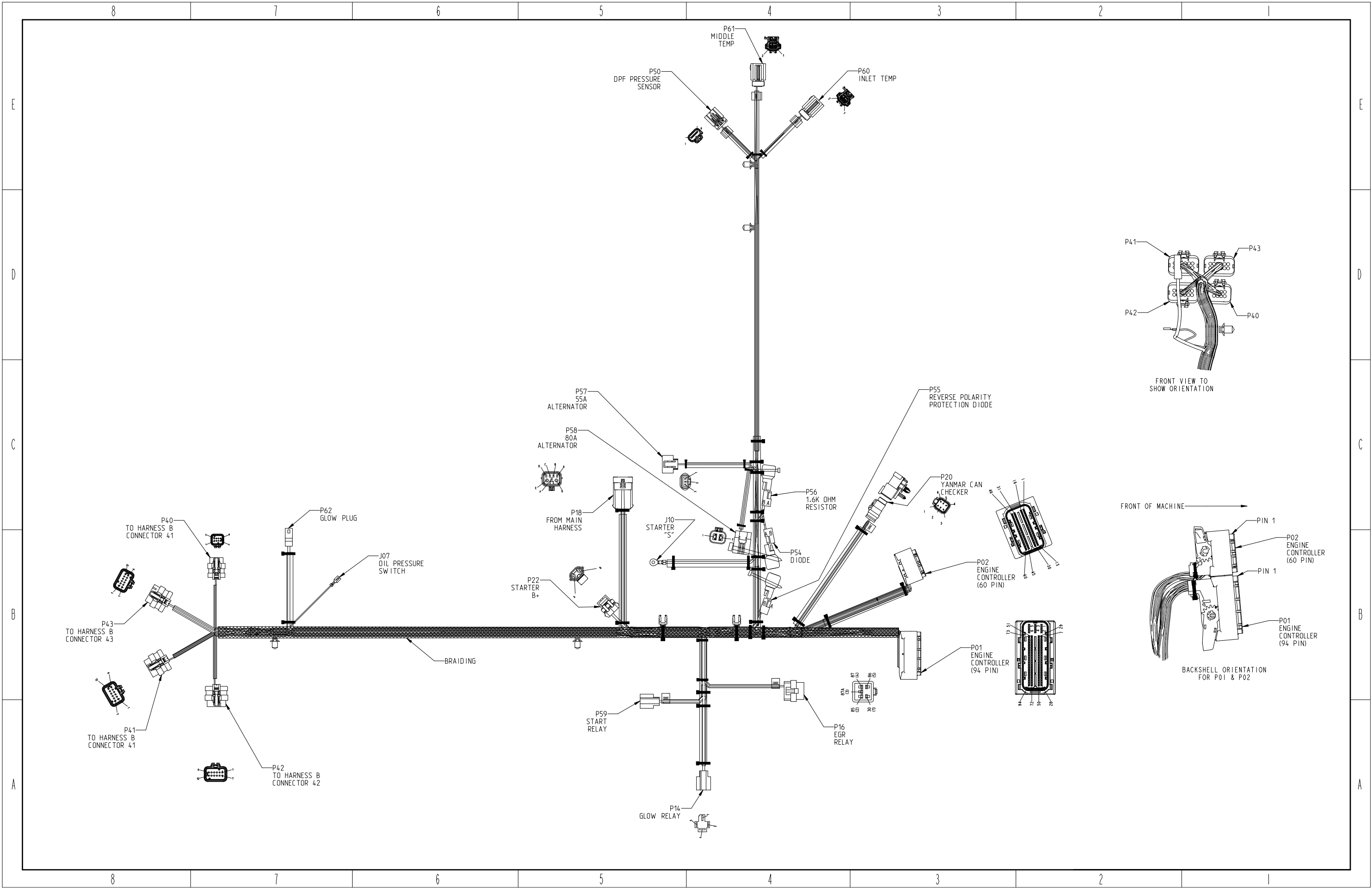


g277223

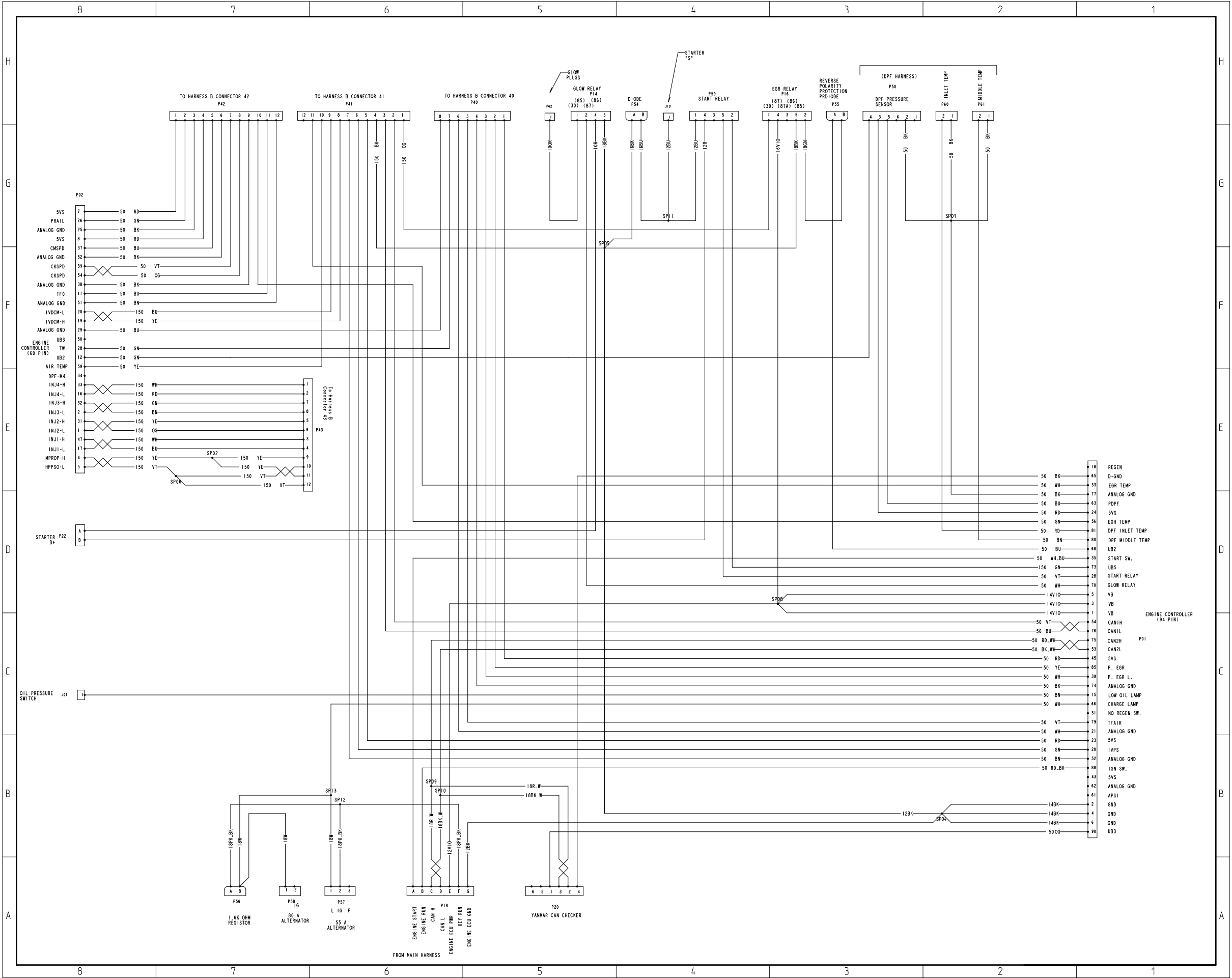
Engine Wire Harness Diagram for Models 30607, 30609, 30636 (For machines serial number below 400000000)



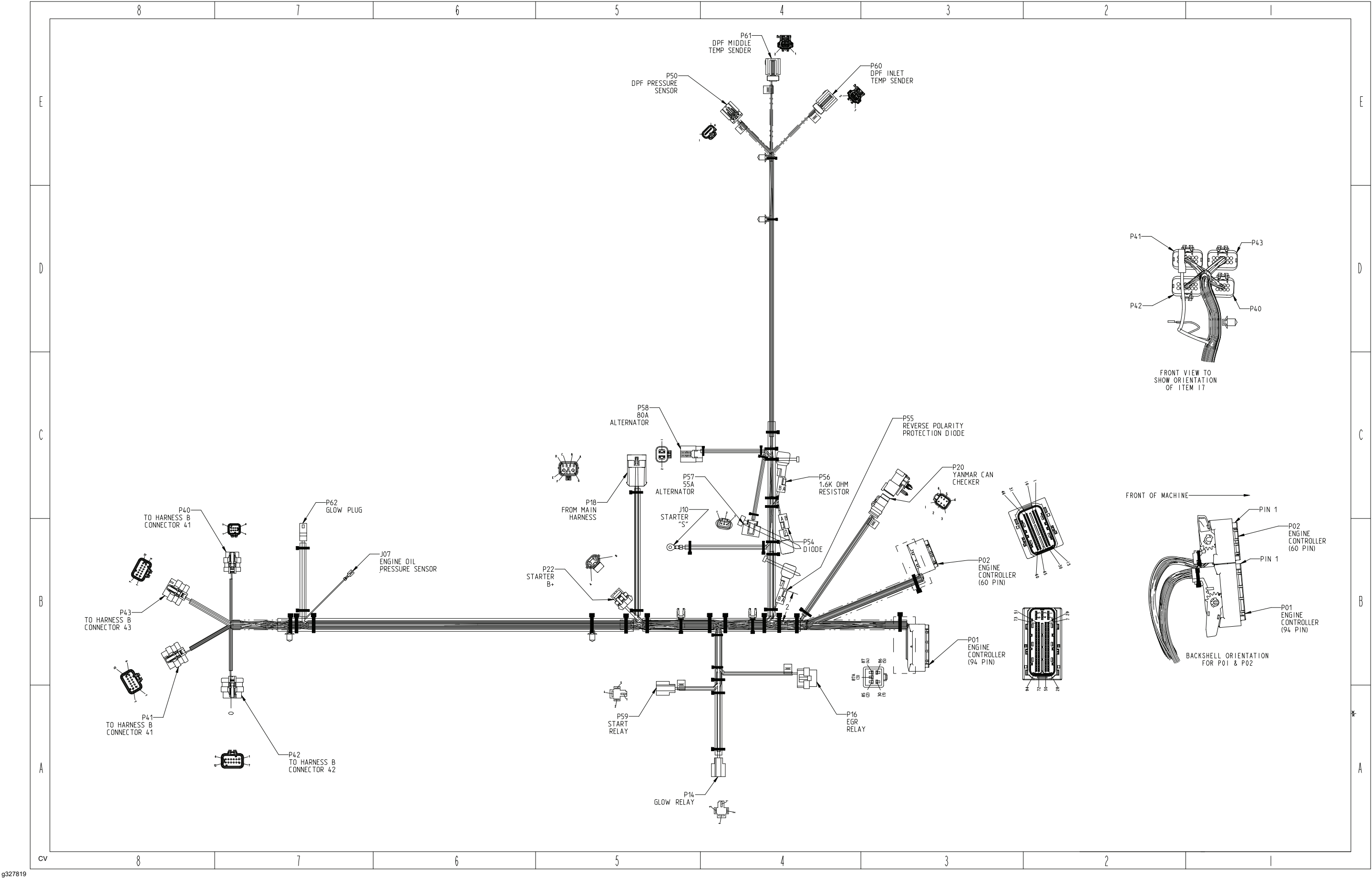
Engine Wire Harness Diagram for Models 30607, 30609, 30636 (For machines serial numbers 400000001 to 403450000)



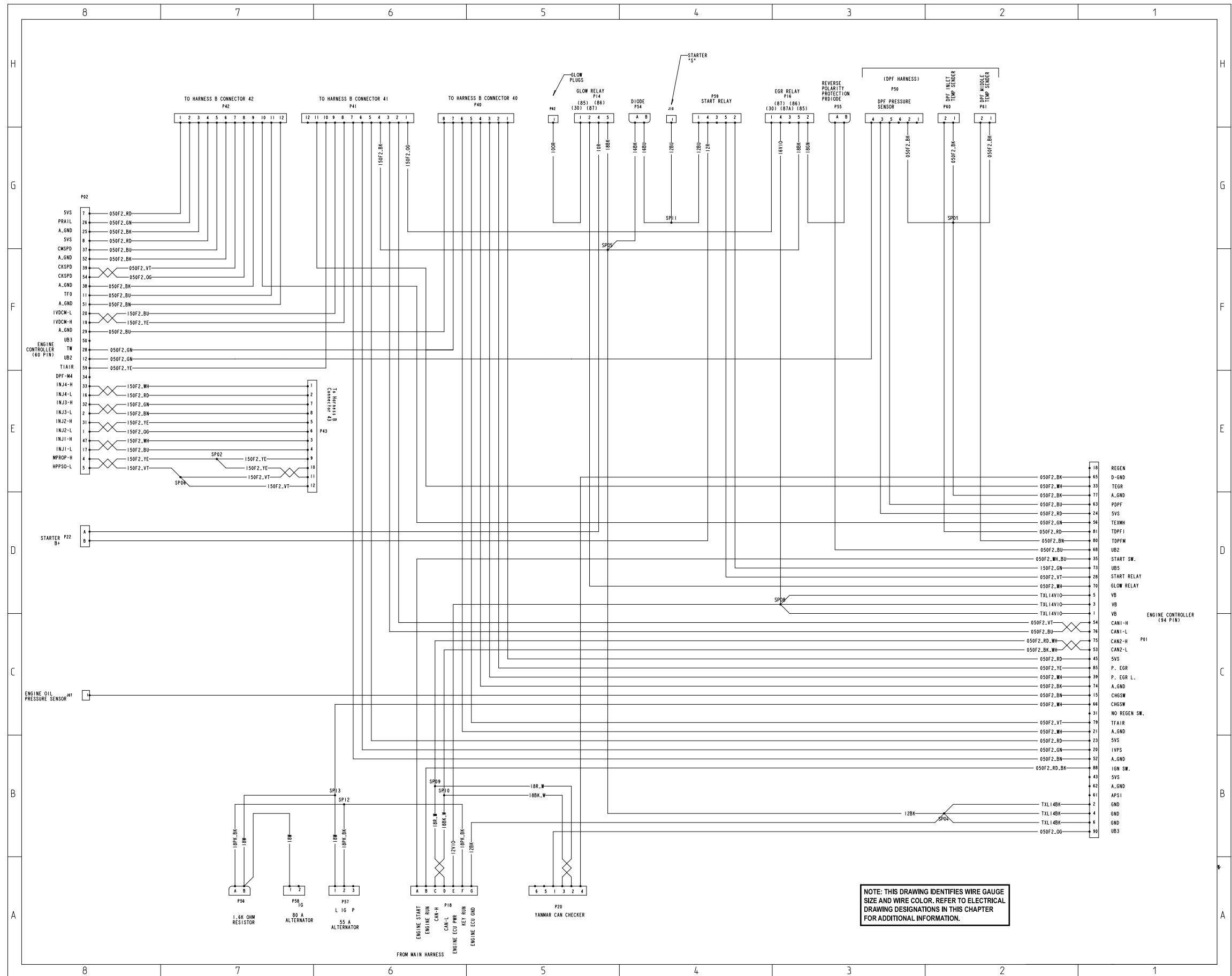
Engine Wire Harness Diagram for Models 30607, 30609, 30636 (For machines serial numbers 400000001 to 403450000)



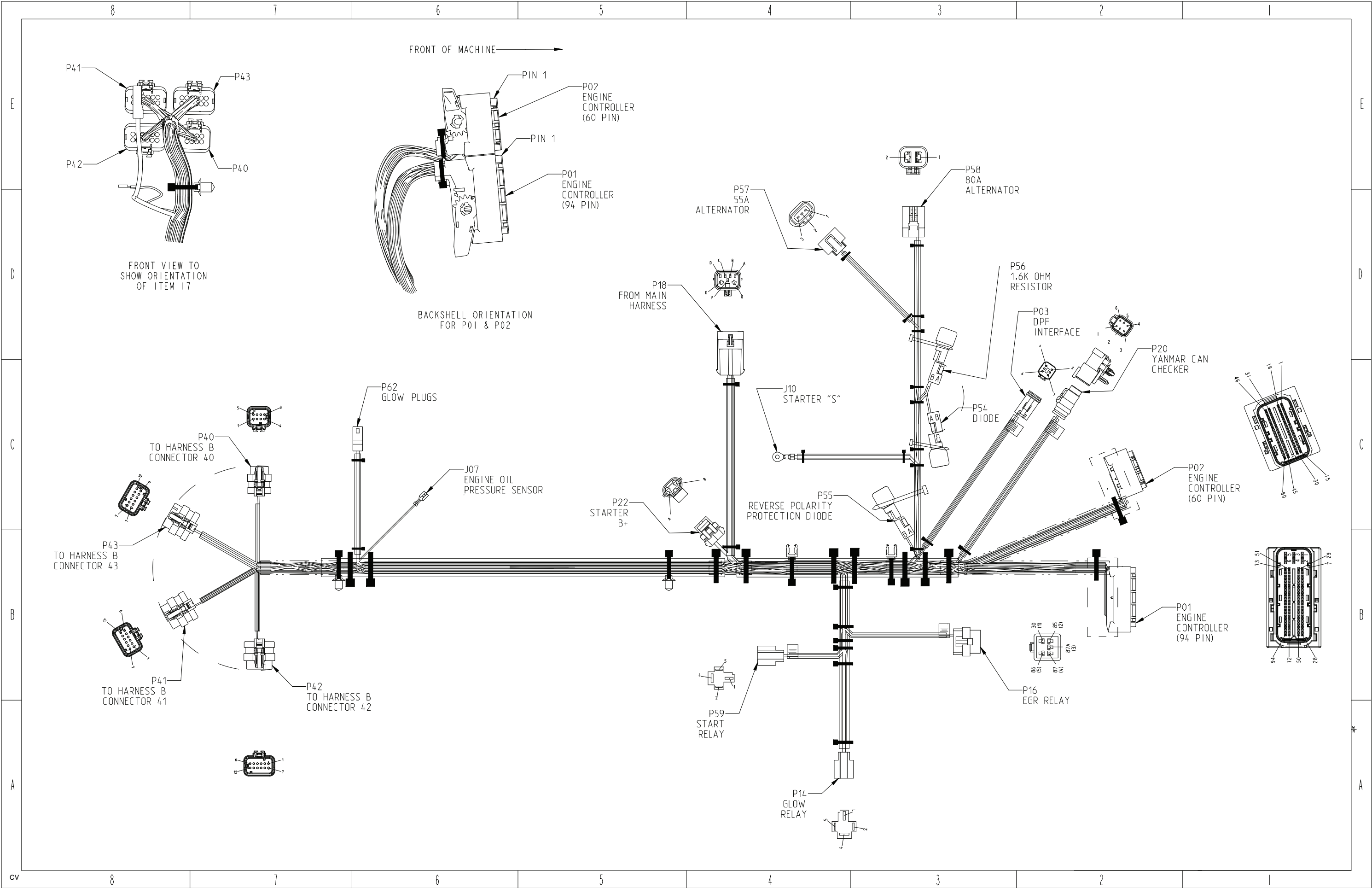
Engine Wire Harness Diagram for Models 30607, 30609, 30636 (For machines serial 403450001 to 408000000)



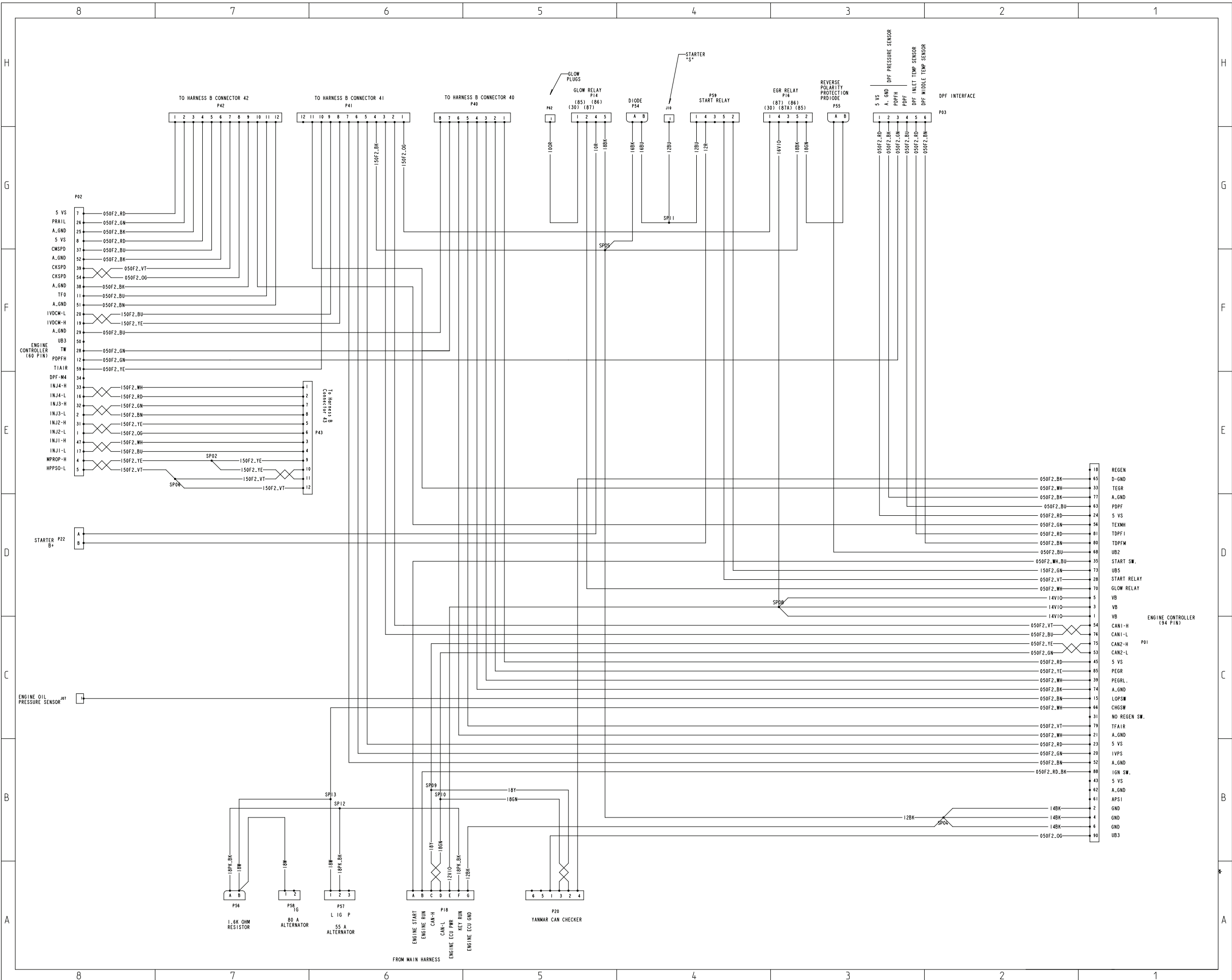
Engine Wire Harness Diagram for Models 30607, 30609, 30636 (For machines serial 403450001 to 408000000)



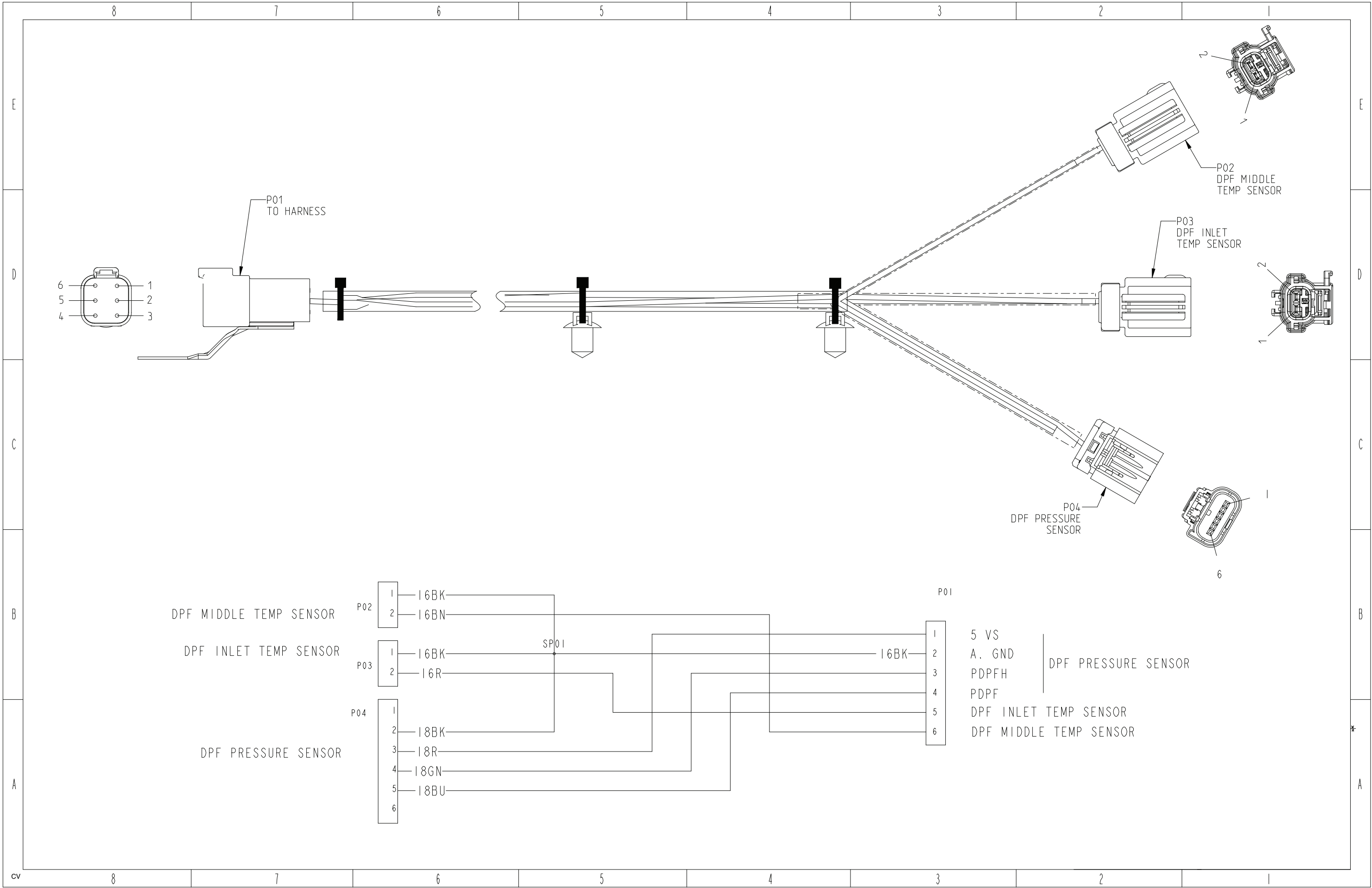
Engine Wire Harness Diagram for Models 30607, 30609, 30636 (For machines serial above 408000000)



Engine Wire Harness Diagram for Models 30607, 30609, 30636 (For machines serial above 408000000)

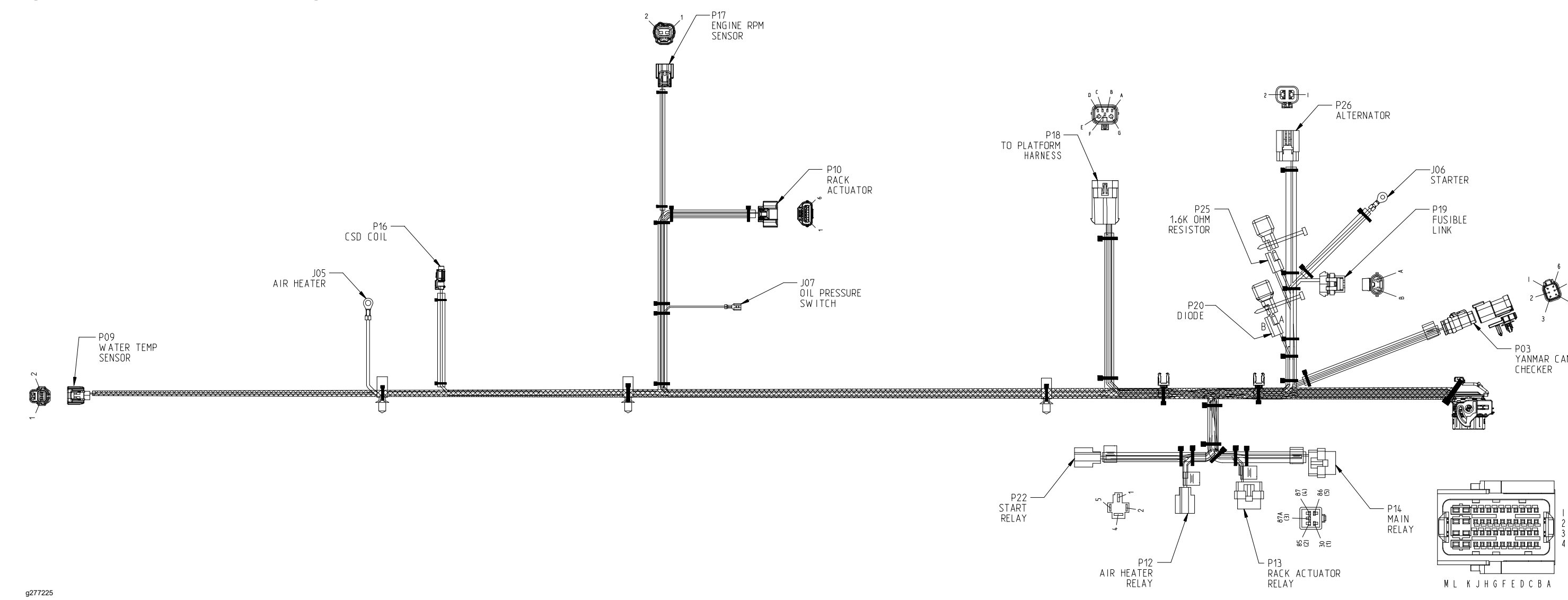


Engine DPF Wire Harness Diagram for Models 30607, 30609, 30636 (For machines serial above 408000000)

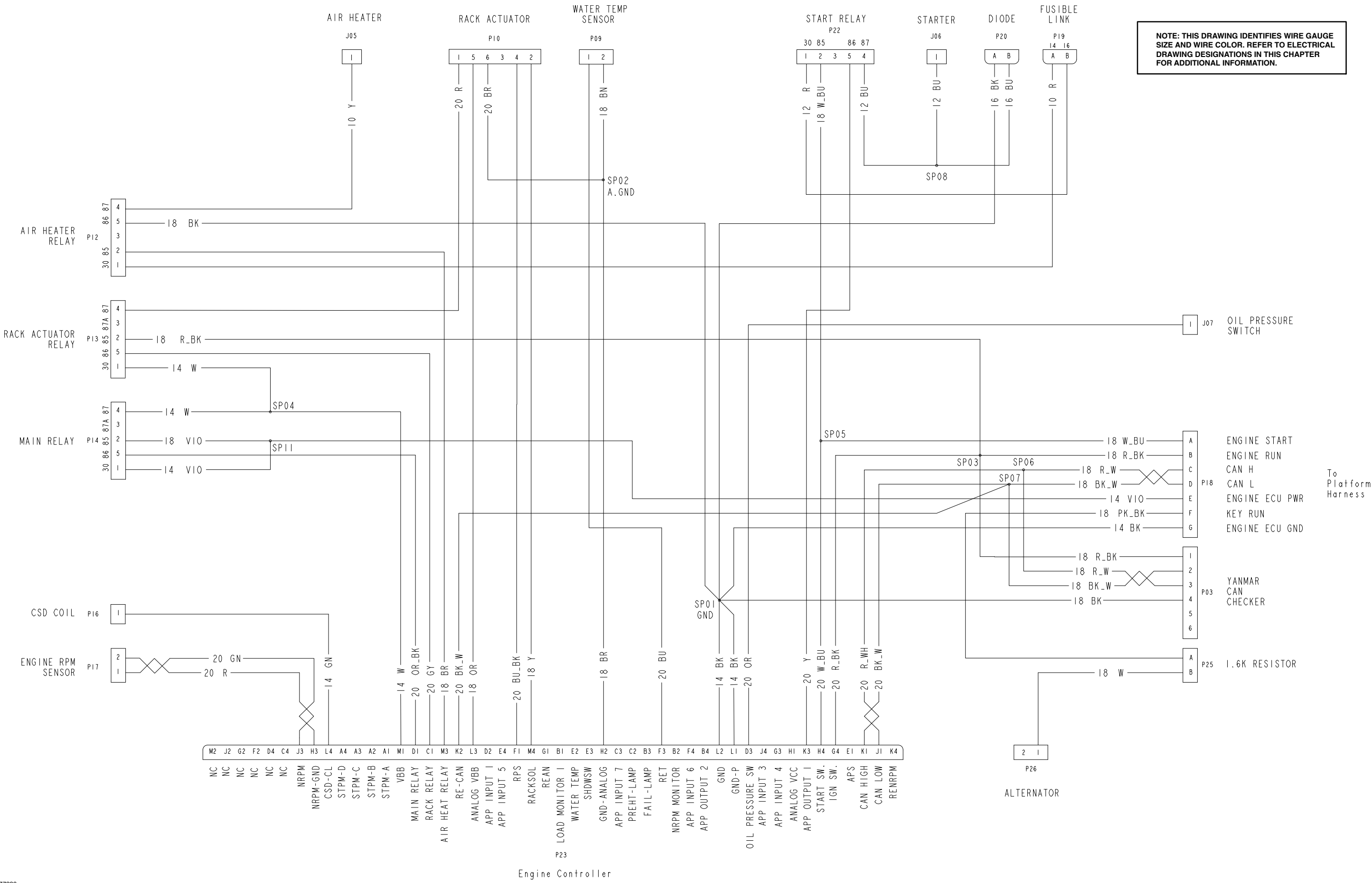


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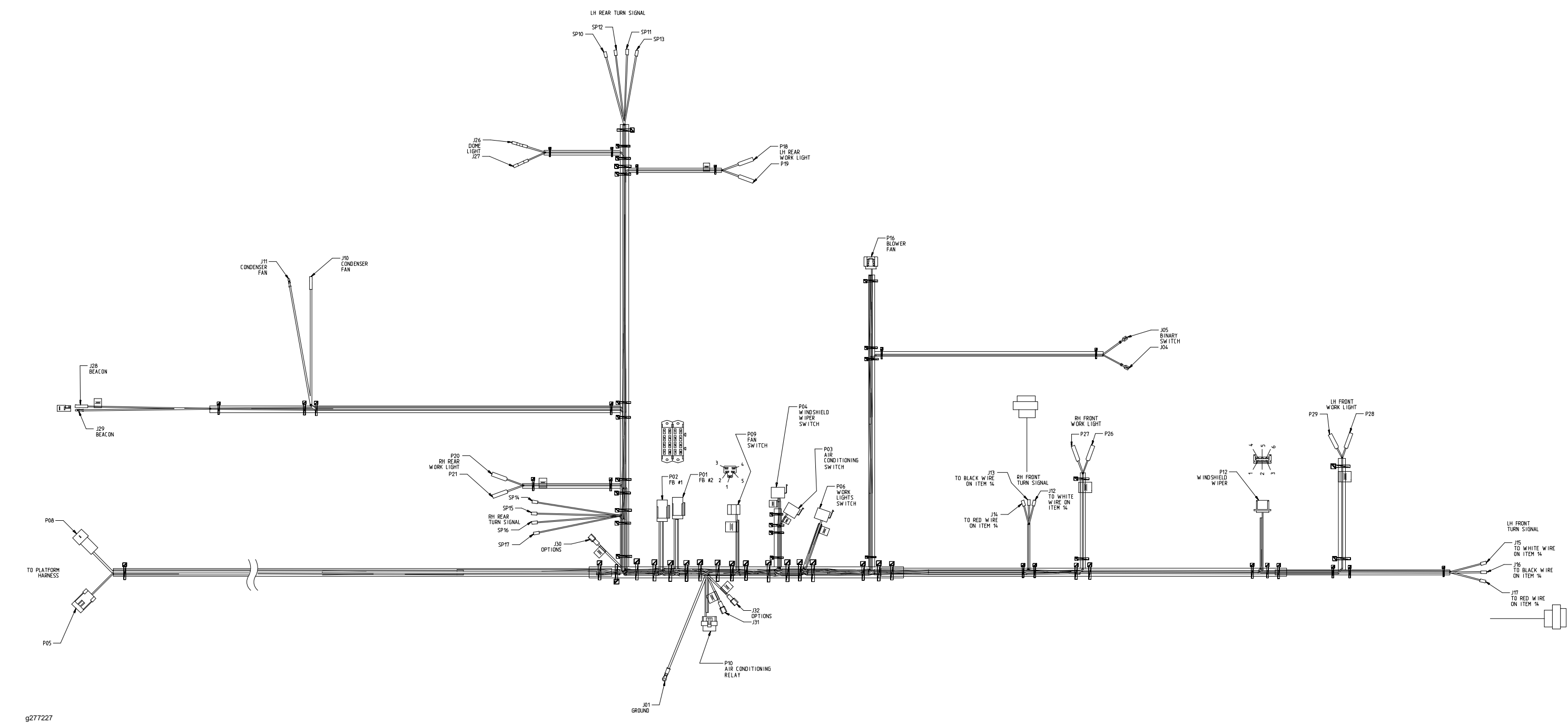
Engine Wire Harness Drawing for Models 30603, 30605, 30635



Engine Wire Harness Diagram for Models 30603, 30605, 30635

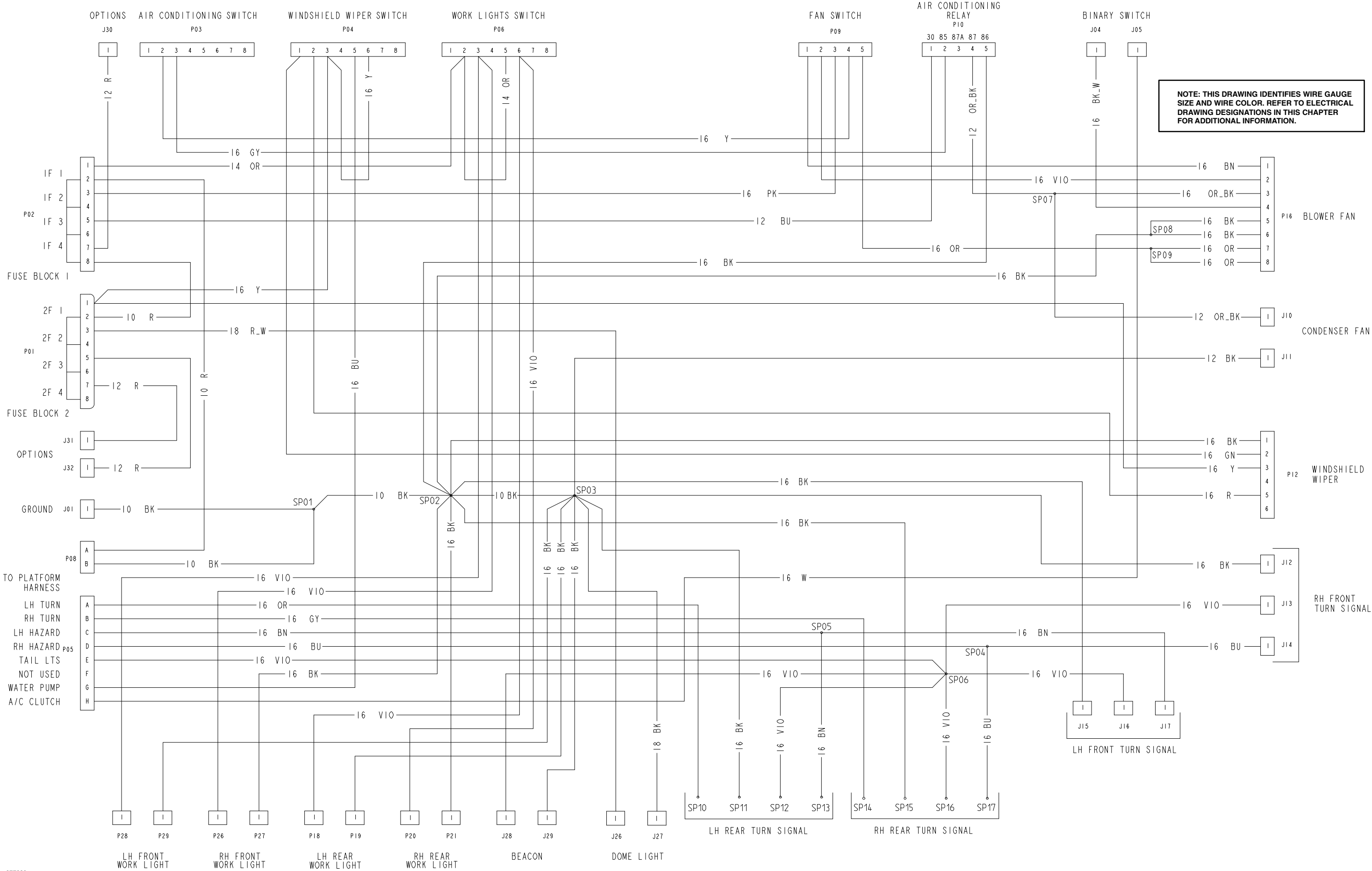


Operator Cab Wire Harness Diagram (For machines serial number below 400000000)

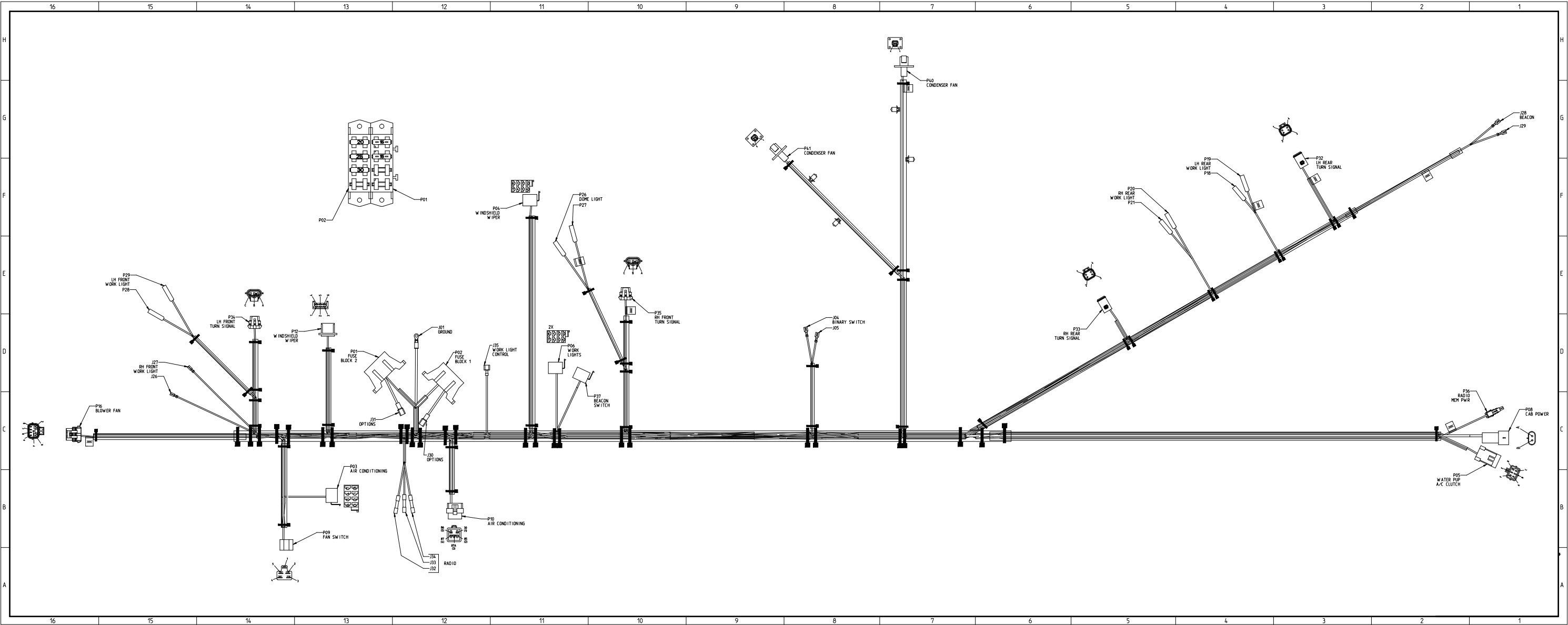


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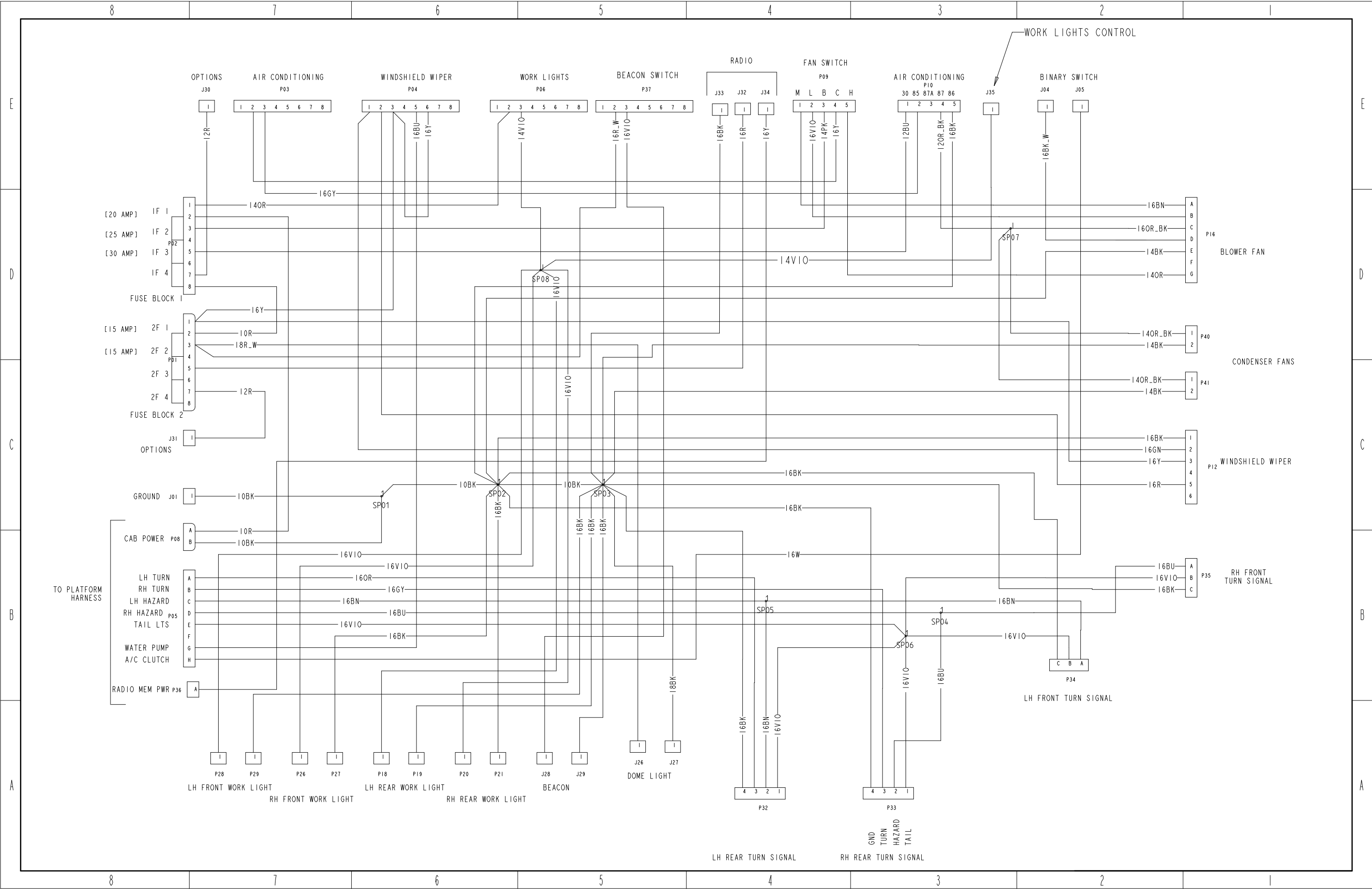
Operator Cab Wire Harness Diagram (For machines serial number below 400000000)



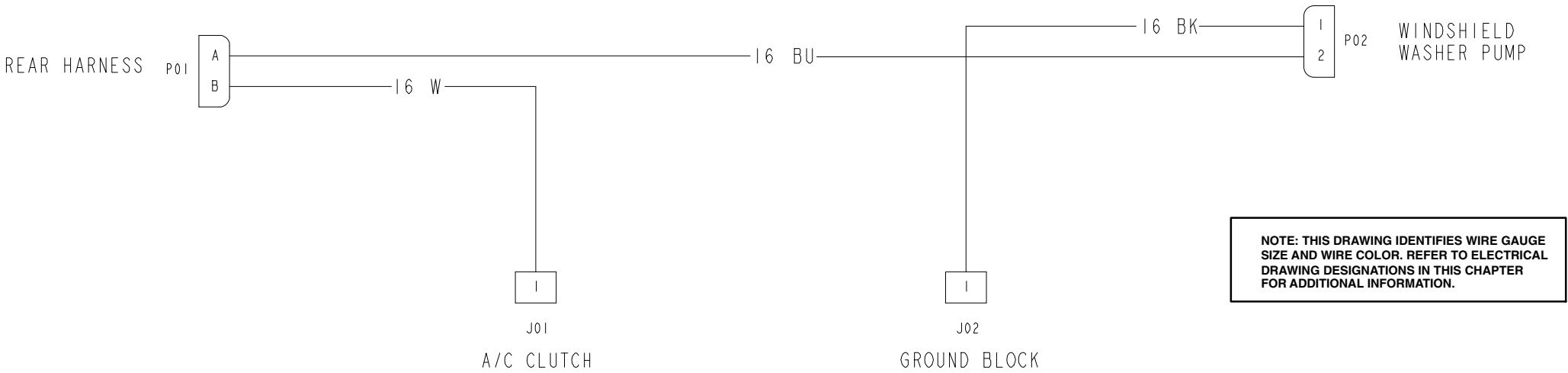
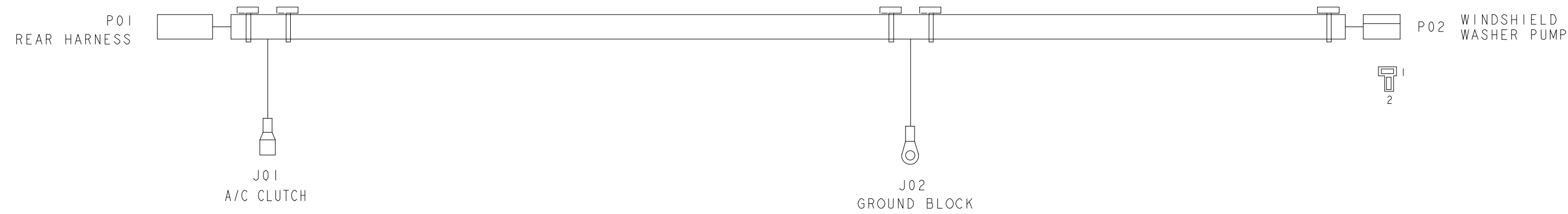
Operator Cab Wire Harness Diagram (For machines serial number above 400000000)



Operator Cab Wire Harness Diagram (For machines serial number above 400000000)



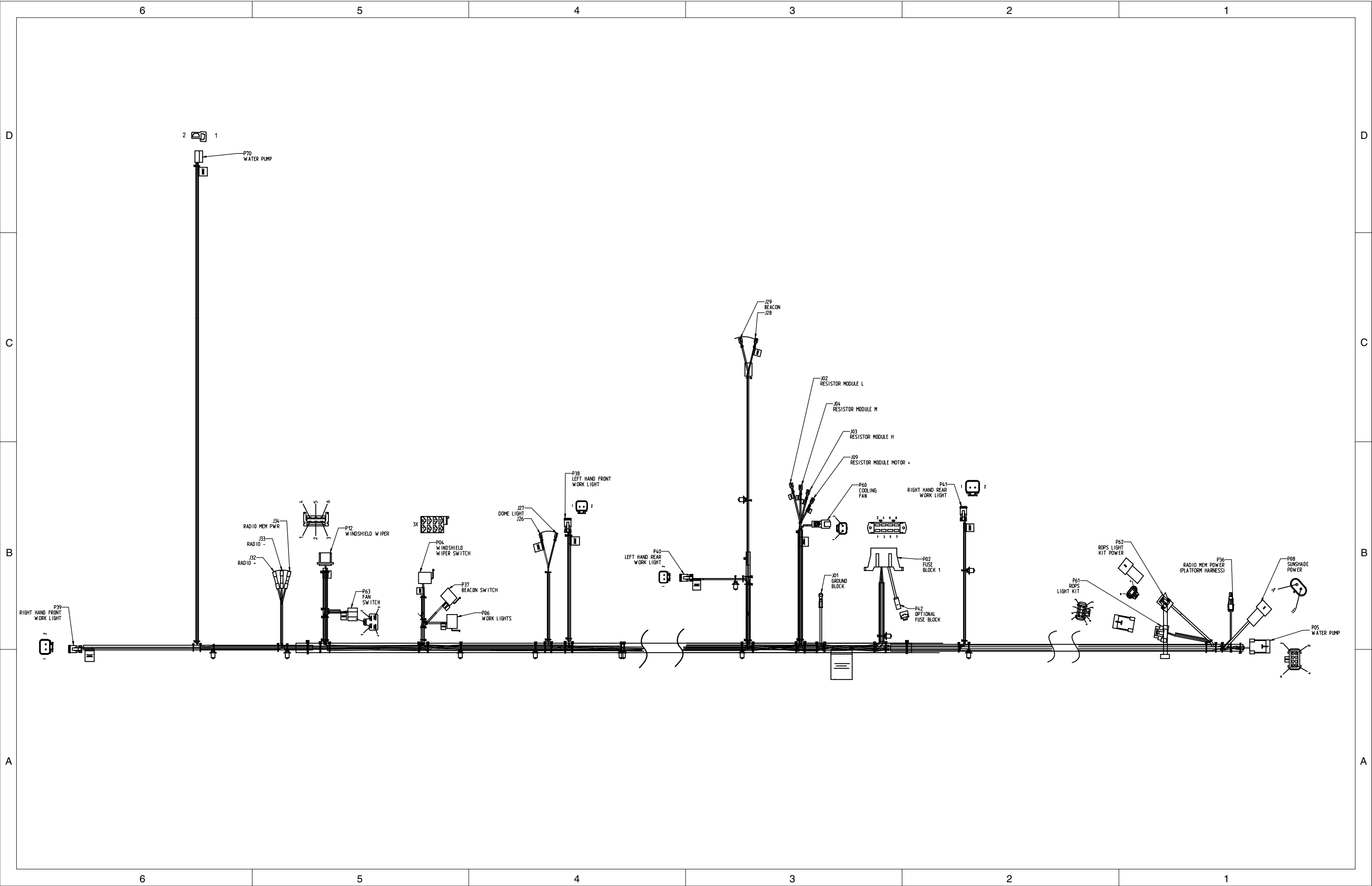
Operator Cab Interconnect Wire Harness



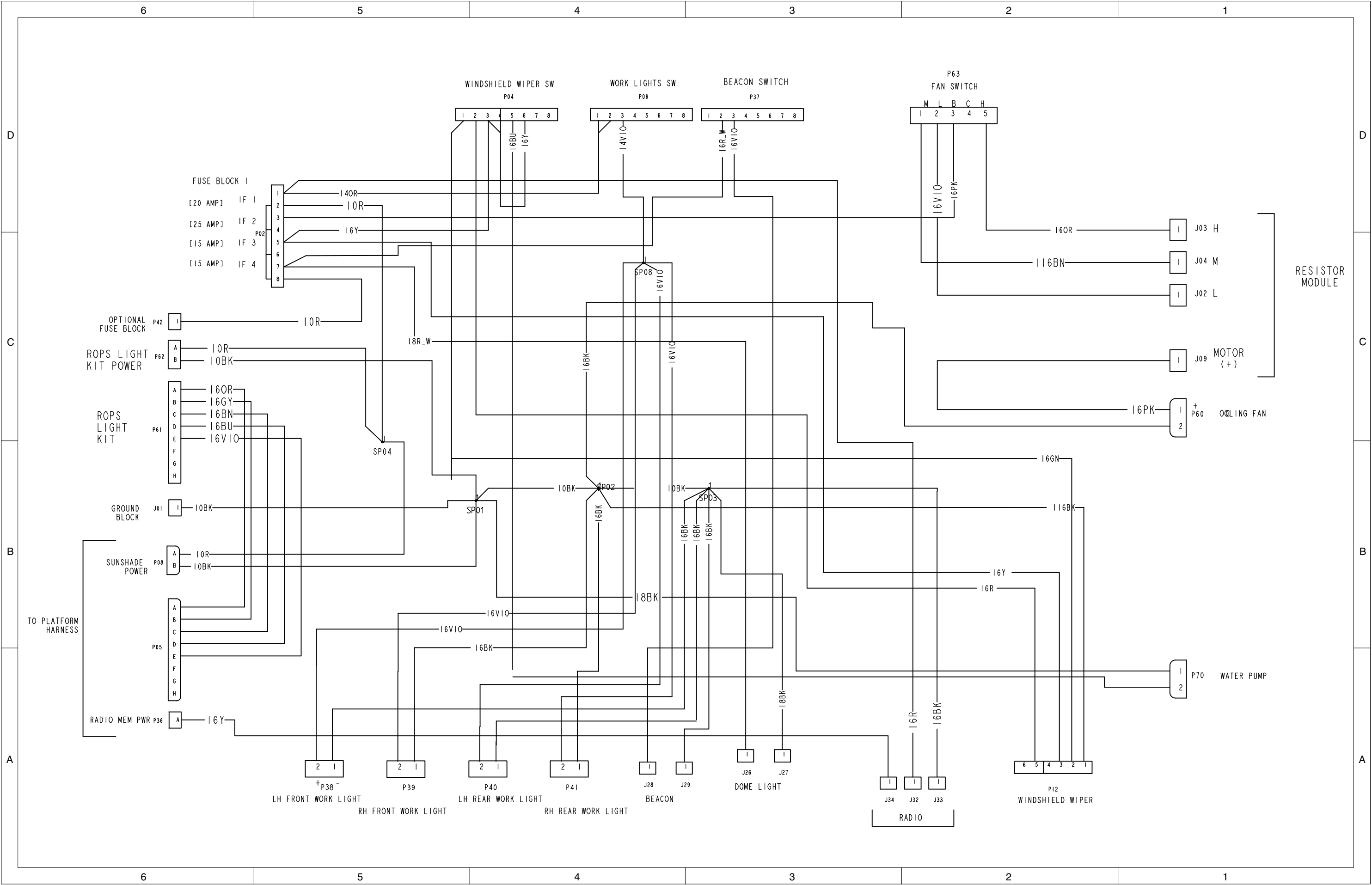
NOTE: THIS DRAWING IDENTIFIES WIRE GAUGE SIZE AND WIRE COLOR. REFER TO ELECTRICAL DRAWING DESIGNATIONS IN THIS CHAPTER FOR ADDITIONAL INFORMATION.

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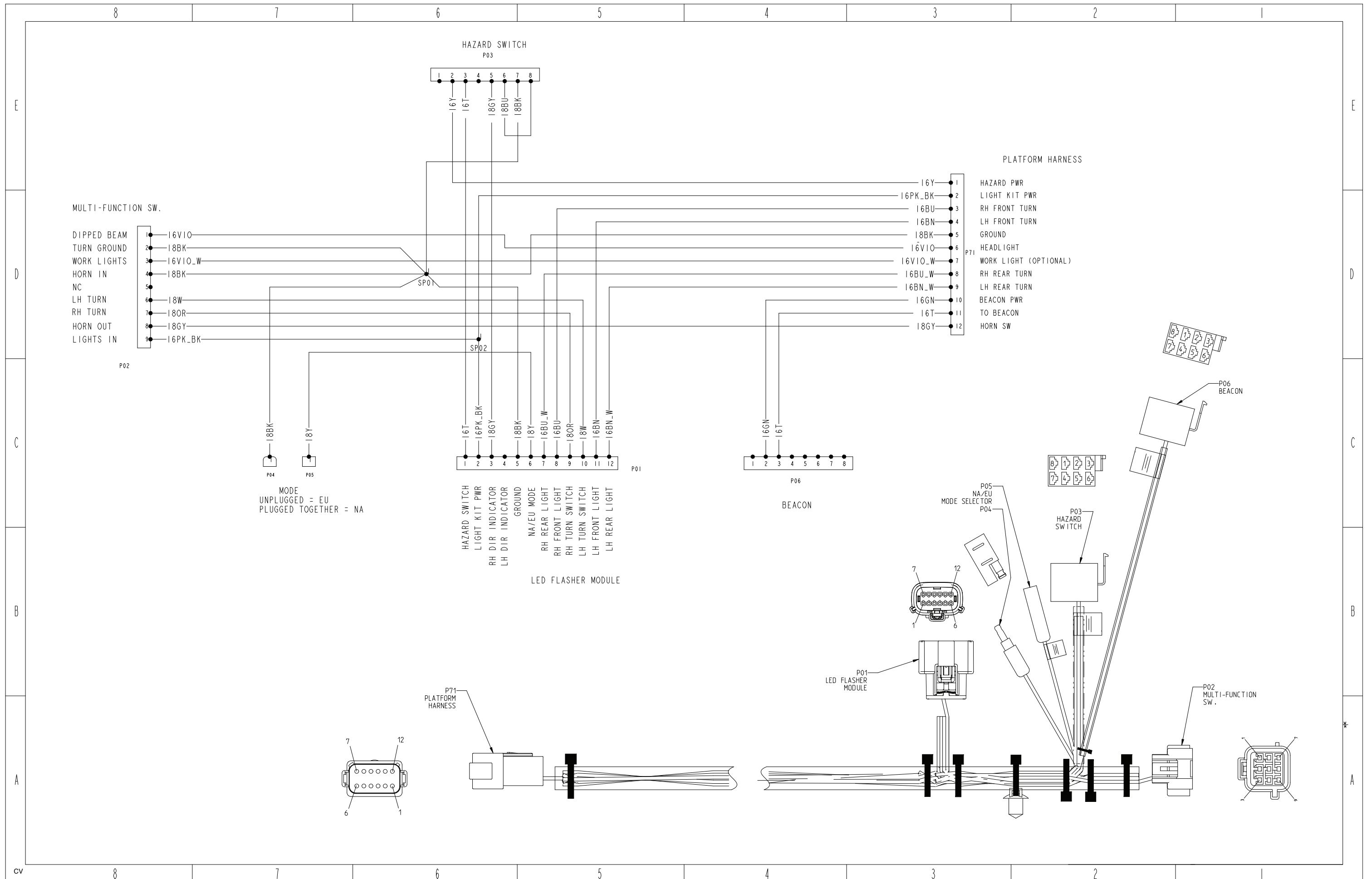
Wire Harness Diagram – Two-Post ROPS Extension (Models 30605 and 30609)



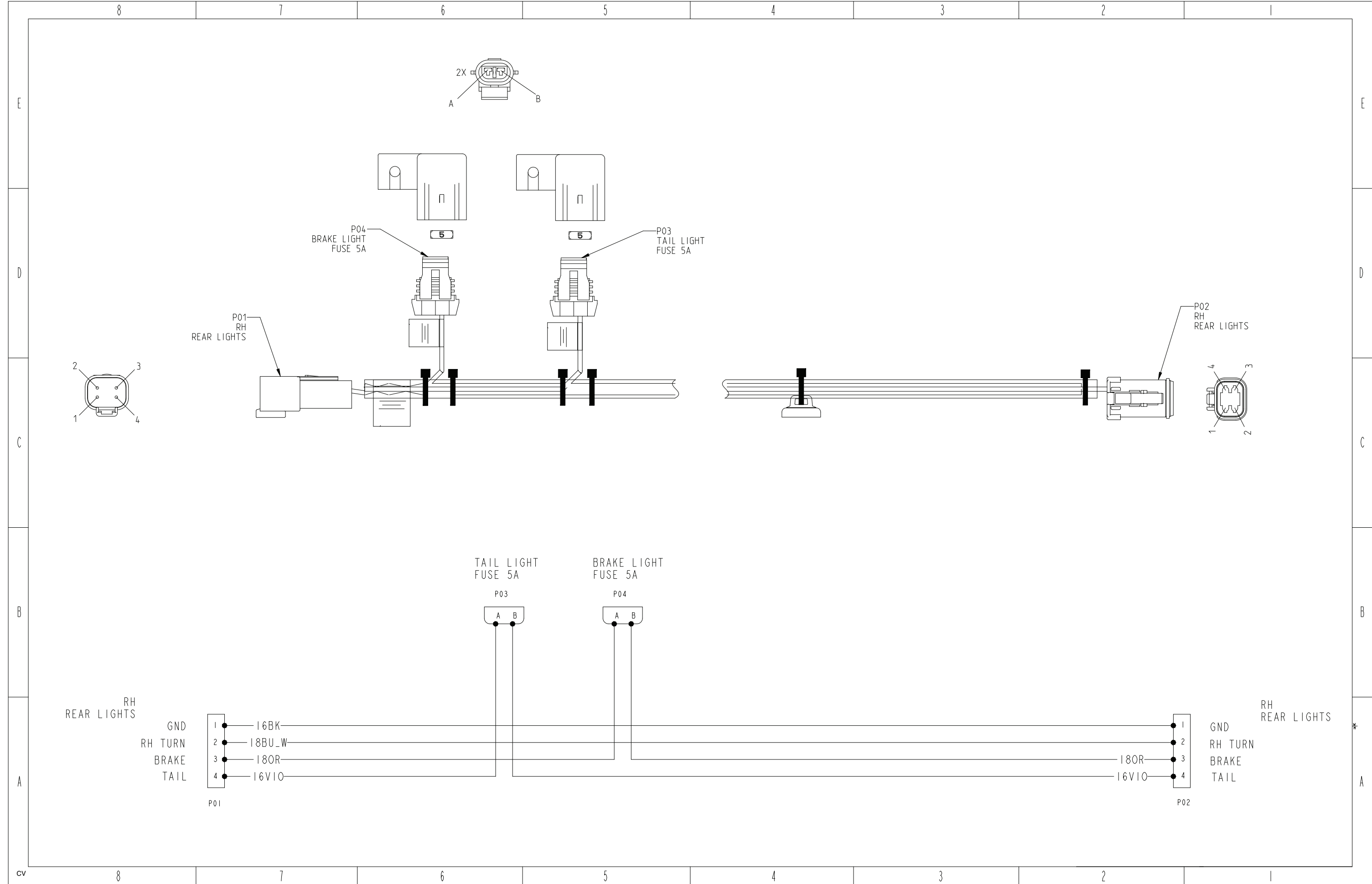
Wire Harness Diagram – Two-Post ROPS Extension (Models 30605 and 30609)



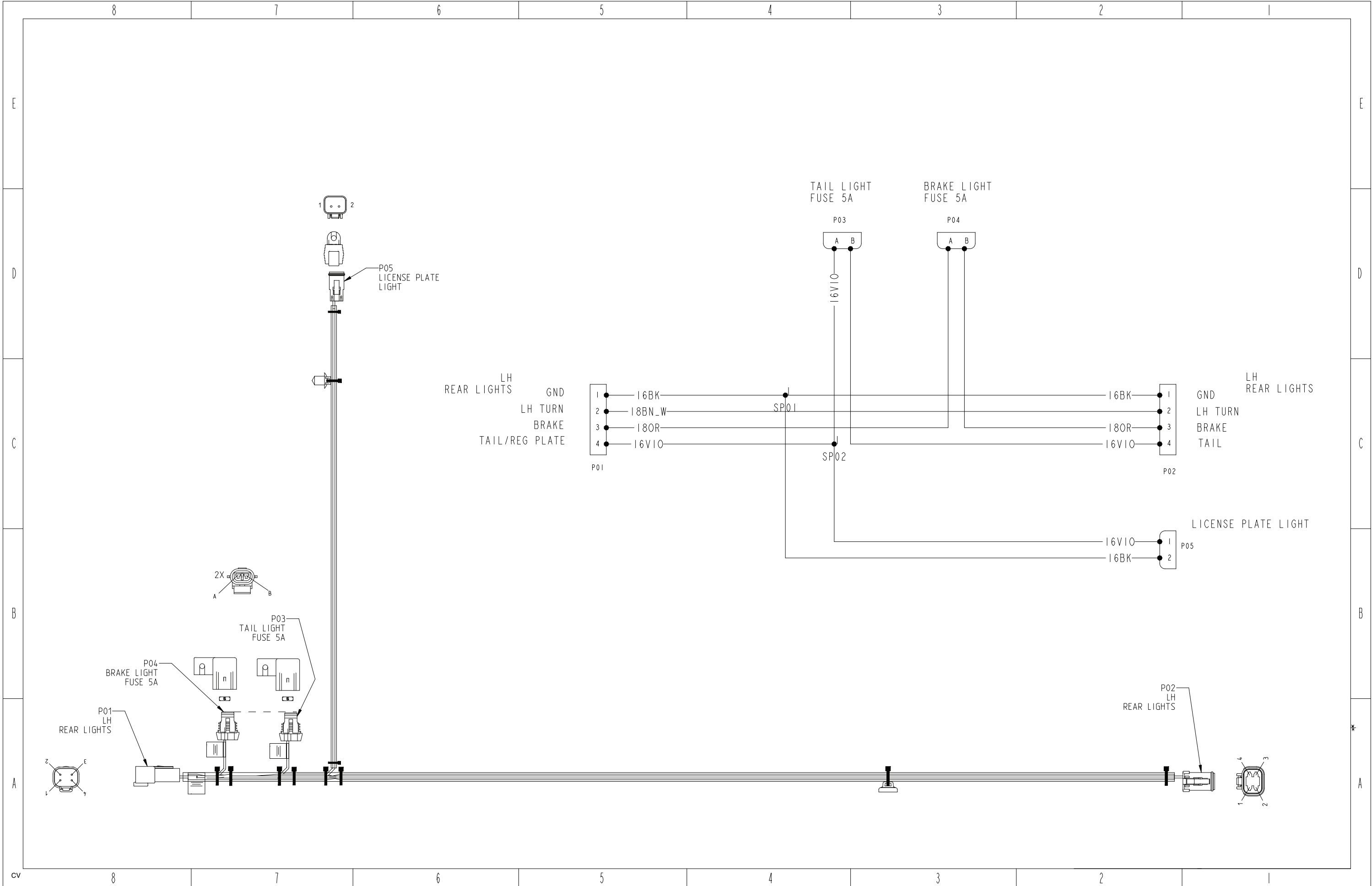
Light Kit Wire Harness



RH Rear Lights Wire Harness



LH Rear Lights Wire Harness





Count on it.