

Count on it.

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Service Manual

Groundsmaster® 4300-D

(Model No. 30864 - Serial No. 314000101 & Up)

Revision History

Revision	Date	Description
А	2016	Initial issue.
В	03/2018	Updated Engine, Electrical chapters and Foldout Drawings. Added Revision History and published in new format.
С	03/2019	Updated Chassis chapter.
D	07/2020	Updated Electrical chapter and Foldout Drawings.
E	06/2021	Updated Engine chapter.

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 the information for troubleshooting, testing, and repair of the major systems and components of Groundsmaster 4300-D (Model No. 30864) machines that are powered by a Yanmar diesel engine.

Refer to the *Operator's Manuals* for operating, maintenance, and adjustment instructions. Space is provided in Torque Specifications (page 2–4) of this book to insert the *Operator's Manuals* and *Parts Catalog* for your machine. 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.

A DANGER A

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.

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CAUTION

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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.



Figure 1

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:

- ٠ 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 2-4).



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 4) Series Service Manual Yanmar TNV (Tier 4) Series Troubleshooting Manual Danfoss LPV Pump Repair Manual Danfoss LPV Pump Service Manual Eaton Delta Motors Parts and Repair Manual Parker Torqmotor Service Procedure (TC, TB, TE, TJ, TF, TG, TH, and TL Series) Danfoss OSPM Steering Unit Service Manual



Chapter 1

Safety

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Safety Instructions

The Groundsmaster 4300-D machine meets or exceeds safety standard specifications when weights are installed according to information in the *Operator's Manual*. Although hazard control and accident prevention are partially 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*.

Supervisor's Responsibilities

- 1. Ensure that the operators are fully trained and familiar with the *Operator's Manual*, *Operator's Training DVD*, and all of the operating and safety decals on the machine.
- 2. Establish your own special procedures and work rules for unusual operating conditions (e.g., slopes too steep for machine operation). Survey the mowing site completely to determine hills on which you can operate safely. When performing this site survey, always understand and take into consideration the turf condition and rollover risk.

Before Operating the Machine

- Review and understand the contents of the *Operator's Manuals* and *Operator's Training DVD* 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.
- 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.
- Tighten any loose nuts, bolts, or screws to ensure that the machine is in safe operating condition.
- Ensure that the interlock switches are adjusted correctly so that the engine does not start unless the traction pedal is in the NEUTRAL position, and the PTO switch is in the OFF (disengaged) position.
- Diesel fuel is highly flammable; handle it carefully.
 - Store fuel in containers specifically designed for storing fuel.
 - Do not remove the fuel tank cap of the machine while the engine is hot or running.
 - Do not smoke while handling fuel.
 - Fill the fuel tank outdoors and only to the bottom of the filler neck. Do not overfill the fuel tank.
 - After refueling the machine, install the fuel tank and fuel container caps.
 - If you spill fuel, do not attempt to start the engine but move the machine away from the spill. Avoid creating any source of ignition until fuel vapors have dissipated. Wipe up any spilled fuel.

While Operating the Machine

- Sit on the seat when starting and operating the machine.
- Anytime you park the machine (short or long term), lower the cutting decks to the ground.

IMPORTANT

When you lower the cutting deck to the ground, the pressure from the hydraulic lift circuit releases and prevents the cutting deck from accidentally lowering.

If you park the machine on a slope, block or chock the wheels.

Before starting the machine



The exhaust fumes are hazardous and have the potential of injury or death.

Do not run the engine in a confined area without adequate ventilation.

- 1. Set the parking brake.
- 2. Ensure that the traction pedal is in the NEUTRAL position and the PTO switch is in the OFF (disengaged) position.
- 3. After you start the engine, release the parking brake and keep foot off the traction pedal. Ensure that the machine does not move.

Note: If machine movement is evident, the traction pedal linkage is adjusted incorrectly; therefore, shut off the engine and adjust the traction pedal linkage until the machine does not move when you release the traction pedal; refer to the *Operator's Manual*.



Running the engine causes the engine, radiator, and exhaust system to become hot. Touching a hot engine, radiator, or exhaust system can burn you.

Do not touch the engine, radiator, or exhaust system while the engine is running or soon after you stop it.

Before stopping the machine

- 1. Ensure that the traction pedal is in the NEUTRAL position.
- 2. Lower and disengage the cutting decks and wait for all moving parts to stop.
- 3. Set the parking brake.
- 4. Shut off the engine and remove the key from the key switch.

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Maintenance and Service

- Before servicing or making any adjustments to the machine, lower the cutting decks, set the parking brake, shut off the engine, and remove the key from the key switch.
- Ensure that the machine is in safe operating condition by keeping all the nuts, bolts, and screws tight.
- Do not store the machine or a fuel container inside where there is an open flame, such as near a water heater or furnace.
- Ensure that all of the hydraulic line connectors are tight and that all the hydraulic hoses and lines are in good condition before applying pressure to the hydraulic system.
- Keep your body and hands away from pin-hole leaks in the hydraulic lines that eject hydraulic fluid under high pressure. Use cardboard or paper to find hydraulic leaks. The hydraulic fluid escaping under pressure can penetrate the skin and cause injury. If hydraulic fluid is accidentally injected into the skin, you must have it surgically removed within a few hours by a doctor familiar with this type of injury. Otherwise, gangrene may result.
- Before disconnecting or performing any work on the hydraulic system, release all the pressure in the system by parking the machine on a level surface, lowering the cutting deck (or implement) completely, and then shutting off the engine.
- Use care when checking or servicing the cutting deck. Wear gloves and use caution when servicing the deck.
- To reduce potential fire hazards, keep the engine area free of excessive grease, grass, leaves, and dirt. Clean the protective screen on the machine frequently.
- If you must run the engine to perform maintenance or to make an adjustment, keep your hands, feet, clothing, and other parts of the body away from the cutting decks and other moving parts. Keep bystanders away.
- Do not overspeed the engine by changing the engine governor setting. To ensure safety and accuracy, check the maximum engine speed with a tachometer.
- Shut off the engine before checking or adding oil to the engine crankcase.
- Disconnect the battery before servicing the machine. Disconnect the negative battery cable and then the positive cable. If battery voltage is necessary for troubleshooting or test procedures, temporarily connect the battery. Connect the positive battery cable and then the negative cable.
- Battery acid is poisonous and can cause burns. Avoid acid contact with skin, eyes, and clothing. Protect your face, eyes, and clothing when working with a battery.
- Battery gases can explode. Keep cigarettes, sparks, and flames away from the battery.
- When changing the attachments, tires, or performing other service, use correct blocks, hoists, and jacks to raise and support the machine. Ensure that the machine is parked on a solid level surface, such as a concrete floor. Before you lift the machine, remove all the attachments that may interfere with the safe and correct lift of the machine. Always block the wheels with chocks. Use appropriate jack stands to support the raised machine. Failing to properly support the machine with appropriate jack stands can cause the machine to move or fall and can result in personal injury; refer to Jacking Instructions (page 1–6).
- If major repairs are necessary, contact your Authorized Toro Distributor.
- When welding on the machine, disconnect all the battery cables to prevent damage to the machine electronic equipment. Disconnect the negative

Maintenance and Service (continued)

battery cable and then the positive cable. Disconnect the engine wire harness from the engine ECU. Also, disconnect the wire harness connector from the machine controller and disconnect the terminal connector from the alternator, attach the welder ground cable not more than 610 mm (2 ft) from the welding location.

 At the time of manufacture, the machine conformed to the safety standards for riding mowers. To ensure the optimum performance and continued safety certification of the machine, use genuine Toro replacement parts and accessories. The replacement parts and accessories of other manufacturers can result in non-conformance with the safety standards and can void the warranty.

Jacking Instructions

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CAUTION

Failing to properly support the machine with appropriate jack stands can cause the machine to move or fall and can result in personal injury.

When changing the attachments, tires, or performing other services, do the following steps:

- Use correct blocks, hoists, and jacks to raise and support the machine.
- Park the machine on a solid level surface, such as a concrete floor.
- Before you lift the machine, remove all the attachments that may interfere with the safe and correct lift of the machine.
- Always block the wheels with chocks.
- Use appropriate jack stands to support the raised machine.
- Do not use the cutting deck or implement as a jacking point.

Raising the Front of the Machine

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1.



- Front wheel 2. Front jacking point
- 1. Set the parking brake and block the 2 rear wheels with chocks to prevent the machine from moving.
- 2. Position the jack under the rectangular pad on the front axle tube, just to the inside of the front wheel (Figure 2).
- 3. Use a jack to raise the front of the machine.
- 4. Position jack stands under the frame as close to the wheel as possible to support the machine.

Raising the Rear of the Machine



- 1. Set the parking brake and block the 2 front wheels with chocks to prevent the machine from moving.
- 2. Position the jack securely at the center of the rear axle under the axle pivot bracket. Lift the rear of the machine off the ground.
- 3. Position the jack stands under the frame to support the machine (Figure 3).

Safety and Instructional Decals

2. Rear axle pivot bracket

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.

Chapter 2



Specifications and Maintenance

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Specifications

Insert a copy of the *Operator's Manuals* and *Parts Catalogs* for your machine at the end of this chapter. Additionally, if any optional equipment or accessories are installed to your machine, insert the *Installation Instructions*, *Operator's Manuals*, and *Parts Catalogs* for those options at the end of this chapter.

The maintenance procedures and recommended service intervals for your machine are covered in the *Operator's Manuals*. Refer to this publication when performing the regular equipment maintenance.

Fractions		Decimals	mm	Fractions		Decimals	mm		
		1/64	0.015625	0.397			33/64	0.515625	13.097
	1/32		0.03125	0.794		17/32		0.53125	13.494
		3/64	0.046875	1.191			35/64	0.546875	13.891
1/16			0.0625	1.588	9/16			0.5625	14.288
		5/64	0.078125	1.984			37/64	0.578125	14.684
	3/32		0.09375	2.381		19/32		0.59375	15.081
		7/64	0.109275	2.778			39/64	0.609375	15.478
1/8			0.1250	3.175	5/8			0.6250	15.875
		9/64	0.140625	3.572			41/64	0.640625	16.272
	5/32		0.15625	3.969		21/32		0.65625	16.669
		11/64	0.171875	4.366			43/64	0.671875	17.066
3/16			0.1875	4.762	11/16			0.6875	17.462
		13/64	0.203125	5.159			45/64	0.703125	17.859
	7/32		0.21875	5.556		23/32		0.71875	18.256
		15/64	0.234375	5.953			47/64	0.734375	18.653
1/4			0.2500	6.350	3/4			0.7500	19.050
		17/64	0.265625	6.747			49/64	0.765625	19.447
	9/32		0.28125	7.144		25/32		0.78125	19.844
		19/64	0.296875	7.541			51/64	0.796875	20.241
5/16			0.3125	7.938	13/16			0.8125	20.638
		21/64	0.328125	8.334			53/64	0.828125	21.034
	11/32		0.34375	8.731		27/32		0.84375	21.431
		23/64	0.359375	9.128			55/64	0.859375	21.828
3/8			0.3750	9.525	7/8			0.8750	22.225
		25/64	0.390625	9.922			57/64	0.890625	22.622
	13/32		0.40625	10.319		29/32		0.90625	23.019
		27/64	0.421875	10.716			59/64	0.921875	23.416
7/16			0.4375	11.112	15/16			0.9375	23.812
		29/64	0.453125	11.509			61/64	0.953125	24.209
	15/32		0.46875	11.906		31/32		0.96875	24.606
		31/64	0.484375	12.303			63/64	0.984375	25.003
1/2			0.5000	12.700	1			1.000	25.400
	1 mn	n = 0.03937	inch			0.001 i	inch = 0.02	54 mm	

Decimal and Millimeter Equivalents

U.S. to Metric Conversions

	To Convert	Into	Multiply By
Linear Measurement	Miles	Kilometers	1.609
	Yards	Meters	0.914
	Feet	Meters	0.305
	Feet	Centimeters	30.48
	Inches	Meters	0.025
	Inches	Centimeters	2.54
	Inches	Millimeters	25.4
Area	Square Miles	Square Kilometers	2.59
	Square Feet	Square Meters	0.093
	Square Inches	Square Centimeters	6.452
	Acre	Hectare	0.405
Volume	Cubic Yards	Cubic Meters	0.765
	Cubic Feet	Cubic Meters	0.028
	Cubic Inches	Cubic Centimeters	16.39
Weight	Tons (Short)	Metric Tons	0.908
	Pounds	Kilograms	0.454
	Ounces (Avdp.)	Grams	28.349
Pressure	Pounds/Sq. In.	Kilopascal	6.895
	Pounds/Sq. In.	Bar	0.069
Work	Foot-pounds	Newton-Meters	1.356
	Foot-pounds	Kilogram-Meters	0.138
	Inch-pounds	Kilogram-Centimeters	1.152
Liquid Volume	Quarts	Liters	0.946
	Gallons	Liters	3.785
Liquid Flow	Gallons/Minute	Liters/Minute	3.785
Temperature	Fahrenheit	Celsius	1. Subtract 32°
			2. Multiply by 5/9

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., Nylock nut), 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.

Identifying the Fastener



Calculating the Torque Values When Using a 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 6) to determine proper tightening torque. When using a torque wrench with a drive-adapter 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)**.

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 I Studs, and Regular H (SAE J995 Stronge	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	12 1 2	147 - 00	15 ± 2	169 ± 23	23 ± 3	262 ± 34	
# 6 - 40 UNF	10 ± 2	13 ± 2	147 ± 23	17 ± 2	192 ± 23	25 ± 3	282 ± 34	
# 8 - 32 UNC	12 + 2	05 I F		29 ± 3	328 ± 34	41± 5	463 ± 56	
# 8 - 36 UNF	13 ± 2	20 ± 5	202 ± 30	31 ± 4	350 ± 45	43 ± 5	486 ± 56	
# 10 - 24 UNC	10 + 0	20	220 - 50	42 ± 5	475 ± 56	60 ± 6	678 ± 68	
# 10 - 32 UNF	18 ± 2	30 ± 5	339 ± 56	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 \pm 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 Bolt Studs with Reg (Class 8 or S	s, Screws, and ular Height Nuts tronger Nuts)	Class 10.9 Bolt Studs with Regu (Class 10 or S	s, Screws, and ular Height Nuts 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 \pm 10% of the nominal torque value.

Other Torque Specifications

Throad Size	Recommended Torque					
Thread Size	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				

SAE Grade 8 Steel Set Screws

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	Recommend	ded 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		Becoline Terrus**
	Туре А	Туре В	Baseline Torque
No. 6	18	20	20 ± 5 in-lb
No. 8	15	18	30 ± 5 in-lb
No. 10	12	16	38 ± 7 in-lb
No. 12	11	14	85 ± 15 in-lb

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

Conversion Factors

in-lb X 11.2985 = N·cm

ft-lb X 1.3558 = N·m

 $N \cdot cm \ X \ 0.08851 = in-lb$ $N \cdot m \ X \ 0.7376 = ft-lb$

Shop Supplies

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

IMPORTANT

Always follow manufacturers instructions when using or storing shop supplies.

Anti-seize lubricant Used to prevent corrosion, galling, and seizure between metal parts. Most often applied to shafts and bores during assembly. Unless otherwise specified, high viscosity regular grade lithium-graphite based anti-seize lubricant should be used. Grease Can be used to pre-fill (pack) bearings, boots, and seals before assembly, ease installation of components during assembly, or fill cavities between moving parts through grease fittings after assembly. Unless otherwise noted, refer to the machine Operator's Manual or Installation Instructions for grease specifications. Thread locking compound (Threadlocker) 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 before fastener installation. Some thread locking compounds use a wicking feature, and can be applied after fastener installation. Most thread locking compounds allow the fastener to be removed with standard tools once cured. High strength thread locking compounds may require applying heat to the fastener and the surrounding area to allow fastener removal. Note: Some fasteners have a dry thread locking compound pre-applied (patch-loc) so no additional thread locking compound is necessary when installing a new fastener. These fasteners are designed to be removed and re-installed only once before applying additional thread locking compound is necessary. Retaining compound (bearings and sleeves) An adhesive used to secure bearings, bushings, and cylindrical parts into housings or onto shafts. When cured, bearing and sleeve retaining compound fills the gap between mating parts with a hard resin that increases load distribution and protects against corrosion. Adhesive Used to secure a variety of components immediately prior to assembly. May be recommended for installing new components or when reusing a component that had a pre-applied adhesive such as hood seals, mouldings, and weather-stripping. Thread sealant Used to seal threaded fittings and sensors from air, fuel, and oil pressure leaks and prevent galling and seizure between threaded parts. A thread sealant in paste firm is preferred over sealant tape. The sealant should remain semi-pliable to allow for component removal with standard tools. Some thread sealants may require the use of a cleaner or primer before use. Gasket compound Used to create a seal between mating parts. Gasket compounds may be used with or without the presence of a pre-formed gasket. Gasket compounds may be solvent or silicone based, and cure when exposed to air or designed to cure in an air-less environment (anaerobic). Most gasket compounds are designed to be applied to clean surfaces free of oil, chemical residue and previously used gaskets or gasket compounds. Silicone sealant Designed for a broad variety of sealing and bonding requirements, silicone sealants are usually room temperature vulcanizing (RTV) which form a flexible silicone rubber that bonds to a wide variety of smooth or porous materials when cured. Standard silicone sealants are designed to perform in temperatures from -51°F to 232°C (-60°F to 400°F), while high temperature variants can preform in temperatures up to 343°C (650°F).

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

High Flow Hydraulic Filter Kit

Toro Part Number: TOR6011

The high flow hydraulic filter kit is designed with large flow (150 L/minute or 40 gallons/minute) and high pressure (34,500 kPa or 5,000 psi) capabilities. This kit provides for bi-directional 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 2–12).



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

Remote Starter Switch

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

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

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

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





Remote Starter Switch (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.





Diesel Engine

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Additional Reference Materials

<u>Yanmar TNV (Tier 4) Series Service Manual</u> Yanmar TNV (Tier 4) Series Troubleshooting Manual

Specifications

Engine

Item	Description
Make/Designation	Yanmar 3TNV86CT: 4-cycle, 3 cylinder common-rail water cooled diesel with EGR, turbocharged, and diesel-particulate filter (DPF). EPA Tier 4 Final compliant.
Bore	86 mm (3.38 inches)
Stroke	90 mm (3.54 inches)
Total displacement	1568 cm ³ (95.68 in ³)
Firing order	1 (closest to the flywheel end) - 3 - 2
Direction of rotation	Counterclockwise (viewed from the flywheel)
Fuel	Diesel or Biodiesel fuel (up to B20) with ultra-low sulfur content
Fuel tank capacity	51.1 L (13.5 US gallons)
Fuel injection pump	CR supply pump
Fuel injection type	Common rail system (EPA Tier 4 certified)
Governor	Electronic
Low idle (no load)	1,175 to 1,225 rpm
High idle (no load)	3,005 to 3,055 rpm
Engine oil	API CJ-4, ACEA E-6, JASO DH-2
Engine-oil viscosity	Refer to the Operator's Manual
Crankcase-oil capacity	4.7 L (4.9 US qt)
Oil pump	Yanmar trochoid pump
Coolant capacity	5.2 L (5.5 US qt)
Alternator/Regulator	12 VDC, 55 A
Engine weight (dry)	200 kg (441 lb)

General Information

This chapter gives information about specifications and repair of the Yanmar diesel engine used in the Groundsmaster 4300-D machine. The general maintenance procedures are described in the *Operator's Manual*. Detailed information on engine troubleshooting, testing, disassembly, and assembly is identified in the Yanmar Engine Service Manual and Troubleshooting Manual.

Additionally, some engine repair procedures are described in this manual. The described adjustments and repairs require tools which are commonly available in many service shops. Special tools are described in the Yanmar Engine 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 the Yanmar engines are supplied through your Authorized Toro Distributor. If the parts list is not available, provide your distributor with the Toro Model and Serial Number of your machine.

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.

Yanmar Engine Service and Troubleshooting Manuals

The engine that powers your Groundsmaster machine is a Yanmar Model 3TNV86CT (used on Groundsmaster 4300-D Model 30864), a Tier 4F compliant engine. The Yanmar Engine Service Manual and Troubleshooting Manual are available for these engines. Ensure that the correct engine manuals are used when servicing the engine on your machine.

Engine Electronic Control Unit (ECU)



The Yanmar engine used in the Groundsmaster 4300-D machine uses an electronic control unit (ECU) for engine management and to communicate with operator InfoCenter on the machine. The engine ECU is located at the right side of the machine near the diesel-particulate filter (DPF) (Figure 7).

Engine Electronic Control Unit (ECU) (continued)

IMPORTANT

Do not plug or unplug the engine ECU for 30 seconds after the machine key switch is turned off. The engine ECU may remain energized even though the key switch is in the OFF position.

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

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

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



The engine used on your Groundsmaster 4300-D machine is a Yanmar TNV Series, turbocharged, diesel engine that complies with EPA Tier 4F emission regulations. The 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), an exhaust diesel-particulate filter (DPF) with active regeneration, and a turbocharger to pressurize the air which flows into the engine (the turbocharger is driven by a turbine that is energized by exhaust gases). Glow plugs are used to assist starting the engine. Numerous engine sensors are used to allow the engine ECU to monitor and control the engine operation for optimum engine performance.

The engine ECU, combined with numerous engine sensors, monitor and control the engine operation for optimum 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 Starting Problems (page 5–34), the Yanmar Troubleshooting Manual, or contact an Authorized Toro Distributor for assistance.

Diesel Particulate Filter (DPF)

a188100

The diesel particulate filter (DPF) used on Yanmar Tier 4F 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 increase in pressure will signal the engine to begin a process called Regeneration. Regeneration increases the exhaust temperature and the length of time the engine operates at a higher than normal exhaust temperature, incinerating the

Regeneration (continued)

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 120-6375J. Use the InfoCenter About screen to verify the software installed on the machine.

- For machines with software 120-6375A thru I: 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.
- For machines with software 120-6375J and up: Complete DPF regeneration instructions can be found in the traction unit *Operator's Manual*. 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)

Туре	Conditions	Description
Passive	Occurs during normal operation of the machine at high engine speed or high engine load	The DPF processes high heat exhaust gasses, oxidizing harmful emissions and incinerating soot to ash.
		The InfoCenter does not display an icon during passive regeneration.
Assist	Occurs because of prolonged operation at low engine speed, low engine load, or when the engine ECU detects the soot filter is becoming obstructed.	The engine ECU adjusts the exhaust intake throttle to raise the exhaust temperature. For software 120-6375A thru I only: the InfoCenter displays the assist regeneration icon.
Reset	Occurs every 100 hours of engine operation Occurs after an assist regeneration if the engine ECU determines the assist regeneration did not sufficiently reduce the soot level Note: Reset regeneration may be temporarily delayed if high exhaust temperatures would create an unsafe condition (the machine is operating indoors or outdoors around trees, brush, tall grass, or other temperature-sensitive plants or materials). Refer to Setting the Inhibit Regen in the traction unit <i>Operators Manual</i> for additional information.	The engine ECU adjusts the exhaust intake throttle and the injector timing to raise the exhaust temperature. For all software revisions: the InfoCenter displays the high exhaust temperature icon.

Regeneration (continued)

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

Туре	Conditions	Description
Parked	Occurs when exhaust back pressure in the DPF increases due to continued soot buildup. May be caused by prolonged operation at low engine speed, low engine load, or the use of incorrect fuel or engine oil.	Manually initiate a parked regeneration as soon as possible. A parked regeneration will take approximately 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.
	May occur if the InfoCenter is set to inhibit regen (preventing a Reset Regeneration) and machine operation is continued. Can be initiated when prompted by the operation ECU or after a minimum of 50	For all software revisions: the InfoCenter displays advisory #188 and/or the stationary regeneration icon
	hours of engine operation.	
	For software 120-6375J and up: if a parked regeneration is ignored, the machine mow function (PTO) will be disabled approximately 2 hours after the first notification.	
Recovery	Occurs when exhaust back pressure in the DPF increases due to soot buildup reaching a critical level.	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
	Can only be initiated when prompted by the engine ECU.	stationary (cannot be operated) during the entire recovery regeneration process.
	For software 120-6375J and up: the machine mow function (PTO) will be disabled at first notification.	 Use the InfoCenter About screen to verify the software installed on the machine. Machines with software 120-6375A thru I: Recovery regeneration must be initiated by an Authorized Toro Distributor service technician using Yanmar SMARTASSIST-Direct
		 Machines with software 120-6375J and up: Recovery regeneration can be initiated from the machine InfoCenter
		For software 120-6375A thru I only: the InfoCenter displays the recovery regeneration icon.
		For software 120-6375J and up: the InfoCenter displays advisory #190 and/or the stationary regeneration icon.
		Note: Verify the model and serial number of the engine installed in the machine. 3TNV86CT-DTR engines below serial number 00391 cannot run a recovery regeneration without first reprogramming the engine ECU. Contact an Authorized Toro Distributor for assistance.

Soot Accumulation

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

Soot Accumulation Engine Faults

Fault Level	Fault Code	Engine Power Rating	Recommended Action
Level 1: Engine Warning	ADVISORY #179	De-rated to 85%	Perform a parked regeneration as soon as possible.
Level 2: Engine Warning	Check Engine SPN: 3251 FMI: 0 Occ: 1 See Service Manual	De-rated to 50%	Perform a recovery regeneration as soon as possible

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.

Ash Accumulation Advisories and Engine Faults

Fault Level	Fault Code	Engine Power Rating	Engine Speed Reduction	Recommended Action
System Advisory (machine software 120-6375A thru I only)	ADVISORY #179	100%	None	Plan to service the DPF in the near future
Level 1: Engine Warning	Check Engine SPN: 3251 FMI: 0 Occ: 1 See Service Manual	De-rated to 85%	None	Service the DPF; refer to Exhaust System (page 3–13)
Level 2: Engine Warning	Check Engine SPN: 3251 FMI: 0 Occ: 1 See Service Manual	De-rated to 50%	None	Service the DPF; refer to Exhaust System (page 3–13)
Level 3: Engine Warning	Check Engine SPN: 3251 FMI: 0 Occ: 1 See Service Manual	De-rated to 50%	Maximum torque + 200 rpm	Service the DPF; refer to Exhaust System (page 3–13)

IMPORTANT

The engine used on the Groundsmaster 4300-D machine is turbo-charged. Before shutting off the engine after mowing or full-load operation, allow the engine to run at low-idle speed for 5 minutes. This allows the turbocharger and internal engine components to adequately cool-down. Failure to allow this cool-down period may lead to premature turbocharger and engine failure.

Service and Repairs

Air Cleaner System



4. Hose clamp

g188092

1.

2.

3.

- Air cleaner assembly 5.
- Flange nut (4 each) 6.
- 10. Bolt (2 each)
- Yanmar engine 11.
- 12. Nut

- 16. Adapter
- 17. Service indicator
- 18. Air cleaner inlet hose

Removing the Air Cleaner System

Note: Refer to the *Operator's Manual* for maintenance procedures and intervals of the air cleaner.

- 1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
- 2. Unlatch the hood and raise it.
- 3. Remove the air cleaner components as shown in Figure 9.
- 4. Examine the air cleaner assembly (item 5 in Figure 9) for wear or damage that could cause possible air leaks.
- 5. Examine the air hoses for wear or damage and replace the hoses if necessary.
- 6. Examine the hood seals for wear or damage and replace the seals if necessary.

Installing the Air Cleaner System



IMPORTANT

Leaks in the air filter system will allow dirt to enter into the engine and can cause serious engine damage. Ensure that all the air cleaner components are in good condition and are properly secured during installation.

Installing the Air Cleaner System (continued)

1. Assemble the air cleaner system as shown in Figure 9.



- A. If the service indicator and adapter were removed from the air cleaner assembly, apply thread sealant to the threads of the adapter before installing the adapter and service indicator to the housing (Figure 10). Install the adapter so that the grooves in the adapter hex and adapter filter element are installed toward service indicator. Torque the service indicator to **1.4 to 1.6 N·m (12 to 15 in-lb)**.
 - B. Ensure that the vacuator valve (item 2 in Figure 10) is pointed down after installation.
 - C. Torque the hose clamps to the values identified in Figure 9.
- 2. Lower the hood and secure it with the latches.

Exhaust System



- 3. Exhaust tube
- 4. Muffler clamp

- 7. Jam nut (2 each)
- 8. Exhaust clamp

- 11. Tailpipe bracket
- 12. Diesel-particulate filter assembly (DPF includes DOC)

The engine that powers your Groundsmaster 4300-D machine is a Yanmar diesel engine model 3TNV86CT that complies with EPA Tier 4F emission regulations. The engine is 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 regular intervals; refer to the *Operator's Manual*. Additionally, the exhaust assembly uses 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; refer to Yanmar Engine (page 3–5). The InfoCenter display will identify the status of DPF regeneration. At recommended intervals, DPF reconditioning is necessary which will require exhaust system disassembly. DPF reconditioning should be done 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.

Information about the diesel-particulate filter (DPF) operation and maintenance can be found in the Yanmar Engine Service Manual and Troubleshooting Manual.

Removing the Exhaust System

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CAUTION

A hot engine and exhaust system can cause burns.

Allow the engine and the exhaust system to cool before working on or near them.

- 1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
- 2. Unlatch the hood and raise it.
- 3. Remove the exhaust tube as shown in Figure 11.

Note: The exhaust system DPF and DOC can be removed from the exhaust system without removing the entire exhaust system from the engine. Refer to the Yanmar Engine Service Manual for complete disassembly and assembly procedures.

Installing the Exhaust System

- 1. Install the exhaust tube as follows:
 - A. Install all the fasteners finger tight.
 - B. Tighten the flange nuts (item 5 in Figure 11).
 - C. Tighten the exhaust clamp (item 8 in Figure 11).
 - D. Tighten the muffler clamp (item 4 in Figure 11).
- 2. Lower the hood and secure it with the latches.

A

Radiator



8. Flange-head screw

(5 each) Flange nut (10 each) 9. 18.

17.

Shroud cap

Fan shroud

27. Coolant reservoir assembly

Reservoir hose

34. Foam seal (2 each) 35. Foam seal

Note: The radiator on your Groundsmaster is combined with the hydraulic oil cooler.

26.

Removing the Radiator

- 1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
- 2. Remove the screen (item 1 in Figure 12) from the machine.
- 3. Unlatch the hood and raise it.

A

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If the radiator or engine is hot, pressurized hot coolant can escape and cause burns.

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

WARNING

A

Ethylene-glycol antifreeze is poisonous.

Keep the coolant away from children and pets.

Keep the coolant in a labelled container.

Discard the coolant in accordance with local hazardous waste ordinances.

- 4. Drain the coolant from the radiator as follows:
 - A. Place a drain pan below the radiator draincock located at the bottom of the radiator. Ensure that the drain pan is large enough to hold the cooling system contents (5.2 L (5.5 US qt)).
 - B. Loosen the radiator draincock (turn clockwise) and allow the coolant to drain from radiator.
- 5. Remove the air cleaner inlet hose from the top of the radiator frame; refer to Air Cleaner System (page 3–10).
- Disconnect the upper and lower radiator hoses (items 21 and 20 in Figure 12) from the radiator.
- 7. Loosen the hose clamp and remove the reservoir hose (item 26 in Figure 12) from the radiator fill opening.



- 8. Read the General Precautions for Removing and Installing the Hydraulic System Components (page 4–87).
- 9. Clean the hydraulic tube ends and oil cooler fittings to prevent hydraulic system contamination.
- 10. Disconnect the hydraulic tubes from the straight hydraulic fittings (Figure 13).
- 11. Cover or plug the hydraulic tubes to prevent contamination.
- 12. Remove the 2 button-head screws (item 29 in Figure 12) and 2 flange nuts that secure the coolant reservoir and reservoir bracket to the fan shroud. Carefully position the coolant reservoir and reservoir bracket away from the fan shroud.
- 13. On the left side of the machine, remove the 2 button-head screws (item 29 in Figure 12) and 2 flange nuts that secure the fan shroud to the radiator frame.
- 14. Remove the 14 flange-head screws (item 6 in Figure 12) that secure the fan shroud to the radiator, and radiator to the radiator frame. Position the fan shroud away from the radiator.
- 15. Carefully remove the radiator and oil cooler assembly from the machine.
- 16. If necessary, remove the 2 straight hydraulic fittings from the oil cooler and discard the O-rings.
- 17. Cover or plug the openings in oil cooler and disconnected coolant and hydraulic tubes to prevent contamination from entering the system.
- 18. Inspect all foam seals on the radiator, fan shroud, and radiator frame. Replace any foam seals that are damaged.

Installing the Radiator

- 1. If the 2 straight hydraulic fittings (Item 2 in Figure 13) were removed from the oil cooler, lubricate and install new O-rings onto the fittings. Install the fittings into the port openings and tighten the fittings; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 4–11).
- 2. Carefully position the radiator and oil cooler assembly to the radiator frame. Position the fan shroud to the radiator.
- 3. Secure the radiator to the radiator frame with the 7 flange-head screws previously removed. Position the fan shroud to the radiator with the 7 fasteners previously removed. Ensure that at least **6.4 mm (0.250 inch)** clearance exists at all points between the fan shroud and the fan.
- 4. Position the coolant reservoir and reservoir bracket to the fan shroud. Secure the reservoir bracket to the fan shroud and radiator frame with the 2 button-head screws (item 29 in Figure 12) and 2 flange nuts.
- 5. On the left side of the machine, secure the fan shroud to the radiator frame with the 2 button-head screws (item 29 in Figure 12) and 2 flange nuts.
- 6. Remove the covers and plugs from the openings in the radiator and the oil cooler and the disconnected coolant and hydraulic tubes that were installed during removal.
- 7. Connect the hydraulic tubes to the straight hydraulic fittings (Figure 13).



- Connect the upper and lower radiator hoses to the radiator and secure the hoses with the hose clamps. Torque the hose clamps to 3.4 to 4.5 N·m (30 to 40 in-lb).
- 9. Connect the reservoir hose (item 26 in Figure 12) to the radiator fill opening and secure the reservoir hose with the hose clamp.
- 10. Install and secure the air cleaner inlet hose; refer to Air Cleaner System (page 3–10).
- 11. Ensure that the radiator draincock is closed.
- 12. To allow air to escape during radiator filling, remove the pipe plug (item 31 in Figure 12) from the top of the radiator. Fill the reservoir with coolant.

Note: Ensure that the coolant level in the coolant reservoir is correct.

13. Apply thread sealant to the threads of the pipe plug.

Note: Ensure to install the plug once all air is bled from the radiator.

- 14. Install the pipe plug into the radiator opening.
- 15. Add hydraulic fluid to the hydraulic reservoir as necessary to raise the hydraulic-fluid level to the operating range; refer to the Operator's Manual.
- 16. Start the engine and check for coolant and hydraulic fluid leaks. Repair any leaks as required before returning the machine to service.
- 17. Continue to run the engine to obtain the operating temperature. Check the coolant and hydraulic fluid levels and adjust as necessary.
- 18. Lower the hood and secure it with the latches.
- 19. Install and latch the screen (item 1 in Figure 12).

Fuel System



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Figure 1	4
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1.	Hose clamp (2 each)	9.	Fuel tank cap	17.	Fuel supply hose	25.	Fuel sender cap
2.	Fuel return hose	10.	Fuel tank	18.	Recess bumper	26.	Fuel/water separator
3.	Hose clamp (6 each)	11.	Washer-head screw (2 each)	19.	Flat washer	27.	90° elbow fitting (2 each)
4.	Fuel supply hose	12.	Clamp (2 each)	20.	Bolt	28.	Flange-head screw (3 each)
5.	Flange-head screw (2 each)	13.	Draincock	21.	Sender cover	29.	Carriage screw (2 each)
6.	Fuel pump	14.	Hose clamp	22.	Cable strap	30.	Separator bracket
7.	Fuel supply hose	15.	Screw (7 each)	23.	Fuel sender gasket	31.	Fuel/water separator head
8.	Locknut (2 each)	16.	Flange nut (5 each)	24.	Fuel sender		

DANGER

Diesel fuel is highly flammable and explosive. A fire or an explosion from the fuel can burn you, burn other people, and damage property.

- Use caution whenever you store or handle diesel fuel.
- Do not smoke while filling the fuel tank.
- Do not fill the fuel tank while the engine is running, while the engine is hot, or when the machine is in an enclosed area.
- Always fill the fuel tank outside and wipe up any spilled diesel fuel before starting the engine.
- Store fuel in a clean, safety-approved container and keep the cap in place.
- Use diesel fuel as an engine fuel only, not for any other purpose.

Checking the Fuel Lines and Connections

A

Check the fuel lines and connections at the scheduled maintenance intervals recommended in the *Operator's Manual*. Check the lines for deterioration, damage, leaks, or loose connections. Replace the hoses, clamps, and fittings as necessary.

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 fuel/water separator, replacing the fuel filter or a fuel hose). To prime the fuel system, ensure that the fuel tank has fuel in it. Then, turn the key switch to the RUN position for 10 to 15 seconds, which allows the fuel pump to prime the fuel system. Do not turn the key switch to the START position to prime the fuel system.

Removing the Fuel Tank

- 1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
- 2. Unlatch the hood and raise it.
- 3. Remove the negative battery cable from the negative post of the battery.
- 4. Allow the engine to completely cool.
- 5. Place a drain pan under the fuel tank. Ensure that the drain pan is large enough to hold the fuel tank contents (refer to Specifications (page 3–2)).
- 6. Open the draincock at the bottom of the fuel tank and allow the tank to fully drain. Close the draincock.
- 7. Disconnect the wire harness connection from the fuel sender (item 24 in Figure 14).

Note: Before removing the fuel hoses from the tank fittings, label the hoses for assembly purposes.

IMPORTANT

To prevent damage to the fuel hoses, numerous cable ties are used to secure the hoses to the machine components. Record the location of all cable ties that are removed from the machine during the fuel tank removal so that they can be properly replaced during the tank installation.

- 8. Loosen the hose clamps and carefully disconnect the fuel supply and return (items 17 and 2 in Figure 14) hoses from the fittings on the top of the fuel sender.
- 9. Cover or plug the fuel hoses or fitting openings to prevent contamination from entering the fuel system.
- 10. Remove the fuel tank as shown in Figure 14.

IMPORTANT

If the fuel sender is removed from the fuel tank, note the orientation of the fittings for assembly purposes (Figure 15).

Installing the Fuel Tank

1. Install the fuel tank to the frame (Figure 14). Secure the fuel hoses with the cable ties as recorded during the fuel tank removal.





1.

2.

- If the fuel sender was removed from the fuel tank, ensure that the fuel fittings on the sender are orientated at 90° from right side of the tank as shown in Figure 15. Torque the fuel sender cap to 20 to 22 N·m (175 to 200 in-lb) and ensure that the fuel sender does not turn as the sender cap is tightened.
- 3. Connect the fuel supply and return (items 17 and 2 in Figure 14) hoses to the fittings on the top of the fuel sender. Secure the fuel hoses with the hose clamps.
- 4. Secure the wire harness connector to the fuel sender.
- 5. Connect the negative battery cable to the negative battery post.
- 6. Ensure that the fuel tank draincock is closed. Fill the fuel tank with clean fuel.
- 7. Prime the fuel system; refer to Priming the Fuel System (page 3-20).
- 8. Check the fuel hoses and fittings for leaks.

Note: Repair all fuel leaks before returning the machine to service.

9. Lower the hood and secure it with the latches.

Engine



- 1. Bolt (14 each)
- 2. Lock washer (14 each)
- 3. Bolt (4 each)
- 4. Right rear engine mount
- 5. Left rear engine mount
- 6. Left front engine mount

- Figure 16
- Spacer (4 each) 7.
- 8. Snubbing washer (4 each)
- 9. Flange nut (10 each)
- 10. Yanmar engine
- 11. Driveshaft assembly
- 12. Bolt (6 each)

- 13. Bolt (2 each)
- 14. Flange nut (10 each)
- 15. Flange-head screw (8 each)
- Right front engine mount 16.
- 17. Lift tab

Removing the Engine

- 1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
- 2. Unlatch the hood and raise it.

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3. Disconnect both the battery cables at the battery. Disconnect the negative battery cable and then the positive battery cable; refer to Servicing the Battery (page 5–95).



If the radiator or engine is hot, pressurized hot coolant can escape and cause burns.

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

WARNING

Ethylene-glycol antifreeze is poisonous.

Keep the coolant away from children and pets.

Keep the coolant in a labelled container.

Discard the coolant in accordance with local hazardous waste ordinances.



- 4. Drain the coolant from the radiator; refer to Removing the Radiator (page 3–16).
- 5. Remove the air cleaner assembly from the machine; refer to Removing the Air Cleaner System (page 3–11).
- 6. Remove the exhaust system from the machine; refer to Removing the Exhaust System (page 3–14).
- 7. Disconnect the hoses from the engine:
 - A. Loosen the hose clamps and remove the upper and lower radiator hoses from the engine.

A

Removing the Engine (continued)

- B. For assembly purposes, label the fuel hoses. Disconnect the fuel supply and return hoses from the fuel filter on the engine (Figure 17).
- C. Cover or plug the fuel hoses and fuel filter fittings openings to prevent contamination. Position the disconnected hoses away from the engine.
- 8. Remove the hydraulic pump driveshaft; refer to Hydraulic Pump Driveshaft (page 4–98).



IMPORTANT

To prevent damage to the electrical wire harness, numerous cable ties are used to secure the wire harness to the machine components. Record the location of all cable ties that are removed from the machine during the engine removal so that they can be properly replaced during the engine installation.

- 9. For assembly purposes, note the location of the cable ties used to secure the wire harness to the machine. Disconnect the wires and/or electrical connections from the following engine electrical components:
 - A. The 2 engine wire harness connectors from the machine wire harness.
 - B. The positive battery cable from the engine starter motor.
 - C. The engine wire harness power cable from the battery clamp. Also, remove the harness power cable from the cord grip in frame so that the cable can be removed with the engine.
 - D. The negative battery cable, engine wire harness ground cable and frame to engine ground cable at the engine block (Figure 18).
 - E. The engine wire harness connectors from the main power, glow, start, and EGR relays (Figure 20).
 - F. The engine wire harness connector from the fuel pump.
 - G. The 2 engine wire harness connectors from the engine ECU.

CAUTION

The engine is very heavy, and a hoist not rated for the weight of the engine may fail, causing possible injury and damage to the engine.

Use hoist equipment rated to lift the engine, which is approximately 200 kg (441 lb).

- 10. Attach a suitable lift or hoist to the lift tabs on the front and rear of the engine (Figure 16). Support the engine with lift or hoist to prevent the engine from shifting or moving.
- 11. Remove the flange nuts (item 9 in Figure 16), snubbing washers, spacers, and bolts that secure the engine mount brackets to the engine mounts.

A

CAUTION

A

A

Use 1 person to operate the lift or hoist while the other person guides the engine from the machine.

IMPORTANT

When removing the engine ensure that you do not damage the engine, fuel hoses, hydraulic lines, electrical harness or other parts.

Removing the Engine (continued)

- 12. Carefully raise the engine from the machine moving it toward the front of the machine and away from the radiator assembly.
- 13. If necessary, remove the engine mount brackets from the engine.

Installing the Engine

IMPORTANT

Ensure that all parts are removed from the engine during maintenance or overhaul are correctly installed on the engine.



 If the engine mount brackets were removed from the engine, secure the brackets to the engine with the lock washers and bolts. Torque the bolts to 46 to 57 N·m (34 to 42 ft-lb).

CAUTION

A

The engine is very heavy, and a hoist not rated for the weight of the engine may fail, causing possible injury and damage to the engine.

Use hoist equipment rated to lift the engine, which is approximately 200 kg (441 lb).

2. Attach a suitable lift or hoist to the lift tabs on the front and rear of the engine. Support the engine with lift or hoist to prevent the engine from shifting or moving.

A

CAUTION

A

Use 1 person to operate the lift or hoist while the other person guides the engine into the machine.

IMPORTANT

When installing the engine ensure that you do not damage the engine, fuel hoses, hydraulic lines, electrical harness, radiator or other parts.

- 3. Carefully lower the engine into the machine. Ensure that the fastener holes of the engine mount brackets aligned with the holes in the engine mounts.
- 4. Insert the bolt down through each engine mount bracket and engine mount. Install the spacer, snubbing washer, and flange nut on the 4 bolts. Tighten the fasteners to secure the engine to the engine mounts.
- 5. Install the hydraulic pump driveshaft; refer to Hydraulic Pump Driveshaft (page 4–98).
- 6. Connect the wire harness connectors to the following engine components:
 - A. The 2 engine wire harness connectors to the machine wire harness.
 - B. The positive battery cable to the engine starter motor.

Installing the Engine (continued)

- C. The engine wire harness power cable to the battery clamp through the cord grip and tighten the cord grip.
- D. The negative battery cable, engine wire harness ground cable and frame to engine ground cable at the engine block (Figure 18).



- E. Torque the engine ground bolt to **46 to 57 N·m (34 to 42 ft-lb)** and apply a coat of terminal protector.
- F. Torque the frame ground bolt to **19.7 to 25.4** N·m (**175 to 225 in-lb**) and apply a coat of terminal protector.

Note: Make sure that the engine and frame ground surfaces are free from corrosion, oil and paint.



- 1. Hydraulic pump driveshaft
- Glow relay
 Main power relay

3. Start relay

EGR relay

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- •
- G. The engine wire harness connectors to the main power, glow, start, and EGR relays (Figure 20).
- H. The engine wire harness connector to the fuel pump.
- I. The 2 engine wire harness connectors from the engine ECU.
- 7. Use the notes that you recorded during removal, secure the wires with cable ties in proper locations.
- 8. Remove all of the covers and plugs from the hoses and engine openings that you placed while removing the engine. Connect the hoses to the engine:
 - A. Use the labels that you attached during removal to correctly connect the fuel supply and return hoses to the fuel filter on the engine (Figure 17). Secure the fuel hoses with the hose clamps.
 - B. Connect the upper and lower radiator hoses to the engine. Secure the radiator hoses with the hose clamps.
- 9. Install the air cleaner assembly; refer to Installing the Air Cleaner System (page 3–11).

Installing the Engine (continued)

- 10. Install the exhaust system to the machine; refer to Installing the Exhaust System (page 3–14). Ensure that the exhaust tube has 9.5 mm (0.375 inch) clearance with tailpipe guard in all directions after assembly.
- 11. Ensure that the radiator draincock is closed and fill the radiator and reservoir with coolant.
- 12. Connect both the battery cables to the battery. First, connect the positive battery cable and then the negative battery cable; refer to Servicing the Battery (page 5–95).
- 13. Ensure that all the wires, fuel lines, hydraulic hoses, and cables are clear of moving parts and secured to their original locations.
- 14. Check the engine-oil level and adjust as necessary.
- 15. Check the hydraulic-fluid level in the hydraulic reservoir and add correct quantity of fluid if necessary; refer to the *Operator's Manual*.
- 16. Prime the fuel system; refer to Priming the Fuel System (page 3-20).
- 17. Start the engine and operate the hydraulic controls to properly fill the hydraulic and engine coolant systems; refer to Charging the Hydraulic System (page 4–94) and refer to proper coolant fill procedure.
- 18. Lower the hood and secure it with the latches.



Hydraulic System

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Additional Reference Materials

Danfoss LPV Pump Repair Manual Danfoss LPV Pump Service Manual Eaton Delta Motors Parts and Repair Manual Parker Torqmotor Service Procedure (TC, TB, TE, TJ, TF, TG, TH, and TL Series) Danfoss OSPM Steering Unit Service Manual

Specifications

Hydraulic System

Item	Description
Piston (traction) pump	Sauer-Danfoss, LPV closed circuit axial
Maximum pump displacement (per	piston design
	Casanna 4 spetion, positive displacement
	gear type pump
Section P1 displacement (per revolution)	16.84 cm³ (1.03 in³)
Section P2 displacement (per revolution)	16.84 cm³ (1.03 in³)
Section P3 displacement (per revolution)	6.1 cm³ (0.37 in³)
Section P4 displacement (per revolution)	$3.9 \text{ cm}^3 (0.24 \text{ in}^3)$
Charge circuit relief (R5) pressure	1,400 kPa (200 psi)
Traction circuit relief pressure	
Forward (R3)	25,000 kPa (3,625 psi)
Reverse (R4)	25,000 kPa (3,625 psi)
Bi-directional relief valve pressure	2,758 kPa (400 psi)
Front wheel motors	Eaton hydraulic
Displacement (per revolution)	395 cm³ (24.1 in³)
Rear wheel motors	Parker Hannifin
Displacement (per revolution)	310 cm³ (18.9 in³)
Mow circuit relief pressure	
Rear mow circuit (PRV1 at 1.2 A)	17,500 kPa (2,500 psi)
Front mow circuit (PRV2 at 0.8 A)	24,100 kPa (3,500 psi)
Cutting deck motor	Casappa gear motor
Displacement (per revolution)	17.16 cm³ (1.05 in³)
Cross over relief valve pressure	12,500 kPa (1,813 psi)
Steering valve	Sauer-Danfoss steering unit, type OSPMS
Displacement (per revolution)	100 cm³ (6.1 in³)
Steering circuit relief (R10) pressure	6,900 kPa (1,000 psi)
Lift circuit relief (PRV at 0.87 A) pressure	13,800 kPa (2,000 psi)
R12 and R13 relief pressure	2,760 kPa (400 psi)
Hydraulic filter (charge and steering circuits)	Spin-on cartridge type with 340 kPa (50 psi) relief in adapter
Hydraulic filter (mow and lift circuits)	Spin-on cartridge type with 340 kPa (50 psi) relief in adapter (filter adapter includes filter change indicator)
Hydraulic fluid	Refer to the Operator's Manual
Hydraulic reservoir capacity	45 L (12 US gallons)

General Information

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

Checking the Hydraulic Fluid



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Figure 21

1. Hydraulic reservoir cap



The hydraulic system on your machine is designed to operate on anti-wear hydraulic fluid. The reservoir holds approximately 45 L (12 US gallons) of hydraulic fluid (Figure 21). Refer to the *Operator's Manual* for the procedure on checking the hydraulic-fluid level and hydraulic fluid recommendations.

Checking the Hydraulic Fluid (continued)

IMPORTANT

Check the hydraulic-fluid level daily.

Pushing or Towing the Traction Unit

In case of emergency, the machine can be pushed for a very short distance. However, Toro does not recommend this as a standard procedure.

- 1. Ensure that the engine is not running.
- 2. Find the bypass valve on the piston (traction) pump (Figure 22). Loosen the valve (rotate them counterclockwise) 1 to 2 turns.

IMPORTANT

Pushing the machine faster than 2 to 3 mph can damage the drive system. If you must move the machine a considerable distance (more than a few feet), transport it on a truck or trailer.

3. Slowly push or tow the machine.

IMPORTANT

Do not start the engine when the bypass valve is open or piston (traction) pump damage will occur.



4. Before you start the engine, tighten the valve to close it; torque the valves to **7 to 9 N·m (62 to 79 in-lb)**.

Releasing Pressure from the Hydraulic System

Release all the pressure in the hydraulic system before you work on the hydraulic system.

System pressure in the cutting circuit is released when the cutting decks are disengaged.

Releasing the Hydraulic Pressure from the Traction Circuit

Note: If you park the machine on an incline or slope, the pressure in the traction circuit does not release.

- 1. Park the machine on a level surface.
- 2. Lower the cutting decks.
- 3. Turn the key switch to the OFF position and allow the engine to stop.
- 4. Move the traction pedal in both the forward and reverse direction.

Releasing the Hydraulic Pressure from the Lift Circuit

- 1. Turn the key switch to the ON (do not start the engine) and fully lower the cutting decks to the ground.
- 2. Turn the key switch to the OFF position and allow the engine to stop.
- 3. After lowering the cutting decks, ensure that the lift cylinder does not support the cutting decks.

Releasing the Hydraulic Pressure from the Steering Circuit

- 1. Park the machine on a level surface.
- 2. Lower the cutting decks.
- 3. Turn the key switch to the OFF position and allow the engine to stop.
- 4. After the engine has come to a complete stop, rotate the steering wheel in both directions.

Traction Circuit Component Failure

The traction circuit of the Groundsmaster 4300-D machines is a closed loop system that includes the piston (traction) pump and 4 wheel motors. If a component failure occurs in the traction circuit (e.g., traction (piston) pump or wheel motor), unwanted material and contamination from the damaged component will circulate throughout the traction circuit. This contamination can damage other components in the circuit, so remove the contamination to prevent additional component failure.

The recommended method to remove contamination from the traction circuit is to temporarily install a Toro high flow hydraulic-fluid filter into the circuit; refer to Special Tools (page 4–31). Use a high flow hydraulic-fluid filter when you connect hydraulic test gauges in order to test the traction circuit components or after you replace a failed traction circuit component (e.g., traction (piston) pump or wheel motor). Using a high flow hydraulic-fluid filter will remove contaminates from the hydraulic fluid in the traction circuit, thereby preventing additional component damage.

After you have installed the Toro high flow hydraulic-fluid filter in the traction circuit, raise and support the machine with all the drive wheels off the ground. Then, operate the traction circuit to allow the hydraulic fluid to flow through the circuit. The filter removes contamination from the traction circuit during the circuit operation. Because the Toro high flow filter is bi-directional, the traction circuit can be operated in both the forward and reverse direction. When you are certain that the filter has removed the contaminates from the hydraulic fluid of the traction circuit (page 4–91) for additional information on using the Toro high flow hydraulic-fluid filter.

The alternative method to remove contamination from the traction circuit is to disassemble the entire traction circuit, drain the hydraulic fluid, and clean all the components, tubes, and hoses in the traction circuit. Operating the machine with contaminants in the traction circuit could cause additional damage to components of the traction circuit.

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 for the following signs of deterioration or damage:

- A hose that is hard, cracked, cut, abraded, charred, leaking, or otherwise damaged.
- A hose that is kinked, crushed, flattened, or twisted.
- A hose cover that is blistered, soft, degraded, or loose.
- Hose fittings that are cracked, damaged, or badly corroded.

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 2 wrenches, hold the hose straight with 1 wrench and tighten the hose swivel nut onto the fitting with the other wrench; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 4–9).

Note: If the hose has an elbow at 1 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 *Hydraulic Hose Servicing* of the Toro Basics Series Training Books (Part No. 94813SL) found on the Service Reference Set available from your Authorized Toro Distributor.



Release all pressure in the hydraulic system before performing any work on the system; refer to Releasing Pressure from the Hydraulic System (page 4–6).

- 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.

Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting)



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.

Figure 23

3.

- Tube or hose 1.
- 2. Swivel nut

O-ring Fitting body 4



- 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 23).
- 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 torgue value within the specified range of torque values; refer to the Hose/Tube Installation Torque Table (page 4-10). 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 2–5).

5. If a torque wrench is not available or if space at the swivel nut prevents the use of a torgue wrench, use the alternative procedure Flats From Wrench Resistance (FFWR) given below (Figure 24).



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).

Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (continued)

- B. Put a mark on the swivel nut and body of the fitting. Hold the hose/tube in alignment with a wrench to prevent the hose/tube from turning.
- C. Use a second wrench to tighten the nut to the correct Flats From Wrench Resistance (FFWR); refer to the Flats From Wrench Resistance Table (page 4–10).

Note: The markings on the nut and body of the fitting show that the connection is correctly tightened.

Hose/Tube Installation Torque Table

Fitting Dash Size	Hose/Tube Side Thread Size (inch(es)—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
Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port)

Installing the Non-Adjustable Fittings



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

IMPORTANT

Before installing the fitting into the port, determine the material of which the port is made. Installing a fitting into an aluminum port requires a reduced installation torque.

4. Install the fitting into the port, then use a torque wrench and socket to tighten the fitting to the recommended torque value within the specified range of torque values; refer to the Fitting Installation Torque Table (page 4–11).

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 2–5).

- If a torque wrench is not available or if space at the port prevents the use of a torque wrench, use the alternative procedure Flat From Finger Tight Table (page 4–12) given below;
 - A. Install the fitting into the port and tighten the fitting down full length until finger-tight.
 - B. If the port material is steel, tighten the fitting to the listed FFFT. If the port material is aluminum, tighten the fitting to 60% of the listed FFFT.

Fitting Installation Torque Table

Fitting Dash Size	Fitting Port Side Thread Size (inch(es)—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)

Installing the Non-Adjustable Fittings (continued) Fitting Installation Torque Table (continued)

Fitting Dash Size	Fitting Port Side Thread Size (inch(es)—threads per inch)	Installation Torque Into Steel Port	Installation Torque Into Aluminum Port
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)

Flat From Finger Tight 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

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- 1. Ensure that all the threads, the sealing surfaces of fitting, and the component port are free of burrs, nicks, scratches, or unwanted material.
- 2. To help prevent a hydraulic leak, replace the O-ring when you open the connection.
- 3. Lightly lubricate the O-ring with clean hydraulic fluid. Ensure that the threads of the fitting are clean with no lubricant applied.
- 4. Turn back the locknut 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 27).

IMPORTANT

Before installing the fitting into the port, determine the material of which the port is made. Installing a fitting into an aluminum port requires a reduced installation torque.

- 5. Install the adjustable fitting into the port by hand until the washer contacts the face of the port (Step 2 in Figure 27).
- 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 27). Do not rotate the adjustable fitting more than 1 turn counterclockwise.

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Installing an Adjustable Fitting (continued)

 Hold the fitting in the correct alignment with a wrench and use a torque wrench and tighten the fitting to the recommended torque value within the specified range of torque values; refer to the Fitting Installation Torque Table (page 4–11). This tightening procedure 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 2–5).

- If a torque wrench is not available or if space at the port prevents the use of a torque wrench, use the alternative procedure Flat From Finger Tight Table (page 4–14) given below;
 - A. Hold the fitting in the correct alignment with a wrench and, if the port material is steel, tighten the locknut with a second wrench to the listed FFFT (Step 4 in Figure 27).
 - B. If the port material is aluminum, tighten the fitting to 60% of the listed FFFT; refer to the Flat From Finger Tight Table (page 4–14).

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

Flat From Finger Tight Table

Hydraulic Schematics



Hydraulic Flow Diagrams



Traction Circuits

The hydraulic traction circuit consists of a variable displacement piston pump (P5) connected in a closed loop, parallel circuit to 4 orbital roller vane wheel motors. The traction pump input shaft is rotated by a driveshaft that is driven from the engine flywheel.

The forward traction circuit pressure can be measured at the test port located in the hydraulic tube that connects the front wheel motors. The reverse traction circuit pressure can be measured at the test ports in the crosstrax manifold.

Forward Direction

Pressing the top of traction pedal, angles the traction pump swash plate to create a flow of fluid. This fluid flow is directed to the wheel motors via hydraulic hoses and tubes to drive the wheels in forward direction. The traction pump flow is directed to the front wheel motors and then to the opposite rear wheel motors to maximize the traction. To reduce the tire scuffing when turning, the traction system pressure is equalized in the crosstrax manifold with an orifice and a bi-directional relief valve. The bi-directional relief valve in the crosstrax manifold allow rear wheel motors to over-run during tight turns. The forward traction relief valve (R3) located in the traction pump.

The fluid flowing from the wheel motors returns to the variable displacement pump and is continuously pumped through the traction circuit as long as the traction pedal is pressed.

The angle of the swash plate determines pump flow and ultimately traction speed. When the traction pedal is pressed a small amount, a small swash plate rotation results in low pump output and lower traction speed. When the traction pedal is pressed fully, the pump swash plate rotates fully to provide maximum pump output and traction speed.

The gear pump section (P3) supplies fluid flow for the steering circuit and also provides a constant supply of charge fluid to the closed loop traction circuit. This charge fluid provides lubrication for traction circuit components and also replenishes traction circuit fluid that is lost due to internal leakage in the traction circuit.

The gear pump section (P3) takes its suction from the hydraulic reservoir. The charge pump flow is directed to the low pressure side of the closed loop traction circuit. Charge relief valve (R5) located in the traction pump limits the charge relief pressure to 1,400 kPa (200 psi).

The piston pump is equipped with a case drain to allow internal leakage to be removed from the pump. The case drain is connected to the gear pump inlet.

The piston pump (P5) includes a flushing valve that bleeds off a small amount of hydraulic fluid for cooling of the closed loop traction circuit. The charge system replenishes fluid that is bled from the traction circuit by the flushing valve.

Reverse Direction

The traction circuit operates essentially the same in reverse as it does in the forward direction. However, in the reverse direction the rear wheel motors are bypassed from the circuit to prevent rear wheel spin and improve steering control. Pressing the bottom of the traction pedal, rotates the traction pump swash plate to create a flow of fluid. The fluid flow is directed to the crosstrax manifold where the 2 internal check valve allows the hydraulic fluid to bypass the rear wheel motors. Then the fluid flows to the front wheel motors, turning them in the reverse direction. The reverse traction pressure is limited to 25,000 kPa (3,625 psi) by the reverse traction relief valve (R4) located in the traction pump.

Reverse Direction (continued)

The fluid flowing from the wheel motors returns to the traction pump and is continuously pumped through the closed loop traction circuit as long as the traction pedal is pressed.

The charge circuit and flushing valve function the same in reverse as they do in the forward direction.

Reverse Direction (continued)



Figure 30

Mow Circuit

A 4-section gear pump is coupled to the piston (traction) pump. The gear pump sections (P1) and (P2) supply hydraulic flow for the mow circuit. These gear pumps take their suction from the hydraulic reservoir.

The deck control manifold contains 2 independent control circuits for the front and rear cutting decks. Each circuit is supplied by its own pump section. The pump section (P1) supplies hydraulic power to the rear cutting decks with circuit control by proportional relief valve (PRV1), relief valve (RV1) and logic cartridge (LC1) in the deck control manifold. The pump section (P2) supplies hydraulic flow for the front cutting decks with circuit control by proportional relief valve (PRV2), relief valve (RV2) and logic cartridge (LC2) in the deck control manifold. Both the circuits share manifold port T, which drains to the oil cooler, oil filter and hydraulic reservoir.

The cutting deck motors are equipped with a cross over relief valve to prevent hydraulic component damage in case a single cutting deck stalls.

The machine controller uses inputs from various machine switches to determine when the solenoids for proportional relief valves (PRV1) and (PRV2) are to be energized. The controller also provides a slight delay in activation of rear cutting decks.

PTO Not Engaged

When the PTO switch is in the OFF position or the cutting decks are raised, the proportional relief valves (PRV1) and (PRV2) are not energized, the flow from pump sections (P1) and (P2) is directed through the unshifted proportional relief valves, and out through the deck control manifold port T and then returns back to the hydraulic reservoir through the oil filter and oil cooler. In this position the hydraulic flow bypasses the deck motors. The manifold logic cartridges (LC1 and LC2) remain in the unshifted position to prevent any return flow to the deck motors so that the motors do not rotate.

PTO Engaged



When the PTO switch is turned ON with the decks lowered, the solenoid valves (PRV1 and PRV2) are energized with outputs from the Toro Electronic Controller (TEC). The energized valves shift to direct pump flow toward the deck motors. As circuit pressure to the deck motors increases, the brake relief cartridge (RV1 and RV2) piston pilots open the relief valves which allows fluid flow through the manifold orifice positioned before the logic cartridge (LC1 and LC2). This flow

PTO Engaged (continued)

creates a pressure increase at the logic cartridge that shifts the logic cartridge and allows fluid return from the deck motors.

The maximum mow circuit pressure is limited at each deck manifold circuit by the proportional relief valve (PRV1/PRV2). The deck relief valve pressure is 17,500 kPa (2,500 psi) for the rear cutting unit circuit and 24,100 kPa (3,500 psi) for the front cutting unit circuit. Mow circuit pressure can be measured at port G1 (rear cutting unit circuit) or G3 (front cutting unit circuit) of the deck control manifold.

The brake relief and logic cartridges control the stopping rate of the blades when the proportional relief valves are de-energized as the PTO switch is turned OFF or if the decks are raised; refer to Mow Circuit Cutting Deck Blade Braking (page 4–22).

Mow Circuit Cutting Deck Blade Braking





Mow Circuit Cutting Deck Blade Braking (continued)



When the operator turns the PTO switch OFF (or if the decks are raised), the deck control manifold proportional relief valves (PRV1 and PRV2) are de-energized. The valves will shift to direct fluid away from the deck motors and toward the oil cooler and filter. Hydraulic pressure is reduced to the cutting deck motors which slows the cutting blades and also allows the deck control manifold relief valves (RV1 and RV2) to shift. The shifted relief valves removes the flow path from the orifice before the logic cartridge, causing the logic cartridge to shift and block the return oil path from the deck motors (Figure 32).

The inertia of the rotating cutting blades, however, effectively turns the deck motors into pumps causing an increase in pressure as the flow from the motors comes up against the closed logic cartridges (LC1 and LC2). When this pressure builds to approximately 10,340 kPa (1,500 psi), the relief valves open which allows a small amount of hydraulic flow past the relief valve (Figure 33). This flow causes a pressure increase that shifts the logic cartridge to once again allow fluid flow from the deck motors (Figure 34). When return pressure drops below 10,340 kPa (1,500 psi), the relief valve re-seats and causes the logic cartridge to close again, blocking return flow from the deck motors to further slow the cutting blades. This action of the relief valve opening and the logic cartridge shifting occurs several times in a very short period as the blades finally come to a stop. Once the blades have stopped, the logic cartridge remains in the closed position to keep the deck motors from rotating.

Mow Circuit Cutting Deck Blade Braking (continued)



Figure 35

Lift Cylinder Circuit: Raise the Cutting Decks

A 4-section gear pump is coupled to the piston (traction) pump. The gear pump section (P4) supplies hydraulic flow to the lift control manifold and lift cylinders. The gear pump takes its suction from the hydraulic reservoir.

The lift control manifold includes 3 electrically operated valves. The solenoid valve (S1) is used to direct fluid flow to extend the lift cylinders (lower the cutting decks) when energized or retract them (raise the cutting decks) when de-energized. The solenoid valve (S2) allows hydraulic flow from the rod end of the lift cylinders when energized, and prevents hydraulic flow from the lift cylinders when de-energized. Using solenoid valve S2 in this manner also helps keep the cutting decks elevated once the machine is switched OFF. The proportional relief valve (PRV) is used to control the operation of the logic cartridge (LC) and acts as a circuit relief valve.

Raise the Cutting Decks

When the joystick is moved to the raise position, the controller energizes the proportional relief valve (PRV) (Figure 35). The energized relief valve (PRV) prevents flow through the valve which allows logic cartridge LC to return to its unshifted (closed) position. With the valves in this position, the pump flow is directed to the rod end of all lift cylinders to retract the cylinders and raise all the cutting decks. The flow to the lift cylinders bypasses the 4 control manifold fixed orifices to prevent the flow restriction during deck raising.

While the cutting decks are being raised, the proportional relief valve (PRV) has a secondary function as a circuit relief to limit lift cylinder circuit pressure to 13,800 kPa (2,000 psi). The lift cylinder circuit pressure can be monitored at lift control manifold port G4.

When the cutting deck is fully raised or the joystick is returned to the NEUTRAL (center) position, the proportional relief valve (PRV) and solenoid valves S1 and S2 are de-energized. The de-energized relief valve (PRV) allows hydraulic flow to return to tank through the manifold. This flow through the proportional relief valve causes a pressure differential that shifts the logic cartridge (LC) which allows the majority pump flow to bypass the lift cylinders. The lift cylinders and cutting decks are held in the raised position by the de-energized valve S2.

Raise the Cutting Decks (continued)



Figure 36

Lift Cylinder Circuit: Lower the Cutting Decks

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LIFT CYLINDER CIRCUIT: COUNTERBALANCE/FLOAT

A 4-section gear pump is coupled to the piston (traction) pump. The gear pump section (P4) supplies hydraulic flow to the lift control manifold and lift cylinders. The gear pump takes its suction from the hydraulic reservoir.

The lift control manifold includes 3 electrically operated valves. The solenoid valve (S1) is used to direct fluid flow to extend the lift cylinders (lower the cutting decks) when energized or retract them (raise the cutting decks) when de-energized. The solenoid valve (S2) allows hydraulic flow from the rod end of the lift cylinders when energized, and prevents hydraulic flow from the lift cylinders when de-energized. Using solenoid valve S2 in this manner also helps keep the cutting decks elevated once the machine is switched OFF. The proportional relief valve (PRV) is used to control the operation of the logic cartridge (LC) and acts as a circuit relief valve.

Note: With the engine running, the cutting units can only be lowered if an operator is in the seat or the parking brake is set, and the mow/speed limiter is in the Mow position. The cutting units can also be lowered without the engine running if the key switch is in the RUN position and the operator is in the seat.

Lower the Cutting Decks

When the joystick is moved to the lower position, the controller energizes all of the lift manifold valves (S1, S2, and PRV). The energized relief valve (PRV) prevents flow through the valve which allows logic cartridge LC to return to its unshifted (closed) position. With the valves in this position, the pump flow is

Lower the Cutting Decks (continued)

directed to the barrel end of all lift cylinders to extend the cylinders and lower the cutting decks. The 4 fixed orifices in the lift control manifold (C2, C4, C6, and C8) control the lowering speed of the cutting decks by providing a restriction for the return flow from the lift cylinders.

While the cutting decks are being lowered, the proportional relief valve (PRV) has a secondary function as a circuit relief to limit lift cylinder circuit pressure to 13,800 kPa (2,000 psi). The lift cylinder circuit pressure can be monitored at lift control manifold port G4.

When the cutting decks are fully lowered, the lift manifold valves (S1 and PRV) are de-energized (Figure 37). The de-energized relief valve (PRV) allows hydraulic flow to return to tank through the manifold. This flow through the pressure relief valve causes a pressure differential that shifts the logic cartridge (LC) which allows the majority pump flow to bypass the lift cylinders. The lift manifold valve S2 remains energized when the cutting units are fully lowered to allow fluid flow to and from the lift cylinders. The bidirectional flow is necessary for proper cutting deck counterbalance/float operation.

Counterbalance/Float

Once the cutting decks are fully lowered, the lift control manifold solenoid valve (S2) remains energized and the proportional relief valve (PRV) is used to maintain an amount of pressure (counterbalance) on the rod ends of the deck lift cylinders (Figure 37). This counterbalance pressure transfers cutting deck weight to the machine to improve the traction.

A pressure transducer located in the forward traction hydraulic tube is used by the controller as an input to determine traction circuit pressure. Based on the transducer input and the machine counterbalance setting, an electrical output from the controller is provided to the lift control manifold proportional relief valve (PRV) to vary the counterbalance pressure. As the traction pressure increases (e.g., climbing a hill) the counterbalance pressure also increases to increase the weight on the tires and improve traction. The counterbalance setting can be adjusted to LOW, MEDIUM, and HIGH via the InfoCenter display; refer to InfoCenter Display (page 5–7) or the *Traction Unit Operator's Manual*.



Counterbalance/Float (continued)

Steering Circuit

A 4-section gear pump is coupled to the piston (traction) pump. The gear pump section P3 supplies hydraulic flow to the steering control valve and for the traction charge circuit. The steering control valve receives the pump supply first, ensuring pressure and volume is always available for steering control, no matter the charge circuit demand. The gear pump takes its suction from the hydraulic reservoir. The steering circuit pressure is limited to 6,900 kPa (1,000 psi) by a relief valve (R10) located in the steering control valve.

With the steering wheel in the neutral position and the engine running, the hydraulic flow enters the steering control valve at the P port and goes through the steering control spool valve, bypassing the rotary meter (V1) and steering cylinder. The flow leaves the control valve through the T port to the transmission oil filter and traction charge circuit.

Left Turn

When a left turn is made with the engine running, the turning of the steering wheel, positions the steering control spool valve so that flow is directed through the bottom of the spool. The flow entering the steering control valve at the P port goes through the spool and is routed to two places. First, most of the flow through the valve is bypassed out the T port back to the transmission oil filter and traction charge circuit. Second, the remainder of the flow is directed through the rotary meter (V1) and out through the L port. The pressure retracts the steering cylinder piston for a left turn. The rotary meter ensures that the fluid flow to the steering cylinder is proportional to the amount of turning on the steering wheel. The fluid leaving the steering cylinder flows back through the steering control spool valve and then out of the steering control valve through the T port.

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

Right Turn

When a right turn is made with the engine running, the turning of the steering wheel, positions the steering control spool valve so that the flow is directed through the top of the spool. The flow entering the steering control valve at the P port goes through the spool and is routed to two places. As in a left turn, most of the flow through the valve is bypassed out through the T port back to the transmission oil filter and traction charge circuit. Also like a left turn, the remainder of the flow is directed through rotary meter (V1) but goes out through port R. The pressure extends the steering cylinder piston for a right turn. The rotary meter ensures that the fluid flow to the steering cylinder is proportional to the amount of the turning on the steering wheel. The fluid leaving the steering cylinder flows back through the steering control spool valve then through the T port and to the hydraulic reservoir.

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

Special Tools

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

Hydraulic Pressure Testing Kit



g031764

Figure 39

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; refer to Testing the Hydraulic System (page 4–44).

15 GPM Hydraulic Tester Kit (Pressure and Flow)



g031765

Figure 40

Toro Part No. TOR214678

Use this tester to test the hydraulic circuits and components for flow and pressure capacities as recommended in Testing the Hydraulic System (page 4–44). This tester includes the following:

- 1. Inlet Hose: This hose connects the system circuit to the inlet side of the hydraulic tester.
- 2. Load Valve: Turn the valve to restrict the flow to create a simulated working load in the circuit.

15 GPM Hydraulic Tester Kit (Pressure and Flow) (continued)

- 3. Pressure Gauge: A glycerine filled pressure gauge 0 to 34,500 kPa (0 to 5,000 psi) to provide operating circuit pressure.
- 4. Flow Meter: This meter measures the actual fluid flow in the operating circuit with a gauge rated at 5 to 55 L/minute (1 to 15 gallons/minute).
- 5. Outlet Hose: A hose from the outlet side of the hydraulic tester that connects to the hydraulic system circuit.
- 6. Fittings: An assortment of hydraulic fittings are included with this kit.

40 GPM Hydraulic Tester (Pressure and Flow)



g035151

Figure 41

Toro Part No. AT40002

Use this tester to test the hydraulic circuits and components for flow and pressure capacities as recommended in Testing the Hydraulic System (page 4–44). This tester includes the following:

- 1. Load Valve: Turn the valve to restrict the flow to create a simulated working load in the circuit.
- 2. Pressure Gauge: A glycerine filled pressure gauge 0 to 35,000 kPa (0 to 5,000 psi) to provide operating circuit pressure.
- 3. Flow Meter: This meter measures the actual fluid flow in the operating circuit with a gauge rated at 20 to 150 L/minute (4 to 40 gallons/minute).

Note: This tester does not include the hoses; refer to Hydraulic Hose Kit (page 4–33).

Hydraulic Hose Kit



Toro Part No. TOR6007

This kit includes the fittings and hoses that are used to connect the 40 GPM hydraulic tester (AT40002) or high flow hydraulic filter kit (TOR6011) to the machine hydraulic traction system components.

O-Ring Kit



Toro Part No. 117-2727

g033395

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.

High Flow Hydraulic Filter Kit



Toro Part No. TOR6011

The high flow hydraulic filter kit is designed with large flow (150 L/minute or 40 gallons/minute) and high pressure (34,500 kPa or 5,000 psi) capabilities. This kit provides for bi-directional filtration which prevents filtered unwanted material from entering into the circuit regardless of 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 hoses; refer to Hydraulic Hose Kit (page 4–33).

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

Hydraulic Test Fitting Kit



g036472

Figure 45

Toro Part No. TOR4079

Hydraulic Test Fitting Kit (continued)

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

The kit includes: tees, unions, reducers, plugs, caps, and male test fittings.

Spindle Plug



g194566

Figure 46

Toro Part No. 94-2703

This spindle plug can be used to prevent contaminant entry into the cutting deck spindle assembly when the hydraulic motor is removed from the spindle.

Wheel Hub Puller



g185941

Figure 47

Toro Part No. TOR6004

The wheel hub puller allows you to safely remove the wheel hub from the wheel motor shaft.

Measuring Container



Figure 48

Toro Part No. 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



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Figure 49
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Remote Starter Switch (continued)



After flushing the hydraulic system or replacing a hydraulic component (e.g., gear pump, piston pump, or wheel motor), it is necessary to prime the hydraulic pumps. A remote starter switch (Figure 49) can be used for priming the hydraulic pumps. You can get this switch locally.

IMPORTANT

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

A remote stater switch can also be constructed using the Toro switch #106-2027, a length of 14 gauge wire, a 20 A in-line fuse, 2 alligator clips, and necessary

Remote Starter Switch (continued)

connectors. Connecting the wire to switch terminals 1 and 2 will allow the momentary switch contacts to be used for the remote starter switch (Figure 50).

Note: For information on using the remote starter switch to prime the hydraulic pumps; refer to Priming the Hydraulic Pumps (page 4–88).

Troubleshooting

The following chart contains suggestions that can be used to solve performance issues specific to the hydraulic system. The suggestions are not all-inclusive. There can be more than 1 cause for a machine malfunction.

Review the hydraulic schematic found in Appendix A—Foldout Drawings and information on the hydraulic system operation in the Hydraulic Flow Diagrams (page 4–16). This information will be useful during the hydraulic troubleshooting process.

Refer to Testing the Hydraulic System (page 4–44) for precautions and specific hydraulic test procedures.

General Hydraulic System Problems

Problem	Possible Causes
The hydraulic fluid is leaking from the system.	• The fitting(s), hose(s), or tube(s) are loose or damaged.
	 The O-ring(s) or seal(s) are missing or damaged.
The hydraulic fluid foams excessively causing fluid leakage	The hydraulic-fluid level in the hydraulic tank is low.
from the hydraulic tank breather.	• The hydraulic system has a wrong type of fluid.
is normal. This aeration (foaming) may be more noticeable	 One of the pump suction lines has an air leak.
after initial filling of hydraulic tank.	 Incompatible hydraulic fluids are mixed in the system.
	There is water in the hydraulic system.
The hydraulic system operates hot.	• The traction system pressure is high due to load or dragging brakes.
	 The hydraulic-fluid level in the hydraulic tank is low or the inlet filter is loose or clogged.
	 The hydraulic fluid is contaminated or the fluid viscosity is too light.
	• The oil cooler is damaged or plugged.
	• The oil cooler air flow is obstructed.
	 The piston (traction) pump bypass valve is open or damaged.
	• The gear pump relief valve is stuck open.
	 The piston (traction) pump check valve is not seating or is damaged.
	• The charge pressure is low.
	 The piston (traction) pump or wheel motor(s) is worn or damaged.
	Engine RPM is too low.
	Note: If 1 traction circuit component has internal wear or damage, it is possible that the other traction components are also damaged.

Traction Circuit Problems

Problem	Possible Causes
The traction response is sluggish.	 The piston (traction) pump bypass valve is open or damaged.
	• The brake is dragging or binding.
	 The piston (traction) pump check valve, relief valve, and/or flushing valve is leaking.
	• The charge pressure is low.
	• The hydraulic fluid is very cold.
	 The piston (traction) pump or wheel motor(s) is worn or damaged.
	 The flushing valve in piston (traction) pump is not seating or is damaged.
	Note: If 1 traction circuit component has internal wear or damage, it is possible that the other traction components are also damaged.
Neutral is difficult to find.	 The traction control linkage is incorrectly adjusted, disconnected, binding, or damaged.
	 The piston (traction) pump check relief valve is not seating or is damaged
	The piston (traction) pump is worn or damaged.
No traction exists in either direction and the engine speed	• The hydraulic-fluid level in the hydraulic tank is low.
	• The piston (traction) pump bypass valve is open.
	The charge pressure is low.
	 The parking brake is applied, dragging or binding.
	 The piston (traction) pump or wheel motor(s) is worn or damaged.
	Note: If 1 traction circuit component has internal wear or damage, it is possible that the other traction components are also damaged.
The wheel motor does not turn.	The piston (traction) pump bypass valve is open.
	 The piston (traction) pump or wheel motor is worn or damaged.
	Note: If 1 traction circuit component has internal wear or damage, it is possible that the other traction components are also damaged.

Traction Circuit Problems (continued)

Problem	Possible Causes
The wheel motor does not hold load in the NEUTRAL position.	The charge pressure is low.
Note: The machine may not be completely stationary if parked on an incline without the parking brake engaged.	• The check valves in the piston (traction) pump are damaged.
	 The valve plate(s) in the piston (traction) pump is worn or damaged.
	• The wheel motor is worn or damaged.
	Note: If 1 traction circuit component has internal wear or damage, it is possible that the other traction components are also damaged.
A single-wheel motor turns while unloaded, but slows down	• The piston (traction) pump bypass valve is open or leaking.
or stops when the load is applied.	• The wheel motor is worn or damaged.
	Note: If 1 traction circuit component has internal wear or damage, it is possible that the other traction components are also damaged.

Mow Circuit Problems

Problem	Possible Causes
All the 3 front cutting deck motors do not operate but rear cutting deck motors operate.	 The solenoid valve PRV2 on deck control manifold is damaged.
	Note: The solenoid valves PRV1 and PRV2 are identical and can be reversed for testing purposes.
	• An electrical problem exists that prevents PRV2 solenoid coil on deck control manifold from being energized (refer to Troubleshooting (page 5–24) or the Electrical Schematic and Wire Harness Drawings/Diagrams in Appendix A (page A–1)).
	One or more front deck spindle is binding.
	 The gear pump section (P2) is worn or damaged.
Both rear cutting deck motors do not operate but front cutting deck motors operate.	 The solenoid valve PRV1 on deck control manifold is damaged.
	Note: The solenoid valves PRV1 and PRV2 are identical and can be reversed for testing purposes.
	• An electrical problem exists that prevents PRV1 solenoid coil on deck control manifold from being energized (refer to Troubleshooting (page 5–24) or the Electrical Schematic and Wire Harness Drawings/Diagrams in Appendix A (page A–1)).
	 One or more rear deck spindle is binding.
	 The gear pump section (P1) is worn or damaged.
A single cutting deck motor does not operate or rotates	 The cutting deck motor is worn or damaged.
Slowly.	• The cross-over relief valve in the cutting deck motor is stuck or damaged.
	Note: If appropriate, transfer a suspected damaged motor to another cutting deck. If problem follows the motor, motor needs to be repair or replacement.

Lift/Lower Circuit Problems

Problem	Possible Causes
One cutting deck raises slowly or not at all.	The cutting deck has excessive unwanted elements.
	• The lift arm or lift cylinder is binding.
	• The flow control orifice in lift control manifold for the affected cutting deck is plugged, stuck, or damaged.
	The lift cylinder leaks internally.
One or more cutting deck raises, but does not stay up.	The lift circuit hydraulic lines or fittings are leaking.
Note: The lift cylinders and control manifold cartridge valves	Air exists in the lift circuit.
will eventually lower if left in the raised position. At minimum, the cutting decks should remain in the raised transport	 The lift cylinder for the affected cutting deck(s) leaks internally.
position long enough to safely move from one fairway to the next.	• The solenoid valve (S2) in lift control manifold is damaged or leaks.
None of the cutting decks will raise or lower. Note: The operator must be in the seat or the parking brake engaged and mow speed limiter must be in mow speed position in order to lower the cutting decks.	 The fluid level in the hydraulic reservoir is low (other hydraulic systems are affected as well).
	• An electrical problem exists that prevents lift control manifold solenoid valve operation (refer to Troubleshooting (page 5–24) or the Electrical Schematic and Wire Harness Drawings/Diagrams in Appendix A (page A–1)).
	 The solenoid valve PRV in the lift control manifold is damaged.
	• The logic cartridge LC in lift control manifold is damaged.
	• The solenoid valve S2 in lift control manifold is damaged.
	• The gear pump section (P4) is worn or damaged.
Neither of the rear cutting decks will raise or lower but the front cutting decks will raise and lower.	• The flow control orifice in lift control manifold for the rear cutting decks (port C8) is plugged, stuck or damaged.
One cutting deck lowers very slowly or not at all.	• The lift arm or lift cylinder for the affected cutting deck is binding.
	• The lift cylinder for the affected cutting deck is damaged.
	 The flow control orifice in the lift control manifold for the affected cutting deck is plugged, stuck or damaged.

Steering Circuit Problems

Problem	Possible Causes
The steering is inoperative or sluggish.	• The steering components (e.g., tie rods, steering cylinder ends) are worn or binding.
	The steering cylinder is binding.
	• The fluid level in the hydraulic reservoir is low (other hydraulic systems are affected as well).
	• The steering relief valve (R10) in the steering control valve is stuck or damaged.
	The steering cylinder leaks internally.
	 The steering control valve is worn or damaged.
	• The gear pump section (P3) is worn or damaged.
	Note: A worn or damaged gear pump section (P3) will also affect the traction (charge) circuit.

Testing the Hydraulic System

The most effective procedure to isolate the problems in the hydraulic system is to use hydraulic test equipment, such as pressure gauges and flow meters in the circuits during different operational checks; refer to Special Tools (page 4–31).



Opening the hydraulic system without releasing pressure from the system will cause the hydraulic fluid to escape, causing possible injury.

Before you disconnect the hydraulic components or work on the hydraulic system, release the pressure in the system; refer to Releasing Pressure from the Hydraulic System (page 4–6).

WARNING

Hydraulic fluid escaping under pressure can penetrate skin and cause injury.

- 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.
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CAUTION

Failing to use gauges having the recommended pressure (kPa/psi) rating could damage the gauge and cause personal injury from contact with hot, leaking hydraulic fluid.

Use gauges with the recommended pressure rating as listed in the test procedures.

IMPORTANT

Before performing the hydraulic tests, check all obvious areas, such as fluid supply, filter, binding linkages, loose fasteners, or improper adjustments before you assume that a hydraulic component is the source of the problem.

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IMPORTANT

Use 2 people to perform all the tests, with 1 person in the seat and the other to read and record the test results.

1. Clean the machine fully before you disconnect or disassemble the hydraulic components.

Note: Cleanliness is required whenever you work on the hydraulic equipment. Contamination causes too much wear on hydraulic components.

- 2. When you perform tests on the hydraulic system, wear eye protection.
- 3. Before you perform a test, check the traction control lever linkages for improper adjustment, binding, or broken parts.
- 4. Perform all the hydraulic tests with the hydraulic fluid at normal operating temperature.
- 5. Install clean metal caps or plugs on the hydraulic lines that are left open or exposed during the testing or component removal.
- 6. When you use a hydraulic tester (pressure and flow), ensure that the inlet and outlet hoses are properly connected and not reversed to prevent damaging the hydraulic tester or components.
- 7. Install the hydraulic fittings by hand and ensure that they are not cross-threaded before you tighten them with a wrench.
- 8. Position the tester hoses to prevent the rotating machine parts from contacting and damaging the hoses or tester.
- 9. After you connect the test equipment, check the hydraulic-fluid level in the hydraulic tank and ensure that the tank has the correct fluid level.
- 10. When you use a hydraulic tester (pressure and flow), open the tester load valve fully before you start the engine to reduce the possibility of damaging the components.
- 11. Ensure that the engine is in good operating condition before performing any hydraulic test.

Note: Use a phototac when you perform a hydraulic test. The engine speed can affect the accuracy of the tester readings.

- 12. If there is a traction circuit problem, perform 1 or more of the following tests: The traction circuit relief valve (R3) and (R4) pressure, traction circuit charge pressure, gear pump (P3) flow, front wheel motor efficiency and/or piston (traction) pump flow tests.
- 13. If there is a lift circuit problem, perform 1 or more of the following tests: lift relief valve (PRV) pressure, gear pump (P4) flow and/or lift cylinder internal leakage tests.
- If there is a cutting (mow) circuit problem, perform 1 or more of the following tests: relief valve (PRV1) and (PRV2) pressure, gear pump (P1) and (P2) flow and/or deck motor efficiency tests.
- 15. If there is a steering circuit problem, perform 1 or more of the following tests: steering relief valve (R10) pressure, steering cylinder internal leakage and/or gear pump (P3) flow tests.

Testing the Traction Circuit–Charge Pressure



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Figure 52

Test Procedure

The charge pressure test is the first in a series of tests recommended to determine traction circuit performance. A charge pressure drop of more than 20% indicates an internal leak in the piston pump/hydrostat. Continued unit operation can generate excessive heat, cause damage to seals and other components in the hydraulic system, and affect overall machine performance.

Special Equipment Required: Pressure gauge

1. Warm oil after test equipment is connected to prevent technician from working on a hot machine—applicable to tests when possible (any test that requires an open un-pluged/capped line (case drain tests) would not apply and oil should be warmed before disconnecting the lines).

CAUTION

Before opening the hydraulic system, operate all the hydraulic controls to release system pressure and avoid injury from the pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 4–6).

2. Park the machine on a level surface with the PTO switch off, lower the cutting decks, shut off the engine, and set the parking brake.

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- 3. Read all Warning, Cautions, and precautions listed at the beginning of this section.
- 4. Raise and support the operator seat to get access to the hydraulic pump assembly.
- 5. Ensure that the traction pedal is in the NEUTRAL position, the steering wheel is stationary and parking brake is set.





- 6. Connect a pressure gauge to the charge circuit test port (Figure 53).
- 7. Connect a pressure gauge to the traction circuit test port (Figure 54).

- 8. Attach a heavy chain to the rear of the machine frame and an immovable object to prevent the machine from moving during testing.
- 9. Block the wheels with chocks to prevent the wheel rotation during testing.
- Start the engine and press the engine speed switch to full speed (3,005 to 3,055 rpm) position. Use the InfoCenter to check that the engine speed is correct.
- 11. Record the reading on the charge circuit pressure gauge. The charge pressure (without load) should read from **1,034 to 1,379 kPa (150 to 200 psi)**. If the charge relief pressure specification is not met, consider the following:
 - A. The gear pump (P3) is damaged (steering circuit performance will also be affected). Test the gear pump (P3) flow; refer to Testing the Steering Circuit–Gear Pump (P3) Flow (page 4–75).
 - B. The piston pump charge relief valve is damaged. Repair or replace the piston pump charge relief valve; refer to Servicing the Piston (Traction) Pump (page 4–106).
- 12. Sit in the operator's seat, release the parking brake, and slowly press the traction pedal forward until **6,900 to 10,340 kPa (1,000 to 1,500 psi)** is reached on the traction circuit pressure gauge.
- 13. Record the reading on the pressure gauge (under load). The charge pressure (under load) should not drop more than 20% when compared to charge pressure (without load) recorded in step 11.

If specifications are not met, perform the piston pump/hydrostat flow and traction relief pressure test; refer to Testing the Traction Circuit–Piston Pump/Hydrostat Flow and Relief Pressure (page 4–55).

- 14. Release the traction pedal, press the engine speed switch to low speed position, and shut off the engine.
- 15. After you complete the charge pressure testing, ensure that the engine is not running and then release hydraulic system pressure; refer to Releasing Pressure from the Hydraulic System (page 4–6). Disconnect the pressure gauges from the test ports.
- 16. Lower and secure the operator seat.
- 17. Start the engine, check for hydraulic-fluid leaks, repair any leaks as required, and fill the hydraulic tank with the correct quantity of new hydraulic fluid before returning the machine to service.

Testing the Traction Circuit–Wheel Motor Efficiency



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Figure 55

The wheel motor efficiency is the second in a series of tests recommended to determine the traction circuit performance. Hydraulic fluid flow of **5.7 L/minute** (1.5 gallons/minute) or more through a single stationary front wheel motor under load indicates an internal leak in the wheel motor. Hydraulic fluid flow of **4.5 L/minute** (1.2 gallons/minute) or more through a single stationary rear wheel motor under load indicates an internal leak in the wheel motor. A worn

wheel motor is less efficient. Eventually, enough fluid bypass will cause the wheel motor to stall under heavy load conditions. Continued operation can generate excessive heat, cause damage to the seals and other components in the hydraulic system, and affect overall machine performance.

There are moments during wheel motor operation (geroller position) when fluid flow through the motor is less restricted. If a wheel motor is tested in this position, the test results will be higher and should not be used to determine wheel motor efficiency. Test the wheel motors in 3 different wheel positions to obtain accurate test results. Record the test readings for all the 3 wheel positions. In the forward direction, hydraulic fluid flows through both front wheel motors (in parallel) before passing through the rear wheel motor on the opposite side of the machine. In the reverse direction, hydraulic flow bypasses the rear wheel motors. Start by testing the front wheel motors combined, then test the front wheel or rear wheel motors individually as necessary.

Special Equipment Required:

- Pressure gauge
- Flow meter with pressure gauge that has at least a 68 L/minute (18 gallons/minute) capacity

IMPORTANT

Refer to Traction Circuit Component Failure (page 4–7) for information regarding the importance of removing contamination from the traction circuit.



- 1. Park the machine on a level surface with the PTO switch off, lower the cutting decks, shut off the engine, and set the parking brake.
- 2. Read all Warning, Cautions, and precautions listed at the beginning of this section.

- 3. Ensure that the traction pedal is correctly adjusted for the NEUTRAL position; refer to the *Operator's Manual*.
- 4. Attach a heavy chain to the rear of the machine frame and an immovable object to prevent the machine from moving during testing.

Testing the Front Wheel Motors

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Hydraulic fluid flows through both front wheel motors (in parallel) before passing through the rear wheel motors (in series). To accurately test the front wheel motors, the rear wheel motors must be removed from the traction circuit.

1. Warm oil after test equipment is connected to prevent technician from working on a hot machine—applicable to tests when possible (any test that requires an open un-pluged/capped line (case drain tests) would not apply and oil should be warmed before disconnecting the lines).

CAUTION	
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Before opening the hydraulic system, operate all the hydraulic controls to release system pressure and avoid injury from the pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 4–6).

2. Clean the junction of the hydraulic hose and right side elbow fitting on the bottom of the traction pump. Disconnect the hydraulic hose from the right side of the pump fitting (Figure 56).

IMPORTANT

Ensure that the fluid flow indicator arrow on the flow meter is showing that the fluid will flow from the pump, through the tester, and into the disconnected hydraulic hose.

- 3. Install a tester with the pressure gauge and flow meter in series between the traction pump and disconnected hydraulic hose. Ensure that the flow control valve on the tester is fully open.
- 4. Disconnect both the hydraulic lines from each rear wheel motor, then connect the lines to each other. Plug the ports in wheel motors to prevent contamination.
- 5. Block the front wheels with chocks to prevent wheel rotation.
- 6. With the engine running, press the engine speed switch to full speed (3,005 to 3,055 rpm) position. Use the InfoCenter to check that the engine speed is correct.

CAUTION

The front wheel motors will try to move the machine forward.

Use extreme caution when performing the test.

- 7. Slowly press the traction pedal in the forward direction until **6,900 kPa (1,000 psi)** is displayed on the tester pressure gauge. Ensure that the front wheels are not rotating and record the flow meter reading.
- 8. Release the traction pedal, shut off the engine, rotate both the front wheels 90° and then test again. Release the traction pedal, shut off the engine,

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Testing the Front Wheel Motors (continued)

rotate both the front wheels 180° and then test again. Use the average of the 3 flow meter readings to judge the front wheel motor performance. Testing of wheel motor leakage in the 3 different wheel positions will provide the most accurate test results.

- 9. The total internal leakage for the front wheel motors combined will be shown on the flow meter. Leakage for the front wheel motors combined should be less than 11.3 L/minute (3 gallons/minute). Proceed to testing the rear wheel motor if test results are within specification. If the leakage specifications are not met, test the front wheel motors individually as follows:
 - A. Remove the front wheel and wheel shield from the wheel motor that is not being tested to get access to the hydraulic tubes and fittings on the wheel motor. Remove the R-clamps that secure the hydraulic tubes to the frame.
 - B. Clean and disconnect hydraulic lines from the front wheel motor that is not being tested. Cap the disconnected hydraulic lines and plug the ports of the disconnected wheel motor to prevent contamination.
 - C. Repeat the procedure described in steps 6 through 8 to identify individual front wheel motor leakage. The flow should be less than 5.7 L/minute (1.5 gallons/minute) for the tested wheel motor.
 - D. If testing is required for other front wheel motor, complete steps A, B, and C for the remaining front wheel motor.
 - E. If specifications are not met, repair or replace the worn wheel motor.
- 10. After you complete the testing, release pressure from the hydraulic system; refer to Releasing Pressure from the Hydraulic System (page 4–6).
- 11. Disconnect the tester from the hydraulic system.
- 12. Connect all the disconnected hydraulic hoses and tubes and secure the hydraulic tubes to the frame.
- 13. Install the wheel shield and wheels; refer to Wheels (page 6-5).
- 14. Start the engine, check for hydraulic-fluid leaks, repair any leaks as required, and fill the hydraulic tank with the correct quantity of new hydraulic fluid before returning the machine to service.



Hydraulic fluid flows through both front wheel motors (in parallel) before passing through the rear wheel motors (in series). To accurately test the rear wheel motors, the front wheel motors must be allowed to rotate.

- 1. To test the right rear wheel motor, disconnect the hose from the upper hydraulic fitting of the wheel motor (Figure 57).
- 2. To test the left rear wheel motor, disconnect the hose from the lower hydraulic fitting of the wheel motor (Figure 58).
- 3. Install a tester with the pressure gauge and flow meter in series between the disconnected hydraulic hose and the rear wheel motor. Ensure that the tester flow control valve is fully open.

IMPORTANT

Before lifting the machine with a jack, review and follow Jacking Instructions (page 1–6).

- 4. Raise off the floor and support both front wheels.
- 5. Block the rear wheels with chocks to prevent wheel rotation.
- With the engine running, press the engine speed switch to full speed (3,005 to 3,055 rpm) position. Use the InfoCenter to check that the engine speed is correct.



Testing the Traction Circuit–Piston Pump/Hydrostat Flow and Relief Pressure



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Figure 59

The hydrostat flow test is the third in a series of tests recommended to determine the traction circuit performance. This test compares fluid flow at No Load with fluid flow Under Load. A drop in flow under load of more than 12% indicates an internal leak or malfunctioning relief valve in the piston pump/hydrostat. The final traction circuit test is verifying the hydrostat relief valve operation. A worn hydrostat or malfunctioning relief valve is less efficient. Eventually, enough fluid bypass will cause the unit to stall under heavy load conditions. Continued operation can generate excessive heat, cause damage to seals and other components in the hydraulic system, and affect overall machine performance.

Special Equipment Required:

- Pressure gauge
- Flow meter with pressure gauge that has at least a 114 L/minute (30 gallons/minute) capacity.

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1. Warm oil after test equipment is connected to prevent technician from working on a hot machine—applicable to tests when possible (any test that requires an open un-pluged/capped line (case drain tests) would not apply and oil should be warmed before disconnecting the lines).



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Before opening the hydraulic system, operate all the hydraulic controls to release system pressure and avoid injury from the pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 4–6).

- 2. Park the machine on a level surface, lower the cutting decks, shut off the engine. Ensure that the mow speed limiter is in the TRANSPORT position to allow full movement of the traction pedal.
- 3. Read all Warning, Cautions, and precautions listed at the beginning of this section.



- 4. Ensure that the traction pedal is correctly adjusted for the NEUTRAL position. Also, ensure that the traction pump is at full stroke when traction pedal is pressed fully in forward position.
- 5. Lift and support the machine so that all the wheels are off the ground; refer to Jacking Instructions (page 1–6).
- 6. Clean the junction of the hydraulic hose and right side fitting on bottom of the traction pump (Figure 60), and disconnect the hose from the fitting.

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IMPORTANT

Ensure that the fluid flow indicator arrow on the flow meter is showing that the fluid will flow from the pump, through the tester, and into the disconnected hydraulic hose.

- 7. Install a tester with the pressure gauge and flow meter in series between the traction pump fitting and the disconnected hose.
- 8. Use the hydraulic hose kit to connect tester to the machine; refer to Special Tools (page 4–31). Ensure that the fitting and hose connections are properly tightened. Also, ensure that the flow control valve on tester is fully open.

CAUTION

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During this procedure, all the wheels will be off the ground and rotating. Ensure that the machine is well supported so it will not move and accidentally fall to prevent injuring anyone around the machine.

- 9. Start the engine and run it at low-idle speed. Check for hydraulic-fluid leaks from the test connections and correct before continuing the test.
- 10. With the engine running, press the engine speed switch to full speed (3,005 to 3,055 rpm) position. Use the InfoCenter to check that the engine speed is correct.
- 11. Verify the pump flow at No Load as follows:
 - A. Slowly press the traction pedal to fully forward position.
 - B. Record the tester pressure and flow readings at no load. Unrestricted pump output should be approximately **106 L/minute (28 gallons/minute)** at **6,900 kPa (1,000 psi)**.
- 12. Verify the pump flow Under Load as follows:
 - A. Slowly press the traction pedal to fully forward position, and keep the pedal pressed in the forward position.
 - B. Apply an additional load of **6,900 to 10,340 kPa (1,000 to 1,500 psi)** by slowly closing the flow meter. The flow meter pressure gauge should read **13,800 to 17,500 kPa (2,000 to 2,500 psi)**.
 - C. Record the tester pressure and flow readings under load.
- 13. Verify the traction relief valve operation as follows:
 - A. Return the traction pedal to the NEUTRAL position.
 - B. Fully close the flow meter flow control valve.
 - C. Slowly set the traction pedal to full forward position.
 - D. Record the tester pressure reading.

The system pressure should reach **26,200 to 26,545 kPa (3,800 to 3,850 psi)** before the relief valve opens.

Note: The relief valve setting is **25,000 kPa (3,625 psi)**. An additional **690 to 1,030 kPa (100 to 200 psi)** is necessary to overcome system charge pressure before the relief valve opens.

E. Release the traction pedal, open the flow control valve fully, press the engine speed switch to low speed, and shut off the engine.

- 14. If the relief pressure can not be met or is greater than specified, the traction relief valve is damaged and should be replaced.
- 15. The under load test flow reading (step 12C) should not drop more than 12% when compared to the no load test flow reading (step 11B). A difference of more than 12% may indicate the piston pump/hydrostat is worn and should be repaired or replaced.
- 16. After you complete the testing, disconnect the tester and connect the hose to the pump fitting.
- 17. Start the engine, check for hydraulic-fluid leaks, repair any leaks as required, and fill the hydraulic tank with the correct quantity of new hydraulic fluid before returning the machine to service.

Testing the Mow Circuit–Circuit Pressure



Figure 61

The cutting unit circuit pressure is the first in a series of tests recommended to check the cutting unit circuit performance. The results from this test will help determine which component(s) are the cause of cutting unit performance issues.

Special Equipment Required: Pressure gauge with extension hose.



2. Deck control manifold

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- 1. Ensure that the hydraulic fluid is at normal operating temperature by operating the machine for at least 10 minutes.
- 2. Park the machine on a level surface with the PTO switch off, lower the cutting decks, shut off the engine, set the mow speed limiter to the Mow position, and set the parking brake.
- 3. Read all Warning, Cautions, and precautions listed at the beginning of this section.
- 4. For testing the rear mow circuit, remove the cap from the test fitting at deck control manifold port (G1) and install a pressure gauge with hydraulic hose to the test fitting (Figure 62). If testing the front mow circuit, remove the cap from the test fitting at deck control manifold port (G2) and install a pressure gauge with hydraulic hose to the test fitting.

CAUTION

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Keep away from the cutting units during test to prevent personal injury from the cutting blades.

- 5. Sit in the operator's seat, start the engine, and press the engine speed switch to full speed **(3,005 to 3,055 rpm)** position. Use the InfoCenter to check that the engine speed is correct.
- Engage the cutting decks. When engaged, the cutting circuit pressure may exceed manifold relief valve pressure setting of 24,100 kPa (3,500 psi) for front mow circuit and 17,500 kPa (2,500 psi) for rear mow circuit momentarily opening the relief valve. The circuit pressure should then stabilize at approximately 8,274 kPa (1,200 psi).
- Safely secure the test pressure gauge and operate the machine under your specific mowing conditions. Monitor the test gauge while mowing. The cutting unit circuit pressure should be approximately: 10,340 to 13,800 kPa (1,500 to 2,000 psi) under low to normal load conditions.
- 8. Disengage the cutting units, press the engine speed switch to low speed (1,175 to 1,225 rpm) position, and shut off the engine.

- 9. If the pressure readings are within specifications and cutting deck performance is still in question, test the cutting deck motors individually; refer to Testing the Mow Circuit–Deck Motor Efficiency/Case Drain (page 4–62).
- 10. If the pressure specifications are not met, consider the following:
 - A. The proportional relief valve (PRV1 or PRV2) is damaged; refer to Testing the Mow Circuit–Relief Valve (PRV1) and (PRV2) Pressure (page 4–65)).
 - B. The gear pump (P1/P2) is damaged; refer to Testing the Mow Circuit–Gear Pump (P1) and (P2) Flow (page 4–69).
- 11. Disconnect the test equipment from the hydraulic manifold.

Testing the Mow Circuit–Deck Motor Efficiency/Case Drain



g189653

Figure 63

The deck motor efficiency/case drain test is the second in a series of tests recommended to check the cutting unit circuit performance. Over a period of time, a deck motor can wear internally. This test measures case drain volume while restricting flow across the motor ports. Case drain volume under load of more than 9% of total motor flow indicates the gears and wear plates in the motor have worn. A worn motor may bypass the hydraulic fluid to its case drain causing the motor to be less efficient. Eventually, enough fluid 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.

One method to find a failing or malfunctioning cutting 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.

Special Equipment Required: Flow meter with pressure gauge that has at least a 56.8 L/minute (15 gallons/minute) capacity.

Test Procedure

- 1. Ensure that the hydraulic fluid is at normal operating temperature by operating the machine for at least 10 minutes.
- 2. Determine which of the deck motor is suspect and begin testing with that motor.
- 3. Park the machine on a level surface with the PTO switch off, lower the cutting decks, shut off the engine, mow speed limiter is in the Mow position, and set the parking brake.

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Before opening the hydraulic system, operate all the hydraulic controls to release system pressure and avoid injury from the pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 4–6).

4. Read all Warning, Cautions, and precautions listed at the beginning of this section.



Note: The deck motors are connected in series. If a damaged deck motor is not obvious (based on quality of cut issues) you may have to test all 3 motors in the circuit. If testing all cutting deck motors, start with the first motor in the series (front left).

- 5. For the deck motor that is to be tested, clean the junction of the motor case drain hose (small diameter hose) where it is connected to the traction unit bulkhead (not at the motor) (Figure 64).
- 6. Disconnect the case drain hose and put a steel cap on the fitting at the traction unit. Leave the case drain hose from the motor open and place the open end of the disconnected hose into a drain pan.

IMPORTANT

Ensure that the fluid flow indicator arrow on the flow gauge is showing that the fluid will flow from the deck motor, through the tester, and into the return hose.

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- 7. For the deck motor that is to be tested, clean the junction of the hydraulic return hose and deck motor fitting at the motor outlet (Figure 64).
- 8. Disconnect the return hose from the motor, install a tester with the pressure gauge and flow meter in series with the motor and disconnected return hose. Ensure that the flow control valve on tester is fully open.

Note: Use a graduated container, the special tool TOR4077, to measure the case drain leakage (Figure 63).

9. Start the engine and run it at low-idle speed. Check for hydraulic-fluid leaks from the test connections and correct before continuing the test.

CAUTION

The cutting deck blades will rotate when you perform the motor efficiency test. Keep away from the cutting decks during the test to prevent personal injury from the rotating blades. Do not stand in front of the machine.

Note: This test requires 2 people (one in the seat and one at the cutting deck motor).

- 10. Sit on the seat with the engine running, press the engine speed switch to full speed **(3,005 to 3,055 rpm)** position. Use the InfoCenter to check that the engine speed is correct. Press the PTO switch to ON position, and engage the cutting decks.
- 11. Monitor the tester pressure gauge carefully while you slowly close the flow control valve until a pressure of **13,800 kPa (2,000 psi)** is obtained.
- 12. Have an assistant place the disconnected motor case drain hose into a container graduated in ounces or milliliters (Toro Part No. TOR4077) and collect the hydraulic fluid for 10 seconds.
- 13. After 10 seconds, remove the hose end from the container, and then move the PTO switch to OFF position, open the tester flow control valve, and shut off the engine.
- 14. Identify the amount of fluid collected in the container. Record the test results. If the flow was greater than 739 ml (25 fl oz) and 4.5 L/minute (1.18 gallons/minute), repair or replace the tested deck motor; refer to Servicing the Cutting Deck Motor (page 4–134).
- 15. After you complete the testing, shut off the engine. Disconnect the tester from the motor and return hose.
- 16. Connect the return hose to the deck motor, remove the plug from the machine bulkhead fitting, and connect the case drain hose to the fitting.
- 17. If necessary, perform the motor efficiency test on the other deck motors.

IMPORTANT

When testing more than one cutting unit motor, check and adjust the hydraulic-fluid level in the tank after testing each motor.

18. When testing is complete, start the engine, check for hydraulic-fluid leaks, repair any leaks as required, and fill the hydraulic tank with the correct quantity of new hydraulic fluid before returning the machine to service.

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Testing the Mow Circuit–Relief Valve (PRV1) and (PRV2) Pressure



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Figure 65

Test the performance of the deck control manifold proportional relief valves (PRV1) and (PRV2) to ensure that the maximum amount of fluid is available to the cutting deck motors up to the set relief pressure. This test also ensures that pump (P1) or (P2) are capable of generating enough pressure to open properly functioning proportional relief valves.

Note: The front cutting deck circuit is supplied by pump (P2) and is protected by a proportional relief valve (PRV2) in the deck control manifold. The rear cutting deck circuit is supplied by pump (P1) and is protected by proportional relief valve (PRV1); refer to the Hydraulic Flow Diagrams (page 4–16).

Special Equipment Required: Flow meter with pressure gauge that has at least a 56.8 L/minute (15 gallons/minute) capacity.

1. Park the machine on a level surface with the PTO switch off, lower the cutting decks, shut off the engine, mow speed limiter is in the MOW position, and set the parking brake.

Before opening the hydraulic system, operate all the hydraulic controls to release system pressure and avoid injury from the pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 4–6).



1. #4 cutting deck motor

2. Deck motor inlet hose



2. Read all Warning, Cautions, and precautions listed at the beginning of this section.

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- 3. To test the front cutting unit circuit relief valve PRV2, clean and disconnect the inlet hose to the #4 (front left) cutting deck motor (Figure 66).
- 4. To test the rear cutting unit circuit relief valve PRV1, clean and disconnect the inlet hose to the #2 (rear left) cutting deck motor (Figure 67).

IMPORTANT

Ensure that the fluid flow indicator arrow on the flow meter is showing that the fluid will flow from the disconnected hose, through the tester, and into the deck motor.

- 5. Install a tester with the pressure gauge and flow meter in series with the disconnected hose and the deck motor. Ensure that the flow control valve on tester is fully open.
- 6. Ensure that the hydraulic fluid is at normal operating temperature by operating the machine for at least 10 minutes.
- 7. With the engine running, press the engine speed switch to full speed (3,005 to 3,055 rpm) position. Use the InfoCenter to check that the engine speed is correct.

WARNING

Keep away from the cutting deck during the test to prevent personal injury.

8. Have a second person to occupy the seat, press the PTO switch to ON position, and then move the joystick lever forward to engage the cutting decks.

IMPORTANT

Do not hold over relief for longer than necessary to obtain the pressure reading, while you perform this test.

9. Monitor the pressure gauge carefully while you slowly close the tester flow control valve. As the relief valve lifts, the pressure gauge needle will momentarily stop.

Note: The system pressure will continue to increase, once the relief valve is opened.

- 10. Once the relief valve lifts, the system pressure should be:
 - Approximately 17,500 kPa (2,500 psi) for the relief valve (PRV1)
 - Approximately 24,100 kPa (3,500 psi) for the relief valve (PRV2)
- 11. Open the tester flow control valve, disengage the cutting decks and shut off the engine.
- 12. If the pressure is incorrect, remove the PRV valve on the mow manifold, and clean or replace the valve; refer to the Servicing the Deck Control Manifold Assembly (page 4–127).
- 13. If you are not able to obtain relief pressure, check for a restriction in the pump intake line and/or check the gear pump (P2) (front cutting deck circuit) and/or

pump (P1) (rear cutting deck circuit) for wear, damage, or inefficiency; refer to Testing the Mow Circuit–Gear Pump (P1) and (P2) Flow (page 4–69).

- 14. After you complete the testing, shut off the engine, and then release hydraulic system pressure; refer to Releasing Pressure from the Hydraulic System (page 4–6). Disconnect the tester from the machine and connect the hydraulic hose to the deck motor fitting.
- 15. Start the engine, check for hydraulic-fluid leaks, repair any leaks as required, and fill the hydraulic tank with the correct quantity of new hydraulic fluid before returning the machine to service.

Testing the Mow Circuit–Gear Pump (P1) and (P2) Flow



g192620

Figure 68

The gear pump (P1) and (P2) flow test is the last in a series of tests recommended to determine cutting unit circuit performance. The gear pump P1 supplies hydraulic flow to the rear cutting decks, while gear pump P2 provides hydraulic flow to the front cutting decks.

This test compares fluid flow at No Load with fluid flow Under Load. A drop in flow under load of more than 15% indicates the gears and wear plates in the pump have worn. A worn pump may bypass the hydraulic fluid that reduces the pump efficiency. After sometime, sufficient fluid loss causes the deck to stall under heavy load conditions. Continued operation with a worn, inefficient pump can generate excessive heat and cause damage to the seals and other components in the hydraulic system.

Special Equipment Required: Flow meter with pressure gauge that has at least a 56.8 L/minute (15 gallons/minute) capacity.

1. Park the machine on a level surface with the PTO switch off, lower the cutting decks, shut off the engine, mow speed limiter is in the Mow position, and set the parking brake.



Before opening the hydraulic system, operate all the hydraulic controls to release system pressure and avoid injury from the pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 4-6).

2. Read all Warning, Cautions, and precautions listed at the beginning of this section.



Pump P1 outlet hose 1.

3. Gear pump assembly

- Pump P2 outlet hose 2
- 3. Lift and support the operator seat to get access to the hydraulic pump.
- 4. Identify the suspect pump section that is to be tested (Figure 69).
- 5. Clean the junction of the gear pump fitting and the hydraulic outlet hose, and then disconnect the hose from the pump fitting:
 - Pump section (P1) for the rear cutting decks.
 - Pump section (P2) for the front cutting decks.

IMPORTANT

Ensure that the fluid flow indicator arrow on the flow gauge is showing that the fluid will flow from the gear pump, through the tester, and into the hose. The engine needs to be started with the tester connected. Route the tester hoses so that the tester can be read while operator seat is fully lowered and occupied.

6. Install a tester with the pressure gauge and flow meter in series between the disconnected hose and the gear pump fitting. Ensure that the flow control valve on the tester is fully open.

- 7. Ensure that the hydraulic fluid is at normal operating temperature by operating the machine for at least 10 minutes.
- 8. Start the engine and run it at low-idle speed. Check for hydraulic-fluid leaks from the test connections and correct before continuing the test.
- With the engine running, press the engine speed switch to full speed (3,005 to 3,055 rpm) position. Do not engage the cutting decks. Use the InfoCenter to check that the engine speed is correct.
- 10. Verify the pump flow at No Load as follows:

Record the tester pressure and flow readings at no load. Unrestricted pump output should be approximately **51.2** L/minute (13.6 gallons/minute).

11. Verify the pump flow Under Load as follows:



Do not close the tester valve fully when performing this test. In this test, the hydraulic tester is positioned before the manifold relief valve.

Pump damage can occur if the fluid flow is fully restricted by fully closing the tester flow control valve.

- A. Monitor the tester pressure gauge carefully while you slowly close the flow control valve until you get **10,340 kPa (1,500 psi)**.
- B. Record the tester pressure and flow readings under load.
- 12. Press the engine speed switch to low speed **(1,175 to 1,225 rpm)** position and shut off the engine.
- 13. The under load test flow reading (step 11B) should not drop more than 15% when compared to the no load test flow reading (step 10A). A difference in flow of more than 15%, or the inability to achieve specified pressure may indicate:
 - A. A restriction in the pump inlet line.
 - B. The gear pump being tested is worn and should be repaired or replaced; refer to Servicing the Gear Pump (page 4–107).
- 14. Release pressure from the hydraulic system; refer to Releasing Pressure from the Hydraulic System (page 4–6).
- 15. Disconnect the tester from the machine and connect the hydraulic hose to the gear pump fitting.
- 16. Start the engine, check for hydraulic-fluid leaks, repair any leaks as required, and fill the hydraulic tank with the correct quantity of new hydraulic fluid before returning the machine to service.
- 17. Lower and secure the operator seat.

Testing the Steering Circuit–Steering Control Valve, Relief Valve (R10) Pressure, and Steering Cylinder



Unit steering performance will be affected by incorrect rear tire pressure, binding in the hydraulic steering cylinder, extra weight on the vehicle, and/or binding of the steering forks. Ensure that these conditions are checked and functioning properly before proceeding with any steering system hydraulic testing.

Note: The relief valve for the steering circuit is integrated into the steering control valve.

Test Procedure

- 1. Ensure that the hydraulic fluid is at normal operating temperature by operating the machine for at least 10 minutes.
- 2. Drive the machine slowly in a figure eight on a flat level surface.
 - A. There should be no shaking or vibration in the steering wheel or rear wheels.
 - B. The steering wheel movements should be followed immediately by a corresponding rear wheel movement without the steering wheel continuing to turn.
- 3. Stop unit with the engine running. Turn the steering wheel with small quick movements in both directions. Let go of the steering wheel after each movement.
 - A. The steering control valve should respond to each steering wheel movement.
 - B. When steering wheel is released, steering control should return to the neutral position with no additional turning.
- 4. If either of these performance tests indicate a steering problem, determine if the steering cylinder is damaged using the following procedure:
 - A. Park the machine on a level surface with the PTO switch off, lower the cutting units, and set the parking brake.
 - B. With the engine running, turn the steering wheel to the right (clockwise) until the steering cylinder rod is fully extended and shut off the engine.
 - C. Read all Warning, Cautions, and precautions listed at the beginning of this section.
 - D. Clean the fitting and hose end, disconnect the hydraulic hose from the fitting on the rod end of the steering cylinder.
 - E. Use an elbow or a tee fitting with a hole plugged and install a pressure gauge at the end of the disconnected hose.
 - F. With the engine off, continue turning the steering wheel to the right (clockwise) with the steering cylinder fully extended. Monitor the open fitting on the steering cylinder as the wheel is turned. If the hydraulic fluid comes out of the fitting while turning the steering wheel to the left, the steering cylinder has internal leakage and should be repaired or replaced.
- 5. The steering circuit relief valve located in the steering control valve can be tested with the pressure gauge installed in the same location as the steering cylinder test (step 4) as follows:
 - A. Start the engine and run it at low-idle speed. Check for hydraulic-fluid leaks from the test connections and correct before continuing the test.
 - B. Set the engine speed to approximately 2,000 rpm. Use the InfoCenter to check that the engine speed is correct.

IMPORTANT

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

C. Monitor the pressure gauge carefully when turning the steering wheel for a right hand turn (clockwise) and holding.

- D. The system pressure should be approximately **6,900 kPa (1,000 psi)** as the relief valve lifts.
- E. Return the steering wheel to the NEUTRAL position, shut off the engine, and record the test results.
- 6. If the specification is not met, repair or replace the steering control valve; refer to Servicing the Steering Control Valve (page 4–154).
- After you complete the testing, shut off the engine, and then release hydraulic system pressure; refer to Releasing Pressure from the Hydraulic System (page 4–6). Disconnect the pressure gauge, and connect removed hydraulic hose to the steering cylinder.
- 8. Start the engine, check for hydraulic-fluid leaks, repair any leaks as required, and fill the hydraulic tank with the correct quantity of new hydraulic fluid before returning the machine to service.

Testing the Steering Circuit–Gear Pump (P3) Flow



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Figure 71

The gear pump (P3) is designed to satisfy the steering cylinder needs (at full speed). The gear pump (P3) flow test compares fluid flow at No Load with fluid flow Under Load. A drop in flow under load of more than 15% indicates the gears and wear plates in the pump have worn. Continued operation with a worn pump can generate excessive heat and cause damage to the seals and other components in the hydraulic system.

Special Equipment Required: Flow meter with pressure gauge that has at least a 16 L/minute (5 gallons/minute) capacity.

Test Procedure

- 1. Park the machine on a level surface with the PTO switch off, lower the cutting decks, shut off the engine, and set the parking brake.
- 2. Read all Warning, Cautions, and precautions listed at the beginning of this section.



CAUTION

Before opening the hydraulic system, operate all the hydraulic controls to release system pressure and avoid injury from the pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 4–6).

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3. Lift and support the operator seat to get access to the hydraulic pump assembly.



4. Clean both ends of the hydraulic tube that connects the charge filter outlet with the traction pump (Figure 72). Disconnect both ends of the hydraulic tube and remove it from the machine. Plug both ends of the removed hydraulic tube to prevent system contamination.

IMPORTANT

Ensure that the fluid flow indicator arrow on the flow meter is showing that the fluid will flow from the hydraulic tube, through the tester, and into the traction pump.

- 5. Install a tester with the pressure gauge and flow meter in place of the removed hydraulic tube. Connect the tester inlet hose to the charge filter fitting and outlet hose to the traction pump fitting. Ensure that the flow control valve on the tester is fully open.
- 6. Ensure that the hydraulic fluid is at normal operating temperature by operating the machine for at least 10 minutes.
- 7. Ensure that the traction pedal is in the NEUTRAL position, steering wheel is stationary, and parking brake is set.
- 8. Start the engine and run it at low-idle speed **(1,175 to 1,225 rpm)**. Check for hydraulic-fluid leaks from the test connections and correct before continuing the test.
- 9. With the engine running, press the engine speed switch to full speed (3,005 to 3,055 rpm) position. Use the InfoCenter to check that the engine speed is correct.
- 10. Verify the pump flow at No Load as follows:

Record the tester pressure and flow readings at no load. Unrestricted pump output should be approximately **18.5 L/minute (4.9 gallons/minute)**.

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11. Verify the pump flow Under Load as follows:

CAUTION

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Do not close the tester valve fully when performing this test. In this test, the hydraulic tester is positioned in an unprotected part of the steering circuit.

Pump damage can occur if the fluid flow is fully restricted by fully closing the tester flow control valve.

- A. Monitor the tester pressure gauge carefully while you slowly close the flow control valve until you get **5,500 kPa (800 psi)**.
- B. Record the tester pressure and flow readings under load.
- 12. Press the engine speed to low speed **(1,175 to 1,225 rpm)** position and shut off the engine.
- 13. The under load test flow reading (step 11B) should not drop more than 15% when compared to the no load test flow reading (step 10A). A difference in flow of more than 15%, or the inability to achieve specified pressure may indicate:
 - A. A restriction in the pump inlet line.
 - B. The gear pump (P3) is worn and should be repaired or replaced; refer to Servicing the Gear Pump (page 4–107)
- 14. After you complete the testing, shut off the engine, and then release pressure from the hydraulic system; refer to Releasing Pressure from the Hydraulic System (page 4–6).
- 15. Disconnect the tester, and connect the removed hydraulic tube.
- 16. Start the engine, check for hydraulic-fluid leaks, repair any leaks as required, and fill the hydraulic tank with the correct quantity of new hydraulic fluid before returning the machine to service.
- 17. Lower and secure the operator seat.

Testing the lift Circuit–Relief Valve (PRV) Pressure



Perform the lift relief valve (PRV) pressure test to ensure that the lift circuit relief pressure is correct.

Test Procedure

- 1. Ensure that the hydraulic fluid is at normal operating temperature by operating the machine for at least 10 minutes.
- 2. Park the machine on a level surface with the PTO switch off, lower the cutting decks, shut off the engine, mow speed limiter is in the Mow position, and set the parking brake.
- 3. Read all Warning, Cautions, and precautions listed at the beginning of this section.



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Lift control manifold

1. PRV solenoid

2. Test port (G4)

- 4. Clean the test port (G4) on the bottom of lift control manifold, and then connect a **35,000 kPa (5,000 psi)** pressure gauge to the test port (Figure 74).
- 5. After installing the pressure gauge to the manifold test port, start the engine and run it at low-idle speed. Check for hydraulic-fluid leaks from the test connections and correct before continuing the test.
- 6. Press the engine speed switch to full speed **(3,005 to 3,055 rpm)** position. Use the InfoCenter to check that the engine speed is correct.

IMPORTANT

Do not allow the pressure to exceed 17,500 kPa (2,500 psi).

IMPORTANT

When performing this test, hold the joystick lever in the RAISE position, only long enough to get a system pressure reading. Holding the lever in RAISE for an extended period may damage system components.

- 7. Ensure that the PTO switch is OFF, and then pull the joystick lever rearward to pressurize the lift circuit. While holding lever in the RAISE (rearward) position, monitor the pressure gauge carefully.
- 8. When the cutting decks reach the fully raised position and the lift relief valve lifts, the system pressure should be approximately **13,800 kPa (2,000 psi)**.
- 9. Return the joystick lever to the NEUTRAL position, and shut off the engine.

- 10. If the measured pressure is incorrect, remove the pressure reducing valve (PRV) from the lift control manifold and clean or replace the valve; refer to Servicing the Lift Control Manifold (page 4–142).
- Also, if the lift circuit pressure is low, check for the restriction in gear pump inlet line. The Internal lift cylinder leakage would also cause low lift circuit pressure; refer to Testing the Lift Circuit–Lift Cylinder Internal Leakage (page 4–81). The gear pump (P4) could also be suspected for wear, damage or inefficiency; refer to Testing the Lift Circuit–Gear Pump (P4) Flow (page 4–84).
- 12. After you complete the testing, shut off the engine, and disconnect the pressure gauge from the lift control manifold test port.
- 13. Start the engine, check for hydraulic-fluid leaks, repair any leaks as required, and fill the hydraulic tank with the correct quantity of new hydraulic fluid before returning the machine to service.

Testing the Lift Circuit–Lift Cylinder Internal Leakage



Perform a lift cylinder internal leakage test if you identify a cutting deck raise and lower problem. This test determines if the lift cylinder being tested is damaged. The lift cylinders must be tested individually.

Note: The raise/lower circuit operation can be affected by the lift cylinder binding, extra weight on the cutting deck, and/or binding of the lift components. Ensure that these items are checked before continuing with the lift cylinder internal leakage test.

Test Procedure



Note: When performing the lift cylinder internal leakage test, the cutting decks should be attached to the lift arms.

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Figure 76

1. #5 lift cylinder

3. Hydraulic hose

- 2. Cylinder rod end fitting
- 1. Park the machine on a level surface with the PTO switch off, position the cutting decks in the turn-around position, shut off the engine, and set the parking brake.
- 2. For the lift cylinder that is to be tested, use a jack to raise the lift arm slightly. This removes the load from the lift cylinder and releases the lift cylinder hydraulic pressure.
- 3. Support the lift arm with jack stands to prevent the lift arm from lowering.

Note: If either of the rear lift cylinders is being tested, both the rear lift arms need to be supported.

 Clean the area around the hydraulic hose end at the rod end of the lift cylinder. Disconnect the hydraulic hose from the lift cylinder barrel end fitting (Figure 76).

IMPORTANT

When capping the lift cylinder fitting and hydraulic hose end, use a steel cap and plug to ensure that there is no fluid leakage. The plastic plugs cannot hold the hydraulic pressure that is developed during this test procedure.

- 5. Install a steel cap on the open lift cylinder fitting to seal the lift cylinder. Also, install a steel plug in the open end of the disconnected hose to prevent leakage or contamination.
- 6. Raise the lift arm slightly with a jack and remove the jack stand, then lower and remove the jack.
- 7. The capped lift cylinder should be able to support the cutting deck long enough for the machine to move from one cutting area to another during operation.
Test Procedure (continued)

- 8. If the lift cylinder allows the cutting deck to lower too quickly, replace or repair the lift cylinder; refer to Lift Cylinder (page 4–144) and Servicing the Lift Cylinder (page 4–147).
- 9. Once the lift cylinder condition is determined, use a jack to raise lift arm slightly which removes the load from the lift cylinder.
- 10. Support the lift arm with jack stands to prevent it from lowering.
- 11. Remove the cap from the cylinder fitting and the plug from the hydraulic hose.
- 12. Connect the hydraulic hose to the lift cylinder fitting.
- 13. Carefully remove the jack from under the lift arm. Start the engine and operate the lift cylinders through several up and down cycles. Shut off the engine and check for any leakage.
- 14. If necessary, repeat the steps 2 through 13 for other lift cylinders.
- 15. Check and fill the hydraulic tank with the correct quantity of new hydraulic fluid before returning the machine to service.

Testing the Lift Circuit–Gear Pump (P4) Flow



The gear pump (P4) is designed to satisfy the lift cylinder needs (at full speed). The gear pump (P4) flow test compares fluid flow at No Load with fluid flow Under Load. A drop in flow under load of more than 15% indicates the gears and wear plates in the pump have worn. Continued operation with a worn pump can generate excessive heat and cause damage to the seals and other components in the hydraulic system.

Special Equipment Required: Flow meter with pressure gauge that has at least a 16 L/minute (5 gallons/minute) capacity.

Note: If the flow from gear pump (P4) is low, the operation of all the lift cylinders will be affected.

Test Procedure

1. Park the machine on a level surface with the PTO switch off, lower the cutting decks, shut off the engine, mow speed limiter is in the Mow position, and set the parking brake.

Before opening the hydraulic system, operate all the hydraulic controls to release system pressure and avoid injury from the pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 4–6).

2. Read all Warning, Cautions, and precautions listed at the beginning of this section.



- 3. Lift and support the operator seat and remove the floor plate to get access to the hydraulic pump.
- 4. Clean the hydraulic hose end and the pump fitting at the outlet of pump (P4) (Figure 78).

IMPORTANT

Ensure that the fluid flow indicator arrow on the flow gauge is showing that the fluid will flow from the pump (P4), through the tester, and to the lift control manifold.

- 5. Connect the tester inlet to the pump fitting, and connect the tester outlet to the disconnected hydraulic hose. Ensure that the flow control valve on tester is fully open.
- 6. Start the engine and run it at low-idle speed. Check for hydraulic-fluid leaks from the test connections and correct before continuing the test.
- With the engine running, press the engine speed switch to full speed (3,005 to 3,055 rpm) position. Use the InfoCenter to check that the engine speed is correct.

Test Procedure (continued)

8. Verify the pump flow at No Load as follows:

Record the tester pressure and flow readings at no load. Unrestricted pump output should be approximately **11.9 L/minute (3.2 gallons/minute)**.

9. Verify the pump flow Under Load as follows:

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CAUTION

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Do not close the tester valve fully when performing this test. In this test, the hydraulic tester is positioned before the manifold relief valve.

Pump damage can occur if the fluid flow is fully restricted by fully closing the tester flow control valve.

- A. Monitor the tester pressure gauge carefully while you slowly close the flow control valve until you get **8,274 kPa (1,200 psi)**.
- B. Record the tester pressure and flow readings under load.
- 10. Press the engine speed switch to low speed (1,175 to 1,225 rpm) position and shut off the engine.
- 11. The under load test flow reading (step 9B) should not drop more than 15% when compared to the no load test flow reading (step 8). A difference in flow of more than 15%, or the inability to achieve specified pressure may indicate:
 - A. A restriction in the pump inlet line.
 - B. The gear pump (P4) is worn and should be repaired or replaced; refer to Servicing the Gear Pump (page 4–107)
- 12. After you complete the testing, shut off the engine, and then release pressure from the hydraulic system; refer to Releasing Pressure from the Hydraulic System (page 4–6).
- 13. Remove the tester, and connect the hydraulic hose to the gear pump (P4) outlet.
- 14. Start the engine, check for hydraulic-fluid leaks, repair any leaks as required, and fill the hydraulic tank with the correct quantity of new hydraulic fluid before returning the machine to service.
- 15. Install the floor plate, lower and secure the operator seat.

Service and Repairs

General Precautions for Removing and Installing the Hydraulic System Components

Before Repairing or Replacing the Components

- 1. Before removing any parts from the hydraulic system, park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
- 2. Clean the machine before you disconnect, remove, or disassemble the hydraulic components.

Note: Cleanliness is necessary whenever you work on the hydraulic equipment. Ensure that you clean the hydraulic components, hoses, connections, and fittings.

- 3. Label all the disconnected hydraulic lines and hoses for proper installation after repairs are completed.
- 4. Note the position of the hydraulic fittings (especially elbow fittings) on the hydraulic components before removal.

Note: Mark the parts, if necessary before removal and ensure that they are aligned properly when installing the hydraulic fittings, hoses, and tubes.

CAUTION

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Before opening the hydraulic system, operate all the hydraulic controls to release system pressure and avoid injury from the pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 4–6).

- 5. The hydraulic fluid may be hot. Be careful when you loosen and remove the hydraulic system components.
- 6. Install clean caps or plugs on the hydraulic lines, hydraulic fittings, and components that are left open or exposed to prevent hydraulic system contamination. Cap the opening as soon as the line or port is exposed.

After Repairing or Replacing the Components

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1. Check the hydraulic-fluid level in the hydraulic tank and add correct quantity of fluid if necessary. Use the hydraulic fluids that are specified in the *Operator's Manual*.

IMPORTANT

Drain and fill the hydraulic tank and change the oil filter if the component failure is severe or the system is contaminated; refer to Flushing the Hydraulic System (page 4–89).

- 2. If a component failure occurred in the closed-loop traction circuit (e.g., piston pump or wheel motor), filtering the traction circuit is necessary; refer to Filtering the Closed-Loop Traction Circuit (page 4–91).
- 3. Lubricate the O-rings and seals with clean hydraulic fluid before installing the hydraulic components.

After Repairing or Replacing the Components (continued)

- 4. Remove all the caps or plugs from the hydraulic tubes, hydraulic fittings, and components before connecting them again.
- 5. Use proper tightening procedures when installing the hydraulic hoses and fittings; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 4–9) and Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 4–11).
- 6. After you complete the repairs, check the control linkages or cables for proper adjustment, binding, or broken parts.
- 7. After you complete the repairs, clean the hydraulic components, hose connections, and fittings to prevent future accumulation of dirt and unwanted material on the hydraulic components.
- 8. After you disconnect or replace any hydraulic components, operate the machine functions slowly until the air is out of the system; refer to Charging the Hydraulic System (page 4–94).
- 9. Check for hydraulic-fluid leaks. Shut off the engine and repair leaks if necessary.
- 10. Check the hydraulic-fluid level in the hydraulic tank and add correct quantity of fluid if necessary.

Checking the Hydraulic Lines and Hoses

WARNING

Hydraulic fluid escaping under pressure can penetrate skin and cause injury.

- Ensure that all hydraulic-fluid hoses and lines are in good condition and all hydraulic connections and fittings are tight before applying pressure to the hydraulic system.
- Keep your body and hands away from pinhole leaks or nozzles that eject high-pressure hydraulic fluid.
- Use a piece of cardboard or paper to find hydraulic leaks.
- Release all pressure in the hydraulic system before performing any work on the system.
- Seek immediate medical attention if hydraulic fluid is injected into your skin.

IMPORTANT

Check the hydraulic lines and hoses daily for leaks, kinked lines, loose mounting supports, wear, loose fittings, and hose deterioration. Repair the damaged hydraulic lines and hoses before operating the machine.

Priming the Hydraulic Pumps

When the hydraulic system is flushed, the hydraulic system is charged, or the hydraulic components are installed, it is important to properly prime the hydraulic pumps. The hydraulic pump priming ensures that the gear pump and piston

Priming the Hydraulic Pumps (continued)

(traction) pump have sufficient fluid during initial start-up and running. The pumps can be primed by using a remote starter switch (refer to Special Tools (page 4-31)) to crank the engine which allows the pumps to prime.

Use the following procedure to prime the hydraulic pumps:

- 1. Ensure that the key switch is in the OFF position and the key is removed from the key switch.
- 2. Check the hydraulic-fluid level in the hydraulic reservoir and add correct quantity of fluid if necessary; refer to the Operator's Manual.



Note: A blue wire connects to the starter motor solenoid B+ terminal (Figure 79). It is not necessary to remove this blue wire from the solenoid terminal for hydraulic pump priming.

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

Flushing the Hydraulic System

2

IMPORTANT

Flush the hydraulic system whenever there is a severe component failure or the system is contaminated (for example, the fluid appears milky, black, or contains metal particles).

IMPORTANT

If a component failure occurs in the traction circuit; refer to the Traction Circuit Component Failure (page 4–7) for information regarding the importance of removing contamination from the traction circuit.

1. Ensure that the hydraulic fluid is at normal operating temperature by operating the machine for at least 20 minutes.

A CAUTION

Before opening the hydraulic system, operate all the hydraulic controls to release system pressure and avoid injury from the pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 4–6).

2. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.

Note: Ensure that you clean all the hydraulic connections that are disconnected for draining.

- 3. Drain the hydraulic fluid from the hydraulic tank. Remove the tank cap, screen filter, and clean the tank. Consider removing and cleaning the reservoir if necessary.
- 4. Clean the area around the mounting areas of the hydraulic-fluid filters. Remove and replace the hydraulic-fluid filters.
- 5. Inspect and clean the hydraulic tank; refer to Inspecting the Hydraulic Tank (page 4–97).
- 6. Drain the complete hydraulic system. Drain all the hoses, tubes, and components while the system is warm. Flush the hoses and tubes to remove any contamination.
- 7. Ensure that the mounting surfaces of the hydraulic-fluid filters are clean. Apply clean hydraulic fluid to the gasket on new filters. Tighten the filters until the gasket contacts the mounting plate, then tighten the filter 3 quarters of a turn.

IMPORTANT

Using other hydraulic fluids could damage the hydraulic system. Use the hydraulic fluids that are specified in the *Operator's Manual*.

- 8. Fill the hydraulic tank with the correct quantity of new hydraulic fluid.
- 9. Prime the hydraulic pumps; refer to Priming the Hydraulic Pumps (page 4–88).
- 10. Start the engine and operate it at low-idle speed (1,175 to 1,225 rpm) for a minimum of 2 minutes. Increase the engine speed to high idle (3,005 to 3,055 rpm) for a minimum of 1 minute under no load.
- 11. Raise and lower the cutting decks several times. Turn the steering wheel fully left and right several times.

A

Flushing the Hydraulic System (continued)

- 12. Move the PTO switch to the ON position to engage the cutting decks and let them run for several minutes. Move the PTO switch to the OFF position.
- 13. Shut off the engine and check for hydraulic-fluid leaks.

Note: Check the hydraulic-fluid level in the hydraulic tank and add correct quantity of fluid if necessary; refer to the *Operator's Manual*.

- 14. Operate the machine for 2 hours under normal operating conditions.
- 15. Check the condition of hydraulic fluid. If new fluid shows any signs of contamination, repeat steps 1 through 14 again until the fluid is clean.
- 16. When the hydraulic fluid is free from contamination, assume normal operation and follow the recommended maintenance intervals.

Filtering the Closed-Loop Traction Circuit



Filtering a closed-loop hydraulic system after a major component failure (e.g., traction (piston) pump or wheel motor) is necessary to prevent unwanted material from transmitting throughout the system. If a closed-loop hydraulic system filtering tool is not used to ensure the system cleanliness, repeat failures, as well as subsequent damage to other hydraulic components in the affected system, will occur. To effectively remove the contamination from the closed-loop traction circuit, use the Toro high flow hydraulic filter and hydraulic hose kits (refer to Special Tools (page 4–31)).

1. Park the machine on a level surface, shut of the engine, and remove the key from the key switch.

IMPORTANT

Before lifting the machine with a jack, review and follow Jacking Instructions (page 1–6).

2. Lift and support the machine so that all the wheels are off the ground.

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

- 3. Clean the junction of the hydraulic hose and left elbow fitting at the bottom of the traction pump (Figure 80). Disconnect the hose from the left pump fitting.
- 4. Connect the Toro high flow hydraulic filter in series between the traction pump fitting and disconnected hose. Use the hydraulic hose kit (refer to Special Tools (page 4–31)) to connect the filter to the machine. Ensure that the fitting and hose connections are properly tightened.

IMPORTANT

Using other hydraulic fluids could damage the hydraulic system. Use the hydraulic fluids that are specified in the *Operator's Manual*.

- 5. After you install the high-flow filter to the machine, check and fill the hydraulic tank with the correct quantity of new hydraulic fluid.
- 6. Start the engine and run it at low-idle speed **(1,175 to 1,225 rpm)**. Check for hydraulic-fluid leaks at the filter and hose connections. Correct any leaks before you proceed.

A

CAUTION

During this procedure, all the wheels will be off the ground and rotating.

Ensure that the machine is well supported so it will not move and accidentally fall to prevent injuring anyone around the machine.

IMPORTANT

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

7. With the 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 the traction circuit engaged in forward for 5 minutes while gradually increasing both forward pressure on the traction pedal and engine speed. Monitor the filter indicator to ensure that the green color is showing during operation.

A

Filtering the Closed-Loop Traction Circuit (continued)

8. With the engine running at high-idle speed **(3,005 to 3,055 rpm)** and traction pedal moved to the forward direction, periodically apply brakes to increase pressure in the traction circuit. While monitoring the filter indicator, continue this process for 5 more minutes.

IMPORTANT

If you are using a filter that is not the Toro high flow filter that is bi-directional, do not press the traction pedal in the reverse direction. If the flow is reversed when using a filter that is not bi-directional, unwanted material from the filter will again enter the traction circuit.

- 9. With the engine running at high-idle speed, alternately move the traction pedal from forward to reverse. While monitoring the filter indicator, continue this process for 5 more minutes.
- 10. Shut off the engine and remove the key from the key switch.
- 11. Remove the high flow hydraulic filter and hydraulic hose kit from the machine. Connect the hydraulic hose to the left piston (traction) pump fitting. Ensure that you properly tighten the hoses; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 4–9).
- 12. Lower the machine to the ground.
- 13. Check the hydraulic-fluid level in the hydraulic tank and add correct quantity of fluid if necessary; refer to the *Operator's Manual*.

Charging the Hydraulic System

Note: When initially starting the hydraulic system with new or rebuilt components such as pumps, wheel motors, or lift cylinders, it is important that the hydraulic system is charged properly. Remove the air from the system and its components to reduce the chance of damage.

IMPORTANT

Change the hydraulic-fluid filters when you repair or replace the hydraulic components.

- 1. Park the machine on a level surface and shut off the engine.
- 2. After the hydraulic system components have been properly installed and if the traction pump was rebuilt or replaced, ensure that the traction pump housing is at least half full of clean hydraulic fluid.
- 3. Ensure that all of the hydraulic connections, lines, and components are secured tightly.

Note: Flush and fill the hydraulic system and tank whenever there is a severe component failure or the system is contaminated; refer to Flushing the Hydraulic System (page 4–89).

- 4. Ensure that the hydraulic tank is full. Add correct quantity of hydraulic fluid if necessary; refer to the *Operator's Manual*.
- 5. Check the control linkage for proper adjustment, binding, or damaged parts.
- 6. Prime the hydraulic pumps; refer to Priming the Hydraulic Pumps (page 4–88).

IMPORTANT

Before lifting the machine with a jack, review and follow Jacking Instructions (page 1–6).

7. Lift and support the machine with jack stands so that all the drive wheels are off the ground.



Ensure that the machine is safely supported so that it does not move or accidentally fall and prevent injuring anyone under the machine.

8. Ensure that the traction pedal is in the NEUTRAL position. Start the engine and run it at low-idle speed (1,175 to 1,225 rpm).

Note: The hydraulic pumps must pick up the hydraulic fluid and fill the hydraulic system. If there is no indication of fill in 30 seconds, shut off the engine and find the cause.

- 9. After the hydraulic system starts to show the signs of fill, actuate a joystick switches until the lift cylinder rod moves in and out several times.
- 10. If the lift cylinder does not move after 3 to 5 seconds or if the pump emits abnormal sounds, shut off the engine immediately, and find the cause or problem. Inspect for the following:
 - A. The oil filter or suction lines that are loose.
 - B. An incorrect hose routing.

A

Charging the Hydraulic System (continued)

- C. The suction line that is blocked.
- D. The charge relief valve in the traction pump that is damaged.
- E. The gear pump that is damaged.
- 11. After the lift cylinder moves normally, proceed to step 12.
- 12. Turn the steering wheel in both directions so that the steering cylinders move in and out several times.
- 13. Operate the traction pedal in the forward and reverse directions. The drive wheels should rotate in the proper direction. If the wheels rotate in the wrong direction, shut off the engine, inspect the hydraulic line placement at the traction pump and wheel motors. Correct the hydraulic line installation before you proceed.
- 14. Ensure that the traction pedal returns to the NEUTRAL position when released from the forward or reverse direction and adjust if necessary.
- 15. Check the operation of the traction interlock switches; refer to Checking the Operation of the Interlock Switches (page 5–40).
- 16. Shut off the engine and lower the machine to the ground.
- 17. If the traction pump was replaced or rebuilt, operate the traction circuit so that all the wheels rotate slowly for 10 minutes.
- 18. Operate the machine by gradually increasing its work load to full over a 10 minute period.
- 19. Stop the machine. Check the hydraulic-fluid level in the hydraulic tank and add correct quantity of fluid if necessary; refer to the *Operator's Manual*.
- 20. Check the hydraulic components for leaks and tighten any loose connections.

Hydraulic Tank



- 5. Gear pump
- Flange nut (3 each) 6.
- 7. Recess bumper
- 8. Flat washer

- 13. O-ring
- Hydraulic hose 14.
- 15. O-ring
- 16. Adapter

- 21. Screen filter
- 22. Hydraulic tank cap

Removing the Hydraulic Tank

- 1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
- 2. Clean the hydraulic hose ends and fittings on the hydraulic tank to prevent contaminants from entering into the hydraulic system.
- 3. For assembly purposes, label all the hydraulic hoses and fittings.
- 4. Disconnect the hydraulic hose (item 14 in Figure 81) from the adapter fitting at the bottom of the hydraulic tank, and drain the hydraulic fluid from the tank into a suitable container.
- 5. Remove the remaining hydraulic hoses from the fittings on the hydraulic tank and drain the hoses into a suitable container.
- 6. Install clean caps or plugs on the hydraulic hoses and fittings to prevent system contamination.
- 7. Remove the hydraulic tank from the machine (Figure 81).
- 8. Remove the tank strainer (item 2 in Figure 81) from the hydraulic tank and discard the O-ring from the tank strainer.
- 9. If the hydraulic fittings are to be removed from the hydraulic tank, mark the fitting orientation for assembly purposes. Remove the fittings from the tank and discard the O-rings from the fittings.

Inspecting the Hydraulic Tank

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

Installing the Hydraulic Tank

1. If the hydraulic fittings were removed from the hydraulic tank, lubricate and install new O-rings to the fittings. To properly align and install the fittings into the tank openings, use the marks that you made during the removal process. Tighten the fittings; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 4–11).



- 2. Lubricate and install new tank strainer O-ring onto the strainer. Tighten the tank strainer into the hydraulic tank and torque the strainer to **143 to 155 N·m (105 to 115 ft-lb)**.
- 3. Install the hydraulic tank to the machine and secure the tank to the frame with the 2 clamps (item 19 in Figure 81), 2 washer-head screws, and 2 flange nuts.
- 4. Remove the caps or plugs that were installed to the hydraulic hoses and fittings during the removal process.
- 5. Use the labels that you attached during tank removal to correctly connect the hydraulic hoses to the fittings on the hydraulic tank; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 4–9).
- 6. Fill the hydraulic tank with the correct quantity of new hydraulic fluid.
- 7. Operate the machine. Check the hydraulic-fluid level and adjust if necessary.
- 8. Check the hydraulic components for leaks. Tighten any loose connections.

Hydraulic Pump Driveshaft



Removing the Hydraulic Pump Driveshaft

- 1. Park the machine on a level surface, set the parking brake, lower the cutting decks, shut off the engine, and remove the key from the key switch.
- 2. Remove the 2 flange-head screws (item 9 in Figure 82) and 2 flange nuts that secure the driveshaft guard hoop to the machine frame, and remove the guard.
- 3. Remove the 2 bolts (item 5 in Figure 82) and 2 flange nuts that secure the driveshaft yoke to the traction pump input shaft.
- 4. Remove the 8 flange-head screws (item 13 in Figure 82) that secure the flywheel adapter plate to the engine flywheel.
- 5. Remove the driveshaft assembly from the machine.

Removing the Hydraulic Pump Driveshaft (continued)

6. If necessary, remove the 6 bolts (item 1 in Figure 82), 6 flange nuts, and a back-up ring that secure the driveshaft assembly to the flywheel adapter plate.

Servicing the Driveshaft Cross and Bearing



3. Shaft yoke

1.

2.

1. Remove the snap rings that secure the bearings in the yokes.

IMPORTANT

Support the yokes when removing and installing the bearings to prevent damage.

- 2. Use a press to remove the cross and bearings from the yokes. Clean the driveshaft yokes.
- 3. Install new cross and bearings as follows:
 - A. Apply a thick layer of grease to the bearing bores in the end yoke and shaft yoke.
 - B. Press 1 bearing partially into yoke.
 - C. Insert the cross into the yoke and bearing.
 - D. Hold the cross in alignment and press the bearing in until it hits the yoke.
 - E. Install the snap ring into the yoke groove to secure the installed bearing.
 - F. Place second bearing into the yoke bore and onto the cross shaft. Press the bearing into the yoke and secure with the snap ring.
 - G. Repeat the procedure for the other yoke.
 - H. Apply grease to the cross until it comes out of all the 4 bearing cups.
- 4. Ensure that the assembled joint moves without any binding. Lightly rap the yoke lugs with a soft-faced hammer to remove slight binding. If the binding continues, disassemble the joint to identify the source of binding.

Installing the Hydraulic Pump Driveshaft

- 1. Apply anti-seize lubricant to the traction pump input shaft.
- 2. If removed, secure the driveshaft assembly to the flywheel adapter plate with the back-up ring, 6 bolts, and 6 flange nuts.
- 3. Position the driveshaft assembly to the engine and pump input shaft.



- Apply loctite (or equivalent) to the threads of the flange-head screws (item 13 in Figure 82). Secure the driveshaft assembly to the engine flywheel with the 8 flange-head screws; torque the flange-head screws to 23 to 31 N·m (17 to 23 ft-lb) in a criss-cross pattern.
- 5. Slide the driveshaft yoke on the pump input shaft so that the yoke is flush with end of the input shaft. Secure the driveshaft yoke to the pump input shaft with the 2 bolts (item 5 in Figure 82) and 2 flange nuts.
- 6. Position the driveshaft guard hoop to the machine frame and secure with the 2 flange-head screws (item 9 in Figure 82) and 2 flange nuts.
- 7. Lubricate the grease fittings on the driveshaft.

Hydraulic Pump Assembly



Note: The traction pump and gear pump should be removed from machine as an assembly. Once removed from the machine, pumps can be separated for service.

CAUTION

Before opening the hydraulic system, operate all the hydraulic controls to release system pressure and avoid injury from the pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 4–6).



A

Removing the Hydraulic Pump Assembly (continued)

Â

- 1. Park the machine on a level surface, set the parking brake, lower the cutting decks, and shut off the engine. Remove the key from the key switch.
- 2. Read the General Precautions for Removing and Installing the Hydraulic System Components (page 4–87).
- 3. Clean the traction and gear pump assembly and all hydraulic connections to prevent hydraulic system contamination.
- 4. For assembly purposes, label all the hydraulic connections.
- 5. Disconnect the hoses and tubes from the fittings on the traction and gear pump assembly. Allow the hydraulic lines to drain into a suitable container.
- 6. Install clean caps or plugs on the openings of pumps and disconnected lines to prevent contamination.
- 7. Remove the hydraulic pump driveshaft; refer to Removing the Hydraulic Pump Driveshaft (page 4–98).
- 8. Separate the traction cable assembly from the traction pump (Figure 86) as follows:
 - A. Remove the flange nut (item 7 in Figure 86) that secures the lever damper to the traction cable bracket.
 - B. Remove the bolt (item 5 in Figure 86), flat washers, and locknut that secure the traction cable to the pump lever.
 - C. Loosen the 2 jam nuts that secure the traction cable to the traction cable bracket.
 - D. Position the traction cable assembly away from the pump assembly.
- 9. Disconnect the wire harness electrical connector from the traction neutral switch.

CAUTION

The weight of the pump assembly is approximately 30.5 kg (67 lb).

Ensure that the lift or hoist can support the total weight of the pump assembly before removing the bolts from the pump assembly and frame.

- 10. Connect a lift or hoist to the hole in the traction cable bracket on the traction pump to support the pump assembly and for pump removal.
- 11. Loosen and remove the 2 carriage screws (item 22 in Figure 84) and 2 flange nuts that secure the pump support bracket to the frame.
- 12. Remove the 2 flange-head screws (item 38 in Figure 84) and 2 flange nuts that secure the traction pump flange to the machine frame.

IMPORTANT

Ensure that you do not damage the machine components while removing the pump assembly.

13. Carefully lift the pump assembly from the machine.

A



- 8.
 - 9. Gear pump
- 14. Separate the traction and gear pumps (Figure 87) as follows:
 - A. Remove the 2 socket-head screws, 2 lock washers, and 2 flat washers that secure the gear pump to the traction pump.
 - B. Remove the gear pump from the traction pump. Locate and discard the O-ring from the pumps.
 - C. If necessary, remove the 2 locknuts that secure the pump support bracket to the gear pump, and remove the bracket and 2 flat washers from the gear pump.
- 15. If necessary, remove the hydraulic fittings from the pumps. Note the orientation of the fittings for assembly purposes.
- 16. Remove and discard all the O-rings from the hydraulic hoses and fittings that were removed.

Installing the Hydraulic Pump Assembly

1.

4. Lock washer (2 each)

5. Socket-head screw (2 each)

- 1. If the hydraulic fittings were removed from the pumps, lubricate and install new O-rings to the fittings. Install the fittings into the pumps; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 4-11).
- 2. Assemble the traction and gear pumps (Figure 87) as follows:
 - A. Lubricate and position new O-ring between the pumps.
 - B. Position the gear pump to the traction pump and secure with the 2 socket-head screws, 2 lock washers, and 2 flat washers.
 - C. If the pump support bracket was removed from the gear pump, install the 2 flat washers and bracket to the gear pump and secure the pump with the 2 locknuts.

IMPORTANT

Ensure that you do not damage the machine components while installing the pump assembly.

- 3. Carefully lower the pump assembly into the machine frame.
- 4. Secure the pump assembly to the machine frame with the 2 flange-head screws (item 38 in Figure 84) and 2 flange nuts.
- 5. Secure the pump support bracket to the inside of the frame bracket with the 2 carriage screws (item 22 in Figure 84) and 2 flange nuts.
- 6. Use the labels that you attached during the removal process to correctly connect the hydraulic hoses and tubes to the fittings on the pump assembly; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 4–9).
- 7. Connect the machine wire harness electrical connector to the traction neutral switch.
- 8. Secure the traction cable assembly to the traction pump (Figure 86) as follows:
 - A. Position the traction cable assembly to the pump assembly.
 - B. Secure the traction cable (item 9 in Figure 86) to the pump lever with the bolt (item 5 in Figure 86), flat washers, and locknut.
 - C. Secure the lever damper (item 12 in Figure 86) to the traction cable bracket with the flange nut.
 - D. Secure the traction cable to the traction cable bracket with the 2 jam nuts.
- 9. Install the hydraulic pump driveshaft; refer to Installing the Hydraulic Pump Driveshaft (page 4–100).
- 10. Check the hydraulic-fluid level in the hydraulic tank and add correct quantity of fluid if necessary; refer to the *Operator's Manual*.
- 11. Operate the machine functions slowly until air is out of system; refer to Charging the Hydraulic System (page 4–94).
- 12. Check the traction drive for neutral and traction neutral switch operation. Adjust if necessary.

Servicing the Piston (Traction) Pump



Note: For the piston (traction) pump repair information; refer to the Sauer-Danfoss LPV Closed Circuit Axial Piston Pumps Repair Manual and Service Instructions at the end of this chapter.

IMPORTANT

If a piston (traction) pump failure occurs, refer to Traction Circuit Component Failure (page 4–7) for information regarding the importance of removing contamination from the traction circuit.

Servicing the Gear Pump



Disassembling the Gear Pump

Note: The gear pump must be replaced as a complete assembly. Individual gears, housings, and thrust plates are not available separately. Disassemble the 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 the parts between the pump sections.

1. Plug the pump ports and clean the outer surface of the pump with cleaning solvent. Ensure that the work area is clean.



2. Use a marker to make a diagonal line across the gear pump for assembly purposes (Figure 90).

IMPORTANT

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

- 3. Secure the front cover of the pump in a vise with the driveshaft pointing down.
- 4. Loosen the 2 bolts (item 21 in Figure 89) and 2 nuts that secures the pump assembly.
- 5. Remove the pump from the vise and remove the fasteners.
- 6. Support the pump assembly and gently tap the pump case with a soft-faced hammer to loosen the pump sections. Do not drop the parts or disengage the gear mesh.

IMPORTANT

Mark the relative positions of the gear teeth and thrust plates so that you can be assemble them 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 the mating teeth to retain

Disassembling the Gear Pump (continued)

timing. The 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 the parts between sections.

- 8. Clean all the parts. Check all the components for burrs, scoring, nicks, and other damage.
- 9. Replace the entire pump assembly if the parts are excessively worn or scored.

Assembling the Gear Pump

1. Apply clean hydraulic fluid to all the parts before you assemble them.

Note: The pressure seals and back-up rings fit in the grooves machined into the thrust plates. The body seals fit in the grooves machined in the body faces.

- 2. Assemble the pump sections starting at the front cover end. Apply grease or petroleum jelly to new section seals to hold them in position during the gear pump assembly.
- 3. After the pump has been assembled, tighten the bolts and nuts by hand. Rotate the driveshaft to check for binding. Protect the shaft if you use pliers.



4. Torque the bolts and nuts evenly to **45 N·m (33 ft-lb)** in a crossing pattern.

Front Wheel Motors



A

CAUTION

A

Before opening the hydraulic system, operate all the hydraulic controls to release system pressure and avoid injury from the pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 4–6).

- 1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
- 2. Block the rear wheels with chocks to prevent the machine from moving.
- 3. Loosen, but do not remove the locknut (item 13 in Figure 91) that secures the wheel hub to the wheel motor.
- 4. Read the General Precautions for Removing and Installing the Hydraulic System Components (page 4–87).

IMPORTANT

Before lifting the machine with a jack, review and follow Jacking Instructions (page 1–6).

- 5. Lift the machine with a jack to remove the front wheel, support the machine with jack stands.
- 6. Remove the front wheel from the machine; refer to Removing the Wheel (page 6–6).
- 7. Remove the brake return spring (item 16 in Figure 91) and clevis pin that attach the brake cable to the brake actuator lever. Position the brake cable away from the actuator lever.
- 8. Remove the brake drum (item 12 in Figure 91) from the brake assembly.
- 9. Ensure that the locknut (item 13 in Figure 91) on the wheel motor shaft is loosened at least 2 turns.

IMPORTANT

Do not hit the wheel hub, wheel-hub puller, or wheel motor with a hammer while removing or installing. Hammering can damage the wheel motor.

- 10. Use a hub puller (refer to Special Tools (page 4–31)) to loosen the wheel hub from the wheel motor.
- 11. Remove the locknut and wheel hub from the motor shaft. Discard the locknut.
- 12. Locate and retrieve the square key from the wheel motor shaft.
- 13. Clean the hydraulic tube ends and fittings on the wheel motor to prevent contaminants from entering into the hydraulic system.
- 14. For assembly purposes, label all the hydraulic connections at the wheel motor.
- 15. Loosen and remove the hydraulic tubes from the fittings on the wheel motor. Allow the tubes to drain into a suitable container.
- 16. Install clean caps or plugs on the hydraulic tubes and fittings to prevent system contamination.

Removing the Front Wheel Motor (continued)

- 17. Support the wheel motor to prevent it from falling during removal. Remove the 4 locknuts (item 4 in Figure 91) from the 4 bolts that secure the motor and brake bracket to the frame.
- 18. Remove the 4 bolts (item 8 in Figure 91), brake assembly with the brake adapter, and spring clip from the wheel motor and frame.
- 19. Remove the wheel motor from the machine.
- 20. If the hydraulic fittings are to be removed from the wheel motor, mark the fitting orientation for assembly purposes. Remove the fittings from the wheel motor and discard the O-rings from the fittings.

Installing the Front Wheel Motor

IMPORTANT

Because of the internal differences in the wheel motors, do not interchange the wheel motors on the machine (e.g., do not put the right motor on the left side of the machine). If necessary, use the *Parts Catalog* and Part Number on the wheel motor to identify the right and left motors, there is also a yellow dot on the left motor.

- If the hydraulic fittings were removed from the wheel motor, lubricate and install new O-rings to the fittings. To properly align and install the fittings into the wheel motor ports, use the marks that you made during the removal process; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 4–11).
- 2. Position the wheel motor to the frame. Slide the brake assembly with the brake adapter (item 7 in Figure 91), spring clip, and 4 bolts onto the wheel motor and frame.



- Install and tighten the 4 locknuts onto the 4 bolts to secure the motor and brake components to the frame. Torque the bolts to 109 to 135 N·m (80 to 100 ft-lb).
- 4. Clean the tapers of the wheel hub and wheel motor shaft.
- 5. Insert the square key (item 6 in Figure 91) into the wheel motor shaft keyslot. Align the wheel hub with key and slide the wheel hub onto the motor shaft.

IMPORTANT

Do not use the removed locknut to secure the wheel hub to the wheel motor.

- 6. Install new locknut (item 13 in Figure 91) onto the wheel motor shaft to secure the wheel hub to the motor shaft.
- 7. Remove the caps or plugs from the hydraulic tubes and wheel fittings.
- 8. Lubricate and install new O-rings to the fittings on the wheel motor. Use the labels that you attached during the removal process to correctly connect the hydraulic tubes to the wheel motor fittings; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 4–9).
- 9. Install the brake drum (item 12 in Figure 91).
- 10. Position the end of the brake cable to the brake actuator lever. Attach the cable to the brake actuator lever with the clevis pin and brake return spring.

Installing the Front Wheel Motor (continued)

- 11. Install the front wheel to the machine; refer to Installing the Wheel (page 6–6).
- 12. Lower the machine to the ground.



- 13. Torque the locknut (item 13 in Figure 91) to **427 to 521 N·m (315 to 385 ft-lb)**.
- 14. Operate the machine functions slowly until air is out of system; refer to Charging the Hydraulic System (page 4–94).
- 15. Start the engine, check for hydraulic-fluid leaks, repair any leaks as required, and fill the hydraulic tank with the correct quantity of new hydraulic fluid before returning the machine to service.

Servicing the Front Wheel Motor



Note: The front wheel motors of the Groundsmaster 4300-D machine are Eaton Delta motors of the same basic design with minor differences. The right side motor has a reverse timed manifold to allow correct rotation direction for forward and reverse. The left side wheel motor can be identified by the machined groove on the end of the output shaft.

Note: For the front wheel motor repair procedures; refer to the Eaton Delta Motors Parts and Repair Manual at the end of this chapter.

Servicing the Front Wheel Motor (continued)

IMPORTANT

If a wheel motor fails; refer to the Traction Circuit Component Failure (page 4–7) for information regarding the importance of removing contamination from the traction circuit.

Rear Wheel Motors



- 5. O-ring (2 each per motor)
- 10. Lock washer (4 each per motor)

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CAUTION

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Before opening the hydraulic system, operate all the hydraulic controls to release system pressure and avoid injury from the pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 4–6).

- 1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
- 2. Block the front wheels with chocks to prevent the machine from moving.
- 3. Loosen, but do not remove the locknut (item 7 in Figure 93) that secures the wheel hub to the wheel motor.
- 4. Read the General Precautions for Removing and Installing the Hydraulic System Components (page 4–87).

IMPORTANT

Before lifting the machine with a jack, review and follow Jacking Instructions (page 1–6).

- 5. Lift the machine with a jack to remove the rear wheel, support the machine with jack stands.
- 6. Remove the rear wheel from the machine; refer to Removing the Wheel (page 6–6).
- 7. Ensure that the locknut on the wheel motor shaft is loosened at least 2 turns.

IMPORTANT

Do not hit the wheel hub, wheel-hub puller, or wheel motor with a hammer while removing or installing. Hammering can damage the wheel motor.

- 8. Use a hub puller (refer to Wheel Hub Puller (page 4–35)) to loosen the wheel hub from the wheel motor.
- 9. Remove the locknut and wheel hub from the motor shaft. Discard the locknut.
- 10. Locate and retrieve the woodruff key from the wheel motor shaft.
- 11. Clean the hydraulic tube ends and fittings on the wheel motor to prevent contaminants from entering into the hydraulic system.
- 12. Loosen and remove the hydraulic tubes from the fittings on the wheel motor. Allow the tubes to drain into a suitable container.
- 13. Install clean caps or plugs on the hydraulic tubes and fittings to prevent system contamination.
- 14. Support the wheel motor to prevent it from falling during removal.
- 15. Remove the 4 bolts (item 9 in Figure 93) and 4 lock washers that secure the wheel motor to the motor housing.
- 16. Remove the wheel motor from the machine.
- 17. If the hydraulic fittings are to be removed from the wheel motor, mark the fitting orientation for assembly purposes. Remove the fittings from the wheel motor and discard the O-rings from the fittings.

IMPORTANT

Because of the internal differences in the wheel motors, do not interchange the wheel motors on the machine (e.g., do not put the right motor on the left side of the machine). If necessary, use the *Parts Catalog* and Part Number on the wheel motor to identify the right and left motors, there is also a yellow dot on the left motor.

- If the hydraulic fittings were removed from the wheel motor, lubricate and install new O-rings to the fittings. To properly align and install the fittings into the wheel motor ports, use the marks that you made during the removal process; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 4–11).
- 2. Position the rear wheel motor to the motor housing. Ensure that the ports in the wheel motor are facing toward the rear of the machine.



- 3. Secure the wheel motor to the spindle with the 4 bolts and 4 lock washers. Torque the bolts to **109 to 135 N·m (80 to 100 ft-lb)**.
- 4. Remove the caps or plugs that were installed to the hydraulic tubes during the removal process.
- Lubricate and install new O-rings to the fittings on the wheel motor. Use the labels that you attached during the removal process to correctly connect the hydraulic tubes to the wheel motor fittings; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 4–9).
- 6. Clean the tapers of the wheel hub and wheel motor shaft.
- 7. Position the woodruff key (item 8 in Figure 93) to the keyslot in the wheel motor shaft.

IMPORTANT

Do not use the removed locknut to secure the wheel hub to the wheel motor.

- 8. Install the wheel hub onto the motor shaft and secure with new locknut (item 7 in Figure 93).
- 9. Install the rear wheel to the machine; refer to Installing the Wheel (page 6–6).
- 10. Lower the machine to the ground.



- 11. Torque the locknut to **366 to 447 N·m (270 to 330 ft-lb)**.
- 12. Fill the hydraulic tank with the correct quantity of new hydraulic fluid.
- 13. After you complete the assembly, ensure that the hydraulic tubes and fittings do not contact anything through the full range of axle motion. Also, check for any hydraulic-fluid leaks.
- 14. Operate the machine functions slowly until air is out of system; refer to Charging the Hydraulic System (page 4–94).
- 15. Start the engine, check for hydraulic-fluid leaks, repair any leaks as required, and fill the hydraulic tank with the correct quantity of new hydraulic fluid before returning the machine to service.
Servicing the Rear Wheel Motor



Note: The rear wheel motors of the Groundsmaster 4300-D machine are the Parker TorqmotorTM motors of the same basic design with minor differences. The right side motor has a reverse timed manifold to allow correct rotation direction for forward and reverse. The left side wheel motor is identified with a yellow dot on the motor housing near the B port.

Note: For the rear wheel motor repair procedures; refer to the Parker Torqmotor[™] Service Procedure (TC, TB, TE, TJ, TF, TG, TH, and TL Series) at the end of this chapter.

Servicing the Rear Wheel Motor (continued)

IMPORTANT

If a wheel motor fails; refer to the Traction Circuit Component Failure (page 4–7) for information regarding the importance of removing contamination from the traction circuit.

CrossTrax™ AWD Control Manifold Assembly



Removing the CrossTrax AWD Control Manifold Assembly

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

Before opening the hydraulic system, operate all the hydraulic controls to release system pressure and avoid injury from the pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 4–6).

- 2. Read the General Precautions for Removing and Installing the Hydraulic System Components (page 4–87).
- 3. Locate the CrossTrax AWD control manifold that is attached to the bracket at rear of the frame.
- 4. For assembly purposes, label all the hydraulic connections. Clean the hydraulic connections before loosening the hydraulic lines.

Removing the CrossTrax AWD Control Manifold Assembly (continued)

- 5. Disconnect the hydraulic hoses and tubes from the fittings in the AWD control manifold assembly. Allow the lines to drain into a suitable container. Remove and discard the O-rings from the fittings.
- 6. Install clean caps or plugs on the hydraulic lines and fittings to prevent system contamination.
- 7. Support the AWD control manifold assembly to prevent it from falling.
- 8. Remove the 3 bolts (item 13 in Figure 95) and 3 lock washers that secure the AWD control manifold to the frame bracket.
- 9. Locate and retrieve the 3 spacers between the frame bracket and the manifold.
- 10. Remove the AWD control manifold from the machine.
- 11. If necessary, remove the hydraulic fittings from the manifold. Discard the O-rings that were removed.

Installing the CrossTrax AWD Control Manifold Assembly

- 1. If the hydraulic fittings were removed from the AWD control manifold, lubricate new O-rings with clean hydraulic fluid, position the O-rings to the fittings, and install the fittings into the manifold; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 4–11).
- 2. Position the manifold and 3 spacers to the frame bracket. Install the 3 lock washers (item 14 in Figure 95) and 3 bolts but do not fully tighten the bolts.
- 3. Remove the caps and plugs from the hydraulic lines and fittings.
- 4. Lubricate and install new O-rings on the AWD control manifold fittings.
- 5. Use the labels that you attached during manifold removal, correctly connect the hydraulic hoses and tubes to the AWD control manifold assembly; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 4–9).
- 6. Tighten the 3 bolts to secure the AWD control manifold to the frame.
- 7. Check the hydraulic-fluid level in the hydraulic tank and add correct quantity of fluid if necessary; refer to the *Operator's Manual*.
- 8. Operate the machine functions slowly until air is out of system; refer to Charging the Hydraulic System (page 4–94).

Servicing the CrossTrax AWD Control Manifold Assembly



For the control manifold service procedures; refer to Servicing the Deck Control Manifold Assembly (page 4–127). Refer to Figure 96 for CrossTrax AWD control manifold cartridge valve and plug installation torque.

Note: Do not adjust the bi-directional relief valve (item 11 in Figure 96).

Note: The CrossTrax AWD control 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. When installing the plugs into the control manifold; torque the plugs to the values identified in Figure 96.

Deck Control Manifold Assembly



Note: For testing the solenoid valve coils; refer to Testing the Hydraulic Solenoid Valve Coils (page 5–75).

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CAUTION

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Before opening the hydraulic system, operate all the hydraulic controls to release system pressure and avoid injury from the pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 4–6).

- 1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
- 2. Read the General Precautions for Removing and Installing the Hydraulic System Components (page 4–87).
- 3. Tilt the operator seat and engage the seat prop to retain the seat in the raised position.
- 4. Locate the hydraulic deck control manifold.
- 5. For assembly purposes, label all the hydraulic and electrical connections. Clean the hydraulic connections before loosening the hydraulic lines.
- 6. Disconnect the hydraulic hoses and tubes from the fittings in the manifold. Allow the lines to drain into a suitable container. Remove and discard the O-rings from the fittings.
- 7. Install clean caps or plugs on the hydraulic tubes and fittings to prevent contamination.
- 8. Disconnect the wire harness leads from the solenoid coils on the deck control manifold.
- 9. Remove the 3 flange-head screws (item 11 in Figure 97) that secure the deck control manifold to the bracket, and remove the deck control manifold from the machine.
- 10. If necessary, remove the hydraulic fittings from the manifold (Figure 98). Discard the O-rings that were removed.



- If the hydraulic fittings were removed from the deck control manifold, lubricate new O-rings with clean hydraulic fluid, position the O-rings to the fittings, and install the fittings into the manifold ports; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 4–11). Torque the fittings to the values identified in Figure 98.
- 2. Position the deck control manifold to the bracket and install the 3 flange-head screws (item 11 in Figure 97) but do not fully tighten.
- 3. Remove the caps and plugs from the hydraulic lines and fittings.
- 4. Lubricate and install new O-rings on the manifold fittings. Use the labels that you attached during removal, correctly connect the hydraulic lines to the fittings and tighten all the connections; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 4–9).
- 5. Tighten the 3 flange-head screws to secure the deck control manifold to the bracket.
- 6. Connect the wire harness leads to the solenoid coils on the deck control manifold.
- 7. Lower and secure the operator seat.
- 8. Check the hydraulic-fluid level in the hydraulic tank and add correct quantity of fluid if necessary; refer to the *Operator's Manual*.
- 9. Operate the machine functions slowly until air is out of system; refer to Charging the Hydraulic System (page 4–94).

Servicing the Deck Control Manifold Assembly



Note: The ports on the deck control manifold are marked for easy identification of the components. Example: P1 is the pump P1 connection port and PRV2 is the location for the proportional relief valve PRV2; refer to the Hydraulic Schematic in Appendix A—Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each manifold port.

Note: The deck control 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. When installing the plugs; torque the plugs to the values identified in Figure 99.

Servicing the Deck Control Manifold Assembly

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WARNING

Before opening the hydraulic system, operate all the hydraulic controls to release all the pressure in the system and avoid injury from pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 4–6).

- 1. Ensure that the entire outer surface of the manifold is clean before you remove the cartridge valve.
- 2. If the solenoid cartridge valve is being serviced, remove the nut that secures the solenoid coil to the cartridge valve. Carefully slide the solenoid coil off the valve.

IMPORTANT

Carefully handle the valve cartridge. Slight bending or distortion of the stem tube can cause binding and malfunction. When removing the cartridge valve from the control manifold, ensure that the deep well socket fully engages the valve base.

- 3. Remove the cartridge valve with a deep well socket wrench. Note the correct location of the O-rings, sealing rings, and back-up rings.
- 4. Remove and discard the seal kit.
- 5. Visually examine the port in the manifold for damaged sealing surfaces, damaged threads, and contamination. Also, inspect the cartridge valve for damaged sealing surfaces and contamination.
 - A. Contamination can cause the valves to stick or hang up. Contamination can accumulate in small valve orifices or seal areas and cause malfunction.
 - B. If the sealing surfaces of the valve are pitted or damaged, the hydraulic system can be too hot or there can be water in the system.

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CAUTION

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Use the eye protection such as goggles when using the compressed air.

Servicing the Deck Control Manifold Assembly (continued)

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CAUTION

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Sudden movement of the internal valve spools can release the stored fluid suddenly.

6. Use clean-mineral spirits and clean the cartridge valve. Put the valve in the clean-mineral spirits to flush out contamination.

IMPORTANT

Particles as fine as talcum powder can affect the operation of high-pressure hydraulic valves.

If the cartridge design allows, use a wood or plastic probe to press the internal spool in and out for 20 to 30 times to flush out contamination.

Ensure that you do not damage the cartridge. Use the compressed air for cleaning.

- 7. Install the cartridge valve as follows:
 - A. Lubricate the new seal kit components with clean hydraulic fluid and install them onto the valve.
 - B. Install the O-rings, sealing rings, and back-up rings correctly on the cartridge valve for proper operation and sealing.

IMPORTANT

Carefully handle the valve cartridge. Slight bending or distortion of the stem tube can cause binding and malfunction. When installing the cartridge valve into the control manifold, ensure that the deep well socket fully engages the valve base.

- C. Turn the cartridge valve carefully into the manifold port. The valve should go in easily without binding.
- D. Use a deep well socket and torque the cartridge valve to the values identified in Figure 99.
- 8. If the solenoid coil was removed from the cartridge valve, do the following steps:
 - A. Carefully install the coil onto the valve.

IMPORTANT

Overtightening the nut can damage the solenoid or cause valve malfunction. Do not overtighten the nut.



- B. Install the nut and torque the nut to 6.7 N·m (60 in-lb).
- 9. If the problems still exist, remove the valve and clean it again or replace the valve.

Cutting Deck Motor



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- 1. #4 hydraulic deck motor
- 2. O-ring
- 3. 90° hydraulic fitting
- 4. O-ring
- 5. Hydraulic hose
- 6. O-ring
- 7. 45° hydraulic fitting
- 8. O-ring

Figure 100

- 9. Hydraulic hose
- 10. 90° hydraulic fitting
- 11. Hydraulic hose
- 12. Hydraulic hose
- 13. 45° hydraulic fitting
- 14. Hydraulic hose
- 15. #1 hydraulic deck motor
- 16. #5 hydraulic deck motor

- 17. Hydraulic hose
- 18. Hydraulic hose
 - 19. Hydraulic hose
 - 20. #3 hydraulic deck motor
- 21. Hydraulic fitting
- 22. Hydraulic hose
- 23. #2 hydraulic deck motor



- 1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
- 2. Read the General Precautions for Removing and Installing the Hydraulic System Components (page 4–87).
- 3. For assembly purposes, label all the hydraulic connections. Clean the hydraulic connections before loosening the hydraulic lines from the deck motor.

CAUTION

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Before opening the hydraulic system, operate all the hydraulic controls to release system pressure and avoid injury from the pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 4–6).



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2.

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Removing the Cutting Deck Motor (continued)

- 4. Disconnect the hydraulic hoses from the fittings in the deck motor. Allow the lines to drain into a suitable container. Remove and discard the O-rings from the fittings.
- 5. Install clean caps or plugs on the hydraulic hoses and fittings to prevent system contamination.
- 6. Remove the 2 socket-head screws and 2 flat washers that secure the hydraulic motor to the cutting deck (Figure 102), and remove the hydraulic motor and O-ring from the deck.
- 7. Cover the top of the spindle to prevent unwanted material from entering into the spindle. A spindle plug (refer to Spindle Plug (page 4–35)) can be used to cover the spindle.
- 8. If the hydraulic fittings are to be removed from the motor, mark the fitting orientation for assembly purposes. Remove the fittings from the motor and discard the O-rings from the fittings.

Installing the Cutting Deck Motor

- If the hydraulic fittings were removed from the deck motor, lubricate and install new O-rings to the fittings. Install the fittings into the motor ports; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 4–11). Ensure that the fittings are orientated correctly.
- 2. Remove the cover from the top of the spindle that was placed to prevent unwanted material from entering into the spindle.



- 3. Ensure that the O-ring is positioned to the top of the spindle housing. Secure the hydraulic motor to the cutting deck with the 2 socket-head screws and 2 flat washers (Figure 102).
- 4. Remove the caps or plugs from the hydraulic hoses and fittings.

IMPORTANT

When installing the hydraulic hoses, ensure that the hydraulic hoses are straight (not twisted) before tightening the hoses to the motor fittings.

Installing the Cutting Deck Motor (continued)

- 5. Lubricate and install new O-rings to the fittings on the deck motor. Use the labels that you attached during the removal process to correctly connect the hydraulic hoses to the motor fittings; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 4–9).
- 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 Charging the Hydraulic System (page 4–94).

Servicing the Cutting Deck Motor



Disassembling the Cutting Deck Motor

1. Install clean plugs in the motor ports and clean the outer surface of the motor. After cleaning, remove the plugs and drain the hydraulic fluid out of the motor.



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1. Marker line



- 2. Use a marker to make a diagonal line across the front flange, body, and rear cover for assembly purposes (Figure 105).

IMPORTANT

When you clamp the motor in a vise, clamp the front flange only to prevent damage. Also, use a vise equipped with soft jaws.

- 3. Clamp the front flange of the motor in a vise with the shaft end down.
- 4. Loosen the 4 bolts from the rear cover.
- 5. Remove the motor from the vise. Turn the motor so that the shaft end is facing down, and remove the 4 bolts and 4 lock washers.
- 6. Separate the rear cover from the body and lift the rear cover from the motor.
- 7. Lift the body straight up and carefully remove it. Ensure the rear wear plate remains on the drive and idler gear shafts.

Disassembling the Cutting Deck Motor (continued)

8. Remove and discard the O-rings from the body. Locate and retrieve the dowel pins.

 IMPORTANT

 Before removing the wear plates, note the position of the open and closed side of the wear plates. Also identify the wear plates (front and rear) with a marker for proper assembly.

 IMPORTANT

 Mark the relative positions of the gear teeth and wear plates so that you can assemble them in the same position. Do not touch the gear surfaces as residue on hands may be corrosive to gear finish.

 9. Carefully remove the rear wear plate, idler gear, drive gear, and front wear plate from the front flange.

- 10. Remove and discard the back-up gaskets and pressure seals from the wear plates.
- 11. Turn the front flange over, with the seal side up.

IMPORTANT

Ensure that you do not damage the front flange counterbore when removing the seals from the front flange.

12. Carefully remove the dust seals, retaining ring, flange washer, and shaft seal from the front flange (Figure 106). Discard the seals.

Inspecting the Cutting Deck Motor

1. Remove any nicks and burrs from all the parts with emery cloth.

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CAUTION

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Use eye protection such as goggles when using compressed air.

2. Clean all the motor parts with solvent and dry them with compressed air.

Inspecting the Cutting Deck Motor (continued)



- 3. Inspect the drive gears and idler gears for the following (Figure 107):
 - A. Gear shafts must be free of rough surfaces and excessive wear at the bushing points and sealing areas. Replace the gears if you find any scoring, rough surfaces, or wear on the gear shafts.
 - B. Gear teeth must be free from excessive scoring and wear. Replace the gears if you find broken or nicked gear teeth.
 - C. Gear face edge must be free from sharpness. The sharp edges of gears will mill into the wear plates. Replace the gears if you find any sharp gear face edge.
- 4. Inspect the wear plates for the following:
 - A. Bearing areas must not have excessive wear or scoring.
 - B. Face of the wear plates that are in contact with the gears must be free of wear, roughness, or scoring.
 - C. Thickness of the wear plates should be equal.
- 5. Inspect the front flange and rear cover for damage or wear.

Assembling the Cutting Deck Motor

Note: When assembling the motor, check the marker line on each part to ensure that the parts are properly aligned.

- 1. Lubricate new O-rings, pressure seals, and back-up gaskets, and wear plate grooves with a thin coat of petroleum jelly. Lubricate all other internal parts freely with clean hydraulic fluid.
- 2. Install new seals into the front flange (Figure 107) as follows:
 - A. Press the shaft seal into the front flange until it reaches the bottom of the bore.
 - B. Install the flange washer into the front flange and then install the retaining ring into the groove of the front flange.
 - C. Install new dust seals into the front flange. The inner dust seal should have the seal lip and spring toward the installed retaining ring. The outer dust seal should have the seal lip and spring toward the outside of the motor.
- 3. Place the front flange, seal side down, on a flat surface.

Assembling the Cutting Deck Motor (continued)

- 4. Install the pressure seals, flat side outward, into the grooves in the wear plates. Follow by carefully placing the back-up 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 fluid.
- 7. Insert the drive end of the driveshaft 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.
- 8. Carefully install the shaft into the front flange.
- 9. Lubricate the idler gear shaft with clean hydraulic fluid. Install the idler gear shaft into the remaining position in the front wear plate. Apply a light coating of clean hydraulic fluid to the gear faces.
- 10. Install the rear wear plate with a pressure seal side up and the open side of pressure seal pointing to the inlet side of the motor.
- 11. 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.
- 12. Install the locating dowels in the body. Align the marker line on the body and front flange.

IMPORTANT

Do not dislodge the seals during installation.

- 13. Gently slide the body onto the assembly and align the dowels with firm hand pressure.
- 14. Check that the surface of the rear wear plate is slightly below the face of the body.

Note: If the wear plate is not below the body, check the assembly for a shifted pressure seal, back-up gasket, or O-ring. Correct the shifting before you proceed.

- 15. Apply a light coating of petroleum jelly to the exposed side of the rear cover.
- 16. Use the marker line for proper location and place the rear cover on the assembly, and align the dowels with firm hand pressure.
- 17. Install the 4 bolts with 4 washers and tighten them by hand.

IMPORTANT

When you clamp the motor in a vise, clamp the front flange only to prevent damage. Also, use a vise equipped with soft jaws.

18. Clamp the front flange of the motor in a vise equipped with soft jaws.



- 19. Alternately torque the bolts to 45 N·m (33 ft-lb).
- 20. Remove the motor from the vise.
- 21. Put a small quantity of clean hydraulic fluid in the inlet of the motor and rotate the driveshaft away from the inlet for 1 revolution. If there is any binding, disassemble the motor and check for assembly problems.

Lift Control Manifold



Note: For testing the solenoid valve coils; refer to Testing the Hydraulic Solenoid Valve Coils (page 5–75).

Removing the Lift Control Manifold

- 1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
- 2. Read the General Precautions for Removing and Installing the Hydraulic System Components (page 4–87).
- 3. Locate the hydraulic lift control manifold that is attached to the frame bracket under the front platform.

Removing the Lift Control Manifold (continued)

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4. For assembly purposes, label all the hydraulic connections. Clean the hydraulic connections before loosening the hydraulic lines.



Before opening the hydraulic system, operate all the hydraulic controls to release system pressure and avoid injury from the pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 4–6).

WARNING

Ensure that the cutting decks are fully lowered and supported before loosening the hydraulic lines, cartridge valves, or plugs from the lift control manifold.

If the decks are not fully lowered as the manifold components are loosened, the decks may drop unexpectedly.



- 5. Disconnect the hydraulic hoses and tubes from the fittings in the manifold. Allow the lines to drain into a suitable container. Remove and discard the O-rings from the fittings.
- 6. Install clean caps or plugs on the hydraulic hoses and fittings to prevent system contamination.

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Removing the Lift Control Manifold (continued)

- 7. For assembly purposes, label all the solenoid coil wire harness leads. Disconnect the wire harness leads from the solenoid coils on the manifold.
- 8. Remove the 2 flange-head screws that secure the manifold to the machine frame.
- 9. Remove the lift control manifold from the machine.

IMPORTANT

A flow control orifice is placed below several hydraulic fittings on the lift control manifold (Figure 109). The lift control manifold uses 2 different orifice sizes. If the fittings are removed from the manifold and an orifice is in the manifold port, ensure that you remove the orifice and label its position for assembly purposes.

- 10. If necessary, remove the hydraulic fittings from the manifold (Figure 109), and discard the O-rings.
- 11. Locate, retrieve, and label the orifice from the manifold port (if equipped).

Installing the Lift Control Manifold

- 1. If the hydraulic fittings were removed from the lift control manifold (Figure 109), do the following:
 - A. Lubricate new O-rings with clean hydraulic fluid, install the lubricated O-rings onto the fittings.

IMPORTANT

When installing the orifice in the manifold, ensure that the orifice is flat in the base of the fitting cavity. Letting the orifice stay cocked in the cavity can damage the manifold.

- B. For the manifold ports with orifice, install correct orifice in the port with the orifice slot facing out.
- C. Install the fittings into the manifold. Torque the fittings to the torque values identified in Figure 109.
- 2. Position the lift control manifold to frame. Install the 2 flange-head screws but do not fully tighten.
- 3. Remove the caps and plugs from the hydraulic lines and fittings.
- Lubricate and install new O-ring(s) on the manifold fittings. Correctly connect the hydraulic hoses and tubes to the hydraulic manifold fittings and tighten all the connections; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 4–9).
- 5. Tighten the 2 flange-head screws to secure the lift control manifold to the frame.
- 6. Use the labels that you attached during removal to connect the wire harness leads to the solenoid coils on the manifold.
- 7. Check the hydraulic-fluid level in the hydraulic tank and add correct quantity of fluid if necessary; refer to the *Operator's Manual*.
- 8. Operate the machine functions slowly until air is out of system; refer to Charging the Hydraulic System (page 4–94).

Servicing the Lift Control Manifold



Note: The ports on the lift control manifold are marked for easy identification of the components. Example: P is the gear pump (P4) connection port and S2 is the location for solenoid valve S2; refer to the Hydraulic Schematic in Appendix A—Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each manifold port.

For the control manifold service procedures; refer to Servicing the Deck Control Manifold Assembly (page 4–127). Refer to Figure 110 for lift control manifold cartridge valve installation torque.

Servicing the Lift Control Manifold (continued)

A WARNING A

Ensure that the cutting decks are fully lowered and supported before loosening the hydraulic lines, cartridge valves, or plugs from the lift control manifold.

If the decks are not fully lowered as the manifold components are loosened, the decks may drop unexpectedly.

Lift Cylinder





Note: The procedure for lift cylinder removal and installation is the same for all Groundsmaster 4300-D lift cylinders. Figure 111 shows the center, front (deck #1) lift cylinder.



- 1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
- 2. Read the General Precautions for Removing and Installing the Hydraulic System Components (page 4–87).
- 3. If the lift cylinder for deck #4 or #5 is being removed, remove the flange nut and carriage screw that secure the R-clamp to the lift cylinder (Figure 113).
- 4. For assembly purposes, label all the hydraulic connections. Clean the hydraulic connections before loosening the hydraulic lines from the lift cylinder.

CAUTION

A

Before opening the hydraulic system, operate all the hydraulic controls to release system pressure and avoid injury from the pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 4–6).

- 5. Disconnect the hydraulic hoses from the fittings in the lift cylinder that is to be removed. Allow the hoses to drain into a suitable container. Remove and discard the O-rings from the fittings.
- 6. Install clean caps or plugs on the hydraulic hoses and fittings to prevent contamination.
- 7. Remove 1 retaining ring (item 3 in Figure 111) and thrust washer from the cylinder slide pin. Pull the pin from the lift cylinder and lift arm. Locate and retrieve the second thrust washer.
- 8. Remove the flange-head screw (item 12 in Figure 111) and flat washer that secure the lift cylinder to the pivot shaft.
- 9. Remove the lift cylinder from the pivot shaft and frame.
- 10. If the hydraulic fittings are to be removed from the lift cylinder, mark the fitting orientation for assembly purposes. Remove the fittings from the lift cylinder and discard the O-rings from the fittings.

Installing the Lift Cylinder

- If the hydraulic fittings were removed from the lift cylinder, lubricate new O-rings with clean hydraulic fluid, position the O-rings to the fittings, and install the fittings into the lift cylinder ports; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 4–11). Ensure that the fittings are orientated correctly.
- 2. Position the lift cylinder to the frame.

Note: The lift cylinder barrel end should be attached to the machine frame.



- 3. Slide the barrel end of the lift cylinder onto the pivot shaft. Secure the cylinder with the flange-head screw (item 12 in Figure 111) and flat washer. Torque the flange-head screw to **91 to 112 N**⋅**m** (**67 to 83 ft-lb**).
- 4. Align lift cylinder to the lift arm mounting holes. Slide the cylinder slide pin (item 1 in Figure 111) (with a thrust washer and retaining ring installed on the one end) through the lift cylinder and lift arm. Install the second thrust washer on pin and secure with the retaining ring.
- 5. Remove the caps and plugs that were installed to the hydraulic hoses and fittings during the removal process.
- 6. Put a coating of clean hydraulic fluid on new fitting O-rings, install the O-rings, and connect the hydraulic hoses to the fittings on the lift cylinder. Tighten the hose connections; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 4–9).
- 7. If the lift cylinder for deck #4 or #5 was removed, secure the R-clamp to the lift cylinder with the flange nut and carriage screw (Figure 113).
- 8. Lubricate the lift cylinder grease fittings.
- 9. Check the hydraulic-fluid level in the hydraulic tank and add correct quantity of fluid if necessary; refer to the *Operator's Manual*.
- 10. Operate the machine functions slowly until air is out of system; refer to Charging the Hydraulic System (page 4–94).

Servicing the Lift Cylinder



Note: The lift cylinders used on the Groundsmaster 4300-D machines are very similar. The service procedures for all lift cylinders are the same.

Disassembling the Lift Cylinder

1. Slowly pump the cylinder shaft to remove the hydraulic fluid from the lift cylinder into a drain pan. Plug both the ports and clean the outer surface of the cylinder.

IMPORTANT

When you clamp the lift cylinder in a vise, clamp the clevis end of the barrel only to prevent damage.

2. Mount the lift cylinder in a vise. Use a vise equipped with soft jaws.

Disassembling the Lift Cylinder (continued)

- 3. Use a spanner wrench, rotate the head clockwise until the edge of the retaining ring (item 7 in Figure 114) appears in the barrel opening. Insert a screwdriver under the beveled edge of the retaining ring to start the retaining ring through the opening. Rotate the head counterclockwise to remove the retaining ring from the barrel and head.
- 4. Remove the plugs from the ports. Carefully twist and pull the shaft and remove the shaft with head and piston.

IMPORTANT

Clamping the vise jaws against the shaft surface could damage the shaft. When securing the shaft in a vise, clamp the shaft clevis only.

5. Mount the shaft in a vise by clamping on the clevis of the shaft. Remove the locknut and piston from the shaft. Carefully slide the head off the shaft.

Note: Do not scratch or damage the components.

6. Remove and discard all the seals, back-up rings, and O-rings from the head and piston.

Inspecting the Lift Cylinder

A

CAUTION

A

Use eye protection such as goggles when using compressed air.

- 1. Wash all the cylinder components in clean solvent and dry them with compressed air.
- 2. Inspect the internal surface of the barrel for deep scratches, out-of-roundness, and bending.
- 3. Inspect the head, shaft, and piston for excessive pitting, scoring, and wear.
- 4. Replace the lift cylinder if the internal components are worn or damaged.

Assembling the Lift Cylinder

- 1. Ensure that all the parts are clean before assembly.
- 2. Put a coating of clean hydraulic fluid on new O-rings, back-up washer, and other seals. Carefully install new seals, back-up rings, and O-rings to the head and piston.

IMPORTANT

Clamping the vise jaws against the shaft surface could damage the shaft. When securing the shaft in a vise, clamp the shaft clevis only.

- 3. Mount the shaft in a vise by clamping on the clevis of the shaft, and do the following steps:
 - A. Put a coating of clean hydraulic fluid on the shaft.
 - B. Slide the head onto the shaft.

Note: Ensure that you do not damage the seals.

Assembling the Lift Cylinder (continued)



- C. Install the piston onto the shaft and secure the piston with the locknut. Torque the locknut to **54 N·m (40 ft-lb)**.
- D. Remove the shaft from the vise.

IMPORTANT

When you clamp the lift cylinder in a vise, clamp the clevis end of the barrel only to prevent damage.

4. Mount the barrel in a vise by clamping on the clevis end of the barrel.

IMPORTANT

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

5. Put a light coating of clean hydraulic fluid on all internal parts. Carefully slide the piston, shaft, and head assembly into the barrel.

Note: Do not damage the seals during assembly.

- 6. Secure the head in the barrel with retaining ring as follows:
 - A. Align the retaining ring hole in the head with the access slot in the barrel.
 - B. Insert the retaining ring hook into the hole and rotate the head clockwise until the retaining ring is completely pulled into the barrel and the ring ends are covered.
 - C. Apply silicone sealer to the barrel access slot.

Steering Control Valve





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Figure 116

- 1. Platform shroud
- 2. Washer-head screw (6 each)
- 3. Washer (2 each)
- 4. Screw (2 each)

- 5. Cover plate
- 6. Bushing (2 each)
- 7. Spacer (2 each)
- 8. Flange nut (2 each)
- 1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
- 2. Remove the fasteners that secure the shroud to the front of the machine (Figure 116). Remove the shroud from the machine to get access to the steering control valve.
- 3. Locate and retrieve the 2 rubber bushings and 2 spacers.
- 4. Slide the rubber bellows up from the bottom of the steering column.
- 5. Support the steering column to prevent it from falling.
- 6. Loosen and remove the 4 screws and 4 flange nuts that secure the steering column brace (item 12 in Figure 115) to the machine, and remove the brace.
- 7. Read the General Precautions for Removing and Installing the Hydraulic System Components (page 4–87).
- 8. For assembly purposes, label all the hydraulic connections. Note the port designations on the steering control valve (Figure 117).
- 9. Clean the hydraulic connections before loosening the hydraulic lines.

A

CAUTION

Before opening hydraulic system, operate all the hydraulic controls to release system pressure and avoid injury from the pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 4–6).

A

Removing the Steering Control Valve (continued)



- 10. Disconnect the hydraulic lines from the steering control valve. Allow the lines to drain into a suitable container.
- 11. Install clean caps or plugs on the hydraulic lines and fittings to prevent contamination.
- 12. Loosen and remove the remaining 2 socket-head screws and 2 flange nuts that secure the steering column to the machine.
- 13. Remove the steering column and steering control valve assembly from the machine.
- 14. Loosen and remove the 4 socket-head screws that secure the steering control valve to the steering column.
- 15. Remove the steering control valve from the steering column.

Removing the Steering Control Valve (continued)

- 16. If necessary, remove the hydraulic fittings from the steering control valve.
- 17. Remove and discard the O-rings from the fittings.

Installing the Steering Control Valve

- If the hydraulic fittings were removed from the steering control valve, lubricate new O-rings with clean hydraulic fluid, position the O-rings to the fittings, and install the fittings to the steering control valve; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 4–11).
- 2. Apply anti-seize lubricant to the splines of the steering control valve input shaft.



- 3. Slide the steering control valve input shaft into the steering column universal joint. Position the control valve with the ports toward front of the machine. Secure the steering control valve to the steering column with the 4 socket-head screws. Torque the socket-head screws to **9.5 to 13.5 N·m (84 to 120 in-lb)** in a criss-cross pattern.
- 4. Position the steering column assembly to the machine. Secure the steering column in place with the 2 socket-head screws and 2 flange nuts at rear two mounting holes.
- 5. Remove the caps and plugs that were installed to the hydraulic lines and fittings during the removal process.
- Lubricate new O-rings and use the labels that you attached during valve removal to connect the hydraulic lines to the fittings on the steering control valve. Tighten the connections; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 4–9).
- 7. Position the steering column brace (item 12 in Figure 115) to the machine and secure with the 4 screws and 4 flange nuts.
- 8. Slide the rubber bellows to the bottom of the steering column.
- 9. Place the rubber bushings and spacers into the holes of the shroud (Figure 116). Position the shroud in place and secure with the removed fasteners.
- 10. Check the hydraulic-fluid level in the hydraulic tank and add correct quantity of fluid if necessary; refer to the *Operator's Manual*.
- 11. Operate the machine functions slowly until air is out of system; refer to Charging the Hydraulic System (page 4–94).

Servicing the Steering Control Valve



Note: For the steering control valve repair procedures, refer to the Sauer-Danfoss Steering Unit Type OSPM Service Manual at the end of this chapter.
Steering Cylinder



Removing the Steering Cylinder

- 1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
- 2. Read the General Precautions for Removing and Installing the Hydraulic System Components (page 4–87).



 Figure 120

 1. Ball joint
 2. Cylinder front head

- 8. Separate the steering cylinder ball joints from the axle assembly. Remove the steering cylinder from the machine.
- 9. If necessary, remove the ball joint from the steering cylinder barrel and shaft. If the ball joint is to be removed from the cylinder shaft, fully retract the cylinder shaft and measure the distance from the cylinder front head to the center of the ball joint for easy installation of the ball joint into the cylinder shaft (Figure 120).
- 10. If the hydraulic fittings are to be removed from the steering cylinder, mark the fitting orientation for assembly purposes. Remove the fittings from the steering cylinder and discard the O-rings from the fittings.

Installing the Steering Cylinder

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1. If the hydraulic fittings were removed from the steering cylinder, lubricate new O-rings with clean hydraulic fluid, position the O-rings to the fittings, and install the fittings into the steering cylinder ports; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 4–11).

Installing the Steering Cylinder (continued)

- 2. If removed, press the ball joint (item 9 in Figure 119) into the barrel and secure the ball joint with the retaining ring.
- 3. If the ball joint was removed from the cylinder shaft, fully retract the cylinder shaft and thread the ball joint into the shaft so that the distance from the cylinder front head to the center of the ball joint is as measured during removal process. Tighten the jam nut.
- 4. Clean the tapers on the ball joints and axle assembly.
- 5. Position the steering cylinder to the machine.
- 6. Secure the steering cylinder to the axle with the 2 jam nuts (item 11 in Figure 119). Tighten the first jam nut and then, while holding the first jam nut with wrench, tighten the second jam nut.
- 7. Secure the steering cylinder to the right drag link with the slotted hex nut (item 13 in Figure 119) and cotter pin.
- 8. Remove the caps and plugs from the hydraulic hoses and fittings.
- 9. Lubricate and install new O-rings on the steering cylinder fittings. Correctly connect the hydraulic hoses to the steering cylinder; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 4–9).
- 10. Check the hydraulic-fluid level in the hydraulic reservoir and add correct quantity of fluid if necessary; refer to the *Operator's Manual*.
- 11. Lubricate the steering cylinder ball joint grease fittings.
- 12. Operate the machine functions slowly until air is out of system; refer to Charging the Hydraulic System (page 4–94).
- 13. Check that the steering cylinder does not contact the axle or frame as cylinder moves from fully retracted to fully extended. Also, check that the distance between the drag links and steering stops are equal on both sides of the machine. If necessary, adjust the location of the ball joint on the cylinder shaft.

Servicing the Steering Cylinder



- 5. Wear ring
- 6. O-ring

- 11. External collar (2 each)
- 12. Dust seal

17. Front head (1 inch)

Disassembling the Steering Cylinder

1. Slowly pump the cylinder shaft to remove the hydraulic fluid from the steering cylinder into a drain pan. Plug both the ports and clean the outer surface of the cylinder.

IMPORTANT

When you clamp the steering cylinder in a vise, clamp the barrel clevis only to prevent damage. Do not close the vise on the barrel.

- 2. Mount the steering cylinder securely in a vise by clamping on the barrel clevis. Use a vise equipped with soft jaws.
- 3. Use a spanner wrench to loosen and remove the external collars from both ends of the barrel.
- 4. Use a twisting and pulling motion to carefully extract the rear head from the barrel and rear shaft.

Disassembling the Steering Cylinder (continued)

- 5. Hold the end of the front shaft and use a twisting and pulling motion to carefully extract the rear shaft, piston, front shaft, and front head assembly from the barrel.
- 6. Remove the cylinder from the vise.

IMPORTANT

When removing the roll pin from the front and rear shafts, ensure that the shaft surfaces are not damaged.

- 7. Remove and discard the roll pin (item 7 in Figure 121) that secures the front shaft to the rear shaft. Then, remove the rear shaft, piston, and front head from the front shaft.
- 8. Remove and discard the seals, O-rings, and wear ring from the piston and heads.

Inspecting the Steering Cylinder



Use eye protection such as goggles when using compressed air.

- 1. Wash all the cylinder components in clean solvent and dry them with compressed air.
- 2. Inspect the internal surface of the barrel for deep scratches, out-of-roundness, and bending.
- 3. Inspect the head, shaft, and piston for excessive pitting, scoring, and wear.
- 4. Replace the steering cylinder if the internal components are worn or damaged.

Assembling the Steering Cylinder

1. Use a new seal kit and replace all the seals, O-rings, and wear ring to the piston and heads. Apply clean hydraulic fluid to all the seal kit components before you install them.

Note: Do not damage the head seals during installation.

2. Install the front head (item 17 in Figure 121) with new seals onto the front shaft.

IMPORTANT

Ensure that you do not damage O-ring (item 6 in Figure 121) as piston is installed over the roll pin hole in the front rod.

3. Install the piston (item 14 in Figure 121) with new seal, O-ring, and wear ring onto the front shaft.

A

IMPORTANT

When installing the roll pin into the front and rear shafts, ensure that the shaft surfaces are not damaged.

4. Slide the rear shaft into the front shaft and align the roll pin holes in the shafts. Install new roll pin to secure the shafts.

IMPORTANT

When clamping the cylinder's barrel in a vise; clamp on the clevis only to prevent damage. Do not close the vise on the barrel.

5. Mount the steering cylinder barrel in a vise equipped with soft jaws by clamping on the barrel clevis.

Note: Do not damage the seals during installation.

6. Coat all the internal cylinder components with clean hydraulic fluid. Slide the shaft assembly into the barrel.

Note: Do not damage the head seals during installation.

- 7. Insert the rear head with new seals into the barrel.
- 8. Secure the front and rear heads in the barrel with external collars, tighten the collars with a spanner wrench.

Oil Cooler Assembly



Note: The hydraulic oil cooler on your Groundsmaster is combined with the radiator. Refer to Radiator (page 3–15) for information on removal and installation of the radiator/oil cooler assembly.

assembly

TORO_®

Electrical System

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General Information

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 Schematic and Wire Harness Drawings/Diagrams

Refer to the Electrical Schematic and Wire Harness Drawings/Diagrams in Appendix A (page A–1).

Toro Electronic Controller (TEC)

The Groundsmaster 4300-D machines use a Toro Electronic Controller (TEC) to manage the machine electrical functions. The controller is a microprocessor controlled device that monitors the condition of various switches (inputs) and then directs electrical power to control the appropriate machine functions (outputs) based on the inputs. The status of inputs to the controller as well as outputs from the controllers can be monitored with the InfoCenter display.

The TEC is located behind the control arm access cover next to the fuse block.

IMPORTANT

Before performing any welding on the machine, do the following to prevent damaging the electrical system of the machine:

- Disconnect the battery cables from the battery.
- Disconnect the wire harness connector from the Toro Electronic Controller.
- Disconnect the wire harness connectors from the engine ECU.
- Disconnect the terminal connector from the alternator.



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)**.

CAN-bus Communications

The TEC, Yanmar engine ECU, and InfoCenter display used on the Groundsmaster 4300-D machines communicate with each other on a CAN-bus system. This system allows the traction unit to fully integrate all the different electrical components of the machine and bring them together as one. The CAN-bus system reduces the number of electrical components and connections that are used on the machine and allows the number of wires in the wire harness to be significantly reduced. The integration of the electrical functions also allows the InfoCenter display to assist with the electrical system diagnostics.

The CAN identifies the controller area network that is used on the machine. The 2 specially designed, twisted cables form the bus. These wires provide the data pathways between the TEC, Yanmar engine ECU, and InfoCenter display used on the machine. The engineering term for these cables are the CAN High and CAN Low. At the ends of the twisted pair of bus cables are the 120-ohm terminator resistors.

The CAN-bus link controls each of the components that requires only 4 wires to operate and communicate to the system: CAN High, CAN Low, B+ (power), and ground.

CAN-bus Communications (continued)

IMPORTANT

The terminator resistors at the ends of the bus cables are required for proper electrical system operation.

Yanmar Engine Electronic Control Unit (ECU)



The Groundsmaster 4300-D machines use an electronic control unit (ECU) for engine management and to communicate with the TEC and InfoCenter display on the machine. If you must disconnect the engine ECU for any reason, ensure that the key switch is in the OFF position with the key removed for a minimum of 30 seconds before disconnecting the engine ECU.

Yanmar Engine Electrical Components

When servicing or troubleshooting the engine electrical components use the Yanmar Engine Service Manual and Troubleshooting Manual. Contact your Toro distributor for additional engine troubleshooting assistance.

Special Tools

You can order these special tools from your Authorized Toro Distributor. Some tools are also available from a local supplier.

Multimeter



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Figure 124

The meter can test the electrical components and circuits for current, resistance, or voltage. You can get the digital multimeter locally.

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.

Terminal Protector



g033638

Figure 125

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.

Battery Hydrometer



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

Dielectric Gel



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Figure 127

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.

InfoCenter Display



The InfoCenter display used on your Groundsmaster is a LCD device that is located on the control arm (Figure 128). The InfoCenter provides information to the operator during the operation of the machine, provides the electrical system diagnostic assistance for the technicians, and allows inputs for the adjustable machine settings (Figure 129).

The power for the InfoCenter is available when the main power relay is energized (key switch in the RUN or START position). A CAN-bus system involving the machine TEC, Yanmar engine ECU, InfoCenter, and cutting deck motors provide necessary machine communication for the InfoCenter operation.

Note: Icons that are used on the InfoCenter display are identified in the *Traction Unit Operator's Manual.*



Splash Screen



- 1. Battery voltage
- 2. Fuel gauge
- 3. Hour meter
- 4. Glow plugs energized



- 6. Down button
- 7. Menu/back button



When the key switch is initially turned to the RUN or START position, the fault indicator illuminates for a few seconds to verify indicator operation and the InfoCenter splash screen appears (Figure 130 and Figure 131). The splash screen provides the following information to the operator:

- Battery voltage
- Fuel tank level

Splash Screen (continued)

- Hour meter (displayed for first 5 seconds)
- Glow plug indicator (displayed only while glow plugs are energized)
- Engine RPM (displayed after 5 seconds)

After the splash screen has been displayed for 10 seconds, the main information screen will appear on the InfoCenter.

Main Information Screen



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- 1. Engine coolant temperature
- 2. Fuel gauge
- 3. PTO on
- 4. Left/right button
- 5. Down button

6. Menu/back button

- 7. Parking brake (engaged)
- 8. Traction system (neutral)
- 9. Operator seat (unoccupied)
- 10. Cutting decks (raising)

Main Information Screen (continued)



The InfoCenter main information screen (Figure 132) is displayed after the initial splash screen has been displayed for 10 seconds. The main information screen is the default screen as it will be displayed during normal machine operation. The main information screen provides the following information to the operator:

- Engine coolant temperature
- Fuel tank level
- Traction system

Either the neutral, high (transport) speed range, or low (mow) speed range icon will appear at all times.

Parking brake

The icon appears when the parking brake is engaged.

Cutting decks

Up icon appears while the cutting decks are raising

- Down icon appears while the cutting decks are lowering
- PTO

The icon appears when the PTO is engaged.

• Operator seat

The icon appears when the operator is out of the seat and the seat must be occupied before machine operation can continue.

Press the menu/back button once to expose the navigation pane, then press the left/right button (as indicated by the ➡ in the navigation pane) to toggle between the main information screen and the splash screen (tachometer) (Figure 133). The navigation pane will close automatically if another button is not pressed within 6 seconds.

Operator Advisory Screen



If the Toro Electronic Controller (TEC) inputs are not in the correct position to allow certain machine operations, or are malfunctioning, the fault indicator will illuminate and an advisory screen will appear on the InfoCenter display (Figure 134). Each advisory screen has 3 elements: the advisory number/code, advisory description, and advisory qualifier.

An advisory qualifier denotes the condition(s) that triggered the advisory and provides instruction on eliminating the advisory. An operator advisory may involve one or more advisory qualifier. Typically, an advisory can be eliminated by changing the position of the operator control(s) referenced by the advisory qualifier. Once the first qualifier displayed is satisfied, any additional qualifiers that remain to be satisfied will appear in the operator advisory screen individually.

Note: If a machine fault occurs during machine operation, the InfoCenter fault indicator will blink to notify the operator. Accessing the fault log is described in the Faults Screen (page 5–14).

Main Menu Screen



- 1. Navigation pane
- 2. Left/right button

- 3. Menu/back button
- 1 Main Menu Faults Service 5 Diagnostics ImfoCei\ter 2 g187148 Figure 136 1. Main menu 4. Menu/back button Left/right button 2. 5. Menu items 3. Down button

The main menu screen (Figure 136) is accessed from the InfoCenter main information screen. Press the menu/back button once to expose the navigation pane (Figure 135), then press the menu/back button again (as indicated by the i in the navigation pane). The main menu screen provides access to the following menu screens:

- Faults
- Service
- Diagnostics
- Settings
- About

Main Menu Screen (continued)

Press the down button (as indicated by the \clubsuit at the bottom of the screen) to highlight the desired menu screen, then press the left/right button (as indicated by the \Longrightarrow at the bottom of the screen) to enter the highlighted menu screen.

To return to the main information screen from the main menu screen, press the menu/back button (as indicated by the \square at the bottom of the screen).

Faults Screen

Machine Faults



Machine Faults (continued)

The faults screen (Figure 137 and Figure 138) 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 number code and when the fault occurred. The faults that might occur on the machine are listed in the Machine Faults (page 5–30).

If a machine fault occurs during operation, the InfoCenter fault indicator will blink to notify the operator, and machine functionality may be affected due to the fault. To regain full machine functionality:

- 1. Disengage the cutting deck, release the traction pedal.
- 2. Turn the key switch OFF and allow all machine functions to stop.
- 3. Allow the machine to remain OFF for at least 1 minute.
- 4. Restart the engine and check the machine operation.
- 5. If a fault continues to occur, further system evaluation and possible component repair or replacement will be necessary.

To view a description of a fault that has occurred since the faults were last

cleared from the InfoCenter, press the down button (as indicated by the \clubsuit at the bottom of the screen) to highlight the desired fault, then press the left/right button (as indicated by the \clubsuit).

To return to the previous screen, press the menu/back button (as indicated by the \square at the bottom of the screen).

Clear System Faults (PIN required) If the correct passcode (PIN) has been entered (refer to the Protected Menus in the <u>Settings Screen (page 5–21)</u>) the InfoCenter fault log can be cleared by selecting Clear System Faults. The cleared faults will be removed from the InfoCenter list but will be retained in the TEC memory. Contact your Toro Distributor to view faults stored in the TEC memory.



Yanmar Diesel Engines – If an engine fault occurs during machine operation, the fault indicator will illuminate and the fault will be displayed on the InfoCenter to notify the operator (Figure 139). The engine fault will continue to appear until the offending condition is corrected. Once the offending condition has been corrected, the engine fault will be retained in the engine electronic control unit (ECU) and can only be viewed using the engine diagnostic tool. Engine faults are not stored in the Toro Electronic Controller (TEC) so that the engine fault history cannot be viewed using the InfoCenter faults screen.

Note: Refer to the Yanmar Engine Service Manual and Troubleshooting Manual for additional information.

Service Screen



The service screen (Figure 140) contains operational information of the machine including hours and counts. If the correct passcode (PIN) has been entered (refer to the Protected Menus in the Settings Screen (page 5–21)) the service screen allows access to initiate a manual DPF regeneration, provides information on DPF ash accumulation, and allows resetting the Service Due timer. To scroll through the list of service records and view the current values, press the down

button (as indicated by the at the \clubsuit bottom of the screen).

To return to the previous screen, press the menu/back button (as indicated by the \square at the bottom of the screen).

Hours provides access to the following information:

- **Key On** identifies the number of hours that the key switch has been in the ON position.
- Engine 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 HIGH (transport) speed range.
- Service Due identifies the number of hours before the next scheduled maintenance is due. This is a count down timer and the numbers of hours displayed will decrease as the machine is used.
- Service Reset (PIN required) identifies the total number of hours between scheduled maintenance intervals. Reset the Service Due timer to the service interval (250 hours) by pressing the left/light button (as indicated by the ➡ at the bottom of the screen) and then pressing the down button (as indicated by the Yes or ➡ at the bottom of the screen).

Counts provides access to the following information:

- Engine Starts identifies the number of times that the engine has been started.
- **PTO Starts** identifies the number of times that the PTO switch has been engaged.

Service Screen (continued)

DPF Regeneration (PIN required) allows an operator or technician to initiate a stationary regeneration for the exhaust system DPF (diesel-particulate filter) on the machines with Yanmar diesel engines. If the engine ECU identifies that a stationary DPF regeneration is necessary, an advisory will occur on the InfoCenter display.

Move the machine to a well ventilated area and initiate a stationary DPF regeneration by pressing the left/right button (as indicated by the \Rightarrow at the bottom of the screen) and then pressing the down button (as indicated by the Yes or \Rightarrow at the bottom of the screen). Additional information can be found in the Yanmar Engine Service Manual.

DPF Ash (PIN required) DPF ash is the level of ash accumulated in the DPF (diesel-particulate filter) on the machines with Yanmar diesel engines. Ash is the byproduct of performing numerous regeneration operations. An engine fault will be generated if the ash accumulation exceeds 50 g/l. If excessive ash accumulation levels exist, DPF replacement may be necessary.

Diagnostics Screen

The diagnostics screen (Figure 141) lists a variety of machine operations and the current state of the Toro Electronic Controller (TEC) inputs, qualifiers, and outputs required to allow the operation to proceed. The diagnostics screen should be used to troubleshoot machine operation issues, and check that necessary components and circuit wiring are functioning correctly (refer to Troubleshooting (page 5–24)). To scroll through the list of operations and select (highlight) the operation to be viewed, press the down button (as indicated by the \checkmark at the bottom of the screen).

To return to the previous screen, press the menu/back button (as indicated by the \square at the bottom of the screen).

For each of the diagnostics screen items, inputs, qualifiers, and outputs are identified. The diagnostics screen includes the following:

Lift identifies the machine requirements necessary to allow the TEC to raise the cutting decks.

Inputs	Qualifiers	Outputs
Joystick Raise	Engine Running	CounterBal PRV

Lower identifies the machine requirements necessary to allow the TEC to lower the cutting decks.

Inputs	Qualifiers	Outputs
Joystick Lower	Low Range	Solenoid SV1
	Seat or P Brake	Solenoid SV2

PTO identifies the requirements necessary to allow the TEC to engage the cutting decks.

Inputs	Qualifiers	Outputs
Input	Joystick Lower OFF	Front MSV1
	Low Range	Rear MSV2
	In Seat	
	Engine Temp OK	
	Engine Running	

Diagnostics Screen (continued)

1. 2.

3.



Engine identifies the requirements necessary to allow the TEC to start and run the engine.

Note: The components for engine operation (i.e., glow plugs, starter) are controlled by the Yanmar engine ECU.

Inputs	Qualifiers	Outputs
Key Start	Key Run	ETR
	Neutral	Engine Start
	Joystick Lower OFF	
	Joystick Raise OFF	
	Seat or P Brake	
	PTO Switch OFF	

Settings Screen





The settings screen (Figure 142 and Figure 143) allows the operator or technician to customize the InfoCenter display, modify a variety of machine functions, and provides access to unlock various protected menus and settings. To scroll through the list of functions, view its current setting, and select (highlight) the setting to be modified, press the down button (as indicated by the 4 at the bottom of the screen).

To return to the previous screen, press the menu/back button (as indicated by the \mathbb{F} at the bottom of the screen).

Settings Screen (continued)

Units: Use the left/right button (as indicated by the \equiv at the bottom of the screen) to select between metric or English units of measure. Allow the desired selection to remain in view for 5 seconds.

Language: Use the left/right button (as indicated by the \equiv at the bottom of the screen) to select from numerous language options. Allow the desired selection to remain in view for 5 seconds.

Backlight: Press the left/right button (as indicated by the \Rightarrow at the bottom of the screen) then use the down button to decrease or the left/right button to increase the InfoCenter display brightness (as indicated by the – and the + at the bottom of the screen).

Contrast: Press the left/right button (as indicated by the \Rightarrow at the bottom of the screen) then use the down button to decrease or the left/right button to increase the InfoCenter display contrast (as indicated by the – and the + at the bottom of the screen).

Protected Menus: Authorized individuals can enter the 4 digit passcode (PIN) to reveal the following service functions (refer to Faults Screen (page 5–14) and Service Screen (page 5–17)):

- Clear System Faults
- Service Reset
- DPF Regeneration
- DPF Ash

Entering the correct PIN will also reveal and allow adjustment of various machine functions on the settings screen if Protect Settings is set to ON (refer to the Protected Menus in the Settings Screen (page 5–21)).

Use the down button and left/right button (as indicated by the \checkmark and the \Rightarrow at the bottom of the screen) to enter the 4 digit passcode (PIN). Once the correct PIN has been entered, press the down button (as indicated by the \checkmark at the bottom of the screen). PIN will appear in the upper right hand corner of the InfoCenter display. The protected items will be visible as long as the key switch remains in the RUN position.

To edit the passcode (PIN), enter the current PIN as previously described (PIN will appear in the upper right hand corner). Select Protected Menus again and

use the down button and left/right button (as indicated by the \clubsuit and the \Rightarrow at the bottom of the screen) to enter a new 4 digit PIN. Press the down button to save the change (as indicated by the \blacksquare at the bottom of the screen).

The initial PIN will either be 1234 or 0000. If the PIN has been changed and is forgotten, you can obtain a temporary PIN from your Toro distributor.

The following settings will only be visible if the Protect Settings is set to ON and the correct passcode (PIN) has been entered, or Protect Settings is set to OFF:

Note: To change the machine PIN, access the protected menu items by entering the current PIN. The InfoCenter display screen should indicate "PIN" in the upper right hand corner after the current PIN number is entered. Select the protected menu item again and note that "Edit PIN" is indicated on InfoCenter display screen. A new PIN can be entered and then saved.

Protect Settings: Use the left/right button (as indicated by the \equiv at the bottom of the screen) to select OFF or ON. When the Protect Settings is set to OFF, the remaining settings will be visible and adjustable at all times. When the Protect Settings is set to ON, the remaining settings will be visible and adjustable only

Settings Screen (continued)

after the correct passcode (PIN) has been entered (refer to the Protected Menus in the Settings Screen (page 5–21)).

Counterbalance: Controls the amount of counterbalance applied to the cutting decks.

Auto Idle: (Yanmar diesel engines only) When the engine is running and the machine is in neutral, the engine will automatically return to the low idle setting after the set time delay. When the engine is running and the machine is not in neutral, the engine will automatically return to the high idle setting after the set time delay. Use the left/right button (as indicated by the \equiv at the bottom of the screen) to select 8, 10, 15, 20, or 30 seconds or the auto idle feature can be set to OFF.

About Screen



To return to the previous screen, press the menu/back button (as indicated by the \square at the bottom of the screen).

Troubleshooting

A

CAUTION

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

For the effective troubleshooting and repairs, you must have a good understanding of the electrical circuits and components that are used on this machine; refer to the Electrical Schematic and Wire Harness Drawings/Diagrams in Appendix A (page A–1).

If the machine has any interlock switches that are bypassed, connect the switches for the correct troubleshooting and safety.

Note: Use the InfoCenter display when troubleshooting a Groundsmaster 4300-D electrical problem.

Operator Advisories

If controls are not selected properly to allow certain machine operations, the InfoCenter indicator light will illuminate and an advisory will be displayed on the InfoCenter display, refer to Operator Advisory Screen (page 5–12).

Advisory numbers, descriptions, and reason for advisories are listed in the Advisories Table (page 5–24). Some advisories can be caused by several machine settings.

Advisory Number	Advisory Description	Possible Reason for Advisory
160	Inhibit start	Neither seat occupied nor parking brake applied
		Traction pedal is not in NEUTRAL position
		Wait to start until system functions have been initialized
		Joystick is in RAISE position
		Joystick is in LOWER position
161	Inhibit PTO	No operator in seat
		Engine coolant temperature is excessive
162	Inhibit cutting deck lower	Mow speed limiter is in TRANSPORT position
169	Engine shutdown	No operator in seat
		Parking brake is applied
		Engine coolant temperature is excessive
		Engine oil pressure is low
170	Recycle key switch	Engine starter motor has been engaged for 30 seconds
171	Auto idle engaged	
173	Master Address Claim	Check the TEC and InfoCenter wire harness connections

Advisories Table

A

Operator Advisories (continued) Advisories Table (continued)

Advisory Number	Advisory Description	Possible Reason for Advisory
178	Low fuel	Fuel level in the fuel tank is low
179	Ash cleaning warning	Excessive ash accumulated in DPF
Advi	sory Qualifiers	Qualifiers Description
160		Engine is running
162		Version check restriction
	163	Sit down or set parking brake
	164	Machine not in neutral
	171	Raise switch closed
	172	Lower switch closed
	173	Operator not in seat
	174	High range engaged
	176	Engine is overheating
	179	PTO switch closed
	184	Parking brake is set
	188	Loss of CAN
	189	Key start held too long
190		Safety shutdown
208		Recycle key switch

Using the InfoCenter Display for Troubleshooting



- 1. Diagnostics menu
- 2. Left/right button
- 3. Down button

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- 4. Menu/back button
- 5. Diagnostics items



The diagnostics screen of the InfoCenter display can be very helpful when troubleshooting machine operation issues (refer to Diagnostics Screen (page 5–19)). The diagnostics screen (Figure 145) lists a variety of machine operations and the current state of the inputs, qualifiers, and outputs required to allow the operation to proceed. The electrical components involved in the following machine operations can be evaluated using the diagnostics screen prior to testing each component individually:

- Lift The components necessary to raise the cutting decks.
- Lower The components necessary to lower the cutting decks.

Using the InfoCenter Display for Troubleshooting (continued)

- **PTO** The components necessary to engage the cutting decks.
- Engine The components necessary to start and run the engine.

If a machine operation is malfunctioning, the following procedure can help identify the cause of the component or circuit wiring causing the malfunction.

- 1. Park the machine on a level surface, lower the cutting decks, set the parking brake, and shut off the engine.
- 2. Set the key switch to the ON position and navigate to the InfoCenter Diagnostic Screen.
- 3. Select (highlight) the malfunctioning machine operation and press the left/right button (as indicated by the ➡ at the bottom of the screen). For this example, the PTO operation has been selected (Figure 146).
- 4. Select (highlight) the Inputs and press the left/right button (as indicated by the ➡ at the bottom of the screen).



Using the InfoCenter Display for Troubleshooting (continued)



5. Manually operate each input item listed (Figure 147). The input condition on the InfoCenter display should alternate ON and OFF as the input is switched open and closed. If ON and OFF do not alternate during input operation, the input component or its circuit wiring is damaged and should be tested; refer to Testing the Electrical Components (page 5–45).

In the PTO operation example, the only input is the PTO switch. If ON and OFF do not alternate when the switch is moved back and forth from ENABLE to DISABLE, the switch or the circuit wiring for the switch is damaged and should be tested as described.

Press the menu/back button (as indicated by the ^I□ at the bottom of the screen). Select (highlight) the Qualifiers and press the left/right button (as indicated by the → at the bottom of the screen).

Note: All of the qualifiers for the machine operation must be in the desired condition (\square) before the operation Outputs can be energized.

CAUTION A

It may be necessary to start and run the engine, raise and lower the cutting decks, or otherwise operate the machine during the troubleshooting process.

Ensure that the machine is in a well ventilated area and keep your hands and feet away from the cutting decks and moving parts while troubleshooting to prevent personal injury.
Using the InfoCenter Display for Troubleshooting (continued)

In the PTO operation example, the following qualifiers must be in the desired condition (\square) before any operation Outputs can be energized:

- Joystick lower off
- Mow/transport switch in Low (mow) range
- Operator must be in seat (seat switch)
- Engine temperature is ok
- Engine must be running

Engine RPM above 800 as reported by engine ECU

If \square and \square do not alternate when the qualifier condition is changed, the qualifier or the circuit wiring for the qualifier is damaged and should be tested as described.

- Press the menu/back button (as indicated by the I at the bottom of the screen). Select (highlight) the Outputs and press the left/right button (as indicated by the → at the bottom of the screen).
- 9. If all the Inputs are ON and all the Qualifiers are in their desired condition (☑), the Outputs for the machine operation should be ON. If the outputs remain OFF, the Toro Electronic Controller (TEC) or TEC software may be damaged and require reloading or replacement. Contact your Toro Distributor for assistance.
- 10. If the outputs listed on the InfoCenter display are ON, and the operation is still malfunctioning:
 - Test the specific output and output wiring; refer to Testing the Electrical Components (page 5–45).
 - Test the hydraulic components related to the operation; refer to Chapter 4: Hydraulic System (page 4–1).

In the PTO operation example, the outputs are the front MSV1 and rear MSV2 solenoid valves. If ON appears next to these outputs on the InfoCenter display:

- Test the hydraulic solenoid valve coils; refer to Hydraulic Solenoid Valve Coils (page 5–74).
- Perform the cutting deck hydraulic circuit tests; refer to Chapter 4: Hydraulic System (page 4–1).

Machine Faults

The Machine Fault Table (page 5–31) identifies the fault codes that are generated by the Toro Electronic Controller (TEC) to identify an electrical system fault (malfunction) that occurred during the operation of the machine. Use the InfoCenter display to view faults that have occurred since the faults were last cleared from the InfoCenter; refer to Faults Screen (page 5–14).

The Yanmar engine ECU can also generate electrical faults. The faults generated by the ECU are specific to the engine; refer to Engine Faults (page 5–33).

Note: Fault codes identify electrical problems that typically will prevent normal machine operation. For fault codes that identify problems with TEC inputs (e.g., switches, sensors), use the InfoCenter display to check the different switch positions before removing or replacing the component. Fault codes that identify problems with TEC outputs (e.g., solenoid coils) might involve issues with the wire harness or the actual output device.

Using Machine Faults

If an electrical fault is identified by the machine controllers (TEC and cutting deck motors), the InfoCenter display will identify the fault code number and when the fault occurred. An electrical fault can cause disruption in how the machine functions but in some instances, the fault may occur with little, if any, change in machine operation. The following suggestions should be considered when using fault codes that are displayed.

- If a fault code is displayed on the InfoCenter and machine operation remains normal, continue to use the machine. The fault code number can be retrieved in the future by using the InfoCenter faults screen.
- If a fault code is displayed on the InfoCenter and machine operation has changed, move the machine to a level surface, disengage the cutting decks, and turn the key switch to the OFF position. Leave the switch in the OFF position for 30 seconds and then start the machine. During this system reboot process, the machine controllers often can reset the electrical components to allow normal machine operation. Assuming that the fault code is no longer displayed, continue to use the machine. The fault code number can be retrieved in the future by using the InfoCenter faults screen.
- There is the possibility that an electrical issue can result with several fault codes being generated. For example, a broken wire or damaged fuse would prevent operation of a cutting deck motor and multiple fault codes could be displayed. Reviewing the fault code descriptions should suggest possible causes for the circuit problem. Using the electrical schematic and electrical wire harness drawings will also help in problem diagnosis.
- The InfoCenter will display fault code numbers as an indication that the machine electrical system has experienced an unusual change that might be very minor resulting in no change of the machine operation or more severe which could prevent machine use. Use the fault codes in conjunction with noting what machine operations have changed, when did the change occur, and whether the problem occurs all the time or is intermittent to help identify the source of a machine problem.
- The InfoCenter faults screen can be used to list all machine electrical faults that have occurred since the faults were last cleared from the InfoCenter. If a fault that is listed on the InfoCenter faults screen occurred at some point in the distant past and has not reoccurred, that fault is likely not causing a current machine problem. Recurring faults may indicate a problem with a particular circuit or component.
- When machine electrical issues occur and fault codes have been displayed on the InfoCenter display, consider contacting your Toro Distributor for additional assistance.

Using Machine Faults (continued)

Machine Fault Table

Fault Code	Fault Description	Service Suggestions
1	1 Excessive engine coolant temperature (above 105°C) caused PTO to disengage	Check the radiator and screen for debris buildup
		Check the engine cooling fan and drive belt
		Check the engine coolant level
2	Excessive engine coolant temperature (above 115°C)	Check the radiator and screen for debris buildup
	caused engine to stop	Check the engine cooling fan and drive belt
		Check the engine coolant level
3	One of the TEC output fuses (7.5 A) is damaged	Check the TEC output fuses
4	IPE voltage is low indicating that	Check the TEC fuses
		Consider that the TEC is damaged
5	Main power relay is damaged	Check the main power relay and circuit wiring
6	The key switch was held in the	Cycle the key switch
	30 seconds or the key switch is	Check the fuel level in the fuel tank
	oamageo	Check the key switch and circuit wiring
		Check the fuel pump
7	TEC software needs to be reprogrammed	Contact Toro Distributor for reprogramming assistance
8	Engine alternator charging is too high	Check the engine alternator
9	Engine alternator charging is too	Check the alternator drive belt
	IOW	Check the engine alternator and circuit wiring
10	Engine has not been seen on the CAN-bus for 10 seconds	
12	InfoCenter has not been seen on the CAN-bus for 1 second	
13	Key switch is damaged	Check the switch and circuit wiring
15	Engine speed switch is damaged	Check the control arm engine speed switch and circuit wiring
19	Engine coolant temperature sensor circuit has open or short	Check the engine coolant sensor and circuit wiring
20	Pressure sensor circuit is out-of-range	Check the pressure sensor and circuit wiring
24	Joystick raise and lower switches closed at same time	Check the joystick switches and circuit wiring
26	TEC output current to energize start relay is excessive	Check the start relay and circuit wiring
27	TEC output current to fuel pump is excessive	Check the fuel pump and circuit wiring

Using Machine Faults (continued) Machine Fault Table (continued)

Fault Code	Fault Description	Service Suggestions
37	TEC output current to energize glow relay is excessive	Check the glow relay and circuit wiring
53	TEC output current for hydraulic solenoid coil SV1 is excessive	Check the lift control manifold solenoid coil SV1 and circuit wiring
54	TEC output current for hydraulic solenoid coil SV2 is excessive	Check the lift control manifold solenoid coil SV2 and circuit wiring
59	TEC output current for hydraulic solenoid coil PRV1 is excessive	Check the deck control manifold solenoid coil PRV1 and circuit wiring
60	TEC output current for hydraulic solenoid coil PRV2 is excessive	Check the deck control manifold solenoid coil PRV2 and circuit wiring
61	TEC output current for hydraulic solenoid coil PRV is excessive	Check the lift control manifold solenoid coil PRV and circuit wiring
68	Alternator not charging	Check the engine alternator and circuit wiring
69	Low engine oil pressure	Check the engine oil pressure switch and circuit wiring

Engine Faults



The engine faults are generated by the Yanmar engine ECU to identify an electrical system malfunction (fault) pertaining to the engine during operation. When an engine fault occurs, the fault indicator will flash and the InfoCenter will display information about the fault. The number of flashes and/or the flashing pattern vary depending on the type or source of the fault, enabling quick-fix. Depending on the severity of the fault, a Stop icon may display as well.

The Toro Electronic Controllers (TECs) can also generate electrical faults. The faults generated by the TECs are specific to the machine; refer to Machine Faults (page 5–30).

If an engine fault occurs:

- 1. The engine fault information will be displayed on the InfoCenter (Figure 149).
- 2. If a Stop fault is displayed on the InfoCenter, the operator should cease operation of the machine and the engine as quickly and as safely as possible to reduce damage to the engine.
- 3. If a Check Engine fault is displayed on the InfoCenter, the operator should take the machine for service as soon as possible.
- 4. Return to the previous screen by pressing the menu/back button (as indicated by the \mathbb{P} at the bottom of the screen).

The engine fault will continue to appear until the fault is cleared. In order to clear the displayed fault, the engine problem has to be resolved. Refer to the Yanmar Engine Service Manual and Troubleshooting Manual for additional information.

Note: The engine faults that are no longer active are stored in the Yanmar engine ECU and can only be viewed by using the engine diagnostic tool. Contact your Toro distributor for any assistance in the Yanmar engine troubleshooting.

Starting Problems

Problem	Possible Causes	
All the electrical power is dead, including the	The battery is discharged or damaged.	
InfoCenter display.	The battery cables are loose or corroded.	
	• The fuse F1-1 (15 A) or F1-2 (10 A) is damaged.	
	The ground connection is loose or corroded.	
	• The key switch or circuit wiring is damaged.	
	• The fusible link harness at the engine starter motor is damaged.	
The starter solenoid clicks, but the starter does	The battery charge is low.	
not crank.	 The battery is discharged or damaged. 	
is not in the interlock circuit.	 The battery cables are loose or corroded. 	
	The ground connection is loose or corroded.	
	• The wiring at the starter motor is damaged.	
	 The starter solenoid or starter motor is damaged. 	
The engine cranks, but does not start.	The fuel tank is empty.	
	The fuel filter is plugged.	
	• The wiring in the engine crank circuit is loose, corroded, or damaged; refer to the Electrical Schematic in Appendix A—Foldout Drawings.	
	• The engine and/or fuel can be too cold.	
	 The engine fuel pump or circuit wiring is damaged. 	
	• The engine glow plug circuit does not operate properly.	
	• The engine or fuel system is malfunctioning; refer to Chapter 3: Diesel Engine (page 3–1).	
	• The hydraulic load is slowing engine cranking speed (disconnect the hydraulic pump driveshaft from the engine to test).	
The glow plug circuit does not operate properly.	• The wiring in the engine glow circuit is loose, corroded, or damaged; refer to the Electrical Schematic in Appendix A—Foldout Drawings.	
	• The engine glow plugs are damaged.	
	• The glow relay is damaged.	
	• The fusible link harness at the engine starter motor is damaged.	
	• The TEC fuses are damaged.	
	• The TEC is damaged.	
The engine cranks, but should not, when the traction pedal is pressed.	• The traction neutral switch is out of adjustment.	
	• The traction neutral switch or circuit wiring is damaged.	

Starting Problems (continued)

Problem	Possible Causes	
The engine starts, but stops when the key	The circuit wiring is damaged.	
switch is released from the START position.	• The key switch is damaged.	
Nothing happens when you attempt to start the engine. The InfoCenter display operates with	• The traction pedal is not in the NEUTRAL position.	
Note: An operator advisory is displayed on the InfoCenter if the interlock switches for engine start are not functioning. Use the InfoCenter display to assist with identifying the problem.	• The operator seat is unoccupied or the parking brake is not applied.	
	• The cutting decks are engaged (the PTO switch is in the ON position or it is damaged).	
	• The battery is discharged or damaged.	
	The battery cables are loose or corroded.	
	• The ground connection is loose or corroded.	
	 The traction neutral switch is out of adjustment. 	
	• The traction neutral switch or circuit wiring is damaged.	
	• The seat switch or circuit wiring is damaged.	
	• The parking brake switch or circuit wiring is damaged.	
	 The joystick switch or circuit wiring is damaged. 	
	• The key switch or circuit wiring is damaged.	
	• The start relay or circuit wiring is damaged.	
	 The main power relay or circuit wiring is damaged (headlights and power point inoperative as well). 	
	• The TEC fuses are damaged.	
	• The fusible link harness at the engine starter motor is damaged.	
	• The wiring to start circuit components is loose, corroded, or damaged; refer to the Electrical Schematic in Appendix A—Foldout Drawings.	
	• The starter solenoid is damaged.	
	 The high temperature shutdown switch or circuit wiring is damaged. 	
	• The TEC is damaged.	
	• The starter motor is damaged.	
	• The engine ECU or circuit wiring is damaged.	

General Run and Transport Problems

Problem	Possible Causes	
The engine continues to run, but should not, when the key switch is turned to the OFF position.	• The key switch or circuit wiring is damaged.	
	 The main power relay or circuit wiring is damaged. 	
	• The engine or fuel system is malfunctioning; refer to Chapter 3: Diesel Engine (page 3–1).	
The engine continues to run, but should not,	• The seat switch or circuit wiring is damaged.	
operator in the seat.	The TEC fuses are damaged.	
	• The traction neutral switch is out of adjustment.	
	• The traction neutral switch or circuit wiring is damaged.	
	• The TEC is damaged.	
The engine shuts off during the operation, but	• The parking brake is engaged.	
Note: Excessive coolant temperature will	• The operator is raising from the seat (the seat switch is not fully pressed).	
and can cause the engine to shutdown. If the	• The seat switch or circuit wiring is damaged.	
excessive engine coolant temperature causes the engine to shutdown, the operator can	• The key switch or circuit wiring is damaged.	
start the engine by moving the machine to a short distance. After starting the engine in this condition, the engine runs for approximately	• The engine coolant temperature is excessive (above 115°C/240°F).	
10 seconds before it shuts off again.	 The machine is being operated on a slope with a low fuel level. 	
	• The engine or fuel system is malfunctioning; refer to Chapter 3: Diesel Engine (page 3–1).	
The engine shuts off when the traction pedal	• The parking brake is engaged.	
Note: If the machine controls are not in the	• The operator is not fully pressing the seat switch.	
(e.g., the parking brake is engaged), an	• The seat switch or circuit wiring is damaged.	
advisory message may be displayed on the InfoCenter display.	• The key switch or circuit wiring is damaged.	
	• The engine coolant temperature is excessive.	
	• The machine is operated on a slope with a low fuel level.	
	• The TEC fuses are damaged.	
	• The TEC is damaged.	
The battery does not charge.	• A loose, corroded, or broken wires exist in the charging circuit; refer to the Electrical Schematic in Appendix A—Foldout Drawings.	
	 The engine alternator belt is loose or damaged. 	
	The battery cables are loose or corroded.	
	• The fusible link connecting the engine starter motor is damaged.	
	• The alternator is damaged.	
	• The battery is damaged.	

Cutting Deck Operating Problems

Problem	Possible Causes
The cutting decks remain engaged, but should	• The seat switch or circuit wiring is damaged.
not, with no operator in the seat.	• The TEC is damaged.
The cutting decks run, but should not, when raised. The cutting decks shut off with the	• A hydraulic problem in the cutting deck circuit exists; refer to Troubleshooting (page 4–39).
PTO switch.	• The TEC is damaged.
The cutting decks run, but should not, when	• The PTO switch or circuit wiring is damaged.
the PTO switch.	• A hydraulic problem in the cutting deck circuit exists; refer to Troubleshooting (page 4–39).
	• The TEC is damaged.
None of the cutting decks operate. Cutting	• The PTO switch is in the OFF position.
Note: For cutting deck operation, the operator	 High coolant temperature has disabled the cutting decks.
needs to be in Mow position, decks need to	• The seat switch or circuit wiring is damaged.
be fully lowered, and the PTO switch needs to be engaged.	• The PTO switch or circuit wiring is damaged.
5.5	• The mow/transport switch or circuit wiring is damaged.
	• The circuit wiring to the deck control manifold solenoids may be damaged.
	• A hydraulic problem in the cutting deck circuit exists; refer to Troubleshooting (page 4–39).
	• The TEC is damaged.
The cutting decks run, but should not, when	• The PTO switch or circuit wiring is damaged.
the OFF position.	• The TEC is damaged.
The front cutting decks do not operate. The rear cutting decks operate. The cutting decks	• The deck control manifold PRV2 solenoid coil or circuit wiring is damaged.
are able to raise and lower.	• A hydraulic problem in the front mow circuit exists; refer to Troubleshooting (page 4–39).
	• The TEC is damaged.
The rear cutting decks do not operate. The front cutting decks operate. The cutting decks	• The deck control manifold PRV1 solenoid coil or circuit wiring is damaged.
	• A hydraulic problem in the rear mow circuit exists; refer to Troubleshooting (page 4–39).
	• The TEC is damaged.

Cutting Deck Lift/Lower Problems

Problem	Possible Causes	
None of the cutting decks will lower.	• The seat switch or circuit wiring is damaged.	
	• The mow speed limiter is in the TRANSPORT position.	
	 The lower/mow switch on the joystick or circuit wiring is damaged. 	
	 The mow/transport switch or circuit wiring is damaged. 	
	 The lift control manifold PRV solenoid coil or circuit wiring is damaged. 	
	 The lift control manifold S1 solenoid coil or circuit wiring is damaged. 	
	• A hydraulic problem in the cutting deck lift/lower circuit exists; refer to Troubleshooting (page 4–39).	
	• The TEC is damaged.	
None of the cutting decks will raise.	• The seat switch or circuit wiring is damaged.	
	 The raise switch on the joystick or circuit wiring is damaged. 	
	 The lift control manifold PRV solenoid coil or circuit wiring is damaged. 	
	 The lift control manifold S2 solenoid coil or circuit wiring is damaged. 	
	• A hydraulic problem in the cutting deck lift/lower circuit exists; refer to Troubleshooting (page 4–39).	
	• The TEC is damaged.	
One cutting deck will not raise or lower, but all other cutting decks will raise and lower.	• A hydraulic problem in the cutting deck lift/lower circuit exists; refer to Troubleshooting (page 4–39).	
	• The TEC is damaged.	

Electrical System Quick Checks

Testing the Battery (Open Circuit Test)

Use a multimeter to measure the voltage between the battery terminals; refer to Battery Test Table (page 5–39).

Set the multimeter to the DC volts settings. The battery must be at a temperature of 16°C to 38°C (60° F to 100°F). Ensure that the key switch is in the OFF position and all the accessories are turned off.

Connect the positive (+) multimeter lead to the positive battery post and negative (-) multimeter lead to the negative battery post.

Measure and record the battery voltage. Use the Battery Test Table (page 5–39) to determine charge level of the battery.

Note: This test provides a relative condition of the battery. The load testing of the battery provides additional and more accurate information; refer to Servicing the Battery (page 5–95).

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

Battery Test Table

Testing the Charging System

This is a simple test that determines if a charging system is functioning. It tells you if the charging system has an output, but not its capacity.

Note: The InfoCenter display can be used to identify battery voltage during the operation of the machine.

Tool required: Digital multimeter set to DC volts.

Test instructions: Connect the positive (+) multimeter lead to the positive battery post and negative (-) multimeter lead to the negative battery post. Keep the test leads connected to the battery posts and record the battery voltage.

Note: When starting the engine, the battery voltage drops and then must increase once the engine is running.

Note: Depending upon the condition of the battery charge and battery temperature, the battery voltage increases at different rates as the battery charges.

Start the engine and run it at high-idle speed **(3,005 to 3,055 rpm)**. Allow the battery to charge for a minimum time of 3 minutes. Record the battery voltage.

Note: After running the engine for a minimum time of 3 minutes, the battery voltage must be minimum 0.50 V higher than that of the initial battery voltage.

Refer to the Battery Voltage Table (page 5–40) for an example of a charging system that is functioning.

Testing the Charging System (continued)

Battery Voltage Table

At least 0.50 V over the initial battery voltage.		
Initial battery voltage	= 12.30 V	
Battery voltage after 3 minutes charge	= 12.85 V	
Difference	= +0.55 V	

Testing the Glow Plug System

This is a fast, simple test that helps to determine the integrity and operation of the Groundsmaster glow plug system. Perform this test when you find hard starting (cold engine) on a diesel engine equipped with a glow plug system.

Tool(s) required: Digital multimeter and/or inductive Ammeter (AC/DC Current Transducer).

Test instructions: Properly connect the ammeter to the digital multimeter (refer to the manufacturer's instructions). Set the multimeter to the correct scale. With the key switch in the OFF position, place the ammeter pickup around the main glow plug power supply wire and read the meter prior to activating the glow plug system. Adjust the meter to read zero (if applicable). Activate the glow plug system by turning the key switch to the RUN position and record the multimeter results.

The glow plug system of the Groundsmaster 4300-D machines should have a reading of approximately 21 A. If low current reading is observed, 1 (or more) of the glow plugs is damaged.

Checking the Operation of the Interlock Switches

CAUTION

A

Do not disconnect the 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.

Your Groundsmaster is equipped with a Toro Electronic Controller (TEC) which monitor interlock switch operation. If all of the interlock switches necessary to allow a specific machine operation are not in their desired position, an Operator's Advisory will appear on the InfoCenter display; refer to Operator Advisories (page 5–24).

The interlock system used on your Groundsmaster includes the key switch, seat switch, traction neutral switch, parking brake switch, mow/transport switch, and PTO switch. Testing of individual interlock switches is included in Testing the Electrical Components (page 5–45).

Note: Use the InfoCenter display to test the Toro Electronic Controller inputs and outputs before further troubleshooting of an electrical problem on your Groundsmaster.

Adjustments

Traction Neutral Switch

1.

2.

3.





The traction neutral switch is a normally open proximity switch that closes when the traction pedal is in the NEUTRAL position. The switch mounts to a pump plate on the traction pump (Figure 150). The sensing plate for the traction neutral switch is the pump lever that is secured to the traction pump.

Adjusting the Traction Neutral Switch

1. Before adjusting the traction neutral switch, check and adjust the traction system neutral position; refer to the *Traction Unit Operator's Manual*.

Adjusting the Traction Neutral Switch (continued)

Note: To prevent the traction neutral switch damage, ensure that the pump lever does not contact the switch.

2. When the traction pedal is in the NEUTRAL position, the gap between the head of the neutral switch and the pump lever should be **3.05 to 3.55 mm (0.12 to 0.14 inch)** (Figure 151).



- If gap is incorrect, loosen the jam nuts that secure the neutral switch to the pump plate. Position the switch with jam nuts to allow correct gap between the switch and the pump lever. Torque the jam nuts to 18 to 22 N·m (159 to 195 in-lb). After the jam nuts are tightened, ensure that clearance between the head of the neutral switch and the pump plate has not changed.
- 4. After adjustment to the traction neutral switch, use the InfoCenter display to verify that the traction neutral switch and circuit wiring are functioning correctly; refer to Using the InfoCenter Display for Troubleshooting (page 5–26).

Parking Brake Switch



The parking brake switch is a normally open proximity switch. The parking brake switch is attached to the bottom of the brake pedal (Figure 152).

When the parking brake is not set, the parking brake detent is positioned near the target end of the parking brake switch so that the switch is closed. The parking brake detent is moved away from the switch when the parking brake is set causing the switch to open.

Adjusting the Parking Brake Switch

1. When the parking brake is not set, the gap between the parking brake switch and the tab on the parking brake detent should be **1.8 to 3.3 mm (0.07 to 0.13 inch)**.



- 2. If gap is incorrect, loosen the jam nuts that secure the switch to the brake pedal. Position the switch with jam nuts to allow correct gap between the switch and the detent tab. Tighten the jam nuts to secure the adjustment. Torque the jam nuts to **18 to 22 N·m (159 to 195 in-lb)**. After the jam nuts are tightened, ensure that clearance between the head of the parking brake switch and the tab on the parking brake detent has not changed.
- 3. After adjustment to the parking brake switch, use the InfoCenter display to verify that the parking brake switch and circuit wiring are functioning correctly; refer to Using the InfoCenter Display for Troubleshooting (page 5–26).

Mow/Transport Switch



The mow/transport switch is a normally closed proximity switch that opens when the mow speed limiter is placed in the TRANSPORT position. The switch mounts to a bracket on the footrest platform (Figure 153). The sensing plate for the mow/transport switch is the mow speed limiter.

Adjusting the Mow/Transport Switch

1. The gap between the mow/transport switch and the mow speed limiter should be **1.4 to 2.2 mm (0.055 to 0.085 inch)**.



- 2. If gap is incorrect, loosen the jam nuts that secure the switch to the footrest platform. Position the switch with jam nuts to allow correct gap between the switch and the mow speed limiter. Tighten the jam nuts to secure the adjustment. Torque the jam nuts to 18 to 22 N·m (159 to 195 in-lb). After the jam nuts are tightened, ensure that clearance between the head of the mow/transport switch and the mow speed limiter has not changed.
- 3. After adjustment to the mow/transport switch, use the InfoCenter display to verify that the mow/transport switch and circuit wiring are functioning correctly; refer to Using the InfoCenter Display for Troubleshooting (page 5–26).

Testing the Electrical Components

For accurate resistance and/or continuity checks, electrically disconnect the component being tested from the circuit (e.g., unplug the key switch connector before doing a continuity check of the switch).

Note: Use the InfoCenter display to test the TEC inputs and outputs before further troubleshooting of an electrical problem on your Groundsmaster.

Note: For engine component testing information; refer to the Yanmar Engine Service Manual or Troubleshooting Manual.

IMPORTANT

When testing the electrical components for continuity with a multimeter (ohms setting), ensure that you disconnect the power to the circuit.

Fusible Link Harness



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1.

- Starter motor
- 2. Positive battery cable



Figure 154

3.

The Groundsmaster 4300-D machine uses 3 fusible links for the circuit protection. These fusible links are located in a harness that connects the starter B+ terminal to the wire harness (Figure 154 and Figure 155). If any of these links

Fusible link harness

fail, current to the protected circuit stops; refer to the Electrical Schematic in Appendix A—Foldout Drawings for additional circuit information.

Testing the Fusible Link Harness

- 1. Ensure that the key switch is in the OFF position, disconnect the negative battery cable from the battery terminal, and then disconnect the positive cable from the battery; refer to Servicing the Battery (page 5–95).
- 2. Locate and unplug the fusible link connector P1 from the platform wire harness.
- 3. Use a multimeter to ensure that the continuity exists between each terminal pin in the connector P1 and connector J1 at the starter (Figure 155).
- 4. If any of the fusible links are open, replace the fusible link harness.

Note: Do not 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.

5. After you complete the testing, ensure that the fusible link harness connectors are correctly attached to the starter and platform wire harness. Connect the positive battery cable to the battery terminal and then connect the negative cable to the battery.



 1. Fuse block
 2. TEC (Toro Electronic Controller)



The fuse block is located behind the control arm access cover (Figure 156).

In addition to the fuses in the fuse block, there are 2 additional fuses included in the engine wire harness. These fuses plug into the in-line fuse holders near the starter motor (Figure 157). The fuses have the following functions:

2 A fuse: Protects the TEC logic power circuit.

10 A fuse: Protects the engine ECU and EGR relay power circuit.



Refer to Figure 158 to identify each individual fuse and its correct amperage. The fuses have the following functions.

F1-1 (15 A): Protects starter circuit power supply.

F1-2 (10 A): Protects main power supply.

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F1-3 (10 A): Protects power supply for headlights.

F1-4 (10 A): Protects power supply for power point.

F2-1 (7.5 A): Protects power supply for TEC outputs.

F2-2 (7.5 A): Protects power supply for TEC outputs.

F2-3 (7.5 A): Protects power supply for TEC outputs.

F2-4 (20 A) (if equipped): Protects power supply for the optional air ride operator seat.

Testing the Fuses

Turn the key switch to the ON position (do not start the engine). With the fuse installed in the fuse block, use a multimeter to check that 12 VDC exists at both of the terminal test points on the fuse. If 12 VDC exists at 1 of the fuse test points but not at the other, the fuse is damaged.

If necessary, remove the fuse from the fuse block for testing. The fuse should have continuity between the fuse terminals.

Toro Electronic Controller (TEC)

1.

Fuse block



TEC (Toro Electronic Controller) 2.



The Groundsmaster 4300-D machine uses a Toro Electronic Controller (TEC) to monitor the condition of various switches (inputs) and then direct power output to allow certain machine functions. The controller is located behind the control

Toro Electronic Controller (TEC) (continued)

arm access cover next to the fuse block (Figure 159). Use the InfoCenter display when checking the inputs and outputs of the TEC used on your machine.

The logic power is provided to the controller as long as the battery cables are connected to the battery. Circuit protection for this logic power to the controller is provided by 2 A fuse.

The inputs from the key, neutral, parking brake, PTO, seat, mow/transport, joystick lower/raise, engine speed switches, and pressure transducer are all monitored by the controller.

The current output to the following components are controlled based on the inputs received by the controller.

- Mow circuit hydraulic valve solenoid coils
- · Lift circuit hydraulic valve solenoid coils
- Fuel pump and engine ECU

The InfoCenter displays a machine fault code and description when an issue is detected.

The connection terminal functions for the TEC are shown in Figure 160. Note that electrical power for the controller outputs is provided through 3 connectors (PWR 2, PWR 3, and PWR 4) each protected with a 7.5 A fuse. A 50 pin wire harness connector attaches to the controller. The connector pins are identified in Figure 160.

IMPORTANT

When testing for wire harness continuity at the connector for the TEC, ensure that you do not damage the connector pins with the multimeter test leads. If the 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/Diagrams in Appendix A (page A–1) can be used to identify possible circuit problems between the controller and the input/output devices (e.g., switches and solenoid coils).

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

IMPORTANT

Before performing any welding on the machine, disconnect both negative and positive battery cables from the battery, disconnect the wire harness connector from the TEC and engine ECU, and disconnect the terminal connector from the alternator. This will prevent damage to the electrical system of your Groundsmaster.

Toro Electronic Controller (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)**.

Key Switch



The key switch is located on the control arm and has 3 positions: OFF, RUN, and START (Figure 163).

The Toro Electronic Controller (TEC) monitors the operation of the key switch.

Testing the Key Switch

- 1. Park the machine on a level surface, lower the cutting decks, set the parking brake, and shut off the engine. Remove the key from the key switch.
- Before you disconnect the key switch for testing, ensure that you test the switch and its circuit wiring as a TEC electrical input with the InfoCenter display; refer to Using the InfoCenter Display for Troubleshooting (page 5–26).
- 3. If the input testing verifies that the key switch and circuit wiring are functioning correctly, no further key switch testing is necessary.
- 4. If the input testing determines that the key switch and circuit wiring are not functioning correctly, proceed with the following key switch testing procedure.
- 5. Remove the right control arm cover to get access to the key switch; refer to Disassembling the Control Arm (page 6–24).
- 6. Ensure that the key switch is in the OFF position. Disconnect the wire harness connector from the key switch.
- 7. The key switch terminals are identified in Figure 163 and the circuitry of the switch is shown in the Circuit Logic Table (page 5–53). With the use of a multimeter (ohms setting), test the switch functions to determine if continuity exists between the various terminals for each switch position. Check the continuity between the switch terminals.

Testing the Key Switch (continued)

Circuit Logic Table

Switch Position	Circuits
OFF	None
Run	B+C+F, D+E
Start	A+B+C

- 8. Replace the key switch if testing determines that it is damaged.
- 9. If the key switch testing is correct and a circuit problem still exists, check the wire harness; refer to the Electrical Schematic and Wire Harness Drawings/Diagrams in Appendix A (page A–1).
- 10. After you complete the testing, connect the platform wire harness connector to the key switch.
- 11. Secure the right control arm cover to the machine; refer to Assembling the Control Arm (page 6–24).

PTO Switch



The PTO switch is located on the control arm (Figure 164) and allows the cutting decks to operate when the front of the switch is pressed. An indicator light on the switch identifies when the PTO switch is engaged.

The TEC 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 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, the mow speed limiter has to be in the Mow position, and the cutting decks have to be fully lowered.

Testing the PTO Switch

- 1. Park the machine on a level surface, lower the cutting decks, set the parking brake, and shut off the engine.
- Before you disconnect the PTO switch for testing, ensure that you test the switch and its circuit wiring as a TEC electrical input with the InfoCenter display; refer to Using the InfoCenter Display for Troubleshooting (page 5–26).
- 3. If the InfoCenter verifies that the PTO switch and circuit wiring are functioning correctly, no further switch testing is necessary.
- 4. If the InfoCenter determines that the PTO switch and circuit wiring are not functioning correctly, proceed with the test.
- 5. Remove the control arm covers to get access to the PTO switch; refer to Disassembling the Control Arm (page 6–24).
- 6. Ensure that the key switch is in the OFF position. Disconnect the wire harness electrical connector from the PTO switch.
- 7. The PTO switch terminals are identified in Figure 165 and the circuitry of the switch is shown in the Circuit Logic Table (page 5–55). With the use of a

Testing the PTO Switch (continued)

multimeter (ohms setting), test the switch functions to determine if continuity exists between the various terminals for each switch position. Check the continuity between the switch terminals.

Circuit Logic Table

Switch Position	Normal Circuits	Other Circuits
ON	2+3	5+6
Off	2+1	5+4

- 8. Replace the PTO switch if testing determines that the switch is damaged.
- 9. If the PTO switch testing is correct and a circuit problem still exists, check the wire harness; refer to the Electrical Schematic and Wire Harness Drawings/Diagrams in Appendix A (page A–1).
- 10. After you complete the testing, connect the wire harness connector to the PTO switch.
- 11. Secure the control arm covers to the machine; refer to Assembling the Control Arm (page 6–24).

Engine Speed Switch



The engine speed switch is used as an input for the TEC to signal the engine ECU via the CAN-bus to increase or decrease the engine speed. When the switch is pressed and held in the forward position, the engine speed will increase. Conversely, when the rear of the switch is pressed, the engine speed will decrease. The engine speed switch is located on the control arm (Figure 166).

Testing the Engine Speed Switch

- 1. Park the machine on a level surface, lower the cutting decks, set the parking brake, and shut off the engine.
- 2. Before you disconnect the engine speed switch for testing, ensure that you test the switch and its circuit wiring as TEC input with the InfoCenter display; refer to Using the InfoCenter Display for Troubleshooting (page 5–26).
- 3. If the InfoCenter verifies that the engine speed switch and circuit wiring are functioning correctly, no further switch testing is necessary.
- 4. If the InfoCenter determines that the engine speed switch and circuit wiring are not functioning correctly, proceed with the test.
- 5. Remove the control arm covers to get access to the engine speed switch; refer to Disassembling the Control Arm (page 6–24).
- 6. Ensure that the key switch is in the OFF position. Disconnect the wire harness electrical connector from the engine speed switch.
- 7. The engine speed switch terminals are identified in Figure 167 and the circuitry of the switch is shown in the Circuit Logic Table (page 5–57). With the use of a multimeter (ohms setting), test the switch functions to determine if continuity exists between the various terminals for each switch position. Check the continuity between the switch terminals.

Testing the Engine Speed Switch (continued)

Circuit Logic Table

Switch Position	Normal Circuits	Other Circuits
Decrease	2+1	5+4
Off	None	None
INCREASE	2+3	5+6

Note: The engine speed switch terminals 4, 5, and 6 are not used on the Groundsmaster 4300-D machines.

- 8. Replace the engine speed switch if testing determines that the switch is damaged.
- 9. If the engine speed switch testing is correct and a circuit problem still exists, check the wire harness; refer to the Electrical Schematic and Wire Harness Drawings/Diagrams in Appendix A (page A–1).
- 10. After you complete the testing, connect the wire harness connector to the engine speed switch.
- 11. Secure the control arm covers to the machine; refer to Assembling the Control Arm (page 6–24).

Lower/Raise Joystick Switches





The cutting deck lower and raise switches are located on the joystick assembly that is located on the control arm (Figure 168). When the joystick is pushed forward, the rear switch is used to lower the cutting decks. When the joystick is pulled backward, the front switch is used to raise the cutting decks (Figure 169). The switches are identical.

The Toro Electronic Controller (TEC) monitors the position of the normally open lower/raise switches. The lower/raise joystick switches are inputs used by the TEC to manage various machine functions.

Testing the Lower/Raise Joystick Switches

- 1. Park the machine on a level surface, lower the cutting decks, set the parking brake, and shut off the engine.
- 2. Before you disconnect the joystick switches for testing, ensure that you test the switches and its circuit wiring as TEC input with the InfoCenter display; refer to Using the InfoCenter Display for Troubleshooting (page 5–26).

Testing the Lower/Raise Joystick Switches (continued)

- 3. If the InfoCenter verifies that the joystick switches and circuit wiring are functioning correctly, no further switch testing is necessary.
- 4. If the InfoCenter determines that the joystick switches and circuit wiring are not functioning correctly, proceed with the test.
- 5. Remove the control arm covers to get access to the joystick switches; refer to Disassembling the Control Arm (page 6–24).
- 6. Ensure that the key switch is in the OFF position. Disconnect the wire harness electrical connectors from the raise and lower switches on the joystick assembly.
- 7. Connect a multimeter (ohms setting) across the switch connector terminals to check the continuity of the switches as follows:
 - A. With the joystick in the NEUTRAL position, continuity should only exist between the common and normally closed (NC) terminals.
 - B. With the joystick in the RAISE position (raise switch) or LOWER position (lower switch) continuity should only exist between the common and normally open (NO) terminals.
- 8. Replace the switch if testing determines that the switch is damaged.
- 9. If the switch testing is correct and a circuit problem still exists, check the wire harness; refer to the Electrical Schematic and Wire Harness Drawings/Diagrams in Appendix A (page A–1).
- 10. After you complete the testing, connect the wire harness connectors to the joystick switches.
- 11. Secure the control arm covers to the machine; refer to Assembling the Control Arm (page 6–24).

Headlight Switch



The headlight switch is located on the operator side of the control arm. This rocker switch allows the headlights to be turned on and off.

Testing the Headlight Switch

- 1. Park the machine on a level surface, lower the cutting decks, set the parking brake, and shut off the engine.
- 2. Remove the left control arm cover to get access to the headlight switch; refer to Disassembling the Control Arm (page 6–24).
- 3. Ensure that the key switch is in the OFF position. Disconnect the wire harness electrical connector from the headlight switch.
- 4. The headlight switch terminals are identified in Figure 171 and the circuitry of the switch is shown in the Circuit Logic Table (page 5–60). With the use of a multimeter (ohms setting), test the switch functions to determine if continuity exists between the various terminals for each switch position. Check the continuity between the switch terminals.

Circuit Logic Table

Switch Position	Normal Circuits	Other Circuits
ON	2+3	5+6
Off	2+1	5+4

Note: The headlight switch terminals 1, 4, 5, and 6 are not used on the Groundsmaster 4300-D machines.

5. Replace the headlight switch if testing determines that the switch is damaged.

Testing the Headlight Switch (continued)

- 6. If the switch testing is correct and a circuit problem still exists, check the wire harness; refer to the Electrical Schematic and Wire Harness Drawings/Diagrams in Appendix A (page A–1).
- 7. After you complete the testing, connect the wire harness connector to the headlight switch.
- 8. Secure the left control arm cover to the machine; refer to Assembling the Control Arm (page 6–24).

Seat Switch



g190803 **Figure 173** 1. Operator seat 2. Seat switch harness 4. Seat switch

The seat switch is normally open and closes when the operator is on the seat. 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. The seat switch and its electrical connector are located directly under the operator seat (Figure 173). Testing of the switch can be done without seat removal by disconnecting the switch wire from the platform wire harness (Figure 172).

The Toro Electronic Controller (TEC) monitors the operation of the seat switch.

Testing the Seat Switch

1. Park the machine on a level surface, lower the cutting decks, set the parking brake, and shut off the engine.

Testing the Seat Switch (continued)

- Before you disconnect the seat switch for testing, ensure that you test the switch and its circuit wiring as a TEC electrical input with the InfoCenter display; refer to Using the InfoCenter Display for Troubleshooting (page 5–26).
- 3. If the InfoCenter verifies that the seat switch and circuit wiring are functioning correctly, no further switch testing is necessary.
- 4. If the InfoCenter determines that the seat switch and circuit wiring are not functioning correctly, proceed with the test.
- 5. Ensure that the key switch is in the OFF position.
- 6. Disconnect the platform wire harness electrical connector from the seat switch harness electrical lead near the operator manual tube under the operator seat (Figure 172).
- 7. Connect a multimeter (ohms setting) across the seat switch harness connector terminals to check the continuity of the seat switch.
 - A. With no pressure on the seat, ensure that there is no continuity between the harness terminals of the seat switch.
 - B. Press directly onto the seat switch through the seat cushion. Ensure that there is continuity between the harness terminals of the seat switch as the seat cushion approaches the bottom of its travel indicating that the seat switch is functioning.
- 8. Replace the seat switch if testing determines that the switch is damaged.
- If the seat switch testing is correct and a circuit problem still exists, check the platform wire harness; refer to the Electrical Schematic and Wire Harness Drawings/Diagrams in Appendix A (page A–1).
- 10. After you complete the seat switch testing, connect the platform wire harness connector to the seat switch electrical lead. Lower the seat assembly. Check the operation of the seat switch.

Traction Neutral Switch



The traction neutral switch is a normally open proximity switch that closes when the traction pedal is in the NEUTRAL position. The switch mounts to a pump plate on the traction pump (Figure 174). The sensing plate for the traction neutral switch is the pump lever that is secured to the traction pump.

The Toro Electronic Controller (TEC) monitors the operation of the traction neutral switch.

Testing the Traction Neutral Switch

1.

2.

3.

4.

- 1. Park the machine on a level surface, lower the cutting decks, set the parking brake, and shut off the engine.
- Before you disconnect the neutral switch for testing, ensure that you test the switch and its circuit wiring as a TEC electrical input with the InfoCenter display; refer to Using the InfoCenter Display for Troubleshooting (page 5–26).
- 3. If the input testing verifies that the neutral switch and circuit wiring are functioning correctly, no further neutral switch testing is necessary.
- 4. If the input testing determines that the neutral switch and circuit wiring are not functioning correctly, proceed with the test.
- 5. Locate the traction neutral switch (Figure 174).
- 6. Turn the key switch to the RUN position (do not start the engine) and check the LED on the cable end of the neutral switch. The LED should be illuminated when the traction pedal is in the NEUTRAL position.
- 7. With the key switch still in the RUN position (do not start the engine), press the traction pedal out of the NEUTRAL position and check the LED on the cable end of the neutral switch. The LED should not be illuminated when the traction pedal is not in the NEUTRAL position.
- 8. If the neutral switch LED did not function correctly, do the following:
 - A. Ensure that the neutral switch is properly adjusted; refer to Adjusting the Traction Neutral Switch (page 5–41). If necessary, adjust the switch and return to step 6.
Testing the Traction Neutral Switch (continued)

- B. Ensure that the key switch is in the OFF position and disconnect the traction neutral switch connector from the platform wire harness.
- C. Use a multimeter (ohms setting), check that the platform wire harness connector terminal for black wire is closed (continuity) to the ground.
- D. Turn key switch to the RUN position (do not start the engine) and check with a multimeter that the platform wire harness connector terminal for pink wire has system voltage (12 VDC) present.
- E. If the black wire is closed to the ground, the pink wire has system voltage present, and the switch LED did not function, replace the traction neutral switch. Adjust the switch after installation; refer to Adjusting the Traction Neutral Switch (page 5–41).
- 9. If the neutral switch testing is correct and a circuit problem still exists, check the platform wire harness; refer to the Electrical Schematic and Wire Harness Drawings/Diagrams in Appendix A (page A–1).
- 10. After you complete the neutral switch testing, ensure that the switch connector is plugged into platform wire harness.

Parking Brake Switch



The parking brake switch is a normally open proximity switch. The parking brake switch is attached to the bottom of the brake pedal (Figure 175).

The machine is equipped with an interlock switch on the parking brake. The engine shuts off if the traction control pedal is moved from the NEUTRAL position with the parking brake engaged. Refer to the Checking the Interlock Switches in the *Traction Unit Operator's Manual*.

When the parking brake is not set, the parking brake detent is positioned near the target end of the parking brake switch so that the switch is closed. The parking brake detent is moved away from the switch when the parking brake is set causing the switch to open.

The Toro Electronic Controller (TEC) monitors the operation of the parking brake switch.

Testing the Parking Brake Switch

- 1. Park the machine on a level surface, lower the cutting decks, set the parking brake, and shut off the engine.
- 2. Before you disconnect the parking brake switch for testing, ensure that you test the switch and its circuit wiring as a TEC electrical input with the InfoCenter display; refer to Using the InfoCenter Display for Troubleshooting (page 5–26).
- 3. If the input testing verifies that the parking brake switch and circuit wiring are functioning correctly, no further parking brake switch testing is necessary.
- 4. If the input testing determines that the parking brake switch and circuit wiring are not functioning correctly, proceed with the test.
- 5. Locate the parking brake switch (Figure 175).

Note: Ensure that the parking brake is not set.

6. Turn the key switch to the RUN position (do not start the engine) and check the LED on the cable end of the parking brake switch. The LED should be illuminated when the parking brake is not set.

Testing the Parking Brake Switch (continued)

- 7. With the key switch still in the RUN position (do not start the engine), set the parking brake and check the LED on the cable end of the parking brake switch. The LED should not be illuminated when the parking brake is set.
- 8. If the parking brake switch LED did not function correctly, do the following:
 - A. Ensure that the parking brake switch is properly adjusted; refer to Adjusting the Parking Brake Switch (page 5–43). If necessary, adjust the switch and return to step 6.
 - B. Ensure that the key switch is in the OFF position and disconnect the parking brake switch connector from the platform wire harness.
 - C. Use a multimeter (ohms setting), check that the platform wire harness connector terminal for black wire is closed (continuity) to the ground.
 - D. Turn key switch to the RUN position (do not start the engine) and check with a multimeter that the platform wire harness connector terminal for pink wire has system voltage (12 VDC) present.
 - E. If the black wire is closed to the ground, the pink wire has system voltage present, and the switch LED did not function, replace the parking brake switch. Adjust the switch after installation; refer to Adjusting the Parking Brake Switch (page 5–43).
- If the parking brake switch testing is correct and a circuit problem still exists, check the platform wire harness; refer to the Electrical Schematic and Wire Harness Drawings/Diagrams in Appendix A (page A–1).
- 10. After you complete the parking brake switch testing, ensure that the switch connector is plugged into platform wire harness.

Mow/Transport Switch



The mow/transport switch is a normally closed proximity switch that opens when the mow speed limiter is placed in the TRANSPORT position. The switch mounts to a bracket on the footrest platform (Figure 176). The sensing plate for the mow/transport switch is the mow speed limiter.

The Toro Electronic Controller (TEC) monitors the operation of the mow/transport switch.

Testing the Mow/Transport Switch

- 1. Park the machine on a level surface, lower the cutting decks, set the parking brake, and shut off the engine.
- 2. Before you disconnect the mow/transport switch for testing, ensure that you test the switch and its circuit wiring as a TEC electrical input with the InfoCenter display; refer to Using the InfoCenter Display for Troubleshooting (page 5–26).
- 3. If the input testing verifies that the mow/transport switch and circuit wiring are functioning correctly, no further mow/transport switch testing is necessary.
- 4. If the input testing determines that the mow/transport switch and circuit wiring are not functioning correctly, proceed with the test.
- 5. Locate the mow/transport switch (Figure 176).
- 6. Turn the key switch to the RUN position (do not start the engine) and check the LED on the cable end of the mow/transport switch. The LED should be illuminated mow speed limiter is in the MOW position. The LED should not be illuminated when the limiter is in the TRANSPORT position.
- 7. If the mow/transport switch LED did not function correctly, do the following:
 - A. Ensure that the mow/transport switch is properly adjusted; refer to Adjusting the Mow/Transport Switch (page 5–44). If necessary, adjust the switch and return to step 6.
 - B. Ensure that the key switch is in the OFF position and disconnect the mow/transport switch connector from the platform wire harness.
 - C. Use a multimeter (ohms setting), check that the platform wire harness connector terminal for black wire is closed (continuity) to the ground.

Testing the Mow/Transport Switch (continued)

- D. Turn key switch to the RUN position (do not start the engine) and check with a multimeter that the platform wire harness connector terminal for pink wire has system voltage (12 VDC) present.
- E. If the black wire is closed to the ground, the pink wire has system voltage present, and the switch LED did not function, replace the mow/transport switch. Adjust the switch after installation; refer to Adjusting the Mow/Transport Switch (page 5–44).
- 8. If the mow/transport switch testing is correct and a circuit problem still exists, check the platform wire harness; refer to the Electrical Schematic and Wire Harness Drawings/Diagrams in Appendix A (page A–1).
- 9. After you complete the mow/transport switch testing, ensure that the switch connector is plugged into platform wire harness.

Relays with 4 Terminals

1.

2.





The Groundsmaster 4300-D machine uses 2 identical electrical relays that have 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 the TEC, headlights, power point, and optional electric equipment. When the key switch is in the RUN or START position, the main power relay is energized.

The glow relay is used to provide current to the engine glow plugs. The glow relay is energized and monitored by the engine ECU.

The main power and glow relay are attached to a frame bracket under the hood next to the hydraulic pump driveshaft (Figure 177).

Testing the Relays with 4 Terminals

- 1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
- To ensure that the machine operation does not occur unexpectedly, disconnect the negative (-) cable from the battery and then disconnect the positive (+) cable from the battery; refer to Servicing the Battery (page 5–95).
- 3. Locate the relay that is to be tested.
- 4. Disconnect the wire harness electrical connector from the relay. Remove the relay from the mounting bracket for testing.

Note: Before taking the small resistance readings with a digital multimeter, short the multimeter test leads together. The meter displays a small resistance value (usually 0.5 ohms or less). This resistance is because of the internal resistance of the multimeter and test leads. Subtract this value from the measured value of the component that you are testing.

- 5. Check the coil resistance between the terminals 85 and 86 with a multimeter (ohms setting). The resistance must be approximately 72 ohms (Figure 178).
- Connect the multimeter (ohms setting) leads to the relay terminals 30 and 87. Then ground terminal 85 and apply +12 VDC to terminal 86. The relay should make and break the continuity between the terminals 30 and 87 as +12 VDC is set and removed from terminal 86 (Figure 178).
- 7. Disconnect the voltage and leads from the relay terminals.
- 8. Replace the relay if testing determines that the relay is damaged.
- 9. If the relay testing is correct and a circuit problem still exists, check the platform wire harness; refer to the Electrical Schematic and Wire Harness Drawings/Diagrams in Appendix A (page A–1).
- 10. Secure the relay to the mounting bracket and connect the wire harness electrical connector to the relay.
- 11. Connect the positive (+) cable to the battery and then connect the negative (-) cable to the battery; refer to Servicing the Battery (page 5–95).

Relays with 5 Terminals



The Groundsmaster 4300-D machine uses 2 identical electrical relays that have 5 terminals. A tag near the wire harness relay connector can be used to identify each relay.

The start relay is used in the engine starting circuit. When energized by the engine ECU, the start relay provides a current path to energize the engine starter solenoid.

The EGR relay is used to provide current to the engine EGR valve when energized by the engine ECU.

The start relay and EGR relay are attached to a frame bracket under the hood next to the hydraulic pump driveshaft (Figure 179).

Testing the Relays with 5 Terminals

- 1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
- 2. Ensure that the machine operation does not occur unexpectedly, disconnect the negative (-) cable from the battery and then disconnect the positive (+) cable from the battery; refer to Servicing the Battery (page 5–95).
- 3. Locate the relay that is to be tested.
- 4. Disconnect the wire harness electrical connector from the relay. Remove the relay from the mounting bracket for testing.

Note: Before taking the small resistance readings with a digital multimeter, short the multimeter test leads together. The meter displays a small resistance value (usually 0.5 ohms or less). This resistance is because of the internal resistance of the multimeter and test leads. Subtract this value from the measured value of the component that you are testing.

- 5. Check the coil resistance between the terminals 85 and 86 with a multimeter (ohms setting). The resistance must be approximately 71 to 88 ohms (Figure 180).
- 6. Connect the multimeter (ohms setting) leads to the relay terminals 30 and 87. Then ground terminal 85 and apply +12 VDC to terminal 86. The relay should make and break the continuity between the terminals 30 and 87 as +12 VDC is set and removed from terminal 86.
- 7. Disconnect the voltage from terminal 85 and multimeter lead from terminal 87.
- 8. Connect the multimeter (ohms setting) leads to the relay terminals 30 and 87A and apply +12 VDC to the terminal 85. The relay should make and break continuity between the terminals 30 and 87A as +12 VDC is set and removed from the terminal 85.
- 9. After testing, disconnect the voltage and multimeter test leads from the relay terminals.
- 10. Replace the relay if testing determines that the relay is damaged.
- 11. If the relay testing is correct and a circuit problem still exists, check the platform wire harness; refer to the Electrical Schematic and Wire Harness Drawings/Diagrams in Appendix A (page A–1).
- 12. Secure the relay to the mounting bracket and connect the wire harness electrical connector to the relay.
- 13. Connect the positive (+) cable to the battery and then connect the negative (-) cable to the battery; refer to Servicing the Battery (page 5–95).

Hydraulic Solenoid Valve Coils



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Figure 183

The Groundsmaster 4300-D hydraulic control manifolds use several hydraulic solenoid valve coils for system control. The deck control manifold includes 2 solenoid valves (Figure 181) and the lift control manifold includes 3 solenoid valves (Figure 182). When the solenoid coils are energized, the hydraulic valve shift occurs to control the hydraulic fluid flow. The correct resistance of a coil can be identified by measuring the height and diameter of the coil (Figure 183). Refer to Solenoid Valve Coil Specifications Table (page 5–75). Testing of the coils can be done with the coil installed on the hydraulic valve.

Note: The 2 solenoid valve coils on the deck control manifold (PRV1 and PRV2) are identical. The solenoid valve coils SV1 and PRV on the lift control manifold are identical and are the same as those used on the deck control manifold. The remaining lift control manifold coil (SV2) is different. To assist in troubleshooting, identical coils can be exchanged. If the problem follows the exchanged coil, an electrical problem likely exists with the coil. If the problem remains unchanged, something other than the solenoid coil is the problem source (e.g., switch, circuit wiring, and hydraulic problem).

Testing the Hydraulic Solenoid Valve Coils

Note: Before you disconnect the solenoid valve coils, test the solenoids and their circuit wiring as TEC outputs with the InfoCenter display; refer to Using the InfoCenter Display for Troubleshooting (page 5–26). If the InfoCenter verifies that the solenoid coils and circuit wiring are functioning correctly, then no more testing is necessary.

- 1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
- 2. To get access to the deck control manifold, raise and prop the operator seat. To get access to the lift control manifold, remove the operator floor plate.
- 3. Identify the coil by measuring the height and diameter of the coil.
- 4. Disconnect the wire harness connector from the hydraulic solenoid valve coil that is to be tested.

Note: Before taking the small resistance readings with a digital multimeter, short the multimeter test leads together. The multimeter displays a small resistance value (usually 0.5 ohms or less). This resistance is because of the internal resistance of the multimeter and test leads. Subtract this value from the measured value of the component that you are testing.

Note: The 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 damaged solenoid coil will either be shorted (very low or no resistance) or open (infinite resistance).

5. Use a multimeter (ohms setting), measure the resistance between the 2 connector terminals on the solenoid coil. The resistance for the solenoid coils is identified in the Solenoid Valve Coil Specifications Table (page 5–75).

Solenoid Valve Coil Specifications Table

Solenoid Valve Coil	Diameter	Height	Resistance
PRV1 and PRV2 (deck)	46.7 mm (1.84 inches)	49.9 mm (1.96 inches)	7.1 ohms
SV1 and PRV (lift)	46.7 mm (1.84 inches)	49.9 mm (1.96 inches)	7.1 ohms
SV2 (lift)	35.8 mm (1.41 inches)	36.3 mm (1.43 inches)	8.8 ohms

6. If the solenoid coil resistance is incorrect, replace the solenoid coil; refer to Hydraulic Solenoid Valve Coils (page 5–92).

Testing the Hydraulic Solenoid Valve Coils (continued)

- 7. If the solenoid coil testing is correct and a circuit problem still exists, check the platform wire harness; refer to the Electrical Schematic and Wire Harness Drawings/Diagrams in Appendix A (page A–1).
- 8. After testing the coils, connect the wire harness electrical connector to the solenoid valve coil.
- 9. Lower and secure the operator seat if the deck control manifold was accessed. Install the operator floor plate if the lift control manifold was accessed.

Fuel Sender



The fuel sender is a variable resistance device that is located in the fuel tank (Figure 184). The resistance of the fuel sender increases as the fuel level in the fuel tank decreases. The TEC uses the fuel sender as an input to generate an output for the InfoCenter fuel gauge.

Testing the Fuel Sender

- 1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
- 2. Remove the 5 screws that secure the sender cover to the fuel tank (Figure 184). Lift the cover from the tank.
- 3. Disconnect the wire harness connector from the fuel sender.



Turning the key switch to the RUN position when the circuit wiring is not connected could lead to sparking, resulting in fire or an explosion.

When testing the circuit wiring and fuel sender, ensure that the wire connections are secure before turning the key switch to the RUN position.

Testing the Fuel Sender (continued)

4. To test the circuit wiring and InfoCenter fuel gauge, use a jumper wire to connect the 2 terminals in the wire harness connector. Ensure that the jumper wire connections are secure.



2. Fuel supply fitting

1.

- 5. Turn the key switch to the RUN position. The InfoCenter display should indicate a full fuel tank if the circuit wiring and InfoCenter are working correctly. Turn the key switch to the OFF position and continue testing fuel sender if the circuit wiring and InfoCenter are acceptable.
- 6. Loosen the hose clamps and carefully disconnect the fuel supply and return hoses from the fittings on the top of the fuel sender.

IMPORTANT

Before removing the fuel sender from the tank, note the orientation of the fuel sender fittings for assembly purposes (Figure 185).

- 7. Carefully remove the fuel sender cap that secures the fuel sender in the fuel tank.
- 8. Lift the fuel sender and sender gasket from the fuel tank. Clean all the fuel from the sender.

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

A



- 9. Use a multimeter to check the resistance of the fuel sender across the 2 sender terminals (Figure 186).
 - A. The resistance with the float in the full position (completely up) should be 5 to 8 ohms.
 - B. The resistance with the float in the empty position (completely down) should be 89 to 95 ohms.
- 10. Replace the fuel sender if testing determines that it is damaged.



- 11. After testing, install the sender into the fuel tank and secure the sender with the sender gasket and fuel sender cap. Ensure that the fuel fittings on the sender are orientated at 90° from right side of the tank as shown in Figure 185. Also, to prevent damage to the fuel sender during assembly, ensure that the fuel sender does not turn as the sender cap is tightened. Torque the fuel sender cap to 20 to 22 N·m (175 to 200 in-lb).
- 12. Install the fuel supply and return hoses to the fittings on the sender and secure the hoses with the hose clamps.
- 13. Connect the fuel sender connector to the wire harness.
- 14. Secure the sender cover to the fuel tank with the screws that were removed.

Fuel Pump

The fuel pump is attached to the air cleaner stand adapter below the fuel/water separator (Figure 187). Electrical current is available for the fuel pump when the key switch is in either the RUN or START position.

The Toro Electronic Controller (TEC) energizes the fuel pump.

IMPORTANT

When testing the fuel pump, ensure that the pump is not operated without fuel.

DANGER

Diesel fuel is highly flammable.

- Use caution whenever you handle diesel fuel.
- Do not smoke while testing the fuel pump.
- Do not test the fuel pump while the engine is hot.
- Ensure that there is adequate ventilation when testing.
- Always wipe up any spilled diesel fuel before starting the engine.

Testing the Fuel Pump Capacity



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Figure 187

1. Fuel pump

3. Fuel/water separator

- 2. Pump discharge hose
- 1. Park the machine on a level surface, lower the cutting decks, shut off the engine, and set the parking brake. Ensure that the key switch is in the OFF position.
- 2. Unlatch the hood and raise it.
- 3. Ensure that the fuel hoses attached to the fuel pump are free of obstructions.
- 4. Disconnect the fuel pump discharge hose from the inlet fitting of the fuel/water separator.

Testing the Fuel Pump Capacity (continued)

5. Place the disconnected end of the pump discharge hose into a large, graduated cylinder sufficient enough to collect 0.9 L (32 fl oz).

IMPORTANT

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

6. Turn the key switch to the ON position and collect the fuel in the graduated cylinder. Allow the pump to run for 30 seconds and then turn the switch to the OFF position.

Note: The amount of fuel pumped in 30 seconds must be approximately 350 ml (11.8 fl oz).

7. Replace the fuel pump if output specification is not met.

IMPORTANT

If the fuel pump is replaced, ensure that replacement pump is the correct pump for your Groundsmaster by using your *Parts Catalog*. If incorrect pump is used, the fuel system damage can occur.

- 8. Connect the fuel pump discharge hose to the fuel/water separator. Ensure to secure the hose with the hose clamp.
- 9. Prime the fuel system; refer to Priming the Fuel System (page 3-20).

Fuel Pump Specifications

Pump Capacity	700 ml/minute (23.5 fl oz/minute)	
Pressure	22.8 kPa (3.3 psi)	
Maximum Current Draw	0.9 A	

10. Lower the hood and secure it with the latches.

CAN-bus Terminator Resistor

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The system communication between the electrical components on the Groundsmaster 4300-D machine is accomplished on a CAN-bus communication system. The 2 specially designed, twisted cables form the bus for the network are used on the machine. These wires provide the data pathways between the machine components.

The 120 ohm CAN-bus terminator resistor plugs into the platform wire harness in the control arm. The resistor can be accessed by removing the left control arm cover.

Note: The insulator wedge in the terminator resistor is blue for identification purposes. There is also a center keyway to prevent the terminator resistor from plugging into the wrong wire harness connector.

Note: Refer to the Electrical Schematic and Wire Harness Drawings/Diagrams for additional information on the location of the terminator resistor and wire connections.

IMPORTANT

The terminator resistor is required for proper electrical system operation.

Testing the CAN-bus Terminator Resistor

- 1. The CAN-bus terminator resistor (Figure 188) can be tested using a digital multimeter (ohms setting). Locate the CAN-bus terminator resistor and remove the cable tie that secures the resistor to the wire harness. Unplug the resistor from the wire harness for testing.
- 2. Use a digital multimeter (ohms setting) to measure the resistance value for the CAN-bus terminator resistor. There should be 120 ohms resistance between the terminals A and B. The terminal C is not used.
- 3. If the testing determines that the CAN-bus terminator resistor is damaged, replace the CAN-bus terminator resistor.
- 4. After you complete the testing, ensure that the CAN-bus terminator resistor is fully installed into the wire harness connector and secured to the wire harness with cable tie.

Resistor Assembly



1. End of the resistor body 2. Resistor assembly



A 75 ohm resistor (Figure 190) is necessary for proper key switch operation on all Groundsmaster 4300-D machines. The resistor plugs into the engine wire harness near the engine ECU; refer to the Engine Wire Harness Drawing/Diagram in Appendix A—Foldout Drawings.

The resistor assembly can be identified by its gray color and resistor symbol on the end of the resistor assembly body.

Testing the Resistor Assembly

The resistor can be tested using a digital multimeter (ohms setting).

Note: The resistance across the resistor terminals should be 75 ohms.

Diode Assemblies



- 1. End of the diode body
- 2. Diode assembly

- 3. Male terminal
- 4. Female terminal



The electrical system of the Groundsmaster 4300-D machine includes 2 identical diodes. The maximum current allowed through any of the diodes is 6 A. The diode assemblies can be identified by a black color, diode symbol, and Toro Part Number on the end of the diode assembly body (Figure 191). The 2 diodes plug into the engine wire harness near the Yanmar engine ECU (Figure 192); refer to the Engine Wire Harness Drawing/Diagram in Appendix A—Foldout Drawings.

A diode assembly (D1) is used for circuit protection from the voltage spikes that occur when the engine starter solenoid is de-energized.

A diode assembly (D2) is used to protect the engine ECU from reverse polarity in the EGR relay circuit.

Testing the Diode Assembly

- 1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
- 2. Locate the diode assembly that is to be tested and remove the cable tie that secures the diode to the wire harness. Unplug the diode from the wire harness for testing.

Testing the Diode Assembly (continued)

- 3. The diode (Figure 191) can be tested by using a digital multimeter (diode test or ohms setting) and the Diode Test Table (page 5–85).
- 4. Replace the diode assembly if testing determines that the diode is damaged.
- 5. After you complete the testing, ensure that the diode is fully installed into the wire harness connector and secured to the harness with cable tie.

Diode Test Table

Multimeter Red Lead (+) on Terminal	Multimeter Black Lead (-) on Terminal	Continuity
Female	Male	Yes
Male	Female	No

Pressure Transducer



1. Traction pump

3. Pressure transducer

2. Hydraulic tube



The hydraulic pressure transducer is installed on the forward traction hydraulic tube located in between the front wheels (Figure 193). The transducer senses the counterbalance pressure between the hydraulic motors and the hydraulic pump.

The TEC monitors the counterbalance pressure range using inputs from the pressure transducer and controls the energizing of the hydraulic solenoid valves used to drive the cutting deck motors.

Testing the Pressure Transducer

- 1. Park the machine on a level surface, shut off the engine, and set the parking brake.
- 2. Disconnect the machine wire harness from the pressure transducer.
- 3. Test the machine wire harness to the pressure transducer:
 - A. Turn the key switch to the ON position.
 - B. To simulate a functioning pressure transducer, connect a 1.5 V dry cell battery across the signal (+) pin C and ground (-) pin B of the machine wire harness connector (Figure 194A). A fully charged battery should produce approximately an 550 kPa (80 psi) reading on the InfoCenter display.
 - C. Use a multimeter set to DC voltage and check for 5 VDC across the supply (+) pin A and ground (-) pin B of the machine wire harness (Figure 194B).
 - D. Turn the key switch to the OFF position.
- 4. Test the pressure transducer as follows:
 - A. Connect a 5 VDC power supply to the supply (+) pin A and ground (-) pin B of the sensor connector (Figure 194B).
 - B. Connect a multimeter set to DC voltage to the signal (+) pin C and ground (-) pin B of the sensor connector (Figure 194C). A small amount of voltage should be present 0.5 VDC on the multimeter display.
- 5. Replace the pressure transducer if necessary. Apply thread sealant to the threads of the transducer prior to installation.
- 6. After you complete the testing, connect the wire harness to the pressure transducer.

Fan Speed Switch (Machines with Two-Post ROPS Extension Operator Fan Kit)



Figure 195

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- 1. Fan speed switch
- 2. Control knob



3. Control panel

Back of Switch

The fan speed switch is attached to the overhead control panel (Figure 195). The switch is used to select the fan speed (OFF, LOW, MEDIUMOR 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.
- 4. The switch terminals are identified in (Figure 196). 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.

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Testing (continued)

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 Appendix A (page A–1) Foldout Drawings.
- 7. After you complete the testing, connect the machine wire harness to the switch and install the sunshade.

Resistor Module (Machines with Two-Post ROPS Extension Operator Fan Kit)



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Figure 197

- Operator's fan 1.
- 2. Fan mount bracket



3. Resistor module

- Pin 1 (Violet wire) 1.
- Pin 2 (Brown wire) 2.

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3.

- 4. Pin 4 (Not used)
- 5. Motor pin
- Pin 3 (Orange wire)

Resistor module 6.

The resistor module is attached to the rear of the fan mounting bracket (Figure 197). 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.
- 4. Use a multimeter to check that the resistance values of the resistor module as below (Figure 198).

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 Appendix A (page A–1) Foldout Drawings.
- 7. After you complete the testing, connect the wire harness connectors to the resistor module terminals (Figure 198) and install the sunshade.

Service and Repairs

Note: For engine component repair information, refer to the Yanmar Engine Service Manual or Troubleshooting Manual.

Hydraulic Solenoid Valve Coils



You can replace a hydraulic solenoid valve coil on the deck control manifold (Figure 199) or lift control manifold (Figure 200) without opening the hydraulic system.

Removing the Hydraulic Solenoid Valve Coils

- 1. Park the machine on a level surface, lower the cutting decks, set the parking brake, shut off the engine, and remove the key from the key switch.
- 2. Locate the solenoid valve coil that you replace.
 - A. Tilt the operator seat up to get access to the deck control manifold. Refer to Figure 199 for the location of solenoid coils on the deck control manifold.
 - B. The lift control manifold is attached to a frame bracket under the operator floor plate. To get access to the lift control manifold, remove the operator floor plate. Refer to Figure 200 for the location of solenoid coils on the lift control manifold.
- 3. Disconnect the wire harness electrical connector from the solenoid valve coil that you replace. Note the orientation of the electrical connector on the coil for assembly purposes.
- 4. Remove the nut from the hydraulic valve.
- 5. Slide the solenoid coil from the valve.
- 6. Clean any corrosion or dirt from the valve.

Installing the Hydraulic Solenoid Valve Coils

1. Slide the coil assembly onto the hydraulic valve. Position the coil so that the connector is properly orientated.



2. Install the nut onto the valve and torque the nut to 6.7 N·m (60 in-lb).

Note: Do not overtighten the nut.

- 3. Connect the platform wire harness connector to the solenoid coil.
- 4. Lower and secure the seat if the deck control manifold was accessed. Install the operator floor plate if the lift control manifold was accessed.

Battery Storage

If you store the machine for more than 30 days:

- 1. Ensure that the key switch is in the OFF position. Remove the battery and charge it fully; refer to Servicing the Battery (page 5–95).
- 2. Either store the battery on a shelf or on the machine.
- 3. Disconnect the cables if the battery is kept on the machine.
- 4. Store the battery in a cool atmosphere to avoid quick deterioration of the battery charge.
- 5. To prevent the battery from freezing during storage, ensure that you charge it fully; refer to Servicing the Battery (page 5–95).

Battery Care

1. The battery-electrolyte level must be properly maintained. The top of the battery must be kept clean. If the machine is stored in a location where the temperatures are extremely high, the battery will discharge more rapidly than if the machine is stored in a location where the temperatures are cool.

Battery Care (continued)

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WARNING

The gases are explosive; also, they can cause nausea.

- Wear safety goggles and rubber gloves when working with electrolyte. Charge the battery in a well ventilated place so that the gasses produced while charging can dissipate.
- Keep open flames and electrical sparks away from the battery; do not smoke.
- Disconnect the charger from the electrical outlet before connecting or disconnecting charger leads to or from the battery posts.

IMPORTANT

Do not remove battery fill caps while cleaning.

- 2. Check the battery condition weekly or after every 50 hours of operation. Keep the terminals and entire battery case clean because a dirty battery will discharge slowly.
 - A. Clean the battery by washing entire case with a solution of baking soda and water. Flush the battery case with clear water.
 - B. Coat the battery posts and cable connectors with the battery terminal protector (refer to Terminal Protector (page 5–5)) or petroleum jelly to prevent corrosion.
- 3. Tighten the battery cables on the battery terminals to provide a good electrical contact.



Connecting the cables to the wrong battery post could result in personal injury and/or damage to the electrical system.

Ensure that the cables are properly connected to the correct battery posts before operating the machine.

- 4. If corrosion occurs at the battery terminals, disconnect the cables. Always disconnect the negative (-) cable first. Clean the cable clamps and terminals separately. Connect the cables with the positive (+) cable first. Apply a layer of terminal protector (Toro Part No. 107-0392) or a light coat of petroleum jelly to the terminals to reduce corrosion after you make the connections.
- 5. Check the battery-electrolyte level every 25 operating hours and every 30 days if machine is in storage.
- 6. Maintain the cell level with the distilled or demineralized water.

Note: Do not fill the cells above the fill line.

Servicing the Battery

The battery is the heart of the electrical system. With the regular and correct service, the battery life can be extended. Additionally, the battery and electrical component failure can be prevented.

Battery-electrolyte is corrosive and can burn skin and eyes and damage clothing.

While working with the batteries, use extreme caution to avoid splashing or spilling of the electrolyte. Always wear the safety goggles and a face shield while working with batteries.

Battery Specifications

Battery-electrolyte specific gravity	Fully Charged: 1.250 to 1.280	
	Discharged: less than 1.240	
Battery specifications	BCI Group Size: 55	
	585 CCA at -18°C (0°F)	
	Reserve Capacity of 75 minutes at 27°C (80°F)	
Battery dimensions (including terminal posts	Length 23.1 cm (9.1 inches)	
and caps)	Width 15.2 cm (6.0 inches)	
	Height 21.6 cm (8.5 inches)	

Removing and Installing the Battery



IMPORTANT

Be careful when removing the battery cables and ensure that you do not damage the terminal posts or cable connectors.

- 1. Unlatch, raise the hood and support it.
- 2. Loosen and remove the negative (-) cable from the battery. After you disconnect the negative cable from the battery, loosen and remove the positive cable (+) from the battery.
- 3. Loosen the flange nut that secures the battery retainer.
- 4. Carefully remove the battery from the machine.
- 5. Install the battery in reverse order and ensure to connect and tighten the positive (+) cable to the battery before connecting negative (-) cable. Use 2 wrenches when tightening the cables.

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 A. If the reading is 0.1 A or more, the electrical system of the machine should be tested for short circuits or damaged components and repaired.

6. Lower the hood and secure it with the latches.

Inspecting, Maintaining, and Testing the Battery

- 1. Do the following inspections and maintenance:
 - A. Check for cracks. Replace the battery if cracked or leaking.
 - B. Check the battery terminal posts for corrosion. Use the wire brush to clean corrosion from the posts.

IMPORTANT

Before cleaning the battery, tape or block the vent holes of the filler caps and ensure that the caps are tight.

- C. Check for the 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 the battery case for dirt and oil. Clean the battery with a solution of baking soda and water, then rinse it with clean water.
- D. Check that the cover seal is not broken away. Replace the battery if the seal is broken or leaking.
- E. Check the electrolyte level in each cell. If the level is below the tops of the plates in any cell, fill all the cells with distilled water between the minimum and maximum fill lines. Charge at 15 to 25 A for 15 minutes to allow sufficient mixing of the electrolyte; refer to Charging the Battery (page 5–98).
- 2. Perform the hydrometer test of the battery-electrolyte.

IMPORTANT

Ensure that the area around the cells is clean before opening the battery caps.

- A. Use a hydrometer to measure the specific gravity of each cell. Pull the electrolyte in and out of the hydrometer barrel before 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 27°C (80°F) add 0.004 to the specific gravity reading. For each 5.5°C (10°F) below 27°C (80°F) subtract 0.004 from the specific gravity reading; refer to the Cell Specific Gravity Example (page 5–97).

Cell Specific Gravity Example

Cell Temperature	100°F
Cell Specific Gravity	1.245
38°C minus 27°C equals 11°C	
(100°F minus 80°F equals 20°F)	
11°C multiply by 0.004/5.5°C equals 0.008	
(20°F multiply by 0.004/10°F equals 0.008)	
ADD (conversion above)	0.008
Correction to 27°C (80°F)	1.253

- C. If the difference between the highest and lowest cell specific gravity is 0.050 or more or the lowest cell specific gravity is less than 1.225, charge the battery.
- D. Charge at the rate and time given in Charging the Battery (page 5–98) or until all cells specific gravity is 1.225 or greater with the difference in specific gravity between the highest and lowest cell is less than 0.050. If you can not meet these charging conditions, replace the battery.
- 3. Do a high-discharge test with an adjustable load tester. This is 1 of the most reliable means of testing a battery as it simulates the cold-cranking test. A commercial battery load tester is required to do this test.

CAUTION

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Follow the manufacturer's instructions when using a battery load tester.

- A. Check the voltage across the battery terminals before testing the battery. If the voltage is less than 12.4 VDC, charge the battery before continuing the test; refer to Charging the Battery (page 5–98).
- B. Ensure that the battery terminals are free of corrosion.
- C. Measure the electrolyte temperature of the center battery cell.
- D. Connect a battery load tester to the battery terminals following the manufacturer's instructions. Connect a digital multimeter to the battery terminals.

Inspecting, Maintaining, and Testing the Battery (continued)

- E. If you charge the battery, apply a 150 A load for 15 seconds to remove the surface charge. Wait for 10 minutes before proceeding with load test.
- F. Apply a test load of 270 A (1/2 the cranking performance rating of the battery) for 15 seconds.
- G. After test load has been applied for 15 seconds, take a test voltage reading and then remove the load. Record the test voltage reading.
- H. Use the Minimum Voltage Table (page 5–98), determine the minimum voltage for the center cell electrolyte temperature reading.

Minimum Voltage Table

Minimum Voltage	Battery-Electrolyte Temperature		
9.6	70°F (and up)	21.1°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	

- I. If the test voltage is below the minimum, replace the battery. If the test voltage is at or above the minimum, return the battery to service.
- 4. After you make the connections, apply terminal protector (Toro Part No. 107-0392) or a light layer of grease on all the battery posts and cable connectors to reduce corrosion.

Charging the Battery

To minimize damage to the battery and allow the battery to charge fully, do the following slow charging procedure. You can do this charging procedure with a constant current battery charger that is locally available.

IMPORTANT

Follow the manufacturer's instructions when using a battery charger.

Note: Using specific gravity of the battery cells is the most accurate procedure of determining the battery condition.

1. Determine the battery charge level from either its specific gravity or open circuit voltage.

Battery Charge Level	Specific Gravity	Open Circuit Voltage
100%	1.265	12.68
75%	1.225	12.45
50%	1.190	12.24
25%	1.155	12.06
0%	1.120	11.89

Charging the Battery (continued)

2. Determine the charging time and rate using the manufacturer's battery charger instructions or the following Battery Charge Level Table (page 5–99).

Battery	Battery Charge Level (Percent of Fully Charged)			
Reserve Capacity (Minutes)	75%	50%	25%	0%
80 or less	3.8 hrs	7.5 hrs	11.3 hrs	15 hrs
	@	@	@	@
	3 A	3 A	3 A	3 A
81 to 125	5.3 hrs	10.5 hrs	15.8 hrs	21 hrs
	@	@	@	@
	4 A	4 A	4 A	4 A
126 to 170	5.5 hrs	11 hrs	16.5 hrs	22 hrs
	@	@	@	@
	5 A	5 A	5 A	5 A
171 to 250	5.8 hrs	11.5 hrs	17.3 hrs	23 hrs
	@	@	@	@
	6 A	6 A	6 A	6 A
above 250	6 hrs	12 hrs	18 hrs	24 hrs
	@	@	@	@
	10 A	10 A	10 A	10 A

Battery Charge Level Table

CAUTION

Charging a frozen battery can cause explosion and can cause personal injury. Let the battery warm to 15.5°C (60°F) before connecting to a charger.

- Charge the battery in a well-ventilated place to dissipate the gases produced from the charging.
- These gases are explosive; keep open flame and electrical spark away from the battery. Do not smoke.
- Inhaling the battery gases can cause nausea.
- Unplug the charger from the electrical outlet before connecting or disconnecting the charger leads from the battery posts.
- 3. Follow the battery charger manufacturer's instructions, connect the charger cables to the battery posts. Ensure that you make a good connection.
- 4. Charge the battery following the manufacturer's instructions.
- 5. Occasionally check the temperature of the battery-electrolyte. If the temperature is more than 52°C (125°F) or the electrolyte is violently gassing or spewing, lower and temporarily stop the charging rate.
- 6. Three hours before the end of the charging, measure the specific gravity of a battery cell once per hour.

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Charging the Battery (continued)

Note: 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 3 consecutive readings.


Chapter 6

Chassis

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Specifications

Chassis

Item	Description
Front tire pressure (26.5×14.0-12, 4 ply, tubeless)	83 to 103 kPa (12 to 15 psi)
Rear tire pressure (20×12.0-10, 4 ply, tubeless)	83 to 103 kPa (12 to 15 psi)
Wheel lug nut torque	95 to 122 N·m (70 to 90 ft-lb)
Steering control valve mounting screws	9.5 to 13.5 N⋅m (84 to 120 in-lb) (tighten in a criss-cross pattern)
Steering wheel mounting nut	28 to 35 N·m (20 to 26 ft-lb)
Front wheel motor/wheel hub locknut torque	427 to 522 N·m (315 to 385 ft-lb)
Rear wheel motor/wheel hub locknut torque	366 to 447 N⋅m (270 to 330 ft-lb)
Wheel motor mounting bolts	109 to 135 N·m (80 to 100 ft-lb)
Rear axle pivot pin nut	123 to 162 N·m (90 to 120 ft-lb)
Lift arm pin retainer plate bolts	109 to 135 N·m (80 to 100 ft-lb) (use medium strength threadlocker)
Lift arm pivot bolts	183 to 223 N·m (135 to 165 ft-lb) (use medium strength threadlocker)

General Information

The *Operator's Manual* provides information regarding the operation, general maintenance, and maintenance intervals for your Groundsmaster 4300-D machine. Refer to the *Operator's Manual* for additional information when servicing the machine.

Special Tools

You can order the special tools from your Toro Distributor.

Wheel Hub Puller



The wheel hub puller allows you to safely remove the wheel hub from the wheel motor shaft.

Toro Part No. TOR6004

Service and Repairs





- Front wheel motor (left) 4.
- 8. Brake drum

- Rear wheel hub
- 12. Rear wheel motor (left)

Removing the Wheel

- 1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
- 2. Block the wheels that are not removed with chocks to prevent the machine from moving.
- 3. Loosen, but do not remove the 5 wheel-lug nuts that attach the wheel to the machine.

IMPORTANT

Before lifting the machine with a jack, review and follow Jacking Instructions (page 1–6).

- 4. Lift the machine with a jack until the wheel to be removed is off the ground. Support the machine with appropriate jack stands.
- 5. Remove the 5 wheel-lug nuts that attach the wheel to the machine, and remove the wheel.

Installing the Wheel

- 1. Install the wheel to the machine with the 5 wheel-lug nuts.
- 2. Lower the machine to the ground.

WARNING

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

Maintain the proper torque of the wheel-lug nuts.



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- 3. Torque the wheel-lug nuts evenly to **95 to 122 N·m (70 to 90 ft-lb)** in a crossing pattern.
- 4. Check and adjust the tire pressures; refer to Specifications (page 6–2).

Steering Column





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- 1. Platform shroud
- 2. Washer-head screw (6 each)
- 3. Washer (2 each)
- 4. Screw (2 each)

- 5. Cover plate
 - 6. Bushing (2 each)
 - 7. Spacer (2 each)
 - 8. Flange nut (2 each)



Removing the Steering Column (continued)

- 1. Park the machine on a level surface, set the parking brake, lower the cutting decks, shut off the engine, and remove the key from the key switch.
- 2. Remove the steering wheel cover (item 1 in Figure 204) from the steering wheel by carefully prying up on one of the cover spokes.
- 3. Remove the locknut (item 2 in Figure 204) and flat washer that secure the steering wheel to the steering column.
- 4. Use a suitable puller to remove the steering wheel from the steering column assembly (item 14 in Figure 204).
- 5. Remove the platform shroud (item 1 in Figure 205) from the machine to get access to the steering column fasteners as follows:
 - A. Remove the cover plate from the platform.
 - B. Remove the platform shroud from the machine.
 - C. Locate and retrieve the 2 rubber bushings and spacers.
- 6. Slide the rubber bellows up the steering column to get access to the fasteners that secure the steering column to the machine.
- 7. Support the steering control valve (item 7 in Figure 204) to prevent it from falling during the steering column removal.

Note: Do not allow the steering control valve to hang from the hydraulic lines.

- 8. Loosen and remove the 4 socket-head screws (item 13 in Figure 204) that secure the steering control valve to the steering column.
- 9. Loosen and remove the 4 socket-head screws (item 5 in Figure 204) and 4 flange nuts that secure the steering column to the machine.
- 10. Slide the steering column assembly from the steering control valve and the machine.
- 11. Disassemble the steering column assembly as necessary (Figure 206).

Installing the Steering Column

- 1. Assemble the steering column (Figure 206). 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.
- 2. Apply anti-seize lubricant to the input shaft of the steering control valve (item 7 in Figure 204).
- 3. Slide the steering column assembly (item 14 in Figure 204) onto the steering control valve. Secure the steering column in place with the 4 socket-head screws (item 5 in Figure 204) and 4 flange nuts.



- Secure the steering control valve to the steering column with the 4 socket-head screws (item 13 in Figure 204); torque the socket-head screws to 9.5 to 13.5 N·m (84 to 120 in-lb) in a criss-cross pattern.
- 5. Slide the rubber bellows to the bottom of the steering column.
- 6. Place the rubber bushings and spacers into the holes of the platform shroud (Figure 205). Position the platform shroud in place and secure with the fasteners that were removed.
- 7. Install the cover plate to the platform.
- 8. Clean the tapered surfaces of the steering wheel (item 4 in Figure 204) and steering column.
- 9. Apply anti-seize lubricant to the splines of steering column and ensure to keep the anti-seize lubricant from the steering column taper. Slide the steering wheel onto the steering column.



- 10. 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)**.
- 11. Install the steering wheel cover (item 1 in Figure 204) onto the steering wheel.

Servicing the Brakes



Disassembling the Brake

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



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- Hold down pin (2 each) 1.
- 2. Backing plate
- 3. Rivet (4 each)
- Clevis pin 4.
- 5. Retaining ring
- 6. Brake shoe (2 each)
- Shoe spring 7.

Figure 208

- Hold down spring (2 each) 8.
- 9. Hold down cup (2 each)
- 10. Shoe spring (actuator)
- Brake actuator 11.
- Brake actuator lever 12.
- 13. Back-up plate
- 14. Boot



2. Hold down components

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1.

- Shoe spring 5.
- 3. Shoe spring (actuator)
- 2. Block the rear wheels with chocks to prevent the machine from moving.
- 3. Remove the front wheel assembly; refer to Removing the Wheel (page 6–6).
- 4. Ensure that the parking brake is disengaged.

Disassembling the Brake (continued)

Note: The clevis pin (item 25 in Figure 207) that secures the brake cable to the brake actuator lever is secured with the brake return spring.

- 5. Remove the brake return spring (item 19 in Figure 207) and clevis pin that attach the brake cable to the brake actuator lever.
- 6. Remove the brake drum (item 14 in Figure 207) from the brake assembly.

IMPORTANT

Do not hit the wheel hub, wheel-hub puller, or wheel motor with a hammer while removing or installing the wheel hub. Hammering can damage the wheel motor.

- Ensure that the locknut (item 15 in Figure 207) on the wheel motor shaft is loosened at least to 2 turns. Use a hub puller (refer to Special Tools (page 6–4)) to loosen the wheel hub from the wheel motor shaft.
- 8. Remove the locknut and wheel hub from the motor shaft. Discard the locknut. Locate and retrieve the square key.

Note: If necessary, the complete brake assembly can be removed from the machine for disassembly (refer to step 12).

- 9. Remove the 2 shoe springs (items 10 and 7 in Figure 208) from the brake shoes.
- 10. Remove the 2 hold down cups (item 9 in Figure 208) and 2 hold down springs.
- 11. Remove the 2 brake shoes (item 6 in Figure 208) and 2 hold down pins from the backing plate.
- 12. If necessary, remove the 4 bolts (item 10 in Figure 207) to remove the brake backing plate from the brake adapter.

Assembling the Brake

- 1. Use a wire brush to remove rust and unwanted material from all the brake parts before the installation. Clean all the parts.
- 2. Visually examine the brake shoes and contact surfaces of the brake drum for excessive wear. Replace the parts that are worn and damaged.
- 3. If the brake backing plate was removed from the machine, secure the backing plate to the brake adapter with the 4 bolts (item 10 in Figure 207).
- 4. Lightly lubricate the brake shoe pivot points with general purpose grease.
- 5. Position the brake shoe to the backing plate. Install the hold down pin and secure with the hold down spring and hold down cup. Repeat for the second brake shoe.

Note: The shoe spring (actuator) must be installed at the actuator end of the brake shoes.

6. Install the 2 shoe springs (items 10 and 7 in Figure 208) to the brake shoes. Ensure that the brake shoes are properly positioned to the pivot and actuator points.

IMPORTANT

Before installing the wheel hub, clean the tapers of the wheel hub and wheel motor shaft. Ensure that the tapers are free of grease, oil, rust, and dirt. Do not use anti-seize lubricant, when you install the wheel hub.

7. Mount the square key in the wheel motor shaft, and then install the wheel hub onto the wheel motor shaft.

IMPORTANT

Do not use the locknut previously removed to attach the wheel hub to the wheel motor.

- 8. Install new locknut (item 15 in Figure 207) onto the wheel motor shaft to secure the wheel hub to the motor shaft.
- 9. Install the brake drum (item 14 in Figure 207).
- 10. Position the end of the brake cable to the brake actuator lever (item 12 in Figure 208). Attach the cable to the brake actuator lever with the clevis pin and brake return spring.
- 11. Install the front wheel assembly; refer to Installing the Wheel (page 6–6).
- 12. Check and adjust the brakes; refer to the Operator's Manual.
- 13. Lower the machine to the ground.

WARNING

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

Maintain the proper torque of the wheel-lug nuts.



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14. Torque the wheel hub locknut (item 15 in Figure 207) that secures the wheel hub to **427 to 522 N·m (315 to 385 ft-lb)**.

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CAUTION

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After servicing the brakes, always check the brakes for proper operation in a wide open, level area that is free of other persons and obstructions.

15. Check for the operation of the brake, before you return the machine to operation.

Burnish Brake Pads

After brake pads replacement, burnish (break-in) the brakes before use.

- 1. Bring the machine to full speed and apply the brakes to rapidly stop the machine without skidding or locking up the wheels.
- 2. Repeat this procedure 10 times. To avoid overheating the brakes, wait 1 minute between each stop.

Rear Axle Motor Housings



Removing the Rear Axle Motor Housings

- 1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
- 2. Block the front wheels with chocks to prevent the machine from moving.
- 3. Remove the rear wheel assembly; refer to Removing the Wheel (page 6–6).
- 4. Remove the cotter pin and slotted hex nut that secure the tie rod end (item 22 in Figure 210) to the drag link. Use a ball joint removal tool (pickle fork) and separate the tie rod end from the drag link.
- 5. If the right side motor housing is being removed, remove the cotter pin and slotted hex nut that secure the steering cylinder ball joint (item 25 in Figure 210) to the drag link. Use a ball joint removal tool (pickle fork) and separate the steering cylinder from the drag link.
- 6. Remove the 4 bolts (item 14 in Figure 210) and 4 lock washers that secure the wheel motor to the motor housing. Slide the wheel motor assembly (with the wheel hub and hydraulic hoses attached) from the motor housing. Position the wheel motor away from the housing.
- 7. Support the motor housing to prevent it from falling.

Note: Do not allow the wheel motor assembly to hang from the hydraulic hoses.

- 8. Remove the flange-head screw (item 2 in Figure 210), spindle cap, and retaining ring that secure the motor housing shaft into the axle tube. Slide the motor housing out of the axle tube.
- 9. Locate and retrieve the thrust washer (item 7 in Figure 210) from the motor housing shaft.
- 10. If necessary, remove the drag link from the motor housing.
- 11. Clean the motor housing shaft. Inspect the shaft for wear and replace the motor housing if the shaft is worn or damaged.
- 12. Clean the rear axle bore and inspect the flange bushings (item 5 in Figure 210) in the rear axle for wear or damage. If the bushings need replacement, do the following steps:

Note: Do not damage the bore of the axle tube during bushing removal.

- A. Use a bushing removal tool to extract both the flange bushings from the axle tube.
- B. Clean the inside of the axle tube to remove any dirt or unwanted material.
- C. Apply grease to the inner and outer surfaces of new flange bushings.
- D. Press the new flange bushings into the top and bottom of the axle tube until bushing flange bottoms on the tube.
- E. After bushing installation, ensure that the motor housing shaft slides easily into the bushings. If there is any binding, locate and correct the source of binding.

Installing the Rear Axle Motor Housings

- 1. If removed, secure the drag link to the motor housing.
- 2. Apply a light coating of grease to the motor housing shaft.
- 3. Install the thrust washer (item 7 in Figure 210) onto the motor housing shaft and slide the shaft up through the axle tube.
- 4. Hold the motor housing in place and install the retaining ring (item 4 in Figure 210) onto the end of the spindle shaft.
- 5. Place the spindle cap (item 3 in Figure 210) to the top of the motor housing shaft and secure with the flange-head screw.

Installing the Rear Axle Motor Housings (continued)



- Slide the wheel motor assembly (with the wheel hub and hydraulic hoses attached) into the motor housing. Secure the wheel motor to the motor housing with the 4 bolts and 4 lock washers; torque the bolts to 109 to 135 N·m (80 to 100 ft-lb).
- 7. Clean the tapered surfaces of both mating parts before installation, connect the tie rod end (item 22 in Figure 210) to the drag link with the slotted hex nut and cotter pin.
- 8. If the right side motor housing was removed, clean the tapered surfaces of both mating parts before installation, and secure the steering cylinder ball joint (item 25 in Figure 210) to the drag link the with the slotted hex nut and cotter pin.
- 9. Lubricate the motor housing shafts through the grease fittings on the rear axle.
- 10. Install the rear wheel assembly; refer to Installing the Wheel (page 6–6).
- 11. Check the rear wheel toe-in; refer to the Operator's Manual.
- 12. Ensure that there is no contact between the machine components including hydraulic hoses while the rear wheels move from lock to lock. Adjust if necessary.

Rear Axle



Removing the Rear Axle

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

Removing the Rear Axle (continued)

- 2. Block the front wheels with chocks to prevent the machine from moving.
- 3. Remove the 2 rear wheel assemblies; refer to Removing the Wheel (page 6–6).
- 4. Remove the steering cylinder (with the hydraulic hoses attached) from the rear axle; refer to Removing the Steering Cylinder (page 4–155).
- 5. Remove both wheel motor housings from the rear axle; refer to Removing the Rear Axle Motor Housings (page 6–17).
- 6. Unlatch and open the radiator screen assembly.



- 7. Remove the 3 bolts (item 2 in Figure 212), 3 lock washers, and 3 spacers that secure the CrossTrax AWD control manifold to the frame so that the rear axle pivot pin (item 1 in Figure 211) can be accessed. Lower and support the manifold, ensure that you do not damage the hydraulic tubes.
- 8. Remove the jam nut (item 35 in Figure 211) and thrust washer that secure the axle pivot pin to the frame.
- 9. Support the rear axle to prevent it from falling.
- 10. Pull the axle pivot pin from the frame and rear axle. This releases the rear axle and 2 thrust washers (item 6 in Figure 211) from the frame.

Note: Do not damage the CrossTrax AWD control manifold or attached hydraulic tubes during axle removal.

11. Carefully remove the rear axle from the machine.

Servicing the Rear Axle

- 1. Clean the rear axle pivot pin. Inspect the pin for wear and replace the pivot pin if it is worn or damaged.
- 2. Clean the rear axle bushings and inspect the axle bushings (item 7 in Figure 211) in the rear axle for wear or damage. If the bushings need replacement, do the following steps:

Note: Do not damage the bore of the axle during bushing removal.

- A. Use a bushing removal tool to extract both the axle bushings from the axle pivot.
- B. Clean the inside of the axle pivot to remove any dirt or unwanted material.
- C. Apply grease to the inner and outer surfaces of new axle bushings.
- D. Press the new axle bushings into the axle pivot bore until bushing is flush with the axle.
- E. After bushing installation, ensure that the pivot pin slides easily into the bushings. If there is any binding, locate and correct the source of binding.

Servicing the Tie Rod Assembly



3. Tie rod groove

- Jam nut (right-hand thread)
- Ball joint (right-hand thread) 6.

Note: The tie rod ball joint and jam nut at the grooved end of the tie rod have left-hand threads.

- 1. Loosen the jam nuts and then remove the ball joints from the tie rod.
- 2. Thread new ball joints equally into the tie rod so that the ball joint center to center length is 920.5 mm (36.240 inches).
- 3. Clean the tapered surfaces of the tie rod ball joints before you install the tie rod to the drag links on the rear axle.

Installing the Rear Axle

1. Position the rear axle assembly to the frame. Install the thrust washer (item 6 in Figure 211) between each side of the axle and frame. Slide the pivot pin through the frame, thrust washers, and axle. Ensure that the roll pin on the pivot pin is positioned in the frame reliefs.



- Install a thrust washer (item 36 in Figure 211) and jam nut onto the pivot pin. Torque the jam nut to 123 to 162 N·m (90 to 120 ft-lb). Ensure that the rear axle can still pivot freely after the jam nut is tightened.
- 3. Raise the CrossTrax AWD control manifold to the frame. Position the spacers between the manifold and the frame (Figure 212). Secure the manifold to the frame with the 3 bolts and 3 lock washers.
- 4. Close and latch the radiator screen assembly.
- 5. Install the wheel motor housings to the rear axle; refer to Installing the Rear Axle Motor Housings (page 6–17).
- 6. Install the steering cylinder to the rear axle; refer to Installing the Steering Cylinder (page 4–156).
- 7. Install the 2 rear wheel assemblies; refer to Installing the Wheel (page 6–6).
- 8. Check the rear wheel toe-in; refer to the Operator's Manual.
- 9. Check the hydraulic-fluid level in the hydraulic reservoir and add correct quantity of fluid if necessary; refer to the *Operator's Manual*.
- 10. Lubricate the rear axle grease fittings.
- 11. Ensure that there is no contact between the machine components including hydraulic hoses while the rear wheels move from lock to lock. Adjust if necessary.
- 12. Operate the machine and check the hydraulic connections for leaks.

Control Arm





- 1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
- 2. Disconnect the negative battery cable from the battery; refer to Servicing the Battery (page 5–95).
- 3. Loosen the 2 swell latches (item 13 in Figure 214) and remove the access cover from outside of the control arm.
- 4. At the front of the control arm, remove the screw (item 11 in Figure 214) and locknut that secure the control arm covers to each other.
- 5. Remove the 5 washer-head screws (item 15 in Figure 214) that secure each cover to the control arm.
- 6. Remove the control arm covers from the machine. As the left control arm cover (item 32 in Figure 214) is removed from the control arm, disconnect the wire harness connector from the headlight switch.
- 7. Remove the electrical components from the control arm as necessary (Figure 214).

Assembling the Control Arm

- 1. Install all the electrical components that were removed from the control arm (Figure 214).
- 2. Position the covers to the control arm. As the left control arm cover (item 32 in Figure 214) is placed, connect the wire harness connector to the headlight switch. Also, ensure that the platform wire harness is routed correctly through the cover openings and the harness foam seal is captured between the control arm covers (Figure 215).
- 3. Secure each cover to the control arm with the 5 washer-head screws (item 15 in Figure 214). Install the screw (item 11 in Figure 214) and locknut to secure the covers at the front of the control arm.
- 4. Install the access cover to outside of the control arm.
- 5. Connect the negative battery cable to the battery; refer to Servicing the Battery (page 5–95).

Operator Seat



IMPORTANT

The operator seat, seat base, and control arm assembly are attached to the machine with the same fasteners. Support the seat base and control arm to prevent them from shifting when removing the seat. Damage to the control arm electrical components and platform wiring harness can occur if the seat base and control arm are not properly supported during seat removal.

Removing the Operator Seat



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

Removing the Operator Seat (continued)

- 2. Disconnect the negative battery cable from the battery; refer to Servicing the Battery (page 5–95).
- 3. Disconnect the seat switch wire harness connector from the platform wire harness (Figure 217).
- 4. Record the position of the control arm before removal. The control arm angle is adjustable for operator comfort.
- 5. Remove the 2 flange-head screws and 2 flat washers that secure the control arm assembly to the seat base (Figure 217 and Figure 218).

IMPORTANT

Do not damage the platform wire harness when removing the seat and control arm assembly from the machine.

- 6. Carefully slide the control arm assembly from the seat base. Locate and retrieve the 2 bushings (item 3 in Figure 218). Position and support the control arm assembly to allow seat removal.
- 7. Remove the 4 socket-head screws (item 15 in Figure 216) and 4 flat washers that secure the seat and seat base to the seat adjusters.
- 8. Record which set of seat mounting holes are used, remove the operator seat and seat base from the seat adjusters.

Installing the Operator Seat

- 1. Use the mounting holes that were recorded during removal, position the seat and seat base to the seat adjusters.
- 2. Secure the seat and seat base to the seat adjusters with the 4 flat washers and 4 socket-head screws (item 15 in Figure 216).

IMPORTANT

Do not damage the platform wire harness when installing the control arm assembly to the machine.

- 3. Ensure that the 2 bushings (item 3 in Figure 218) are positioned in the control arm. Carefully slide the control arm assembly onto the seat base post. Secure the control arm assembly to the seat base with the 2 flange-head screws and 2 flat washers (Figure 217 and Figure 218).
- 4. Connect the seat switch wire harness connector to the platform wire harness (Figure 217).
- 5. Connect the negative battery cable to the battery; refer to Servicing the Battery (page 5–95).

Mechanical Seat Suspension



Thrust race (2 each)

Thrust bearing

23.

24.

Push clip (21 each)

Guide link

(2 each)

11. 12. 35.

36.

(2 each)

Damper

Hex nut (3 each)



g185934

- 1. Seat adjuster w/latch
- 2. Seat adjuster
- 3. Flat washer (4 each)
- 4. Flange-head screw (4 each)
- 5. Flange nut (8 each)
- 6. R-clamp (2 each)
- 7. Spacer (4 each)

Figure 220

- 8. Manual tube
- 9. Seat base cover
- 10. Seat frame
- 11. Bolt (4 each)
- 12. Seat suspension bracket (2 each)
- 13. Seat suspension
- 1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
- 2. Remove the seat from the machine; refer to Removing the Operator Seat (page 6–26).

IMPORTANT

Do not damage the platform wire harness when removing the seat suspension from the machine.

- 3. Tilt and support the seat frame to get access to the seat suspension fasteners.
- 4. Support the seat suspension to prevent it from falling.
- 5. Record which set of mounting holes are used, remove the 4 flange-head screws (item 4 in Figure 220) and 4 flange nuts that secure the seat suspension to the seat frame.
- 6. Remove the seat suspension from the machine.
- 7. Locate and retrieve the 4 spacers (item 7 in Figure 220) from the seat suspension and seat frame.
- 8. Remove the seat suspension components as necessary (Figure 219 and Figure 220). If the seat adjusters are being removed, record the seat adjuster mounting holes used.

Installing the Mechanical Seat Suspension

1. Install all the seat suspension components that were removed (Figure 219 and Figure 220). If removed, use the seat adjuster mounting holes that were recorded during removal.

IMPORTANT

Do not damage the electrical harness when installing the seat suspension to the machine.

- 2. Position the seat base cover and 4 spacers (item 7 in Figure 220) to the seat frame.
- 3. Use the mounting holes that were recorded during removal, position the seat suspension to the seat frame and secure with the 4 flange-head screws (item 4 in Figure 220) and 4 flange nuts.
- 4. Install the seat to the machine; refer to Installing the Operator Seat (page 6–27). Ensure to connect the harness electrical connector to the seat switch.

Front Lift Arms



g185924

Figure 221

- Roll pin (1 each per lift arm pivot 1. 8. shaft) Locknut (4 each) 2. 9. Lift arm pivot shaft (3 each) 3. 10. 4. Flange bushing (2 each per lift arm) 11. 5. Bolt (1 each per lift arm) 12. Bolt (4 each) #4 lift arm 6. 13. Bolt (2 each)
- 7. Cutting deck pivot shaft (1 each per 14. lift arm)

- Left tipper bracket
- Bumper (4 each)
- Bolt (1 each per lift arm)
- Flat washer (1 each per lift arm)
- Thrust washer (6 each)

- Locknut (4 each) 15.
- #1 lift arm 16.
- Grease fitting (1 each per lift arm) 17.
- 18. Right tipper bracket
- 19. #5 lift arm

Removing the Front Lift Arms

2.

3.

- 1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
- 2. Remove the cutting deck from the front lift arm to be removed; refer to Removing the Cutting Deck Carrier Frame (page 7–24).



- 3. Disconnect the lift cylinder from the lift arm (item 5 in Figure 222) as follows:
 - A. Remove 1 retaining ring and thrust washer from the cylinder pin that secures the lift cylinder to the lift arm.
 - B. Pull the cylinder pin from the lift cylinder and lift arm. Locate and retrieve the second thrust washer.
 - C. Pivot the lift cylinder rod end away from the lift arm.
- 4. Remove the fasteners that secure the tipper bracket (item 8 or 18 in Figure 221) to the machine, and remove the tipper bracket.
- 5. Slide the front lift arm from the lift arm pivot shaft (item 3 in Figure 221).
- 6. Inspect the flange bushings in the lift arm for wear or damage. If necessary, replace the bushings as follows:

Note: Do not damage the bore of the lift arm during bushing removal.

- A. Use a bushing removal tool to extract both the flange bushings from the lift arm.
- B. Clean the inside of the bore to remove any dirt or unwanted material.
- C. Apply grease to the inner and outer surfaces of the new bushings.
- D. Use an arbor press to install the bushings into the lift arm. Lift arm bushings should be pressed until bushing flange is against the lift arm bore.
- E. After bushing installation, ensure that the lift arm slides easily onto the pivot shaft. If there is any binding, locate and correct the source of binding.
- 7. If necessary, remove the bolt that secures the cutting deck pivot shaft (item 7 in Figure 221) in the lift arm. Remove the cutting deck pivot shaft from the lift arm.
- 8. If necessary, remove the roll pin and lift arm pivot shaft (item 3 in Figure 221) from the frame. Discard the roll pin.

Installing the Front Lift Arms

- 1. If the lift arm pivot shaft (item 3 in Figure 221) was removed from the frame, apply anti-seize lubricant to the pivot shaft surface and insert the shaft into the frame. Align the holes in the frame with the pivot shaft. Secure the pivot shaft with new roll pin.
- 2. If the cutting deck pivot shaft (item 7 in Figure 221) was removed from the lift arm, insert the cutting deck pivot shaft in the lift arm and secure with the bolt.
- 3. Slide the front lift arm onto the pivot shaft.
- 4. Secure the front lift arm to the machine as follows:
 - A. Apply medium strength threadlocker (or equivalent) to the threads of the bolts (items 10, 12, and 13 in Figure 221).
 - B. Position the tipper bracket to the lift arm and frame bracket.
 - C. Install the bolts, flat and thrust washers (items 11 and 14 in Figure 221), and locknut (item 2 in Figure 221) to the tipper bracket, pivot shaft, and frame bracket.



D. Tighten the 1/2 inch fasteners (items 12 and 13 in Figure 221) to 109 to 135 N·m (80 to 100 ft-lb). Then, tighten the 5/8 inch fasteners (item 10 in Figure 221) to 183 to 223 N·m (135 to 165 ft-lb).

- 5. Connect the lift cylinder to the lift arm (item 5 in Figure 222) as follows:
 - A. Align the lift cylinder rod end with the lift arm mounting hole.
 - B. Slide the cylinder pin with the retaining ring and thrust washer through the lift cylinder and lift arm.
 - C. Install the second thrust washer on the pin and secure with the second retaining ring.
- 6. Mount the cutting deck to the lift arm; refer to Installing the Cutting Deck Carrier Frame (page 7–24).
- 7. Lubricate the lift arm and lift cylinder grease fittings.

Rear Lift Arms



Removing the Rear Lift Arms

- 1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
- 2. Remove the cutting deck from the rear lift arm to be removed; refer to Removing the Cutting Deck Carrier Frame (page 7-24).



1. Lift cylinder

g185928

Figure 224

- 2. Retaining ring (2 each)
- Thrust washer (2 each) 3.
- Cylinder pin 4

- 5. Washer-head screw
- 6. R-clamp
- 7. #2 lift arm
- 3. Disconnect the lift cylinder from lift arm (item 7 in Figure 224) as follows:
 - A. Remove 1 retaining ring and thrust washer from the cylinder pin that secures the lift cylinder to the lift arm.
 - B. Pull the cylinder pin from the lift cylinder and lift arm. Locate and retrieve the second thrust washer.
 - C. Remove washer-head screw that secures the R-clamp to the lift arm. Position the R-clamp and hydraulic hoses away from the lift arm.
 - D. Pivot the lift cylinder rod end away from the lift arm.
- 4. Remove the fasteners that secure the bridge plate (item 1 in Figure 223) and bulkhead bracket to the machine. Position the bulkhead bracket with attached hydraulic hoses away from the lift arm. Remove the bridge plate.
- 5. Slide the rear lift arm from the lift arm pivot shaft (item 13 in Figure 223).
- 6. Inspect the flange bushings in the lift arm for wear or damage. If necessary, replace the bushings as follows:

Note: Do not damage the bore of the lift arm during bushing removal.

- A. Use a bushing removal tool to extract both the flange bushings from the lift arm.
- B. Clean the inside of the bore to remove any dirt or unwanted material.
- C. Apply grease to the inner and outer surfaces of the new bushings.
- D. Use an arbor press to install the bushings into the lift arm. Lift arm bushings should be pressed until bushing flange is against the lift arm bore.
- E. After bushing installation, ensure that the lift arm slides easily onto the pivot shaft. If there is any binding, locate and correct the source of binding.

Removing the Rear Lift Arms (continued)

- If necessary, remove the bolt that secures the cutting deck pivot shaft (item 8 in Figure 223) in the lift arm. Remove the cutting deck pivot shaft from the lift arm.
- 8. If necessary, remove the roll pin and lift arm pivot shaft (item 13 in Figure 223) from the frame. Discard the roll pin.

Installing the Rear Lift Arms

- 1. If the lift arm pivot shaft (item 13 in Figure 223) was removed from the frame, apply anti-seize lubricant to the pivot shaft surface and insert the shaft into the frame. Align the holes in the frame with the pivot shaft. Secure the pivot shaft with new roll pin.
- 2. If the cutting deck pivot shaft (item 8 in Figure 223) was removed from the lift arm, insert the cutting deck pivot shaft in the lift arm and secure with the bolt.
- 3. Slide the rear lift arm onto the pivot shaft.
- 4. Secure the rear lift arm to the machine as follows:
 - A. Apply medium strength threadlocker (or equivalent) to the threads of the bolts (items 4, 5, and 7 in Figure 223).
 - B. Position the bridge plate and bulkhead bracket with attached hydraulic hoses to the lift arm and frame bracket.
 - C. Install the bolts, flat and thrust washers (items 3 and 6 in Figure 223), and locknut (item 14 in Figure 223) to the bridge plate, bulkhead bracket, pivot shafts, and frame bracket.



- D. Tighten the 1/2 inch fasteners (items 5 and 7 in Figure 223) to 80 to 100 N⋅m (108 to 135 ft-lb)109 to 135 N⋅m (80 to 100 ft-lb). Then, tighten the 5/8 inch fasteners (item 4 in Figure 223) to 183 to 223 N⋅m (135 to 165 ft-lb).
- 5. Connect the lift cylinder to the lift arm (item 7 in Figure 224) as follows:
 - A. Align the lift cylinder rod end with the lift arm mounting hole.
 - B. Slide the cylinder pin with the retaining ring and thrust washer through the lift cylinder and lift arm.
 - C. Install the second thrust washer on the pin and secure with the second retaining ring.
 - D. Position the R-clamp and hydraulic hoses to the lift arm and secure the R-clamp with the washer-head screw.
- 6. Mount the cutting deck to the lift arm; refer to Installing the Cutting Deck Carrier Frame (page 7–24).
- 7. Lubricate the lift arm and lift cylinder grease fittings.
Hood



- 2. Washer-head screw (10 each)
- 3. Flange nut (10 each)
- Rear hood frame tube 4.
- 5. Rubber bumper (2 each)
- 6. Flange-head screw (10 each)
- 7. Bow tie pin (2 each)

- Side hood frame tube (2 each) 9.
- 10. Rubber latch (2 each)
- Flange-head screw (2 each) 11.
- 12. Hex nut
- 13. Spacer
- 14. Grommet

- 17. Flat washer (4 each)
- Washer-head screw (4 each) 18.
- 19. Catch latch (2 each)
- 20. Hood saddle

Removing the Hood

- 1. Park the machine on a level surface, lower the cutting decks, shut off the engine, and remove the key from the key switch.
- 2. Unlatch the hood.
- 3. Remove the bow tie pins (item 7 in Figure 225) and clevis pins to allow hood removal.
- 4. Lift the hood assembly from the machine.
- 5. Remove the hood components as necessary (Figure 225).

Installing the Hood

- 1. Install all the hood components that were removed (Figure 225).
- 2. Position the hood assembly to the machine.
- 3. Install the clevis pins (item 8 in Figure 225) and secure with the bow tie pins.
- 4. Latch the hood.



Cutting Deck

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Specifications

Cutting Deck



Figure 226

Mounting: All the cutting decks are supported by independent lift arms and are interchangeable to any cutting deck positions. The Groundsmaster 4300-D machine uses 5 cutting decks.

Construction: The deck chamber and frame are welded steel construction reinforced with the channels and plates.

Height-of-cut range: 19 to 101 mm (0.75 to 4 inches) adjustable in 6.4 mm (0.5 inch) increments. The height-of-cut adjustment is made by repositioning the deck on the deck frame.

Deck drive: The closed loop, integrated relief, and hydraulic system operates the cutting deck hydraulic motors. The blade spindles are 31.7 mm (1-1/4 inch) shafts supported by the greaseable, tapered roller bearings in a ductile iron housing.

Cutting blade: Each cutting deck equipped with a 559 mm (22 inches) length, 6.4 mm (0.250 inch) thick, heat treated, steel blade. Anti-scalp cup is installed on the cutting blade. The standard blade is optimized for most cutting applications. Optional high lift, angled sail, and atomic blades are available for those situations where the standard blade is not ideal.

Discharge: The clippings are discharged from the rear of the mowing decks. Pre-drilled mounting holes in the cutting deck allow attachment of optional mulching baffle.

Cutting deck lift: The cutting decks on the Groundsmaster 4300-D machines are controlled with the operator joystick.

Suspension system: A fully floating suspension with hydraulic counterbalance. Main center pivot allows side-to-side deck oscillation. Individual decks supported with 2 front rollers and 1 full width, rear roller.

Weight: Individual cutting deck weighs approximately 63.5 kg (140 lb).

General Information

A

CAUTION

A

Do not install or work on the cutting decks or lift arms with the engine running.

Always shut off the engine and remove the key from the key switch before working on the cutting decks or lift arms.

Cutting Deck Operator's Manual

The *Cutting Deck Operator's Manual* provides information regarding the operation, general maintenance, and maintenance intervals for the cutting deck on your machine. Refer to the *Cutting Deck Operator's Manual* for additional information when servicing the cutting deck.

Troubleshooting

There are a number of factors that can contribute to unsatisfactory quality of cut, some of which may be turf conditions. The turf conditions such as the excessive thatch, sponginess, or attempting to cut off too much grass height may not always be overcome by adjusting the machine. It is important to remember that the lower the height-of-cut, the more critical these factors are.

Remember that the effective or actual height-of-cut depends on the cutting deck weight and turf conditions.

Factors That Can Affect Cutting Performance

Factor	Possible Problem/Correction
1. Maximum governed engine speed	Check that the engine is running at the correct high-idle speed; refer to Chapter 3: Diesel Engine (page 3–1).
	Always mow at high engine speed.
2. Blade speed	All the cutting deck blades should rotate at the same speed. Refer to items in Troubleshooting (page 4–39).
3. Tire pressure	Check the air pressure of all the tires. Adjust to the pressures specified in the <i>Operator's Manual.</i>
4. Blade condition	Sharpen the blades if their cutting edges are dull or nicked.
	Inspect the blade sail for wear or damage. Replace the blade if necessary.
5. Mower housing condition	Ensure that the cutting chambers are in good condition.
	Keep the underside of the deck clean. The unwanted material buildup can reduce the cutting performance.
6. Height-of-cut	Ensure that all the cutting decks are set at the same height-of-cut. Adjust the deck as specified in the <i>Cutting Deck Operator's</i> <i>Manual</i> . The effective (actual) height-of-cut may be different than the bench set height-of-cut.
	Adjust the height-of-cut setting to remove only 25 mm (1 inch) or 1/3 of the grass blade when cutting.
7. Cutting deck alignment and ground following	Check the lift arms and cutting deck pivot linkages for wear, damage, or binding. Also, inspect for bent or damaged pivot shafts.
8. Roller condition	All rollers should rotate freely. Replace the bearings if they are worn or damaged.
9. Grass conditions	Mow when the grass is dry for best cutting results.
10. Machine traction speed	Mowing at too fast of a traction speed will result in poor after cut appearance and missed patches of grass.

Special Tools

You can order these special tools from your Toro Distributor.

Rear Roller Bearing and Seal Installation Tools



These tools are used to assemble the cutting deck rear roller.

Toro Part Numbers:	
Inner Seal Tool	115-0852
Bearing/Outer Seal Tool	115-0853

Bearing Installation Washer

Spindle Plug

-



107-8133

The spindle plug can be used to prevent contaminant entry into the cutting deck spindle assembly when the hydraulic motor is removed from the spindle.

Toro Part No: 94-2703

g193012

Adjustments

A

CAUTION

Do not install or work on the cutting decks or lift arms with the engine running.

Always shut off the engine and remove the key from the key switch before working on the cutting decks or lift arms.

Refer to the *Cutting Deck Operator's Manual* for adjustment procedures of the cutting decks on the Groundsmaster 4300-D machine.

Blade Stopping Time

The blades of the cutting decks should come to a complete stop in less than 5 seconds after you disengage the PTO switch.

Note: When checking the blade stopping time, ensure that the decks are lowered onto a clean section of turf or hard surface to prevent dust and unwanted material.

To check the blade stopping time, instruct a second person to stay away from the machine at least 20 feet and monitor the blade on 1 of the cutting decks. When the machine operator disengage the cutting deck, record the time that it takes for the cutting deck blade to come to a complete stop. If this time is more than 7 seconds, adjust the deck control manifold braking valve (RV).

Cutting Deck

Refer to specific *Cutting Deck Operator's Manual* for cutting deck removal and installation procedure.

A

Service and Repairs



Do not install or work on the cutting decks or lift arms with the engine running.

Always shut off the engine and remove the key from the key switch before working on the cutting decks or lift arms.

Blade Spindle Assembly



Removing the Blade Spindle

g195111

1.

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



- 2. Remove the 2 socket-head screws and 2 flat washers that secure the hydraulic deck motor to the cutting deck (Figure 230), and remove the hydraulic deck motor and O-ring from the deck.
- 3. Cover the top of the spindle to prevent unwanted material from entering into the spindle. A spindle plug (refer to Spindle Plug (page 7–5)) can be used to cover the spindle.
- 4. Start the engine and raise the cutting deck. Shut off the engine and remove the key from the key switch. Support the cutting deck so it cannot fall accidentally. If necessary, remove the cutting deck from the machine.
- 5. Remove the blade bolt, anti-scalp cup, and cutting blade from the spindle.
- 6. Remove the 6 flange nuts that secure the spindle assembly to the cutting deck. Slide the spindle assembly out the bottom of the deck. Remove the spindle plate from the top of the deck.
- 7. If necessary, press the studs from the spindle housing.

Installing the Blade Spindle

- 1. If the studs were removed from the spindle housing, press the studs fully into the housing holes. Ensure that the stud head is seated squarely against housing.
- 2. Position the spindle assembly and spindle plate to the cutting deck. Align the grease fittings on the spindle with the notches on the cutting deck and spindle plate toward the front of the deck.
- 3. Secure the spindle to the cutting deck with the 6 flange nuts. Tighten the flange nuts in a star pattern.



- Install the cutting blade, anti-scalp cup, and blade bolt. Torque the blade bolt 4. to 120 to 146 N·m (88 to 108 ft-lb).
- 5. Remove the cover from the top of the spindle that was placed to prevent unwanted material from entering into the spindle.
- 6. Ensure that the O-ring is positioned on the top of the spindle housing. Secure the hydraulic deck motor to the cutting deck with the 2 socket-head screws and 2 flat washers.

IMPORTANT

A pneumatic grease gun can produce high pressure inside the spindle housing that can damage the spindle seals. Thus, do not use a pneumatic grease gun for greasing of the spindle housings.

- 7. Attach a hand pump grease gun to 1 of the grease fittings on the housing and fill the housing cavity with grease until grease starts to come out of the lower seal.
- 8. After you complete the assembly, raise and lower the cutting deck to check that the hydraulic hoses and fittings do not contact anything.

Servicing the Blade Spindle



4. Bearing

g195112

1.

2.

3.

- Spacer set (2 piece) 5.
- 6. Spacer ring

- 10. Spindle shaft
- 11. Grease fitting (2 each)
- 12. Large snap ring



Figure 232

1. Bearing

g189007

- 2. Spacer ring
- 3. Large snap ring

- 4. Inner bearing spacer
- Outer bearing spacer 5.

Disassembling the Blade Spindle

- 1. Remove the blade spindle from the cutting deck; refer to Removing the Blade Spindle (page 7–8).
- 2. Loosen and remove the spindle nut from the top of the spindle shaft.
- 3. Use an arbor press to remove the spindle shaft from the spindle housing.

Note: Ensure that the spindle shaft spacer remains on the spindle shaft while removing the shaft.

- 4. Carefully remove the oil seals from the spindle housing, note the direction of the seal lips.
- 5. Allow the bearing cones, inner bearing spacer, and spacer ring to drop out of the spindle housing.
- 6. Use an arbor press to remove the 2 bearing cups and outer bearing spacer from the housing.

Note: The large snap ring can remain inside the spindle housing. Removing the large snap ring is very difficult.

Assembling the Blade Spindle

Note: A replacement spindle bearing set contains 2 bearings, a spacer ring, and a large snap ring (items 1, 2, and 3 in Figure 232). You cannot purchase these parts separately. Also, do not mix the bearing set components from one deck spindle to the another.

Note: A replacement bearing spacer set includes the inner spacer and outer spacer (items 4 and 5 in Figure 232). Do not mix the bearing spacers from one deck spindle to the another.

IMPORTANT

If new bearings installed into a used spindle housing, it is not necessary to replace the original large snap ring. If the original large snap ring is in good condition with no sign of damage (e.g., spun bearing), leave the snap ring in the housing and discard the large snap ring that comes with the new bearings. If the large snap ring is damaged, replace the snap ring.

1. If the large snap ring was removed from the spindle housing, install the snap ring into the housing groove.

Note: Ensure that the snap ring is fully seated in the housing groove.

2. Install the outer bearing spacer into top of the spindle housing.

Note: Ensure that the outer bearing spacer fits against the large snap ring.

Assembling the Blade Spindle (continued)





1. Bearing cups

4. Arbor press

- 2. Large snap ring
- 3. Large spacer

Support
 Arbor press base



3. Use an arbor press to push the bearing cups into the top and bottom of the spindle housing.

Note: The top bearing cup must contact the outer bearing spacer that was previously installed, and the bottom bearing cup must contact the large snap ring.

Note: Ensure that the assembly is correct by supporting the first bearing cup and pressing the second cup against it (Figure 233).

- 4. Pack the bearing cones with grease. Apply a film of grease on the lips of the oil seals.
- 5. Install lower bearing cone and greased oil seal into bottom of the spindle housing.

Assembling the Blade Spindle (continued)

Note: The bottom seal must have the lip facing out (down) (Figure 234). This seal installation allows grease to purge from the spindle during the lubrication process.

IMPORTANT

If you are replacing the bearings, ensure to that you use the spacer ring that is included with the new bearing set (Figure 232).

6. Slide the spacer ring and inner bearing spacer into the spindle housing, then install upper bearing cone and greased oil seal into top of the housing.

Note: The upper seal must have the lip facing out (up) (Figure 234).

- 7. Examine the spindle shaft and shaft spacer to ensure that there are no burrs or nicks that could damage the oil seals. Lubricate the shaft and spacer with grease.
- 8. Install the spindle shaft spacer onto shaft. Place a thin sleeve or tape on the spindle shaft splines to prevent damage of the seal during the installation of the shaft.
- 9. Carefully slide the spindle shaft with the spacer up through the spindle housing.

Note: The bottom oil seal and spindle spacer should fit together when the spindle is fully installed.



10. Install the spindle nut onto the shaft and torque the nut to **117 to 216 N·m** (130 to 160 ft-lb).

IMPORTANT

A pneumatic grease gun can produce high pressure inside the spindle housing that can damage the spindle seals. Thus, do not use a pneumatic grease gun for greasing of the spindle housings.

- 11. Attach a hand pump grease gun to one of the grease fittings on the housing and fill the housing cavity with grease.
- 12. Rotate the spindle shaft to ensure that the shaft turns freely.
- 13. Install the blade spindle assembly to the cutting deck; refer to Installing the Blade Spindle (page 7–8).

Rear Roller





- 1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
- 2. If the cutting deck is equipped with a roller scraper (Figure 236), remove the fasteners that secure the left and right scraper rod brackets to the roller mounts, and remove the scraper rod assembly.
- 3. Remove the 4 flange-head screws that secure the roller mounts to the rear of the deck frame, and remove the roller mounts and rear roller assembly from the deck frame.
- 4. Loosen the fasteners that secure each end of the roller to the roller mounts. Remove the mounts and skid brackets from the roller.

Installing the Rear Roller

- 1. Slide the roller mounts onto the roller shaft.
- 2. Install the roller and roller mount assembly into the rear of the deck frame. Secure the assembly to the deck frame with the 4 flange-head screws.

IMPORTANT

During assembly, ensure that the grease groove in each roller mount aligns with the grease hole in each end of the roller shaft.

- 3. Align the roller shaft grease hole with the roller mount grease groove. Use the alignment mark on end of the roller shaft to assist with alignment.
- 4. Position the skid brackets to the roller mounts and install the bolts to retain the brackets in place.



5. If equipped with scraper rod, install and adjust the scraper rod assembly to the roller mounts (Figure 236). The gap between the scraper rod and

Installing the Rear Roller (continued)

the roller should be 0.5 to 1.0 mm (0.020 to 0.040 inch). Torque the bolts to 41 N·m (30 ft-lb).



- 6. Install and tighten the fasteners that secure each end of the roller to the roller mounts. Torque the roller shaft screws (item 4 in Figure 235) and bolts (item 8 in Figure 235) to 40 to 47 N·m (29 to 35 ft-lb).
- 7. After you complete the assembly, raise and lower the cutting deck to check that the hydraulic hoses and fittings do not contact anything.

Servicing the Rear Roller



Disassembling the Rear Roller

- 1. Remove the bearing locknut from each end of the roller shaft.
- 2. Loosely secure the roller assembly in a bench vise and lightly tap one end of the roller shaft until the outer seals and bearing are removed from opposite end of the roller tube. Remove the second set of outer seals and bearing from the roller tube by tapping on opposite end of the shaft. Remove the shaft from the roller tube.
- 3. Carefully remove the inner seal from both ends of the roller tube, ensure that you do not damage the tube surfaces.
- 4. Discard the seals and bearings that were removed.

Disassembling the Rear Roller (continued)

5. Clean the roller shaft and all surfaces on the inside of the roller tube. Inspect components for wear or damage. Also, carefully inspect the seating surface and threads of the bearing locknuts. Replace all the components that were damaged.

Assembling the Rear Roller

 Install the inner seals into the roller tube and ensure that the seal lip (and garter spring) faces end of the tube. Use the inner seal tool (refer to Special Tools (page 7–5)) and soft-faced hammer to fully seat seals against the roller shoulder (Figure 238). Apply a small quantity of grease around the lip of both inner seals after installation.

IMPORTANT

During assembly process, frequently check that the bearings rotate freely and do not bind. If there is any binding, remove the components and install it again correctly.

- 2. Install a new bearing and the outer seals into one end of the roller tube as follows:
 - A. Position a new bearing into one end of the roller tube. Use the bearing/outer seal tool (refer to Special Tools (page 7–5)) with a soft-faced hammer to fully seat bearing against the roller shoulder (Figure 239). After the bearing installation, ensure that the bearing rotates freely without binding.
 - B. Apply a small quantity of grease around the lip of both outer seals.



Assembling the Rear Roller (continued)



- C. Install the first outer seal into the roller tube and ensure that the seal lip (and garter spring) faces end of the tube. Use a bearing/outer seal tool (refer to Special Tools (page 7–5)) and a soft-faced hammer to lightly seat seal against the roller shoulder (Figure 240). Ensure that the bearing still freely rotates after the seal installation.
- D. Use the same process, install the second outer seal and ensure not to crush the installed outer seal. Again, ensure that the bearing still freely rotates.
- 3. From the roller tube end with only the inner seal installed, carefully install the roller shaft into the roller tube. Ensure that the seals are not damaged as the shaft is installed.
- 4. Install the new bearing and outer seals into the second end of the roller tube as follows:
 - A. Position a second new bearing to the roller shaft and tube. Position the washer (refer to Special Tools (page 7–5)) on the bearing to press both the inner and outer bearing races at the same time.
 - B. Use the washer and bearing/outer seal tool (refer to Special Tools (page 7–5)) with a soft-faced hammer to fully seat bearing (Figure 241). After the bearing installation, ensure that the shaft freely rotates and that there is no binding. If necessary, lightly tap the bearing and/or shaft ends to align the shaft and bearings. Remove the washer from the roller.

Assembling the Rear Roller (continued)

- C. Apply a small quantity of grease around the lip of both outer seals.
- D. Carefully install the first outer seal into the roller tube and ensure that the seal lip (and garter spring) faces end of the tube. Use a bearing/outer seal tool (refer to Special Tools (page 7–5)) and a soft-faced hammer to lightly seat seal (Figure 242). Ensure that the shaft and bearings still freely rotate after the seal installation.
- E. Use the same process, install the second outer seal and ensure not to crush the installed outer seal. Again, ensure that the shaft and bearings still freely rotates.



Ensure that all grease is removed from the shaft threads to prevent the loosening of the bearing locknut.

5. Clean the threads on both ends of the roller shaft.

Note: If original bearing locknut(s) are being used, apply the Loctite #242 (or equivalent) to the threads of the locknut(s).



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- 1. Roller tube
- 2. Roller shaft
- 3. Inner seal
- Outer seal
 Bearing/outer seal tool

Bearing

4.



- Install the bearing locknut onto each end of the roller shaft. Ensure that the outer seals are not damaged during the nut installation. Torque the locknut to 68 to 81 N·m (50 to 60 ft-lb).
- 7. If the set screw was removed from either end of the roller shaft, apply the Loctite #242 (or equivalent) to the threads of removed set screw and install it into the roller shaft. Tighten the set screw until it bottoms in the shaft and is recessed in the shaft.

IMPORTANT

When the roller assembly is installed to the cutting deck, ensure that the grease groove in each roller mount aligns with the grease hole in each end of the roller shaft.

Assembling the Rear Roller (continued)

Note: After the roller is installed to the cutting deck, lubricate the roller grease fittings, rotate the roller to properly distribute grease in bearings and clean excess grease from the roller ends. A properly assembled roller should rotate with less than **0.68** N·m (5 in-lb) resistance.

Servicing the Front Roller



Disassembling the Front Roller

1.

2.

3.

- 1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
- 2. Remove the front roller mounting bolt.
- 3. Remove the front roller assembly and spacer from the deck frame.
- 4. Remove the bearings and bearing spacer from the front roller as follows:
 - A. Insert a punch through end of the roller and drive opposite bearing out by alternating taps to opposite side of the inner bearing race. There should be a lip of the inner race exposed for this process.
 - B. Remove the bearing spacer, use a press to remove the second bearing from the roller.
 - C. Discard the bearings after removal.
- 5. Inspect the roller housing and bearing spacer for damage or wear. Replace the components as necessary.

Assembling the Front Roller

- 1. Install the new bearings and bearing spacer into the front roller as follows:
 - A. Press the first bearing into the roller. Press on the outer race only or equally on the inner and outer races.
 - B. Insert the bearing spacer.
 - C. Press the second bearing into the roller pressing equally on the inner and outer races until the inner race comes in contact with the bearing spacer.
- 2. Install the front roller assembly and spacer to the deck frame.



Insert the mounting bolt and torque the mounting bolt to 89 to 128 N·m (65 to 95 ft-lb).

Cutting Deck Carrier Frame



- Carrier frame 11.
- 12. Bolt (2 each per deck)
- Bolt (4 each per deck) 17.
- 18. #2 lift arm

5.

6.

Lynch pin



Each cutting deck is suspended from a carrier frame. The cutting deck carrier frame is attached to the lift arm and allows the cutting deck to pivot on the lift arm pivot shaft. The cutting deck positions are identified in Figure 245.

Remove the cutting deck from the lift arm pivot shaft as follows:

- 1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
- 2. Remove the lynch pin and thrust washer that secure the carrier frame to the lift arm pivot shaft.
- 3. Slide the cutting deck assembly off the pivot shaft and away from the machine.
- 4. Disassemble the carrier frame as necessary (Figure 244).

Installing the Cutting Deck Carrier Frame

- 1. Assemble the carrier frame as necessary (Figure 244).
- 2. Slide the cutting deck assembly onto the pivot shaft on the lift arm.
- 3. Secure the cutting deck to the pivot shaft with the thrust washer and lynch pin.
- 4. Lubricate the carrier frame grease fittings.





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
ВК	BLACK
BR or BN	BROWN
BU	BLUE
GN	GREEN
GY	GRAY
OR	ORANGE
РК	PINK
R or RD	RED
Т	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	





Electrical Schematic (Serial numbers below 403430000)





Electrical Schematic (Serial numbers above 403430001)

r			2	1	
			2		
	1				
					l
					ΙН
			ENGINE CONTROLLER		
			K CONNECTOR = 94 PIN		
			A CONNECTOR = 66 PIN		
			K66 CHARGE L		
					lG
			101.10		-
		1 1 8	KOTVB		
		R	K05 VB		
		R	KA3 CND		
		BK	K04 GND		
e	ik i	BK	KØ6 GND		
		1			1
			K28 START RELAY		1
		~	K73 UB5		1
		-01			1
	I I	1			1
					F
		1			Ľ
OR	30. 87 R				1
	[86mm 85]		K70 GLOW RELAY		1
	GLOW RELAY				
		1			1
			KZE CTADT CW		
		BN/BK-	KOD START SW		-
	ECB BELAY	R/BK	KBB IGN SW		
	85 WW 86 CN B	H A BU	K68 UB2		
1 ←OR	87 R] 02			
2 <	8/0		K54 CAN1 H		
3 ←		O/ V (Live on the		
4 (K43 5 VS		F
			K62 A GND		1
			KOT APSI K31 NO REGEN SW		
			K18 REGEN		
1 6		8	K45 5 VS		
2 ←			K85 PEGR		
3 ←			K39 PEGRL		
4 ←		BK	K74 A GND		
			K23.5.VS		
5 ←		R	K20 IVPS		
7		GN	K52 A GND		
8 ←		Y ^	A19 IVDCM-H		
9 ←		XX	A20 IVDCM-L		
			K77 FOR TEMP		
11 ←			K33 EGR TEMP		D.
10.4		~	A59 AIR TEMP		-
11 ←		80	A11 TFO		
12 ←		BN	A51 A. GND		
10 ←		GN	K36 EAH TEMP		
		-	A28 TW		
8 4		GN	A29 A. GND		
5 ←			K79 TFAIR		
6 ←			K21 A GND		
1 ←		R	A07 5 VS		
2 ←		GN	A26 PRAIL		1
3 ←		8K	A25 A. GND		1
4 ←		R	437 CMSPD		
5 ←		80-	A52 A. GND		C
o ←		BK	A39 CKSPD		1
8 ←			A54 CKSPD		
9 ←		вк	A38 A. GND		1
7 ←			A33 INJ1-H		
8		R	A10 INJ1-L		
5 ←			A17 INJ2-L		
o ←		BU/ \/ \	A48 INJ3-H		
4 4			A18 INJ3-L		
			484 10000 11		
° ← _ ∧	xY				
12 ¢		VO V \			
10 ← .	Y				
11,≫	K				1 B
			KIE LOW OIL L		
		BN			
		-R			
		BN	K80 DPF MIDDLE T		
			K77 A. GND		
			K63 PDPF		-
		GN	A12 PDPFH		¥
		R	VS		
			K00 1103		
		OR	K75 CAN2 H		
	1	R/W	K53 CAN2 L		
_			K65 D-GND		
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, Drawing Rev , Sheet

Wire Harness Drawing - Seat (sheet 1 of 2)









Wire Harness Drawing - Engine (sheet 1 of 2)






Wire Harness Drawing - Main (sheet 1 of 2) (Serial numbers below 403430000)



Wire Harness Drawing - Main (sheet 2 of 2) (Serial numbers below 403430000)



Wire Harness Drawing - Main (sheet 1 of 2) (Serial numbers 403430001 to 405699999)



Wire Harness Drawing - Main (sheet 2 of 2) (Serial numbers 403430001 to 405699999)





Wire Harness Drawing - Main (sheet 1 of 2) (Serial numbers above 405700001)



Wire Harness Drawing - Main (sheet 2 of 2) (Serial numbers above 405700001)

2	1	
		F
UEL LEVEL ENDER		
MOW/TRANSPORT SWITCH NC		E
		D
		С
		В
2	1	¥ A



Wire Harness Diagram – Two–Post ROPS Extension (sheet 1 of 2)

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Wire Harness Diagram – Two–Post ROPS Extension (sheet 2 of 2)



Count on it.