ProGator Utility Vehicle 2020A and 2030A (S.N. 060001-)

TECHNICAL MANUAL

ProGator Utility Vehicle 2020A and 2030A (S.N. 060001-)

TM117819 12OCT16 (ENGLISH)

John Deere Turf Care
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Foreword

This manual is written for an experienced technician. Essential tools required in performing certain service work are identified in this manual and are recommended for use.

Live with safety: Read the safety messages in the introduction of this manual and the cautions presented throughout the text of the manual.

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

Technical manuals are divided in two parts: repair and operation and tests. Repair sections tell how to repair the components. Operation and tests sections help you identify the majority of routine failures quickly.

Information is organized in groups for the various components requiring service instruction. At the beginning of each group are summary listings of all applicable essential tools, service equipment and tools, other materials needed to do the job, service parts kits, specifications, wear tolerances, and torque values.

Technical Manuals are concise guides for specific machines. They are on-the-job guides containing only the vital information needed for diagnosis, analysis, testing, and repair.

Fundamental service information is available from other sources covering basic theory of operation, fundamentals of troubleshooting, general maintenance, and basic type of failures and their causes.

DX,TMIFC -19-15APR14-1/1

Contents

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

Section 10
Safety

Contents

Recognize Safety Information

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

Follow recommended precautions and safe operating practices.

T81389 —UN—28JUN13

OUO1082,0004B04 -19-19JUN12-1/1

Understand Signal Words

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

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

TS187 —19—30SEP88

OUO1082,0004B05 -19-19JUN12-1/1

Replace Safety Signs

Replace missing or damaged safety signs. See the machine operator's manual for correct safety sign placement.

TS201 —UN—15APR13

OUO1082,0004B06 -19-19JUN12-1/1

Handle Fluids Safely—Avoid Fires

When you work around fuel, do not smoke or work near heaters or other fire hazards.

Store flammable fluids away from fire hazards. Do not incinerate or puncture pressurized containers.

Make sure machine is clean of trash, grease, and debris.

Do not store oily rags; they can ignite and burn spontaneously.

TS227 —UN—15APR13

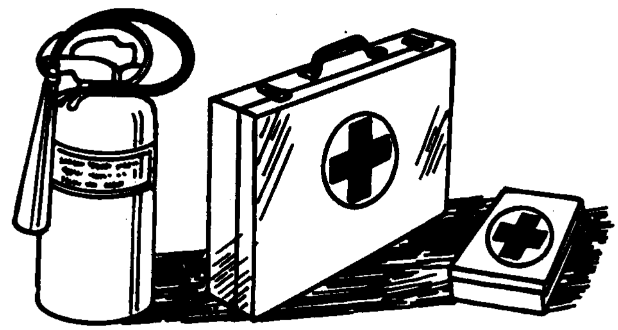
OUO1082,0004B07 -19-19JUN12-1/1

Prepare for Emergencies

Be prepared if a fire starts.

Keep a first aid kit and fire extinguisher handy.

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



TS291 —UN—15APR13

OUO1082,0004B08 -19-19JUN12-1/1

Prevent Battery Explosions

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

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

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

TS204 —UN—15APR13

OUO1082,0004B09 -19-19JUN12-1/1

Prevent Acid Burns

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

Avoid the hazard by:

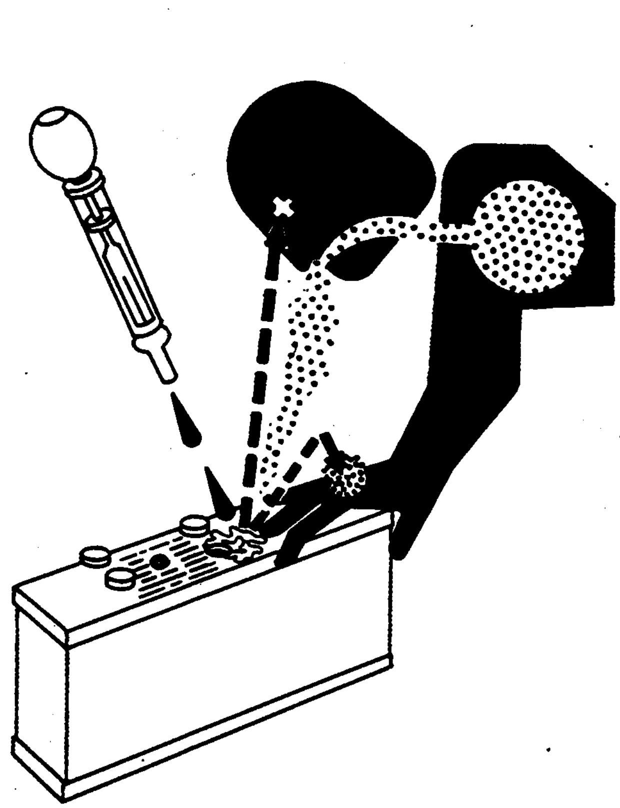
1. Filling batteries in a well-ventilated area.
2. Wearing eye protection and rubber gloves.
3. Avoiding breathing fumes when electrolyte is added.
4. Avoiding spilling or dripping electrolyte.
5. Use proper jump start procedure.

If you spill acid on yourself:

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

If acid is swallowed:

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



TS203 —UN—23AUG88

OUO1082,0004B0A -19-19JUN12-1/1

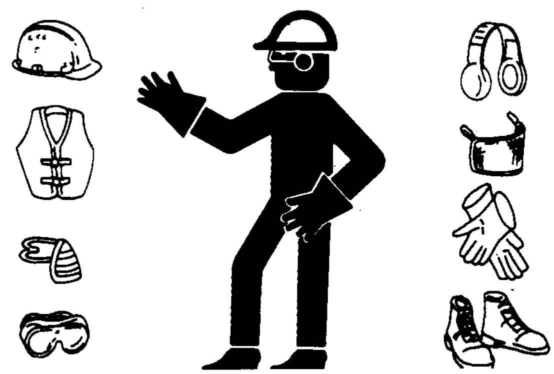
Wear Protective Clothing

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

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

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

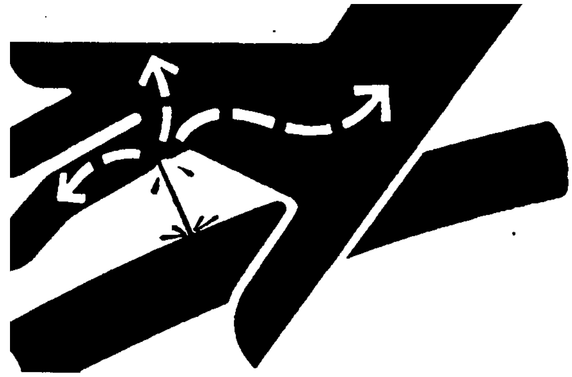
Operating equipment safely requires the full attention of the operator. Do not wear radio or music headphones while operating machine.



TS206 —UN—15APR13

OUO1082,0004B0B -19-19JUN12-1/1

Avoid High-Pressure Fluids



X9811 —UN—23AUG88

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

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

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

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

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

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

OUO1082,0004B0C -19-19JUN12-1/1

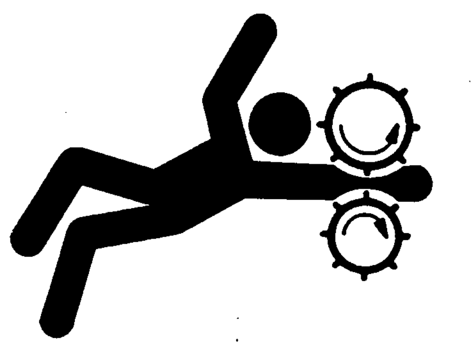
Avoid Heating Near Pressurized Fluid Lines

TS953 —UN—15MAY90

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

OUO1082,0004B0D -19-19JUN12-1/1

Service Machines Safely



TS228 —UN—23AUG88

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

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

OUO1082,0004B0E -19-19JUN12-1/1

Use Proper Tools

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

Use power tools only to loosen threaded parts and fasteners.

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

Use only service parts meeting John Deere specifications.

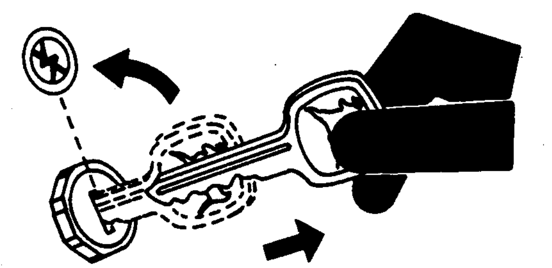
TS779 —UN—08NOV89

OUO1082,0004B0F -19-19JUN12-1/1

Park Machine Safely

Before working on the machine:

- Lower all equipment to the ground.
- Stop the engine and remove the key.
- Disconnect the battery ground strap.
- Hang a "DO NOT OPERATE" tag in operator station.



TS230 —UN—24MAY89

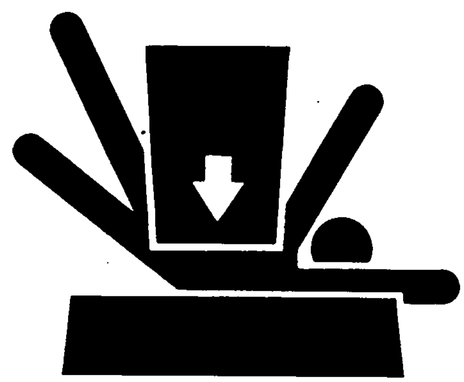
OUO1082,0004B10 -19-19JUN12-1/1

Support Machine Properly

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

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

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



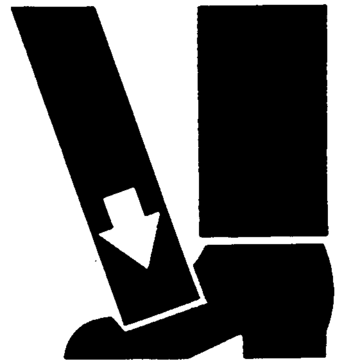
TS229 —UN—23AUG88

OUO1082,0004B11 -19-19JUN12-1/1

Use Proper Lifting Equipment

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

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



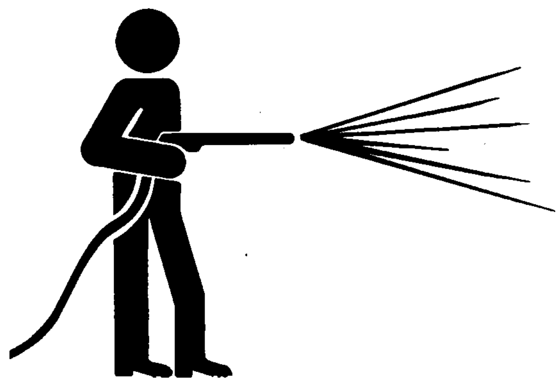
TS226 —UN—23AUG88

OUO1082,0004B12 -19-19JUN12-1/1

Work in Clean Area

Before starting a job:

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



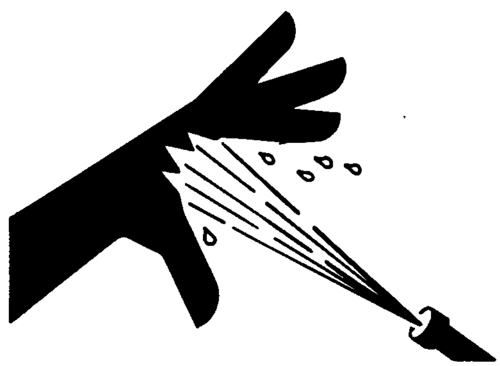
T6642EJ —UN—18OCT88

OUO1082,0004B13 -19-19JUN12-1/1

Protect Against High Pressure Spray

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

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

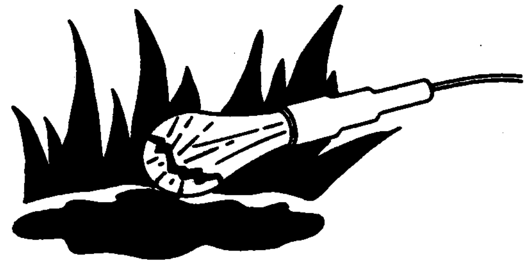


TS1343 —UN—18MAR92

OUO1082,0004B14 -19-19JUN12-1/1

Illuminate Work Area Safely

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



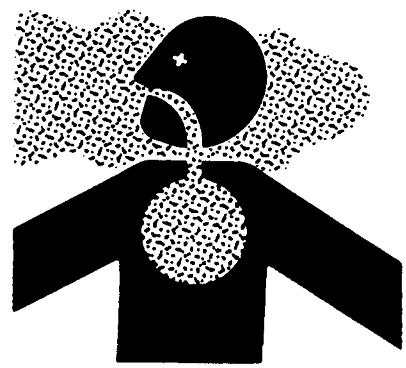
TS223 —UN—23AUG88

OUO1082,0004B15 -19-19JUN12-1/1

Work In Ventilated Area

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

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



TS220 —UN—15APR13

OUO1082,0004B16 -19-19JUN12-1/1

Remove Paint Before Welding or Heating

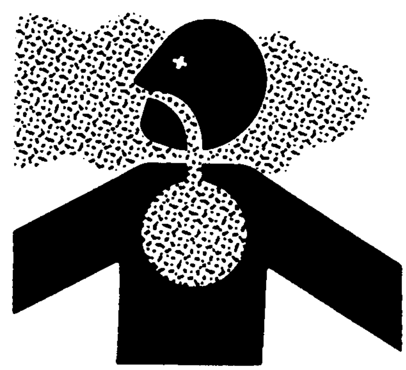
Avoid potentially toxic fumes and dust.

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

Remove paint before heating:

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

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



TS220 —UN—15APR13

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

Dispose of paint and solvent properly.

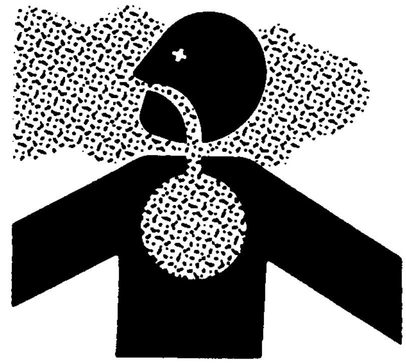
OUO1082,0004B17 -19-19JUN12-1/1

Avoid Harmful Asbestos Dust

Avoid breathing dust that may be generated when handling components containing asbestos fibers. Inhaled asbestos fibers may cause lung cancer.

Components in products that may contain asbestos fibers are brake pads, brake band and lining assemblies, clutch plates, and some gaskets. The asbestos used in these components is usually found in a resin or sealed in some way. Normal handling is not hazardous as long as airborne dust containing asbestos is not generated.

Avoid creating dust. Never use compressed air for cleaning. Avoid brushing or grinding material containing asbestos. When servicing, wear an approved respirator. A special vacuum cleaner is recommended to clean asbestos. If not available, apply a mist of oil or water on the material containing asbestos.



TS220 —UN—15APR13

Keep bystanders away from the area.

OUO1082,0004B18 -19-19JUN12-1/1

Service Tires Safely

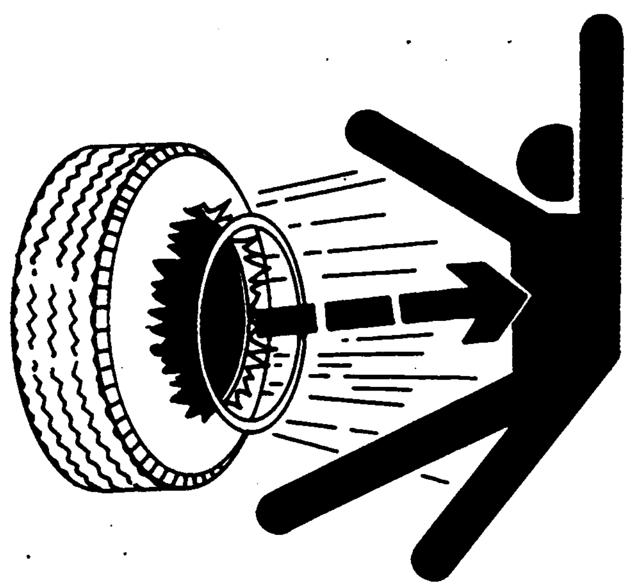
Explosive separation of a tire and rim parts can cause serious injury or death.

Do not attempt to mount a tire unless you have the proper equipment and experience to perform the job.

Always maintain the correct tire pressure. Do not inflate the tires above the recommended pressure. Never weld or heat a wheel and tire assembly. The heat can cause an increase in air pressure resulting in a tire explosion. Welding can structurally weaken or deform the wheel.

When inflating tires, use a clip-on chuck and extension hose long enough to allow you to stand to one side and NOT in front of or over the tire assembly. Use a safety cage if available.

Check wheels for low pressure, cuts, bubbles, damaged rims or missing lug bolts and nuts.



TS211 —UN—15APR13

OUO1082,0004B19 -19-19JUN12-1/1

Stay Clear of Rotating Drivelines

TS1644 —UN—22AUG95

Entanglement in rotating driveline can cause serious injury or death.

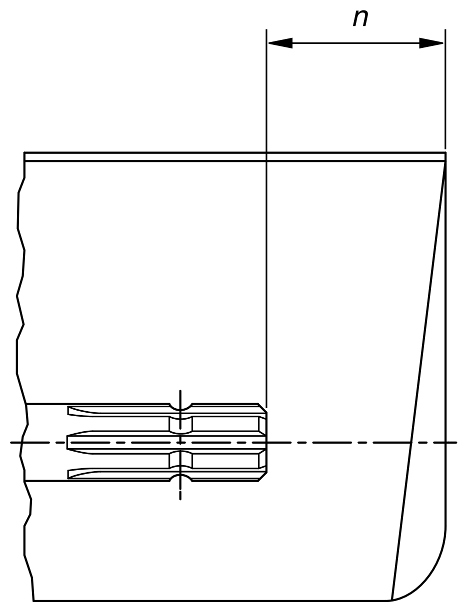
Keep tractor master shield and driveline shields in place at all times. Make sure rotating shields turn freely.

Wear close fitting clothing. Stop the engine and be sure that PTO driveline is stopped before making adjustments, connections, or cleaning out PTO driven equipment.

Do not install any adapter device between the tractor and the primary implement PTO drive shaft that will allow a 1000 rpm tractor shaft to power a 540 rpm implement at speeds higher than 540 rpm.

Do not install any adapter device that results in a portion of the rotating implement shaft, tractor shaft, or the adapter to be unguarded. The tractor master shield shall overlap the end of the splined shaft and the added adaptor device as outlined in the table.

PTO Type	Diameter	Splines	n ± 5 mm (0.20 in.)
1	35 mm (1.378 in.)	6	85 mm (3.35 in.)
2	35 mm (1.378 in.)	21	85 mm (3.35 in.)
3	45 mm (1.772 in.)	20	100 mm (4.00 in.)



H96219 —UN—29APR10

OUO1082,0004B1A -19-19JUN12-1/1

Service Cooling System Safely

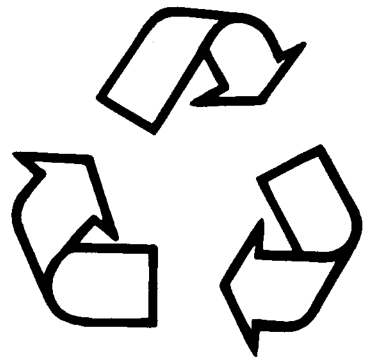
TS281 —UN—15APR13

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

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

OUO1082,0004B1B -19-19JUN12-1/1

Dispose of Waste Properly



TS1133 —UN—15APR13

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

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

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

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

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

OUO1082,0004B1C -19-19JUN12-1/1

Handle Chemical Products Safely

TS1132 —UN—15APR13

Direct exposure to hazardous chemicals can cause serious injury. Potentially hazardous chemicals used with John Deere equipment include such items as lubricants, coolants, paints, and adhesives.

A Material Safety Data Sheet (MSDS) provides specific details on chemical products: physical and health hazards, safety procedures, and emergency response techniques.

Check the MSDS before you start any job using a hazardous chemical. That way you will know exactly what the risks are and how to do the job safely. Then follow procedures and recommended equipment.

(See your John Deere dealer for MSDS's on chemical products used with John Deere equipment.)

OUO1082,0004B1D -19-19JUN12-1/1

Live With Safety

TS231 —19—07OCT88

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

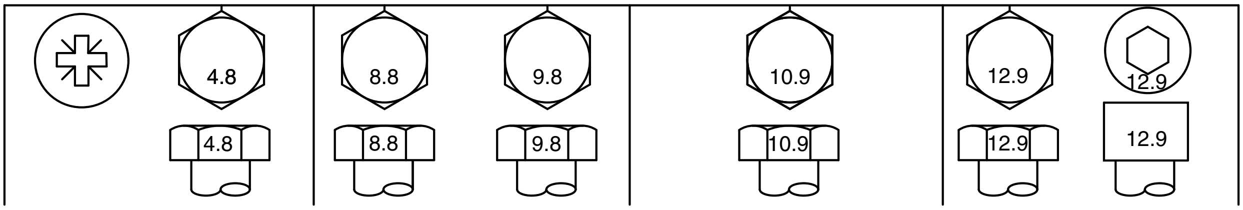
OUO1082,0004B1E -19-19JUN12-1/1

Section 20
Specifications and Information

Contents

Metric Bolt and Screw Torque Values

TS1670 —UN—01MAY03



Bolt or Screw Size	Class 4.8				Class 8.8 or 9.8				Class 10.9				Class 12.9			
	Lubricated[a]		Dry[b]		Lubricated[a]		Dry[b]		Lubricated[a]		Dry[b]		Lubricated[a]		Dry[b]	
	N·m	lb.-in.	N·m	lb.-in.	N·m	lb.-in.	N·m	lb.-in.	N·m	lb.-in.	N·m	lb.-in.	N·m	lb.-in.	N·m	lb.-in.
M6	4.7	42	6	53	8.9	79	11.3	100	13	115	16.5	146	15.5	137	19.5	172
									N·m	lb.-ft.	N·m	lb.-ft.	N·m	lb.-ft.	N·m	lb.-ft.
M8	11.5	102	14.5	128	22	194	27.5	243	32	23.5	40	29.5	37	27.5	47	35
			N·m	lb.-ft.	N·m	lb.-ft.	N·m	lb.-ft.								
M10	23	204	29	21	43	32	55	40	63	46	80	59	75	55	95	70
	N·m	lb.-ft.														
M12	40	29.5	50	37	75	55	95	70	110	80	140	105	130	95	165	120
M14	63	46	80	59	120	88	150	110	175	130	220	165	205	150	260	190
M16	100	74	125	92	190	140	240	175	275	200	350	255	320	235	400	300
M18	135	100	170	125	265	195	330	245	375	275	475	350	440	325	560	410
M20	190	140	245	180	375	275	475	350	530	390	675	500	625	460	790	580
M22	265	195	330	245	510	375	650	480	725	535	920	680	850	625	1080	800
M24	330	245	425	315	650	480	820	600	920	680	1150	850	1080	800	1350	1000
M27	490	360	625	460	950	700	1200	885	1350	1000	1700	1250	1580	1160	2000	1475
M30	660	490	850	625	1290	950	1630	1200	1850	1350	2300	1700	2140	1580	2700	2000
M33	900	665	1150	850	1750	1300	2200	1625	2500	1850	3150	2325	2900	2150	3700	2730
M36	1150	850	1450	1075	2250	1650	2850	2100	3200	2350	4050	3000	3750	2770	4750	3500

Torque values listed are for general use only, based on the strength of the bolt or screw. DO NOT use these values if a different torque value or tightening procedure is given for a specific application. For stainless steel fasteners or for nuts on U-bolts, see the tightening instructions for the specific application. Tighten plastic insert or crimped steel type lock nuts by turning the nut to the dry torque shown in the chart, unless different instructions are given for the specific application.

Shear bolts are designed to fail under predetermined loads. Always replace shear bolts with identical property class. Replace fasteners with the same or higher property class. If higher property class fasteners are used, tighten these to the strength of the original. Make sure fastener threads are clean and that you properly start thread engagement. When possible, lubricate plain or zinc plated fasteners other than lock nuts, wheel bolts or wheel nuts, unless different instructions are given for the specific application.

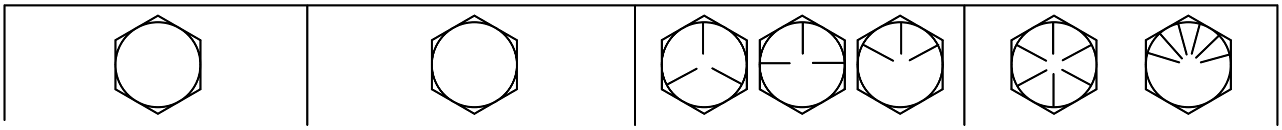
[a] *"Lubricated" means coated with a lubricant such as engine oil, fasteners with phosphate and oil coatings, or M20 and larger fasteners with JDM F13C, F13F or F13J zinc flake coating.*

[b] *"Dry" means plain or zinc plated without any lubrication, or M6 to M18 fasteners with JDM F13B, F13E or F13H zinc flake coating.*

RB14256,0000A60 -19-18JUN12-1/1

Unified Inch Bolt and Screw Torque Values

TS1671 —UN—01MAY03



Bolt or Screw Size	SAE Grade 1				SAE Grade 2[a]				SAE Grade 5, 5.1 or 5.2				SAE Grade 8 or 8.2			
	Lubricated[b]		Dry[c]		Lubricated[b]		Dry[c]		Lubricated[b]		Dry[c]		Lubricated[b]		Dry[c]	
	N·m	lb.-in.	N·m	lb.-in.	N·m	lb.-in.	N·m	lb.-in.	N·m	lb.-in.	N·m	lb.-in.	N·m	lb.-in.	N·m	lb.-in.
1/4	3.7	33	4.7	42	6	53	7.5	66	9.5	84	12	106	13.5	120	17	150
													N·m	lb.-ft.	N·m	lb.-ft.
5/16	7.7	68	9.8	86	12	106	15.5	137	19.5	172	25	221	28	20.5	35	26
									N·m	lb.-ft.	N·m	lb.-ft.				
3/8	13.5	120	17.5	155	22	194	27	240	35	26	44	32.5	49	36	63	46
			N·m	lb.-ft.	N·m	lb.-ft.	N·m	lb.-ft.								
7/16	22	194	28	20.5	35	26	44	32.5	56	41	70	52	80	59	100	74
	N·m	lb.-ft.														
1/2	34	25	42	31	53	39	67	49	85	63	110	80	120	88	155	115
9/16	48	35.5	60	45	76	56	95	70	125	92	155	115	175	130	220	165
5/8	67	49	85	63	105	77	135	100	170	125	215	160	240	175	305	225
3/4	120	88	150	110	190	140	240	175	300	220	380	280	425	315	540	400
7/8	190	140	240	175	190	140	240	175	490	360	615	455	690	510	870	640
1	285	210	360	265	285	210	360	265	730	540	920	680	1030	760	1300	960
1-1/8	400	300	510	375	400	300	510	375	910	670	1150	850	1450	1075	1850	1350
1-1/4	570	420	725	535	570	420	725	535	1280	945	1630	1200	2050	1500	2600	1920
1-3/8	750	550	950	700	750	550	950	700	1700	1250	2140	1580	2700	2000	3400	2500
1-1/2	990	730	1250	930	990	730	1250	930	2250	1650	2850	2100	3600	2650	4550	3350

Torque values listed are for general use only, based on the strength of the bolt or screw. DO NOT use these values if a different torque value or tightening procedure is given for a specific application. For plastic insert or crimped steel type lock nuts, for stainless steel fasteners, or for nuts on U-bolts, see the tightening instructions for the specific application. Shear bolts are designed to fail under predetermined loads. Always replace shear bolts with identical grade.

Replace fasteners with the same or higher grade. If higher grade fasteners are used, tighten these to the strength of the original. Make sure fastener threads are clean and that you properly start thread engagement. When possible, lubricate plain or zinc plated fasteners other than lock nuts, wheel bolts or wheel nuts, unless different instructions are given for the specific application.

[a]Grade 2 applies for hex cap screws (not hex bolts) up to 6 in. (152 mm) long. Grade 1 applies for hex cap screws over 6 in. (152 mm) long, and for all other types of bolts and screws of any length.
[b]"Lubricated" means coated with a lubricant such as engine oil, fasteners with phosphate and oil coatings, or 7/8 in. and larger fasteners with JDM F13C, F13F or F13J zinc flake coating.
[c]"Dry" means plain or zinc plated without any lubrication, or 1/4 to 3/4 in. fasteners with JDM F13B, F13E or F13H zinc flake coating.

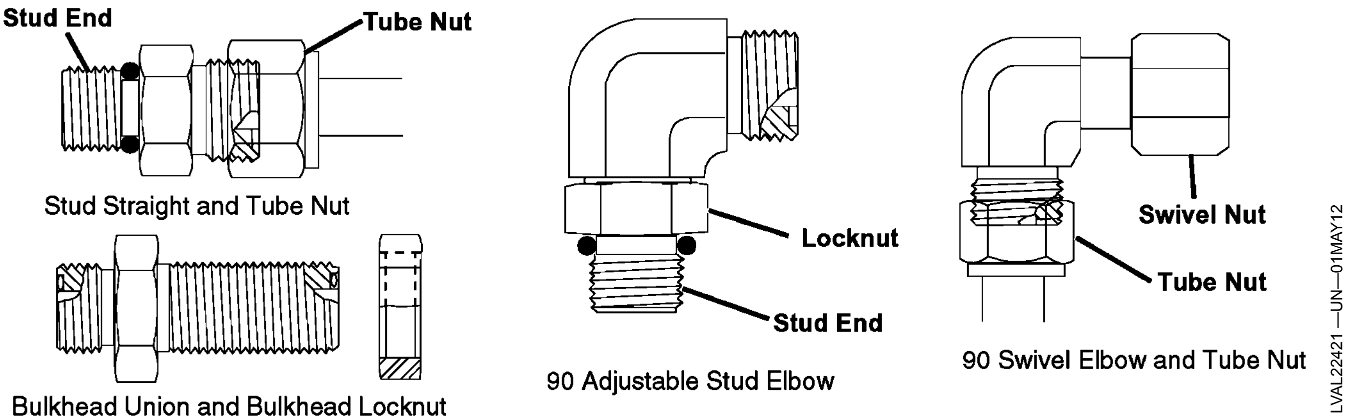
RB14256,0000A61 -19-18JUN12-1/1

Metric Cap Screw Torque Values—Grade 7

Size	Steel or Gray Iron Torque	Aluminum
	N•m (lb-ft)	N•m (lb-ft)
M6	11 (8)	8 (6)
M8	24 (18)	19 (14)
M10	52 (38)	41 (30)
M12	88 (65)	70 (52)
M14	138 (102)	111 (82)
M16	224 (165)	179 (132)

RB14256,0000A62 -19-18JUN12-1/1

Face Seal Fittings With Inch Stud Ends Torque

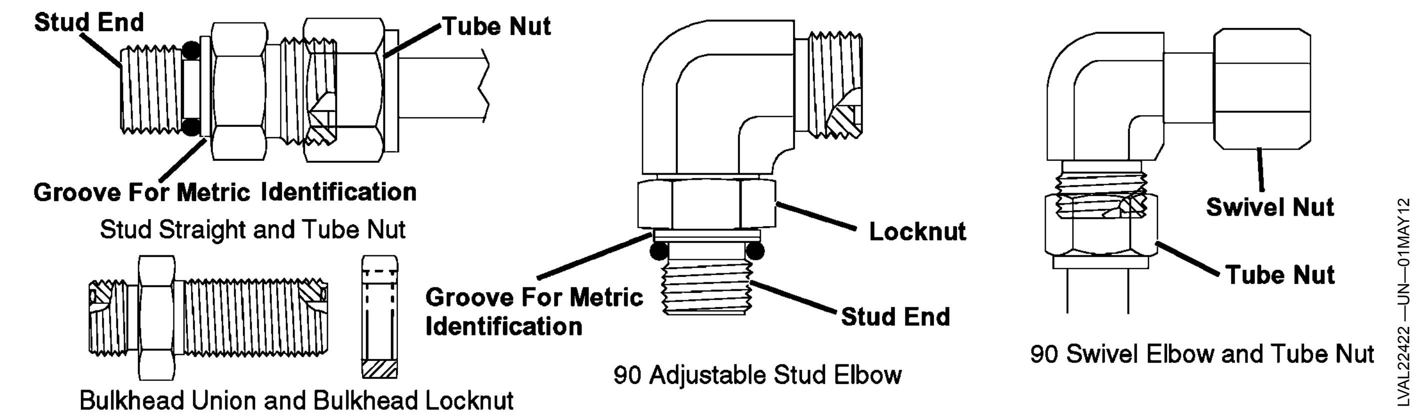


Nominal Tube OD/Hose ID				Face Seal Tube/Hose End					O-Ring Stud Ends		
Metric Tube OD	Inch Tube OD			Thread Size	Tube Nut/Swivel Nut Torque		Bulkhead Lock Nut Torque		Thread Size	Straight Fitting or Lock Nut Torque	
mm	Dash Size	in.	mm	in.	N•m	lb-ft	N•m	lb-ft	in.	N•m	lb-ft
5	-3	0.188	4.76						3/8-24	8	6
6	-4	0.250	6.35	9/16-18	16	12	12	9	7/16-20	12	9
8	-5	0.312	7.94						1/2-20	16	12
10	-6	0.375	9.52	11/16-16	24	18	24	18	9/16-18	24	18
12	-8	0.500	12.70	13/16-16	50	37	46	34	3/4-16	46	34
16	-10	0.625	15.88	1-14	69	51	62	46	7/8-14	62	46
19	-12	0.750	19.05	1-3/16-12	102	75	102	75	1-1/16-12	102	75
22	-14	0.875	22.22	1-3/16-12	102	75	102	75	1-3/16-12	122	90
25	-16	1.000	25.40	1-7/16-12	142	105	142	105	1-5/16-12	142	105
32	-20	1.25	31.75	1-11/16-12	190	140	190	140	1-5/8-12	190	140
38	-24	1.50	38.10	2-12	217	160	217	160	1-7/8-12	217	160

NOTE: Torque tolerance is +15%, -20%.

RB14256,0000A63 -19-18JUN12-1/1

Face Seal Fittings With Metric Stud Ends Torque

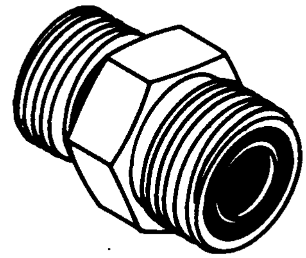


Nominal Tube OD/Hose ID				Face Seal Tube/Hose End						O-Ring Stud Ends, Straight Fitting, or Lock Nut					
Metric Tube OD	Inch Tube OD			Thread Size	Tube Nut/Swivel Nut Torque			Bulkhead Lock Nut Torque		Thread Size	Hex Size	Steel or Gray Iron Torque		Aluminum Torque	
mm	Dash Size	in.	mm	in.	mm	N•m	lb-ft	N•m	lb-ft	in.	mm	N•m	lb-ft	N•m	lb-ft
6	-4	0.250	6.35	9/16-18	17	16	12	12	9	M12X1.5	17	21	15.5	9	6.6
8	-5	0.312	7.94												
										M14X1.5	19	33	24	15	11
10	-6	0.375	9.52	11/16-16	22	24	18	24	18	M16X1.5	22	41	30	18	13
12	-8	0.500	12.70	13/16-16	24	50	37	46	34	M18X1.5	24	50	37	21	15
16	-10	0.625	15.88	1-14	30	69	51	62	46	M22X1.5	27	69	51	28	21
	-12	0.750	19.05	1-3/16-12	36	102	75	102	75	M27X2	32	102	75	46	34
22	-14	0.875	22.22	1-3/16-12	36	102	75	102	75	M30X2	36				
25	-16	1.000	25.40	1-7/16-12	41	142	105	142	105	M33X2	41	158	116	71	52
28										M38X2	46	176	130	79	58
32	-20	1.25	31.75	1-11/16-12	50	190	140	190	140	M42x2	50	190	140	85	63
38	-24	1.5	38.10	2-12	60	217	160	217	160	M48x2	55	217	160	98	72

NOTE: Torque tolerance is +15%, -20%.

RB14256,0000A64 -19-18JUN12-1/1

Service Recommendations For Flat Face O-Ring Seal Fittings



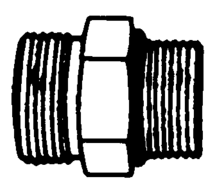
1. Inspect the fitting sealing surfaces. They must be free of dirt or defects.
2. Inspect O-ring. It must be free of damage or defects.
3. Lubricate O-rings and install into groove using petroleum jelly to hold in place.
4. Push O-ring into the groove with plenty of petroleum jelly so O-ring is not displaced during assembly.
5. Index angle fittings and tighten by hand, by pressing joint together to insure O-ring remains in place.
6. Tighten fitting or nut to torque value shown on the chart per dash size stamped on the fitting. Do not allow hoses to twist when tightening fittings.

FLAT FACE O-RING SEAL FITTING TORQUE[a]				
Tube Size Outside Diameter	**Dash Size**	**Thread Size**	**Swivel Nut Torque**	**Bulkhead Nut Torque**
mm (in.)		**in.**	**N•m (lb-ft)**	**N•m (lb-ft)**
6.35 (1/4)	-4	9/16-18	16 (12)	5 (3.5)
9.52 (3/8)	-6	11/16-16	24 (18)	9 (6.5)
12.70 (1/2)	-8	13/16-16	50 (37)	17 (12.5)
15.88 (5/8)	-10	1-14	69 (51)	17 (12.5)
19.05 (3/4)	-12	1-3/16-12	102 (75)	17 (12.5)
22.22 (7/8)	-14	1-3/16-12	102 (75)	17 (12.5)
25.40 (1)	-16	1-7/16-12	142 (105)	17 (12.5)
31.75 (1-1/4)	-20	1-11/16-12	190 (140)	17 (12.5)
38.10 (1-1/2)	-24	2-12	217 (160)	17 (12.5)

[a]*The torque values shown are based on lubricated connections as in reassembly.*

RB14256,0000A65 -19-18JUN12-1/1

Service Recommendations for O-Ring Boss Fittings



STRAIGHT FITTING

1. Inspect O-ring boss seat for dirt or defects.
2. Lubricate O-ring with petroleum jelly. Place electrical tape over threads to protect O-ring. Slide O-ring over tape and into O-ring groove of fitting. Remove tape.
3. Tighten fitting to torque value shown on chart.

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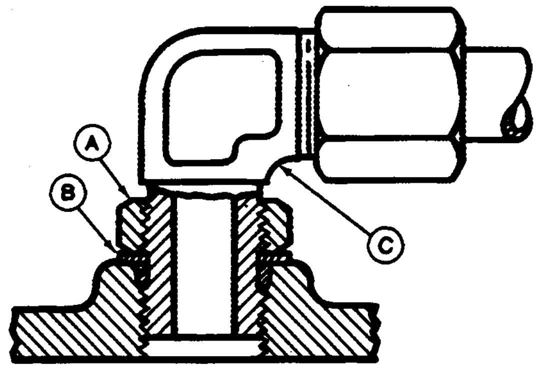
RB14256,0000A66 -19-18JUN12-1/2

ANGLE FITTING



1. Back-off lock nut (A) and back-up washer (B) completely to head-end (C) of fitting.
2. Turn fitting into threaded boss until back-up washer contacts face of boss.
3. Turn fitting head-end counterclockwise to proper index (maximum of one turn).
4. Hold fitting head-end with a wrench and tighten locknut and back-up washer to proper torque value.

NOTE: Do not allow hoses to twist when tightening fittings.

TORQUE VALUE			
Thread Size		N·m	lb-ft
3/8-24	UNF	8	6
7/16-20	UNF	12	9
1/2-20	UNF	16	12
9/16-18	UNF	24	18
3/4-16	UNF	46	34
7/8-14	UNF	62	46
1-1/16-12	UN	102	75
1-3/16-12	UN	122	90
1-5/16-12	UN	142	105
1-5/8-12	UN	190	140
1-7/8-12	UN	217	160

NOTE: Torque tolerance is ± 10%.

RB14256,0000A66 -19-18JUN12-2/2

Gasoline

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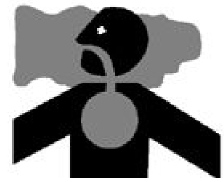

4 - Cycle Engines

CAUTION: Avoid Injury! Gasoline is HIGHLY FLAMMABLE, handle it with care. DO NOT refuel machine while: indoors, always fill gas tank outdoors; machine is near an open flame or sparks; engine is running, STOP engine; engine is hot, allow it to cool sufficiently first; smoking. Help prevent fires: fill gas tank to bottom of filler neck only; be sure fill cap is tight after fueling; clean up any gas spills IMMEDIATELY; keep machine clean and in good repair - free of excess grease, oil, debris, and faulty or damaged parts; any storage of machines with gas left in tank should be in an area that is well ventilated to prevent possible igniting of fumes by an open flame or spark, this includes any appliance with a pilot light. To prevent fire or explosion caused by STATIC ELECTRIC DISCHARGE during fueling:

ONLY use a clean, approved POLYETHYLENE PLASTIC fuel container and funnel WITHOUT any metal screen or filter.

To avoid engine damage:

- DO NOT mix oil with gasoline;
- **ONLY use clean, fresh unleaded gasoline with an octane rating (anti-knock index) of 87 or higher**;
- Fill gas tank at the end of each day's operation to help prevent condensation from forming inside a partially filled tank;
- Keep up with specified service intervals.

Use of alternative oxygenated, gasohol blended, unleaded gasoline is acceptable as long as:

- The ethyl or grain alcohol blends DO NOT exceed 10% by volume or
- Methyl tertiary butyl ether (MTBE) blends DO NOT exceed 15% by volume

RFG (reformulated) gasoline is acceptable for all machines designed for use of regular unleaded fuel. Older machines (that were designed for leaded fuel) may see some accelerated valve and seat wear.

IMPORTANT: Avoid Damage! California Proposition 65 Warning: Gasoline engine exhaust from this product contains chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm.

RB14256,0000A67 -19-18JUN12-1/1

Gasoline Storage

IMPORTANT: Avoid Damage! Keep all dirt, scale, water or other foreign material out of gasoline.

Keep gasoline stored in a safe, protected area. Storage of gasoline in a clean, properly marked (“UNLEADED GASOLINE”) POLYETHYLENE PLASTIC container WITHOUT any metal screen or filter is recommended.

DO NOT use de-icers to attempt to remove water from gasoline or depend on fuel filters to remove water from gasoline. Use a water separator installed in the storage tank outlet. BE SURE to properly discard unstable or contaminated gasoline. When storing the machine or gasoline, it is recommended that you add **John Deere Gasoline Conditioner and Stabilizer (TY15977)** or an equivalent to the gasoline. BE SURE to follow directions on container and to properly discard empty container.

RB14256,0000A68 -19-18JUN12-1/1

Diesel Fuel

Use the proper diesel fuel to help prevent decreased engine performance and increased exhaust emissions. Failure to follow the fuel requirements listed can void your engine warranty.

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

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

Diesel fuels specified to ISO EN 590 or ASTM D975 are recommended.

Required fuel properties

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

Cetane number of 45 minimum. Cetane number greater than 50 is preferred, especially when temperatures are below -20°C (-4°F) or elevations above 1500 m (5000 ft).

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

Fuel lubricity should comply with ISO EN 590 or ASTM D975.

IMPORTANT: Avoid damage! Improper fuel additive usage may cause damage on fuel injection equipment of diesel engines.

If a fuel of low or unknown lubricity is used, addition of John Deere PREMIUM DIESEL FUEL CONDITIONER at the specified concentration is recommended.

Sulfur content

- Diesel fuel quality and fuel sulfur content must comply with all existing emissions regulations for the area in which the engine operates.
- Use only ultra low sulfur diesel (ULSD) fuel with a maximum of 0.0015% (15mg/kg) sulfur content.

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

Using BioDiesel Fuel

BioDiesel fuels may be used only if the BioDiesel fuel properties meet the latest edition of ASTM D6751, ASTM D7467, EN14214, or equivalent specification.

The current maximum allowable BioDiesel concentration is a 7% blend (also known as B7) in petroleum diesel fuel.

To learn of any changes to the recommendations for BioDiesel usage with your diesel engine, ask your John Deere dealer.

Handling and Storing Diesel Fuel

CAUTION: Avoid injury! Handle fuel carefully. Do not fill the fuel tank when engine is running.

Do not smoke while you fill the fuel tank or service the fuel system.

IMPORTANT: Avoid damage! Do not use galvanized containers—diesel fuel stored in galvanized containers reacts with zinc coating in the container to form zinc flakes. If fuel contains water, a zinc gel also forms. The gel and flakes quickly plug fuel filters and damage fuel injectors and fuel pumps.

- Fill the fuel tank at the end of each day’s operation to prevent water condensation and freezing during cold weather.
- When fuel is stored for an extended period, or if there is a slow turnover of fuel, add a fuel conditioner to stabilize the fuel and to prevent water condensation. Contact your fuel supplier for recommendations.

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Diesel Fuel Lubricity

Diesel fuel must have adequate lubricity to ensure proper operation and durability of fuel injection system components. Fuel lubricity should pass a **minimum of 3300 gram load level** as measured by the **BOCLE** scuffing test.

RB14256,0000A6A -19-18JUN12-1/1

Diesel Fuel Storage

IMPORTANT: Avoid Damage! DO NOT USE GALVANIZED CONTAINERS - diesel fuel stored in galvanized containers reacts with zinc coating in the container to form zinc flakes. If fuel contains water, a zinc gel will also form. The gel and flakes will quickly plug fuel filters and damage fuel injectors and fuel pumps.

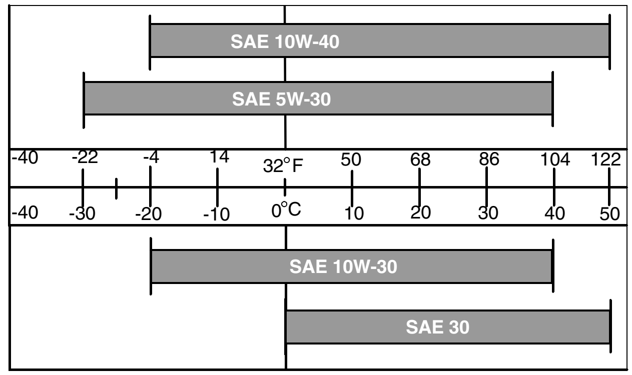
It is recommended that diesel fuel be stored **ONLY** in a clean, approved **POLYETHYLENE PLASTIC** container **WITHOUT** any metal screen or filter. This will help prevent any accidental sparks from occurring. Store fuel in an area that is well ventilated to prevent possible igniting of fumes by an open flame or spark; this includes any appliance with a pilot light.

IMPORTANT: Avoid Damage! Keep all dirt, scale, water or other foreign material out of fuel.

Keep fuel in a safe, protected area and in a clean, properly marked **("DIESEL FUEL")** container. **DO NOT** use de-icers to attempt to remove water from fuel. **DO NOT** depend on fuel filters to remove water from fuel. It is recommended that a water separator be installed in the storage tank outlet. **BE SURE** to properly discard unstable or contaminated diesel fuel and/or their containers when necessary.

RB14256,0000A6B -19-18JUN12-1/1

4-Cycle Gasoline Engine Oil



Use the appropriate oil viscosity based on the expected air temperature range during the period between recommended oil changes. Operating outside of these recommended oil air temperature ranges may cause premature engine failure.

The following John Deere oil is PREFERRED:

- **PLUS-4 - SAE 10W-40**
- **TORQ-GARD SUPREME - SAE 5W-30**

The following John Deere oils are **also recommended**, based on their specified temperature range:

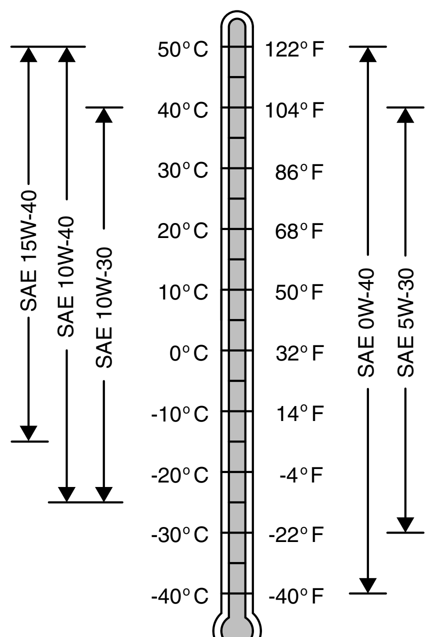
- **TURF GARD - SAE 10W-30**
- **PLUS-4 - SAE 10W-30**
- **TORQ - GARD SUPREME - SAE 30.**

Other oils may be used if above John Deere oils are not available, provided they meet one of the following specifications:

- SAE 10W-40 - API Service Classifications SG or higher
- SAE 5W-30 - API Service Classification SG or higher;
- SAE 10W-30 - API Service Classifications SG or higher;
- SAE 30 - API Service Classification SC or higher.

RB14256,0000A6C -19-18JUN12-1/1

Engine Oil



Oil Viscosities for Air Temperature Ranges

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

The following John Deere oils are preferred:

- John DeerePlus-50™ II
- John DeereTorq-Gard™ Supreme

Other oils may be used if above John Deere oils are not available, provided they meet the following specification:

- API Service Classification CJ-4
- ACEA Specification E6 or E9
- JASO Specification DH-2

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

Plus-50 is a trademark of Deere & Company
Torq-Gard is a trademark of Deere & Company

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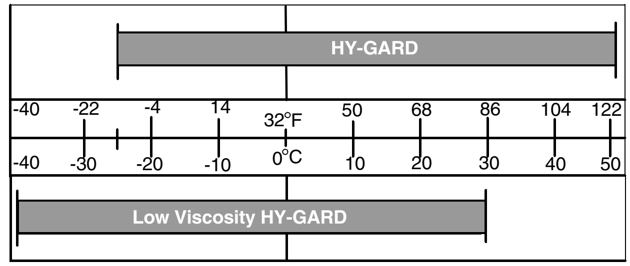
Transaxle Oil

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

John Deere HY-GARD™ transmission and hydraulic oil is recommended for most normal operating temperatures.

NOTE: For temperatures below -13°C (0°F) John Deere low viscosity HY-GARD may be used. If used at temperatures above -13°C (0°F) some brake squeal may be heard due to lower viscosity of the oil at higher temperatures.

IMPORTANT: Avoid Damage! Mixing of LOW VISCOSITY HY-GARD™ and HY-GARD™ oils is permitted. DO NOT mix any other oils in this transaxle. DO NOT use engine oil or "Type F" (Red) Automatic Transmission Fluid in this transaxle.



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Other oils may be used if they meet John Deere standards JDM J20C and JDM J20D.

RB14256,0000A6E -19-18JUN12-1/1

Chassis Grease

Use the following grease based on the air temperature range. Operating outside of the recommended grease air temperature range may cause premature failures.

The following John Deere grease is PREFERRED:

- **John Deere Moly High Temperature EP Grease**

If not using the preferred grease, be sure to use a general all-purpose grease with an NLGI grade No. 2 rating.

Wet or high speed conditions may require use of a special use grease. Contact your Servicing dealer for information.

RB14256,0000A6F -19-18JUN12-1/1

Alternative Lubricants

Use of alternative lubricants could cause reduced life of the component.

If alternative lubricants are to be used, it is recommended that the factory fill be thoroughly removed before switching to any alternative lubricant.

RB14256,0000A70 -19-18JUN12-1/1

Synthetic Lubricants

Synthetic lubricants may be used in John Deere equipment if they meet the applicable performance requirements (industry classification and/or military specification) as shown in this manual.

The recommended air temperature limits and service or lubricant change intervals should be maintained as shown in the operator's manual, unless otherwise stated on lubricant label.

Avoid mixing different brands, grades, or types of oil. Oil manufacturers blend additives in their oils to meet certain specifications and performance requirements. Mixing different oils can interfere with the proper functioning of these additives and degrade lubricant performance.

RB14256,0000A71 -19-18JUN12-1/1

Lubricant Storage

All machines operate at top efficiency only when clean lubricants are used. Use clean storage containers to handle all lubricants. Store them in an area protected from dust, moisture, and other contamination. Store drums on their sides. Make sure all containers are properly marked as to their contents. Dispose of all old, used containers and their contents properly.

RB14256,0000A72 -19-18JUN12-1/1

Mixing of Lubricants

In general, avoid mixing different brands or types of lubricants. Manufacturers blend additives in their lubricants to meet certain specifications and performance requirements. Mixing different lubricants can interfere with the proper functioning of these additives and lubricant properties which will downgrade their intended specified performance.

RB14256,0000A73 -19-18JUN12-1/1

Oil Filters

IMPORTANT: Avoid Damage! Filtration of oils is critical to proper lubrication performance. Always change filters regularly.

The following John Deere oil filters are PREFERRED:

- AUTOMOTIVE AND LIGHT TRUCK ENGINE OIL FILTERS.

Most John Deere filters contain pressure relief and anti-drainback valves for better engine protection.

Other oil filters may be used if above recommended John Deere oil filters are not available, provided they meet the following specification:

- ASTB Tested In Accordance With SAE J806.

RB14256,0000A74 -19-18JUN12-1/1

Brake Fluid

The following John Deere heavy duty brake fluid is PREFERRED for all drum and disc brakes:

- Super-duty DOT4 brake fluid - TY26180 [355ml (12 oz.)]

Other brake fluids may be used if the above John Deere brake fluid is not available and they provide the following:

- DOT3 or DOT4 certified.
- Conforms to Motor Vehicle Safety Standard No. 116.
- Minimum wet boiling point 140°C (284°F).
- Minimum dry boiling point 232°C (450°F) to prevent vapor lock.

RB14256,0000A75 -19-18JUN12-1/1

Diesel Engine Coolant

Preferred coolants:

The following pre-mix engine coolants are preferred:

- **John Deere Cool-Gard™ II**
- **John Deere Cool-Gard™ II PG**

Not all Cool-Gard™ II pre-mix products are available in all countries.

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

Additional Recommended Coolants

The following engine coolant is also recommended:

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

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

Other Coolants

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

- Pre-mix coolant meeting ASTM D6210 requirements
- Coolant concentrates meeting ASTM D6210 requirements in a 40% to 60% mixture of concentrate with quality water
- Pre-mix coolant meeting ASTM D3306 requirements
- Coolant concentrates meeting ASTM D3306 requirements in a 40% to 60% mixture of concentrate with quality water

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

- Is formulated with a quality nitrite-free additive package.
- Protects the cooling system metals (cast iron, aluminum alloys, and copper alloys such as brass) from corrosion.

Water Quality

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

Coolant Drain Intervals

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

When Cool-Gard™ II or Cool-Gard™ II PG is used, the drain interval is 6 yr. or 6000 operating hours.

If a coolant other than Cool-Gard™ II or Cool-Gard™ II PG is used, reduce the drain interval to 2 yr. or 2000 operating hours.

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

IMPORTANT: Avoid damage! Do not mix ethylene glycol and propylene glycol base coolants.

IMPORTANT: Avoid damage! Do not use coolants that contain nitrites.

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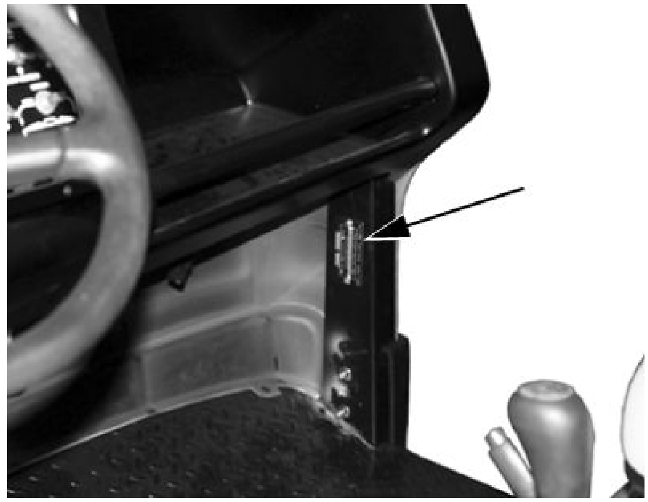
Identification Numbers

When ordering parts or submitting a warranty claim, it is IMPORTANT that you include the product identification number, and the component product identification numbers.

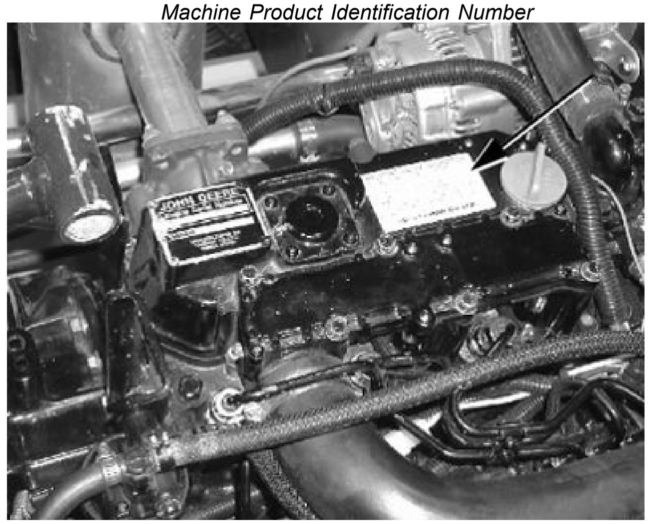
The location of the product identification numbers and component product identification numbers are shown.

Product Identification Number Locations



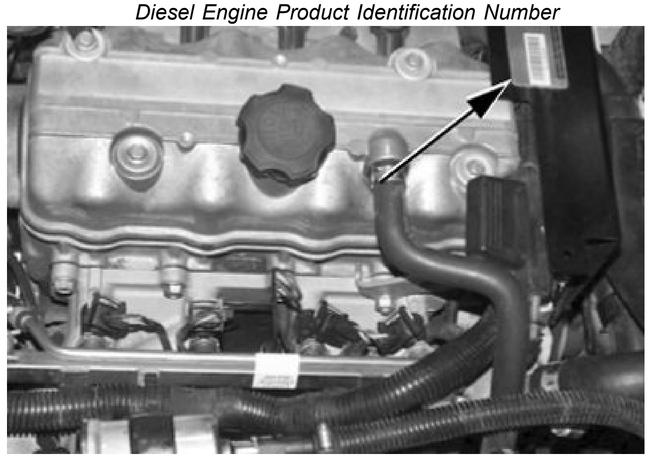
TCAL26584 —UN—15JUN12

Machine Product Identification Number



TCAL26585 —UN—15JUN12

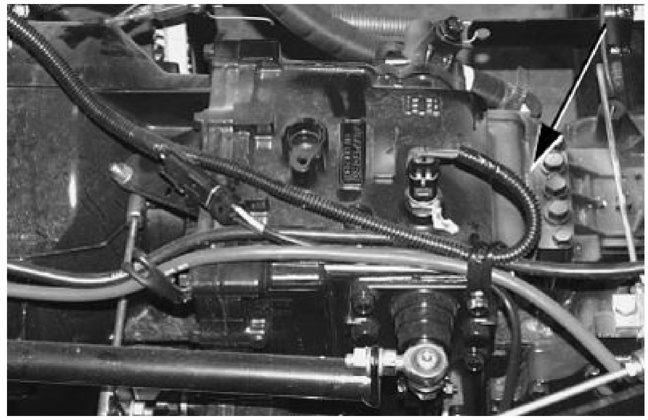
Diesel Engine Product Identification Number



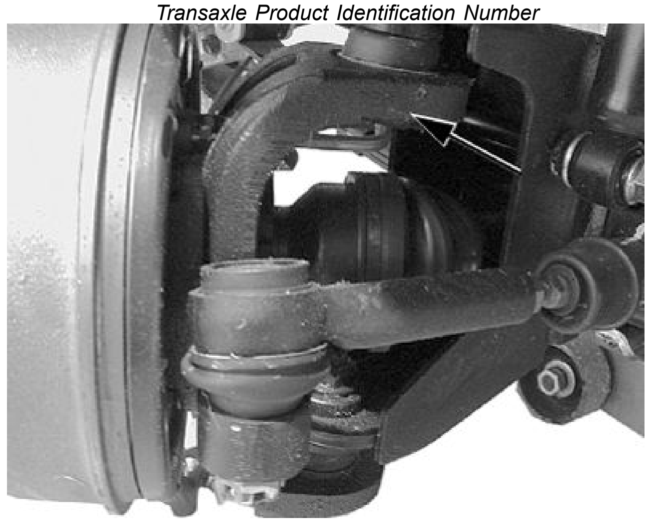
TCAL26586 —UN—15JUN12

EFI Gas Engine Product Identification Number

Continued on next page RB14256,0000A77 -19-20JUN12-1/2


TCAL26587 —UN—15JUN12

Transaxle Product Identification Number


TCAL26588 —UN—15JUN12

4WD Axle Product Identification Number

RB14256,0000A77 -19-20JUN12-2/2

Section 30 Engine-Gasoline

Contents

Specifications

Item	Measurement	Specification
Engine		
Make		John Deere/PSI
Model		0.97L-L4
Type		4-cycle Gasoline
Machine Model Used On		2020A
Cylinders		4
Bore		65.5 mm (2.58 in.)
Stroke		72 mm (2.84 in.)
Valves		Overhead Valves and Camshaft
Lubrication		Full pressure
Oil Filter		Full flow, spin-on filter
Crankcase Oil Capacity Without Filter		3.0 L (3.2 qt)
Cooling System		Liquid with pump and radiator
Fuel Filter		Replaceable (in-line type)
Air Filter		Dry replaceable primary and secondary elements

AP43109,0003760 -19-19JUN14-1/1

Symptom: Engine Cranks but Will Not Start

RB14256,0000A7D -19-06JUL12-1/8

Engine Cranks but Will Not Start

RB14256,0000A7D -19-06JUL12-2/8

Step 1	Is fuel in tank fresh, clean and of proper grade?	**YES:** Go to next step. **NO:** Replace fuel in tank and lines with fresh, clean fuel of proper grade.

RB14256,0000A7D -19-06JUL12-3/8

Step 2	Remove spark plugs. Are the spark plug tips clear of any drops of fuel?	**YES:** Go to next step. **NO:** Check for plugged air Filter.

RB14256,0000A7D -19-06JUL12-4/8

Step 3	Is the correct spark plug installed and properly adjusted?	**YES:** Go to next step. **NO:** Install and properly adjust the correct spark plug.

RB14256,0000A7D -19-06JUL12-5/8

Step 4	The ignition system should produce a steady, strong blue spark. Is the spark weak or is there no spark at all?	**YES:** Go to next step. **NO:** Ignition system operation is satisfactory. Go to step 10.

RB14256,0000A7D -19-06JUL12-6/8

Step 5	Is cylinder compression within specification? (See Test Cylinder Compression.)	**YES:** Go to next step. **NO:** Repair or replace engine as necessary. (See Remove Engine—Gasoline.) (See Remove and Install Cylinder Head—Gasoline.) (See Recondition Cylinder Head—Gasoline.)

RB14256,0000A7D -19-06JUL12-7/8

Step 6	Is fuel pressure to specification? (See Test Fuel Pump Pressure—Gasoline.)	**YES:** Go to next step. **NO:** Replace fuel filter and test again.

RB14256,0000A7D -19-06JUL12-8/8

Symptom: Engine Malfunctions at Low RPM

RB14256,0000A7E -19-18JUN14-1/7

Engine Malfunctions at Low RPM

Continued on next page

RB14256,0000A7E -19-18JUN14-2/7

Step 1	Is the correct spark plug installed and properly adjusted?	**YES:** Go to next step. **NO:** Install and properly adjust the correct spark plug.

RB14256,0000A7E -19-18JUN14-3/7

Step 2	Does the ignition system produce a steady, strong blue spark?	**YES:** Go to next step. **NO:** Follow "Results" of the spark test procedure.

RB14256,0000A7E -19-18JUN14-4/7

Step 3	Is engine operating at normal temperature - engine not overheating?	**YES:** Go to next step. **NO:** Engine load may be excessive. Reduce engine load. **NO:** Clean radiator screen and fins. Check thermostat.

RB14256,0000A7E -19-18JUN14-5/7

Step 4	Is cylinder compression within specification? (See Test Cylinder Compression—Gasoline.)	**YES:** Go to next step. **NO:** Repair or replace engine as necessary. (See Remove Engine—Gasoline.) (See Remove and Install Cylinder Head—Gasoline.)

RB14256,0000A7E -19-18JUN14-6/7

Step 5	Are valves properly adjusted? (See Adjust Valve Clearance—Gasoline.)	**YES:** Go to next step. **NO:** Adjust valve clearance.

RB14256,0000A7E -19-18JUN14-7/7

Symptom: Engine Malfunctions at High RPM

RB14256,0000A7F -19-18JUN14-1/9

Engine Malfunctions at High RPM

RB14256,0000A7F -19-18JUN14-2/9

Step 1	Is the correct spark plug installed and properly adjusted?	**YES:** Go to next step. **NO:** Install and properly adjust the correct spark plug.

RB14256,0000A7F -19-18JUN14-3/9

Step 2	Does the ignition system produce a steady, strong blue spark?	**YES:** Go to next step. **NO:** Follow "Results" of the spark test procedure. Go to next step if problem continues.

Continued on next page

RB14256,0000A7F -19-18JUN14-4/9

Step 3	Is engine operating at normal temperature - engine not overheating?	**YES:** Go to next step. **NO:** Engine load may be excessive. Reduce engine load.

RB14256,0000A7F -19-18JUN14-5/9

Step 4	Is cylinder compression within specification? (See Test Cylinder Compression—Gasoline.)	**YES:** Go to next step. **NO:** Repair or replace engine as necessary. (See Remove Engine—Gasoline.) (See Remove and Install Cylinder Head—Gasoline.)

RB14256,0000A7F -19-18JUN14-6/9

Step 5	Are valves properly adjusted? (See Adjust Valve Clearance—Gasoline.)	**YES:** Go to next step. **NO:** Adjust valve clearance.

RB14256,0000A7F -19-18JUN14-7/9

Step 6	Is fuel pressure to specification? (See Test Fuel Pump Pressure—Gasoline.)	**YES:** Go to next step. **NO:** Replace fuel filter and test again.

RB14256,0000A7F -19-18JUN14-8/9

Step 7	Are intake manifold flanges properly sealed - no air leaks?	**YES:** Go to next step. **NO:** Seal flanged surfaces as required.

RB14256,0000A7F -19-18JUN14-9/9

Symptom: Excessive Oil Consumption

RB14256,0000A80 -19-05JUL12-1/9

Excessive Oil Consumption

RB14256,0000A80 -19-05JUL12-2/9

Step 1	Is engine oil the correct viscosity for conditions?	**YES:** Go to next step. **NO:** Drain oil from engine and replace with oil of proper viscosity.

RB14256,0000A80 -19-05JUL12-3/9

Step 2	Is engine filled with oil to the proper level on the dipstick (crankcase not over full)?	**YES:** Go to next step. **NO:** Drain excessive engine oil.

Continued on next page

RB14256,0000A80 -19-05JUL12-4/9

Step 3	Is cylinder compression within specification? (See Test Cylinder Compression—Gasoline.)	**YES:** Go to next step. **NO:** Repair or replace engine as necessary. (See Remove Engine—Gasoline.) (See Remove and Install Cylinder Head—Gasoline.) (See Recondition Cylinder Head—Gasoline.)

RB14256,0000A80 -19-05JUL12-5/9

Step 4	Is the crankcase breather functioning properly?	**YES:** Go to next step. **NO:** Clean or replace breather. (See Remove and Install Rocker Arm Cover—Gasoline.)

RB14256,0000A80 -19-05JUL12-6/9

Step 5	Is the drain in the breather chamber clear of obstructions?	**YES:** Go to next step. **NO:** Clear obstructions from drain in breather chamber.

RB14256,0000A80 -19-05JUL12-7/9

Step 6	Are the valve guides in good condition and not worn excessively?	**YES:** Go to next step. **NO:** Repair as necessary.

RB14256,0000A80 -19-05JUL12-8/9

Step 7	Are the oil ring grooves clear of obstructions?	**NO:** Clean oil ring grooves. (See Repair Piston and Connecting Rod—Gasoline.)

RB14256,0000A80 -19-05JUL12-9/9

Symptom: Engine Overheats

RB14256,0000A81 -19-18JUN12-1/7

Engine Overheats

RB14256,0000A81 -19-18JUN12-2/7

Step 1	Is engine being operated under normal operating conditions?	**YES:** Go to next step. **NO:** Adjust operation to comply with normal operating conditions. (See owner's manual for more information.)

RB14256,0000A81 -19-18JUN12-3/7

Step 2	Is radiator screen clean?	**YES:** Go to next step. **NO:** Clean screen of debris.

Continued on next page

RB14256,0000A81 -19-18JUN12-4/7

Step 3	Is coolant clean, at proper level in tank and at proper concentration?	**YES:** Go to next step. **NO:** Flush cooling system, replace coolant.

RB14256,0000A81 -19-18JUN12-5/7

Step 4	Is electric radiator fan working properly?	**YES:** Go to next step. **NO:** Check wiring and fan motor. Repair or replace as necessary.

RB14256,0000A81 -19-18JUN12-6/7

Step 5	Is thermostat opening at correct temperature?	**YES:** Go to next step. **NO:** Replace thermostat.

RB14256,0000A81 -19-18JUN12-7/7

Symptom: Excessive Fuel Consumption

RB14256,0000A82 -19-18JUN14-1/6

Excessive Fuel Consumption

RB14256,0000A82 -19-18JUN14-2/6

Step 1	Are the correct spark plugs installed and properly adjusted?	**YES:** Go to next step. **NO:** Install and properly adjust the correct spark plugs.

RB14256,0000A82 -19-18JUN14-3/6

Step 2	Remove spark plugs. Are the spark plug tips clear of any drops of fuel?	**YES:** Go to next step. **NO:** Check for plugged air cleaner.

RB14256,0000A82 -19-18JUN14-4/6

Step 3	The ignition system should produce a steady, strong blue spark. Is the spark weak or is there no spark at all?	**YES:** Go to next step. **NO:** The ignition system is operating satisfactorily. Go to step 5.

RB14256,0000A82 -19-18JUN14-5/6

Step 4	Is cylinder compression within specification? (See <u>Test Cylinder Compression—Gasoline</u>.)	**YES:** Go to next step. **NO:** Repair or replace engine as necessary. (See <u>Remove Engine—Gasoline</u>.) (See <u>Recondition Cylinder Head—Gasoline</u>.)

RB14256,0000A82 -19-18JUN14-6/6

Specifications

Item	Measurement	Specification
Engine Speed		
Slow Idle Speed		1000 rpm
Pressures		
Cylinder Compression (Min @ 300 RPM)		1176 kPa (170 psi)
Compression Differential (Max)		98 kPa (14 psi)
Fuel Pump Pressure		300 kPa (43.5 psi)
Oil Pressure (Min @ 3000 rpm)		241 kPa (35 psi)
Thermostat		
Begin-to-open		Approximately 82° C (180° F)
Full-open		Approximately 90° C (194° F)
Valves		
Intake Valve Clearance (cold)		0.13—0.18 mm (0.005—0.007 in.)
Exhaust Valve Clearance (cold)		0.23—0.28 mm (0.009—0.011 in.)

BS62576,00017A8 -19-18JUN14-1/1

Service Equipment and Tools

NOTE: Order tools according to information given in the SERVICEGARD™ Catalog. Some tools may be available from a local supplier.

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BS62576,00017A9 -19-18JUN14-1/5

Digital Pulse Tachometer....................................JT07270

Used to check engine rpm.

BS62576,00017A9 -19-18JUN14-2/5

Compression Gauge.. JDM59

Used for cylinder compression test.

BS62576,00017A9 -19-18JUN14-3/5

Pressure Test Kit JDG11359

Used to check fuel pump pressure.

Continued on next page

BS62576,00017A9 -19-18JUN14-4/5

Connector..JT03349

Used for oil pressure test.

Hose Assembly..JT03017

Used for oil pressure test.

0-700 kPa (0-100 psi) Gauge.............................JT07034

Used for oil pressure test.

BS62576,00017A9 -19-18JUN14-5/5

Adjust Slow Idle Speed—Gasoline

Reason

To check if engine slow idle rpm is to specification.

RB14256,0000A83 -19-18JUN12-1/3

Digital Pulse Tachometer.....................................JT07270

Used to check engine rpm.

RB14256,0000A83 -19-18JUN12-2/3

Procedure

1. Move transaxle shift lever to NEUTRAL. Lock park brake.
2. Start and warm engine.
3. Use a digital pulse tachometer to check engine slow idle rpm at spark plug wire.

Specifications—Specification

Slow Idle Speed	1000 rpm

RB14256,0000A83 -19-18JUN12-3/3

Adjust Valve Clearance—Gasoline

Reason

To be sure valves are set correctly to avoid burned valves and excess noise.

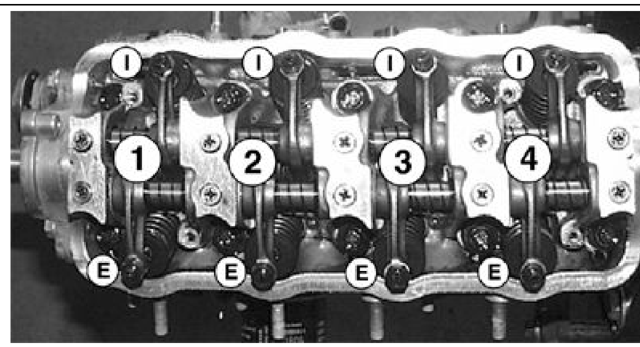
Procedure

1. Engine must be cool (room temperature) before valve clearance is checked.
2. Be sure ignition key is OFF before attempting to turn engine by hand.
3. Remove rocker arm cover.

NOTE: Top Dead Center (TDC) is when the piston is at it's highest point of travel in the cylinder on the compression stroke. The valves must be checked with piston at or near TDC. No. 1 cylinder is located at front of engine (timing belt side).

Engine will be easier to turn if spark plugs are removed.

4. Turn the crankshaft pulley in the direction of engine rotation while watching the rocker arms of the number 1 cylinder. When the intake valve has completely closed (raised up), turn the crankshaft an additional 1/2 turn.



TCAL25970 —UN—15JUN12

I = Intake, E = Exhaust

I— Intake Valve
E—Exhaust Valve
1—Cylinder Number 1
2—Cylinder Number 2
3—Cylinder Number 3
4—Cylinder Number 4

5. Try to move rocker arms for the cylinder to be adjusted.
   - If both rocker arms are loose, the piston is near TDC on the compression stroke and you may proceed to step 6.
   - If both rocker arms and/or push rods are not loose, repeat step four.

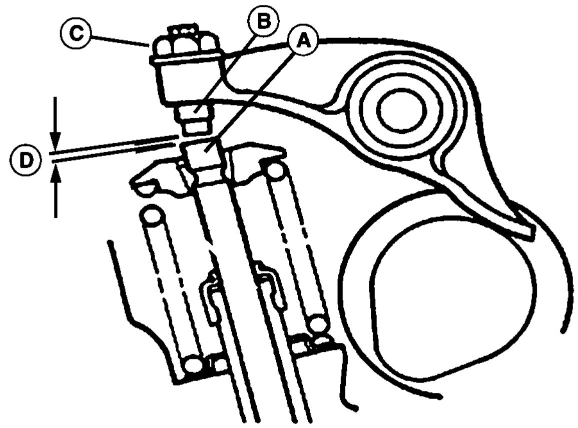
Continued on next page

RB14256,0000A84 -19-18JUN12-1/2

6. Slide 0.13-0.18 mm (0.005-0.007 in.) feeler gauge between valve stem (A) and rocker arm adjusting screw (B) to check valve clearance (D). There should be a slight drag on the feeler gauge when the clearance is correct.
7. To adjust valves, loosen locknut (C) and turn adjusting screw until blade of feeler gauge has a slight drag when inserted between adjusting screw (B) and valve stem (A). Hold adjusting screw while tightening locknut.
8. Recheck valve clearance after tightening locknut.
9. Repeat steps 4-9 for cylinders 2, 3, and 4.
10. Install rocker arm cover.
11. Install spark plugs, if removed earlier.

Specifications—Specification

Intake Valve Clearance (cold)	0.13—0.18 mm (0.005—0.007 in.)
Exhaust Valve Clearance (cold)	0.23—0.28 mm (0.009—0.011 in.)



TCAL25971 —UN—15JUN12

A—Valve Stem
B—Rocker Arm Adjustment Screw
C—Rocker Arm Adjustment Screw Locknut
D—Valve Clearance

RB14256,0000A84 -19-18JUN12-2/2

Test Cylinder Compression—Gasoline

Reason

To check pressure capacity of piston rings and cylinder bore for efficient engine operation.

RB14256,0000A85 -19-18JUN12-1/3

Compression Gauge... JDM59

Used for cylinder compression test.

Continued on next page

RB14256,0000A85 -19-18JUN12-2/3

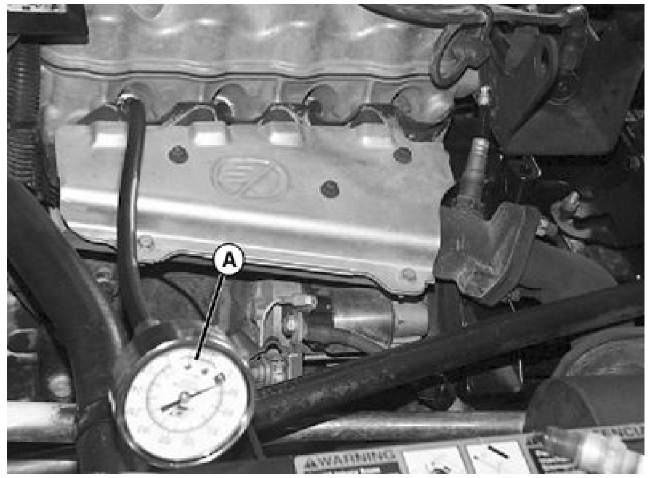
Procedure

CAUTION: Engine will be HOT. Do not touch with bare skin, especially the exhaust pipe or muffler while making test.

1. Warm engine to operating temperature.
2. Park machine safely.
3. Remove spark plugs.
4. Install JDM59 Compression Gauge (A) into spark plug holes (one at a time) and crank engine with starter for four or five compression strokes with throttle wide open.
5. Record reading for each cylinder.

Results

- Minimum compression pressure should be to specification.
- Compression differential between cylinders should not exceed specification.
- If compression is low, squirt about one-half ounce of clean engine oil into cylinder through spark plug hole and retest compression. If compression significantly increases, the piston rings/cylinder are worn.
- If compression does not change with oil added to cylinders, check valves and head gasket for leaks.



TCAL25972 —UN—15JUN12

A—JDM59 Compression Gauge

Specifications—Specification

Cylinder Compression (Min @ 300 RPM)	1176 kPa (170 psi)
Compression Differential (Max)	98 kPa (14 psi)

RB14256,0000A85 -19-18JUN12-3/3

Test Fuel Pump Pressure—Gasoline

Reason

To determine if fuel pump pressure and flow to the injectors is within specification.

RB14256,0000A86 -19-18JUN12-1/4

Pressure Test Kit JDG11359

Used to check fuel pump pressure.

Continued on next page

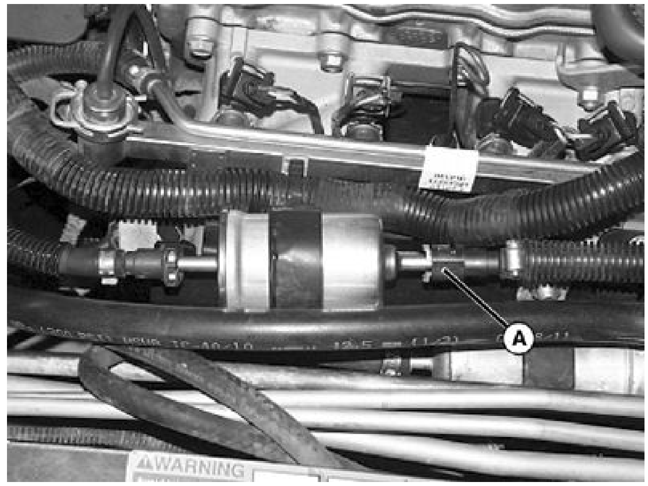
RB14256,0000A86 -19-18JUN12-2/4

Procedure

1. Park machine safely.
2. Allow engine to cool.
3. Check for sufficient fuel in tank to perform test.

CAUTION: Gasoline is extremely flammable. DO NOT SMOKE. Always work in a well-ventilated area away from open flame or spark-producing equipment, including equipment that utilizes pilot lights.

4. Place a shop cloth over connector (A) and press tabs on connector to disconnect hose from fuel filter inlet (A). Wipe up any spilled fuel immediately.

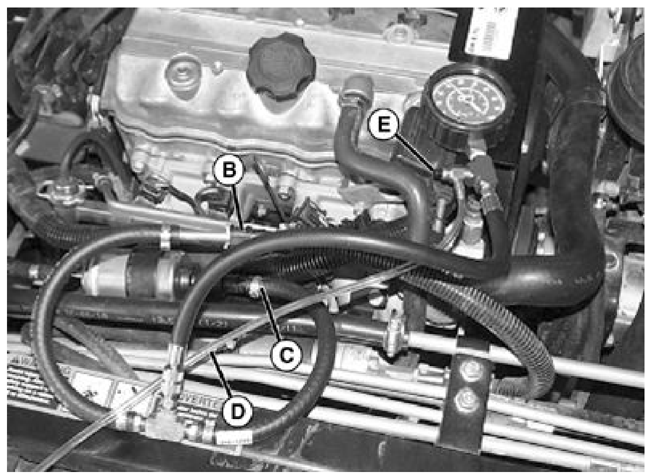


TCAL25973 —UN—15JUN12

A—Fuel Filter Inlet Hose Connector

RB14256,0000A86 -19-18JUN12-3/4

5. Attach one end of JDG11359 Pressure Gauge hose (B) to fuel line coming from fuel pump. Connect other end of pressure gauge hose (C) to fuel filter inlet. Place end of clear line (D) into a fuel container.
6. Turn key switch to ON position. Fuel pump should run for three to five seconds. If fuel pump does not make any noise, check for voltage at fuel pump connector. If no voltage is present, see electrical section for diagnosis of electrical problem.
7. Run fuel pump for 15 seconds or cycle key switch two or three times and observe pressure reading on gauge.
8. When test is complete, press button (E) on tester to release fuel pressure into fuel container before disconnecting tester.
9. If fuel filter is in question, test can be repeated on outlet side of fuel filter. If pressure is any less or it takes longer to obtain pressure, replace fuel filter.



TCAL25974 —UN—15JUN12

B—JDG11359 Pressure Gauge Hose to Fuel Line Coming From Fuel Pump
C—JDG11359 Pressure Gauge Hose to Fuel Filter Inlet
D—Clear Line From JDG11359 Pressure Gauge to Fuel Container
E—JDG11359 Pressure Gauge Pressure Release Button

Results

- Check inlet hose for kink or blockage
- If no blockage is found in inlet hose or stand pipe in tank and pressure is below specification, replace fuel pump.

Specifications—Specification	
Fuel Pump Pressure	300 kPa (43.5 psi)

RB14256,0000A86 -19-18JUN12-4/4

Test Oil Pressure—Gasoline

Reason

To verify that the oil pump has enough oil pressure to lubricate the internal engine components.

Continued on next page

RB14256,0000A87 -19-20JUN12-1/4

Connector...JT03349

Used for oil pressure test.

Hose Assembly...JT03017

Used for oil pressure test.

0-700 kPa (0-100 psi) Gauge JT07034

Used for oil pressure test.

RB14256,0000A87 -19-20JUN12-2/4

NOTE: The connector, hose assembly, coupler, and gauge are found in other SERVICEGARD™ test kits.

Procedure

1. Perform test procedure with engine level.
2. Stop engine.

RB14256,0000A87 -19-20JUN12-3/4

3. Disconnect and remove oil pressure sender (A).
4. Install JT03349 Connector, JT03017 Hose Assembly, and JT07034 Gauge in to oil pressure switch port.
5. Check crankcase oil level and adjust to full mark.

IMPORTANT: If oil pressure is below 69 kPa (10 psi) after 5 seconds of running, STOP engine immediately and correct cause before continuing.

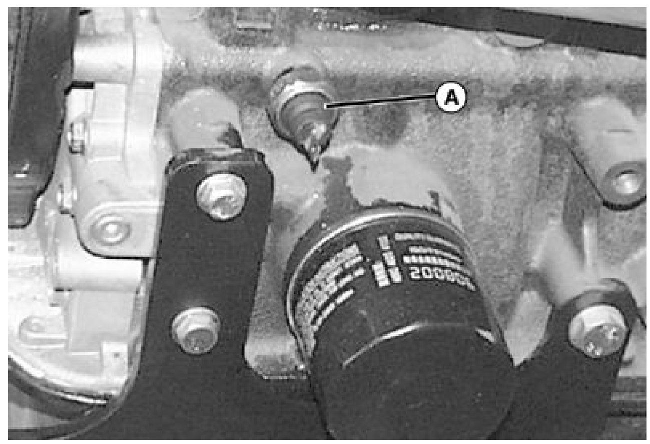
6. Start engine and monitor oil pressure during start-up.
7. Warm up engine by running until coolant temperature reaches 75-85° C (167-185° F).

CAUTION: Engine components are HOT. DO NOT touch with bare skin. Wear protective eye glasses and clothing.

8. Record oil pressure reading at 3000 rpm.
9. Stop engine and allow to cool.
10. Remove hose assembly and gauge.
11. Install oil pressure switch.
12. Check crankcase oil level and adjust to full mark.

Results

If oil pressure readings are not within specification inspect and/or replace the following:



TCAL25975 —UN—15JUN12

A—Oil Pressure Sender

- Oil Filter
- Oil suction screen
- Oil pump assembly (See Remove and Install Oil Pump—Gasoline.)
- Oil passages
- Bearing wear
- Oil seals

Specifications—Specification

Oil Pressure (Min @ 3000 rpm)	241 kPa (35 psi)

RB14256,0000A87 -19-20JUN12-4/4

Test Thermostat—Gasoline

Purpose:

To ensure thermostat opening and closing at specified temperatures.

Equipment:

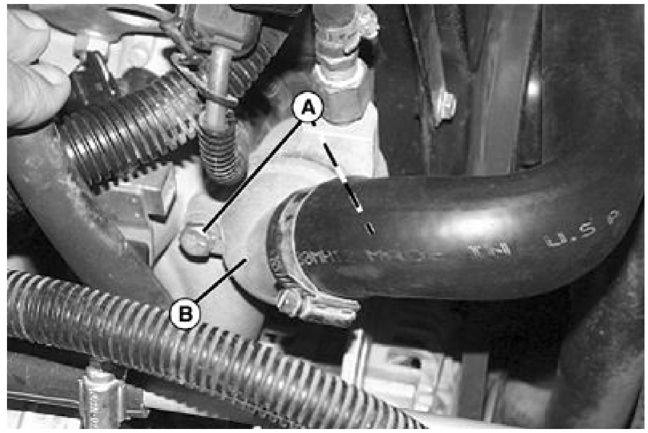
- D-05103ST Thermostat Tester

Procedure:

1. Park machine safely.
2. Allow cooling system to completely cool BEFORE testing.

NOTE: Be sure to wipe-up and wash-off any spilled coolant immediately.

3. Drain coolant from radiator into a clean container.
4. Remove cap screws (A) and pull thermostat cover (B), away from intake manifold.



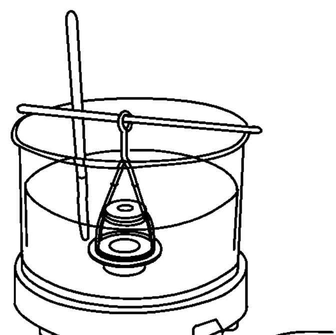
TCAL25976 —UN—15JUN12

A—Cap Screws **B—Thermostat Cover**

5. Remove thermostat.

RB14256,0000A88 -19-06JUL12-1/2

6. Place thermostat in filled D-05103ST Tester. Support thermostat in center of tester and away from heat source.
7. Observe thermostat and thermometer while water heats. Record temperatures as thermostat begins to open and fully opens.
8. Compare recorded observations with specifications. If thermostat does not meet specifications, replace it.
9. Install thermostat, new gasket, and cover (C).
10. Fill and bleed cooling system with properly mixed coolant.



TCAL25977 —UN—15JUN12

Results:

- If thermostat fails to meet any of these specifications, replace it.

Specifications:

Item	Measurement	Specification
Thermostat specifications:		
Begin-to-open		Approximately 82° C (180° F)
Full-open		Approximately 90° C (194° F)

RB14256,0000A88 -19-06JUL12-2/2

Specifications

Item	Measurement	Specification
Belt Tensioner		
Tensioner Cap Screws		18—28 N·m (160—247 lb.-in.)
Belt Cover Cap Screws		4—5 N·m (35—44 lb.-in.)
Camshaft		
Camshaft End Play		0.05—0.15 mm (0.002—0.006 in.)
Camshaft End Play (Max)		0.3 mm (0.012 in.)
Camshaft Bend (Max)		0.00—0.1 mm (0.00—0.0039 in.)
Camshaft Lobe Height		36.152 mm (1.423 in.)
Camshaft Lobe Height Wear Limit		36.1 mm (1.421 in.)
Camshaft Bearing Journals		
Timing Sprocket End (front) Journal OD		43.425—43.450 mm (1.709—1.710 in.)
Second Journal OD		43.625—43.650 mm (1.717—1.718 in.)
Third Journal OD		43.825—43.850 mm (1.725—1.726 in.)
Fourth Journal OD		44.025—44.050 mm (1.733—1.734 in.)
Fifth Journal OD		44.225—44.2450 mm (1.741—1.742 in.)
Camshaft Bores		
Camshaft Bore ID (front)		43.500—43.525 mm (1.7125—1.7135 in.)
Camshaft Second Bore ID		43.700—43.725 mm (1.720—1.721 in.)
Camshaft Third Bore ID		43.900—43.925 mm (1.728—1.729 in.)
Camshaft Fourth Bore ID		44.100—44.125 mm (1.736—1.737 in.)
Camshaft Fifth Bore ID		44.300—44.3125 mm (1.744—1.745 in.)
Camshaft Thrust Plate Cap Screw Torque		11 N·m (96 lb.-in.)
Camshaft Sprocket Cap Screw Torque		55—65 N·m (40—48 lb-ft)

Continued on next page

BS62576,00017A3 -19-18JUN14-1/5

Item	Measurement	Specification
Connecting Rod		
Connecting Rod Side Play (Max)		0.30 mm (0.012 in.)
Connecting Rod Side Play (Max)		0.3 mm (0.011 in.)
Crankshaft Connecting Rod Journal OD		38 mm (1.496 in.)
Crankshaft Connecting Rod Journal OD Wear Limit		37.976 mm (1.495 in.)
Connecting Rod Cap Screw Torque		30 N·m (22 lb.-ft.)
Connecting Rod Bearing Oil Clearance		0.020—0.04 mm (0.0008—0.0015 in.)
Connecting Rod Bearing Oil Clearance Wear Limit		0.08 mm (0.003 in.)
Crankshaft		
Crankshaft Connecting Rod Journal OD		37.976—38.000 mm (1.495—1.496 in.)
Crankshaft Main Bearing Journal OD		49.97—50 mm (1.967—1.968 in.)
Crankshaft Bend (Max)		0.06 mm (0.002 in.)
Main Bearing Cap Screw Torque		43—48 N·m (33—35 lb.-ft.)
Main Bearing Cap Screw Torque		43—48 N·m (33—35 lb-ft)
Crankshaft Main Bearing Oil Clearance		0.026—0.046 mm (0.001—0.002 in.)
Crankshaft Main Bearing Clearance Wear Limit		0.08 mm (0.0031 in.)
Crankshaft Pulley Cap Screw Torque		55—65 N·m (40—48 lb-ft)
Cylinder		
Cylinder Bore		65.5 mm (2.578 in.)
Cylinder Bore Wear Limit		65.53 mm (2.5799 in.)
Piston-to-Cylinder Clearance (Max)		0.06 mm (0.0023 in.)
Cylinder Roundness		0.00—0.008 mm (0.00—0.0003 in.)
Cylinder Roundness (Max)		0.00—0.008 mm (0.00—0.0003 in.)
Cylinder Head		
Initial Torque		30.9 N·m (23 lb.-ft.)

Continued on next page BS62576,00017A3 -19-18JUN14-2/5

Item	Measurement	Specification
Final Torque		43—45 N·m (33—35 lb.-ft.)
Cylinder Head Distortion	Out-of-Flat (Maximum)	0.10 mm (0.004 in.)
Engine Mounting		
Subframe to Engine Mounting Cap Screw Torque M8		26—31 N·m (19—23 lb.-ft.)
Subframe to Engine Mounting Cap Screw Torque M10		43—49 N·m 32—36 lb.-ft.)
Engine Oil		
Engine Crankcase	Capacity (with Filter)	3.2 L (3.4 qt)
Flywheel		
Flywheel Cap Screw Torque		43 N·m (32 lb.-ft.)
Clutch Adapter Plate to Flywheel		61 N·m (45 lb.-ft.)
Clutch Cover Cap Screw Torque		28 N·m (20 lb.-ft.)
Intake Manifold		
Intake Manifold Mounting Surface Warp Not to Exceed		0.10 mm (0.004 in.)
Intake Manifold Cap Screw Torque		21 N·m (185 lb.-in.)
Oil Pan		
Oil Pan Cap Screw Torque	Torque	5 N·m (44 lb.-in.)
Oil Pump		
Gear Recess Wear Limit		0.17 mm (0.007 in.)
Inner Gear-to-Pump Body Crescent		0.6—0.8 mm (0.023—0.031)
Outer Gear-to-Pump Body Crescent Clearance		0.25—0.40 mm (0.010—0.016 in.)
Outside of Outer Gear-to-Pump Body Clearance Wear Limit		0.3 mm (0.012 in.)
Piston		
Piston Pin Bushing ID		16.003—16.013 mm (0.6300—0. 6304 in.)
Piston Pin-to-Bushing Oil Clearance		0.003—0.018 mm (0.0001—0.0007 in.)
Piston Pin-to-Bushing Clearance Wear Limit		0.05 mm (0.0019 in.)

Continued on next page

BS62576,00017A3 -19-18JUN14-3/5

Item	Measurement	Specification
Piston Ring Groove Side Clearance		
Top Piston Ring		0.03—0.07 mm (0.0011—0.0027 in.)
Top Piston Ring (Max)		0.12 mm (0.0047 in.)
Second Piston Ring		0.02—0.06 mm (0.0007—0.0026 in.)
Second Piston Ring (Max)		0.1 mm (0.0039 in.)
Piston Ring End Gap		
Top Ring End Gap		0.15—0.30 mm (0.006—0.012 in.)
Top Ring End Gap (Max)		0.7 mm (0.027 in.)
Second Ring End Gap		0.15—0.35 mm (0.006—0.013 in.)
Second Ring End Gap (Max)		0.7 mm (0.027 in.)
Oil Control Ring End Gap		0.2—0.7 mm (0.008—0.027 in.)
Oil Control Ring End Gap (Max)		1.8 mm (0.070 in.)
Piston Pin OD		15.995—16.00 mm (0.6297—0.6299 in.)
Piston Pin Bore ID		16.00—16.014 mm (0.629—0.630 in.)
Piston Pin-to-Bore Clearance		0.005—0.018 (0.0002—0.0007 in.)
Piston OD		65.465—65.495 mm (2.577—2.578 in.)
Piston Measurement Distance		30 mm (1.2 in.)
Cylinder Bore Wear Limit		66.53 mm (2.58 in.)
Piston-to-Cylinder Clearance		0.04—0.05 mm (0.0014—0.0019 in.)
Rocker Arm		
Rocker Cover Cap Screw Torque		6—8 N·m (53—70 lb.-in.)
Rocker Arm Shaft OD		14.965—14.980 mm (0.589—0.590 in.)
Rocker Arm ID		14.985—15.005 mm (0.590—0.591 in.)
Rocker Arm-to-Shaft Oil Clearance		0.005—0.040 mm (0.0001—0.0015 in.)

Continued on next page

BS62576,00017A3 -19-18JUN14-4/5

Item	Measurement	Specification
Valves		
Intake Valve Seat	Width (Maximum)	1.3—1.5 mm (0.051—0.059 in.)
Exhaust Valve Seat	Width (Maximum)	1.3—1.5 mm (0.051—0.059 in.)
Intake and Exhaust Valves	Axial Runout (Wobble)	0.03 mm (0.001 in.)
Intake and Exhaust Valve	Face Angle	45°
Intake Valve Face Margin	Distance	0.8 mm (0.031 in.)
Intake Valve Face Margin	Distance (Wear Limit)	0.6 mm (0.023 in.)
Exhaust Valve Face Margin	Distance	1.2 mm (0.047 in.)
Exhaust Valve Face Margin	Distance (Wear Limit)	0.7 mm (0.027 in.)
Valve Spring	Free Length (Nominal)	48.9 mm (1.925 in.)
Valve Spring	Free Length (Minimum)	47.7 mm (1.877 in.)
Valve Spring	Inclination Distance (Maximum)	2.0 mm (0.079 in.)
Valve Stem OD		
Intake Valve Stem OD		6.965—6.98 mm (0.274—0.275 in.)
Exhaust Valve Stem OD		6.955—6.97 mm (0.274—0.2744 in.)
Valve Guide ID		7.015 mm (0.276 in.)
Valve Guide-to-Valve Stem Oil Clearance		
Intake		0.02—0.05 mm (0.0008—0.002 in.)
Exhaust		0.03—0.06 mm (0.001—0.002 in.)
Wear Limit (Intake)		0.07 mm (0.0027 in.)
Wear Limit (Exhaust)		0.09 mm (0.0035 in.)

BS62576,00017A3 -19-18JUN14-5/5

Service Equipment and Tools

NOTE: Order tools according to information given in the SERVICEGARD™ Catalog. Some tools may be available from a local supplier.

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BS62576,00017A5 -19-18JUN14-1/6

Clutch Alignment Tool.. JDG1331

Used to align clutch disc.

BS62576,00017A5 -19-18JUN14-2/6

Valve Spring Compressor.....................................JDE138

Used to compress valve springs.

BS62576,00017A5 -19-18JUN14-3/6

Reaming Tool..D20020WI

Used to clean or size valve guides.

BS62576,00017A5 -19-18JUN14-4/6

Ridge Reamer JTO7277

Removes ridge from top of cylinder bore.

BS62576,00017A5 -19-18JUN14-5/6

Clutch Alignment Tool.. JDG1331

Used to align clutch disc with pilot bearing.

BS62576,00017A5 -19-18JUN14-6/6

Other Material

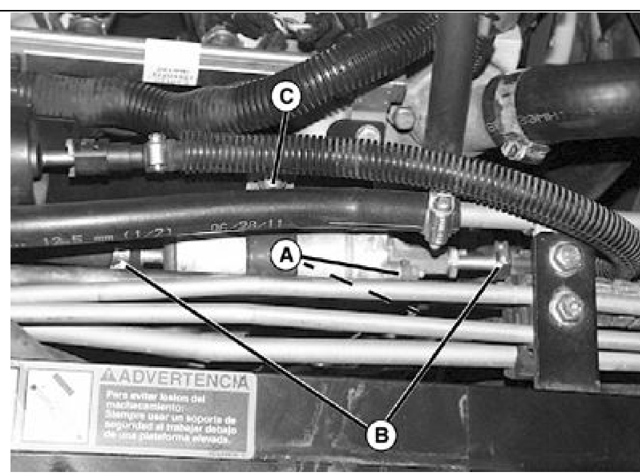
Number	Name	Use
TY24344 (U.S.) (U.S.)	Form-in-Place Gasket	Seals cam covers.

BS62576,00017A6 -19-18JUN14-1/1

Remove and Install Fuel Pump—Gasoline

Procedure

1. Disconnect wire connectors (A).
2. Loosen clamps and remove fuel lines (B).
3. Remove cap screw (C) from fuel pump and remove pump.
4. Install components in reverse order of removal.



TCAL25978 —UN—15JUN12

A—Wire Connectors
B—Fuel Lines
C—Cap Screw

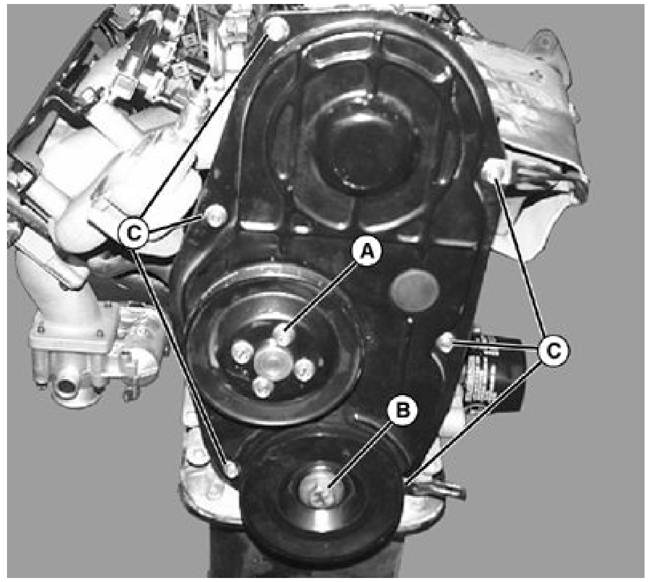
RB14256,0000A89 -19-18JUN12-1/1

Timing Belt Removal—Gasoline

Removal

NOTE: Timing belt can be replaced with engine in the machine. Some photos in this section are shown with engine out for clarity of photo.

1. Park machine safely.
2. Disconnect negative (-) battery cable.
3. Loosen alternator bolts and loosen and remove alternator belt.
4. Remove four cap screws (A) from water pump pulley and remove pulley.
5. Remove cap screw (B) securing crankshaft pulley and remove pulley. Use a puller if necessary.
6. Remove six cap screws (C) securing outer timing belt cover and remove cover.



TCAL25979 —UN—15JUN12

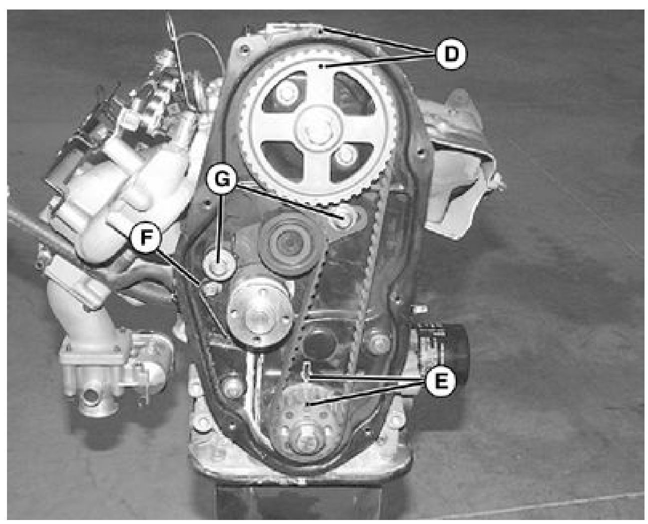
A—Cap Screws Securing Water Pump Pulley
B—Cap Screw Securing Crankshaft Pulley
C—Six Cap Screws Securing Timing Cover

RB14256,0000A8A -19-18JUN12-1/2

7. Turn engine crankshaft until crankshaft and camshaft sprocket timing marks and arrows (D) and (E) are aligned as shown.
8. Loosen cap screws (G) on tensioner assembly and disconnect spring (F).
9. Slide tensioner away from belt and remove belt.

NOTE: If timing belt is broken turn camshaft sprocket bolt with a wrench until marks (D) align, then turn crankshaft until marks (E) align.

D—Camshaft Timing Alignment Marks
E—Crankshaft Timing Alignment Marks
F—Timing Belt Tensioner Spring
G—Cap Screws Securing Timing Belt Tensioner Assembly



TCAL25980 —UN—15JUN12

RB14256,0000A8A -19-18JUN12-2/2

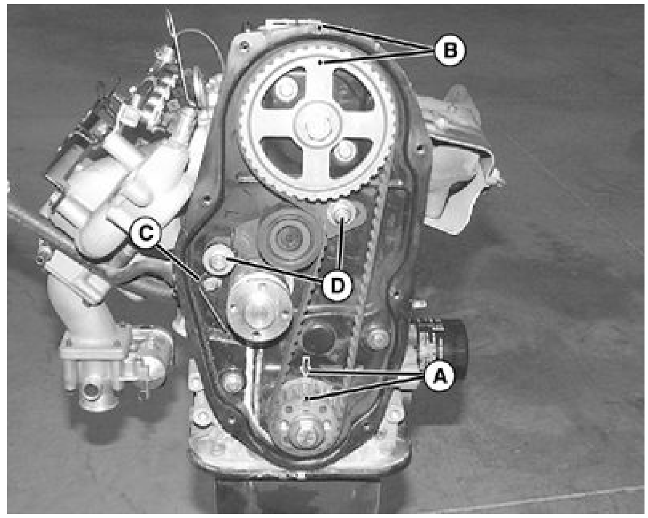
Timing Belt Installation—Gasoline

Installation

1. Inspect belt sprockets for wear or damage. Replace sprockets if worn or damaged.
2. Inspect belt tensioner for wear or damage. Tensioner should turn smoothly and quietly. Outside diameter of tensioner wheel should be smooth and clean. If any defects are found, replace tensioner.
3. Inspect camshaft and crankshaft oil seals for any sign of leakage. Inspect water pump for leakage. Any leaks should be repaired before installing a new belt.
4. Make sure engine crankshaft and camshaft sprocket timing marks and arrows (A) and (B) are aligned as shown.

NOTE: Once timing belt has been installed, engine should be turned only in a clockwise direction as viewed from the front (timing belt) side of engine.

5. Install timing belt. Make sure all marks are still aligned and right side of belt has little or no slack.

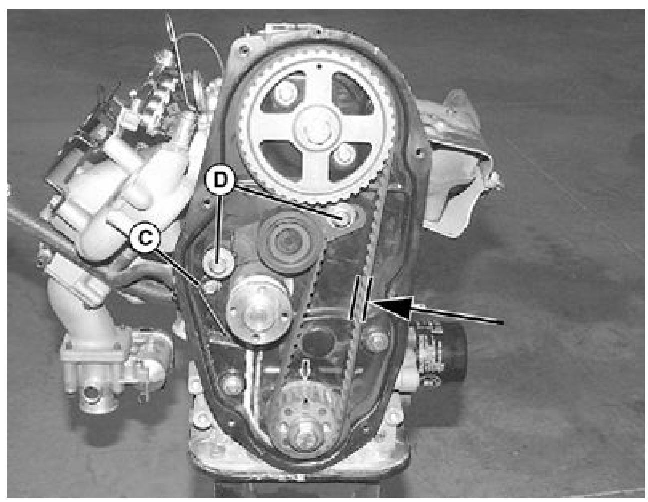


TCAL25981 —UN—15JUN12

A—Crankshaft Timing Alignment Marks
B—Camshaft Timing Alignment Marks
C—Timing Belt Tensioner Spring
D—Cap Screws Securing Timing Belt Tensioner Assembly

RB14256,0000A8B -19-18JUN12-1/3

6. Install tensioner with cap screws finger tight and attach short end of tensioner spring to tensioner bracket and long end to cap screw (C). Tensioner spring will automatically tension belt.
7. Rotate crankshaft clockwise two turns and line up all timing marks again.
8. Tighten tensioner cap screws to 18-28 N·m (160-247 lb-in.).
9. To double check belt tension apply **30 N (6.7 lb)** of finger pressure to belt about halfway between cam and crank sprockets (arrow). The belt should deflect **5.5 - 6.5 mm (0.2 - 0.25 in.)** with 30 N (6.7 lb) pressure. If it does not, loosen tensioner cap screws (D) and move tensioner assembly right for more tension or left for less tension. When proper tension is obtained tighten tensioner cap screws to **18-28 N·m (160-247 lb-in.)**.



TCAL25982 —UN—15JUN12

C—Timing Belt Tensioner Spring
D—Cap Screws Securing Timing Belt Tensioner Assembly

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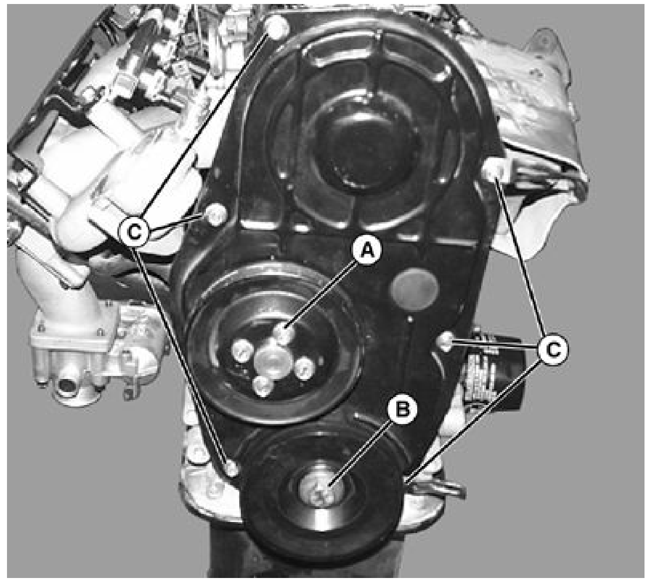
RB14256,0000A8B -19-18JUN12-2/3

10. Install the timing belt cover and secure with cap screws (C).
11. Install crankshaft pulley and tighten bolt (B) to specification.
12. Install the water pump pulley (A).
13. Install alternator belt and adjust belt tension.

Specification—Specification

Crankshaft Pulley Cap Screw	55—65 N·m (40—48 lb.-ft.)
Tensioner Cap Screws	18—28 N·m (160—247 lb.-in.)
Belt Cover Cap Screws	4—5 N·m (35—44 lb.-in.)



A—Cap Screws Securing Water Pump Pulley
B—Cap Screw Securing Crankshaft Pulley
C—Six Cap Screws Securing Timing Cover

RB14256,0000A8B -19-18JUN12-3/3

Remove Engine—Gasoline

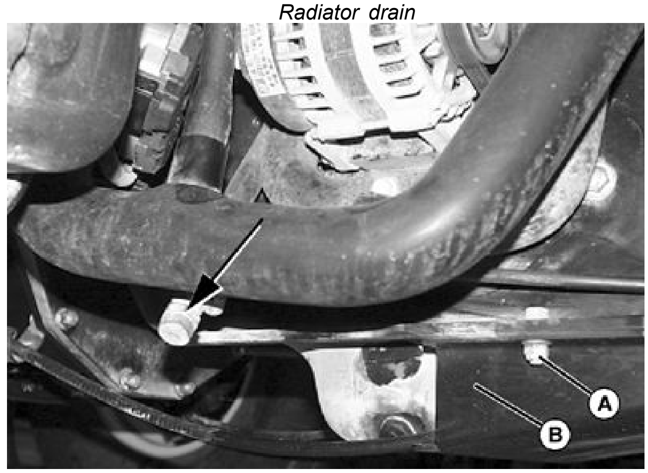
Removal

CAUTION: USE CAUTION AROUND MOVING PARTS. STOP engine. Remove ignition key. Wait for all moving parts to STOP.

1. Park machine safely.
2. Remove cargo box or any attachments that may be limiting engine access.
3. Disconnect negative (-) cable from the battery.
4. Drain coolant from radiator and engine block.
5. Remove nut and bolt (A) from each side of skid plate (B) and remove skid plate.

A—Nut and Bolt
B—Skid Plate

Radiator drain



Engine block coolant drain (Arrow)

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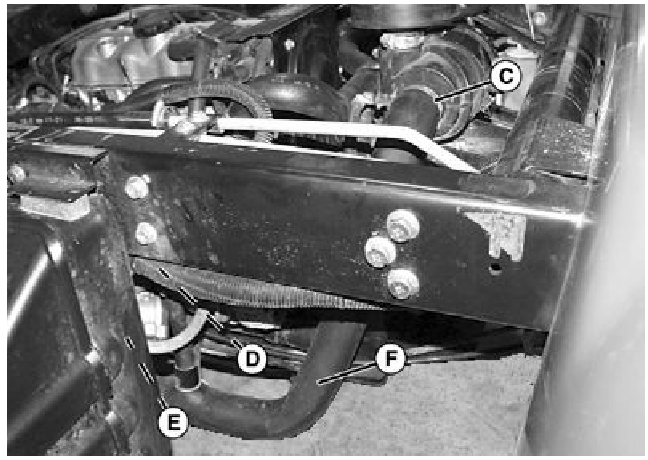
RB14256,0000A8C -19-18JUN12-1/18

IMPORTANT: Cap or plug intake to prevent debris from entering the engine.

6. Loosen clamps at (C) air cleaner, (D) PCV junction, and (E) throttle body. Disconnect and remove air intake tube (F).

C—Clamp at Air Cleaner
D—PCV Junction
E—Throttle Body
F—Air Intake Tube

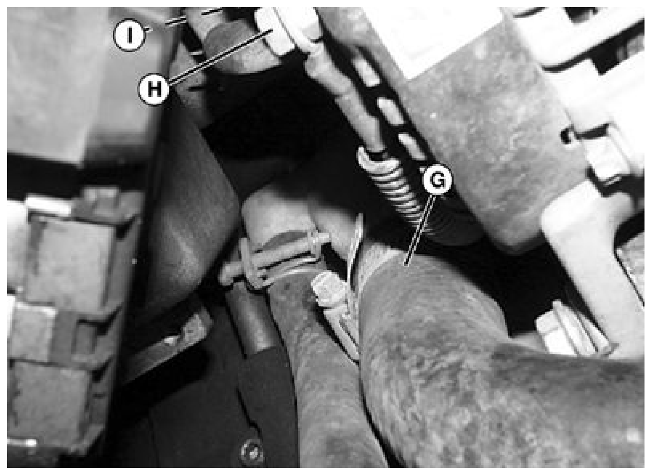


TCAL25986 —UN—15JUN12

RB14256,0000A8C -19-18JUN12-2/18

7. Loosen clamp and remove lower coolant hose (G) from engine block outlet.
8. Disconnect large positive wire (H) and plug (I) from alternator.

G—Lower Coolant Hose and Clamp
H—Large Positive Wire at Alternator
I— Alternator



TCAL25987 —UN—15JUN12

RB14256,0000A8C -19-18JUN12-3/18

9. Remove three screws (J) and front cover.

J—Three Screws Securing Front Cover

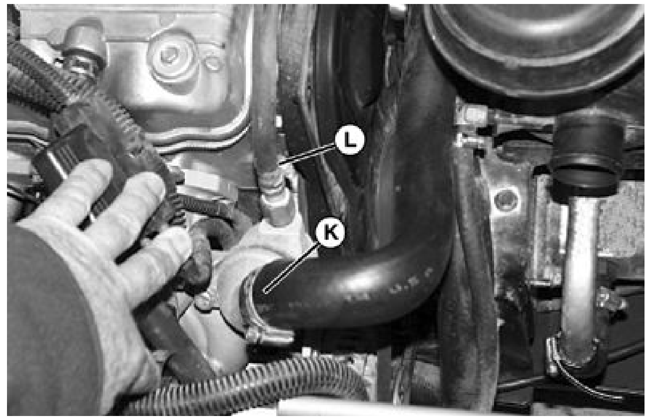
TCAL25988 —UN—15JUN12

Continued on next page

RB14256,0000A8C -19-18JUN12-4/18

10. Remove upper coolant hose (K) and coolant bypass hose (L) from thermostat housing.

K—Upper Radiator Hose
L—Coolant Bypass Hose

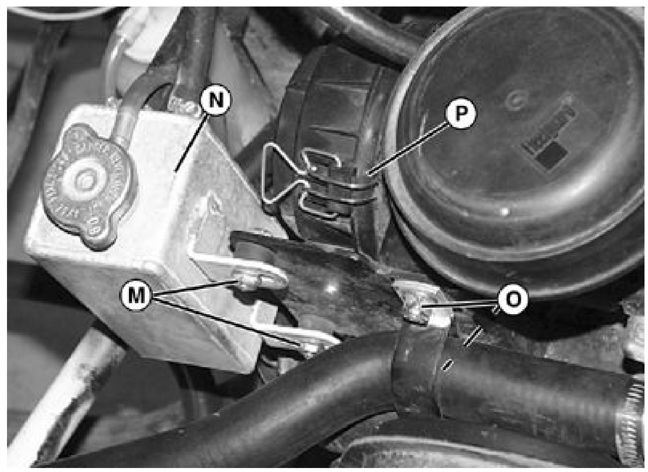


TCAL25989 —UN—15JUN12

RB14256,0000A8C -19-18JUN12-5/18

11. Remove two nuts (M) and remove coolant tank (N).
12. Remove two cap screws and nuts (O) and remove air cleaner assembly (P).

M—Two Nuts Securing Coolant Tank
N—Coolant Tank
O—Two Cap Screws and Nuts Securing Air Cleaner Assembly
P—Air Cleaner Assembly

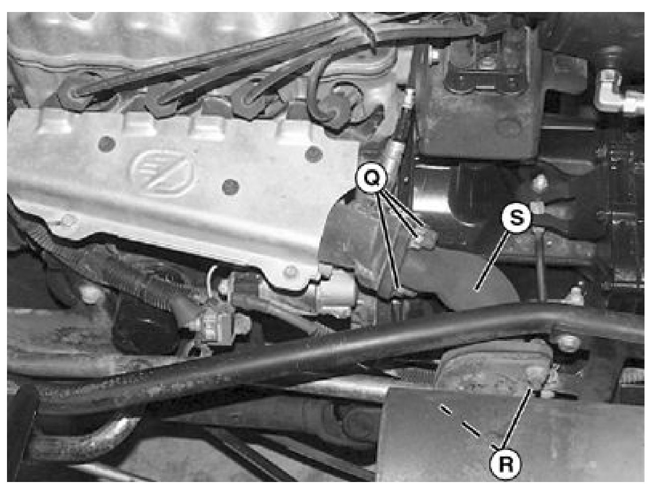


TCAL25990 —UN—15JUN12

RB14256,0000A8C -19-18JUN12-6/18

13. Remove three nuts (Q) securing the exhaust pipe to the exhaust manifold and the two cap screws (R) securing exhaust pipe to muffler. Remove exhaust pipe (S).

Q—Three Nuts Securing Exhaust Pipe to Exhaust Manifold
R—Two Cap Screws Securing Exhaust Pipe to Muffler
S—Exhaust Pipe



TCAL25991 —UN—15JUN12

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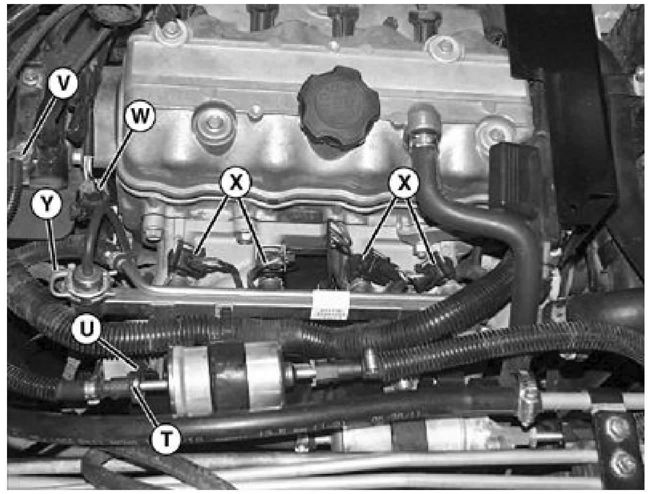
RB14256,0000A8C -19-18JUN12-7/18

CAUTION: Gasoline is extremely flammable. DO NOT SMOKE. Always work in a well-ventilated area away from open flame or spark-producing equipment, including equipment that utilizes pilot lights.

14. Wrap a shop cloth around connector to contain spilled fuel and disconnect fuel hose (T) from fuel filter outlet. Disconnect fuel return hose (U). Plug ends of fuel hoses and filter.

NOTE: Mark fuel injector wire connectors and injectors with indelible ink or write down wire colors before disconnecting to assure reconnection to the proper injector.

15. Disconnect coil connector (V), EGO connector (W), fuel injector connectors (X) and TMAP sensor connector (Y).



TCAL25992 —UN—15JUN12

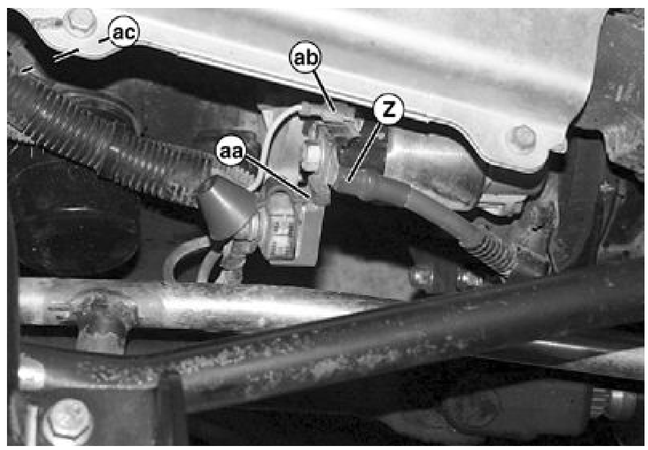
T—Fuel Hose From Fuel Filter Outlet
U—Fuel Return Hose
V—Coil Connnector
W—EGO Connector
X—Fuel Injector Connector
Y—TMAP Sensor Connector

RB14256,0000A8C -19-18JUN12-8/18

16. Disconnect positive (+) battery cable (Z), machine feed (aa), and solenoid exciter wire (ab) from starter solenoid.

17. Disconnect oil pressure sensor (ac).

Z—Positive (+) Battery Cable
aa— Machine Feed Wire
ab— Solenoid Exciter Wire



TCAL25993 —UN—15JUN12

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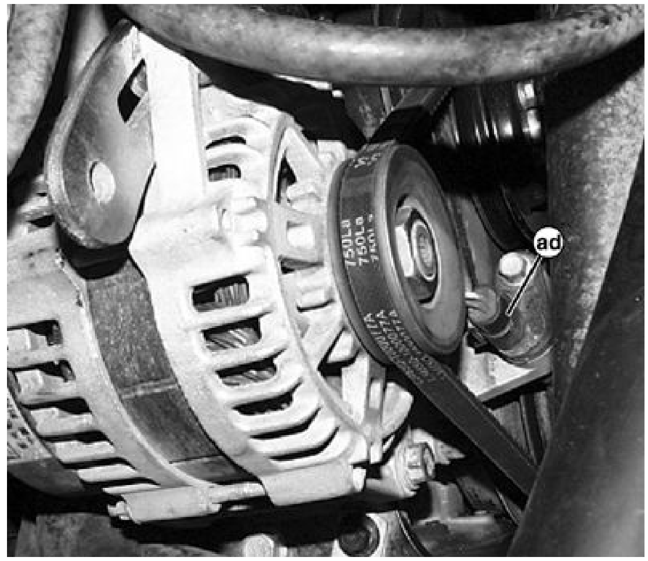
RB14256,0000A8C -19-18JUN12-9/18

18. Disconnect crankshaft position sensor (ad).

ad— Crankshaft Position Sensor

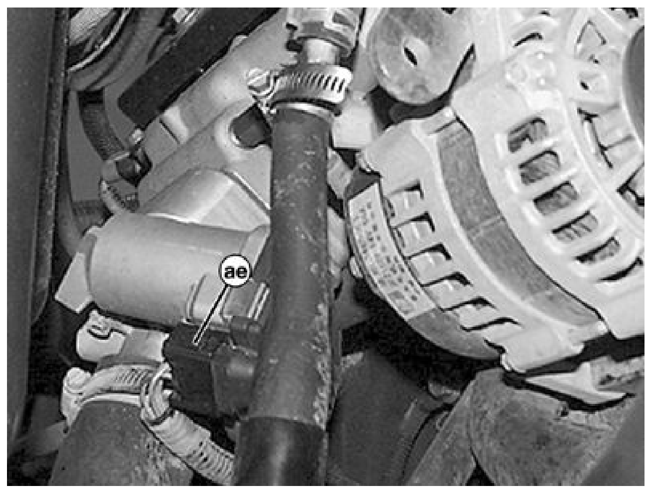


TCAL25994 —UN—15JUN12

RB14256,0000A8C -19-18JUN12-10/18

19. Disconnect throttle body connector (ae).

ae— Throttle Body Connector

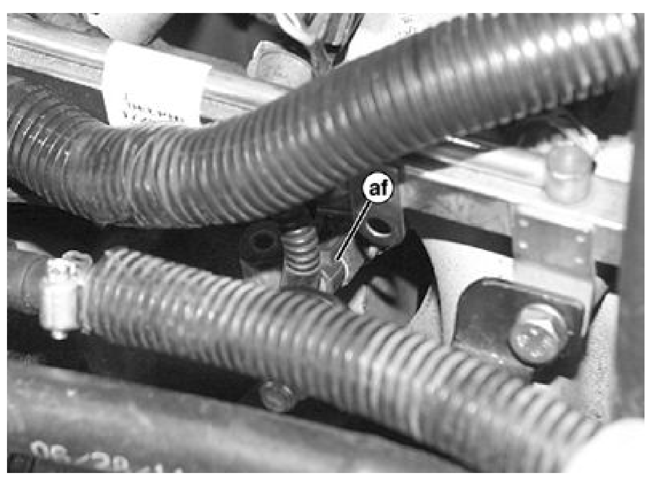


TCAL25995 —UN—15JUN12

RB14256,0000A8C -19-18JUN12-11/18

20. Disconnect coolant temperature sensor (af).

af— Coolant Temperature Sensor



TCAL25996 —UN—15JUN12

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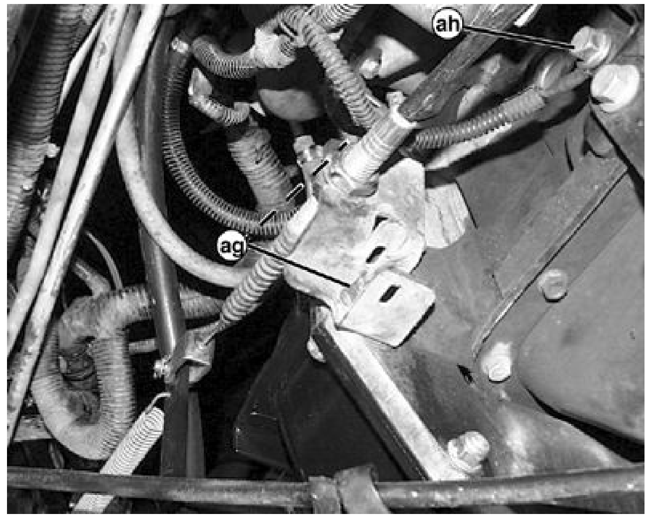
RB14256,0000A8C -19-18JUN12-12/18

21. Remove cap screws and nuts (ag) and slide clutch cable bracket away from engine.
22. Remove cap screw (ah) to disconnect ground wire from engine block.
23. Disconnect any wiring harness clamps and maneuver the wire harness clear of the engine bay.

ag— **Cap Screws and Nuts Securing Clutch Cable Bracket**

ah— **Cap Screw Securing Ground cable to Engine Block**

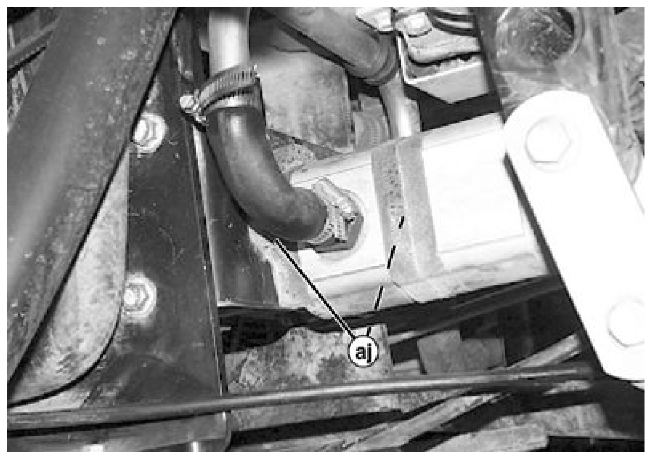


TCAL25997 —UN—15JUN12

RB14256,0000A8C -19-18JUN12-13/18

24. Remove cap screw and nut (aj) on each side of hydraulic pump.

aj— **Cap Screw and Nut at Each Side of Hydraulic Pump**

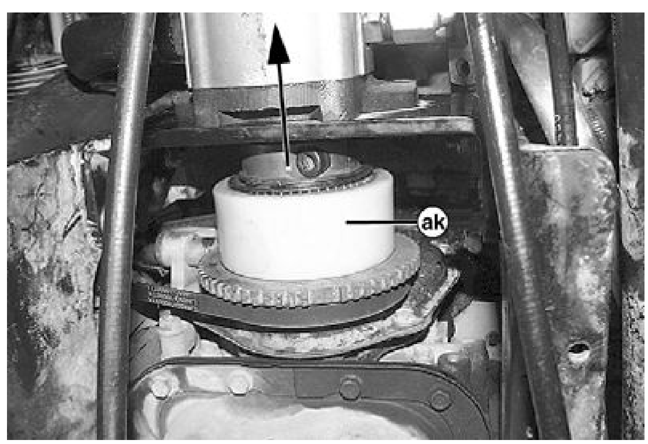


TCAL25998 —UN—15JUN12

RB14256,0000A8C -19-18JUN12-14/18

25. Slide hydraulic pump and bracket away from engine until coupler (ak) can be disconnected from engine drive.

ak— **Coupler Underneath Hydraulic Pump and Bracket**



TCAL25999 —UN—15JUN12

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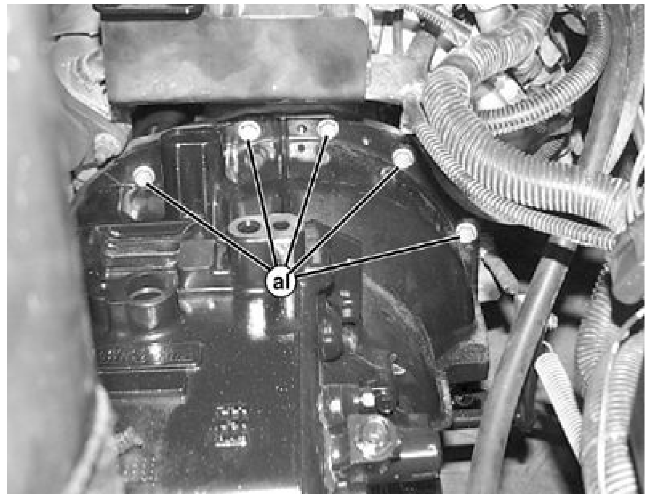
RB14256,0000A8C -19-18JUN12-15/18

26. Support front of transaxle and support engine with hoist while removing cap screws (al) from bell housing.

al— Cap Screws Securing Top of Bell Housing

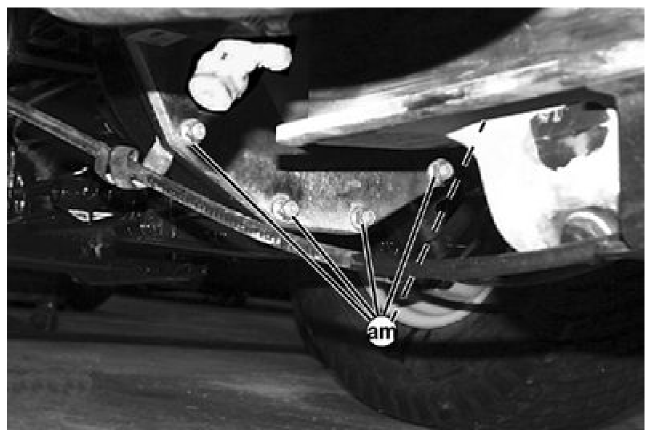


TCAL26000 —UN—15JUN12

RB14256,0000A8C -19-18JUN12-16/18

27. Remove remaining bell housing cap screws and nuts (am).

am—Cap Screws Securing Bottom of Bell Housing

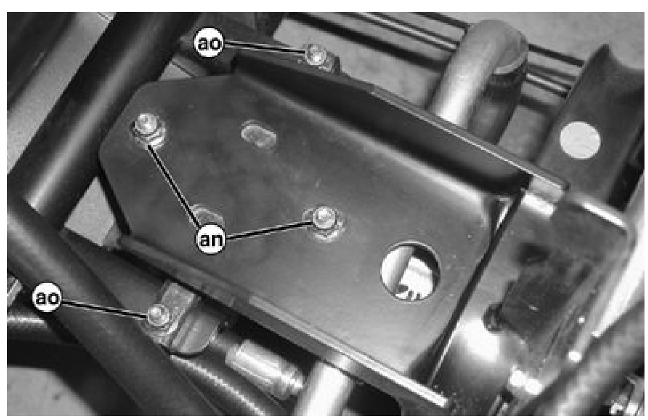


TCAL26001 —UN—15JUN12

RB14256,0000A8C -19-18JUN12-17/18

28. Remove cap screws and nuts (an) and (ao) from engine isolator.
29. Raise engine slightly and remove isolator.
30. Slide engine forward until clutch cover will clear blousing. Carefully turn and raise engine from machine.

an— Cap Screws and Nuts Securing Engine Isolator
ao— Engine Isolator



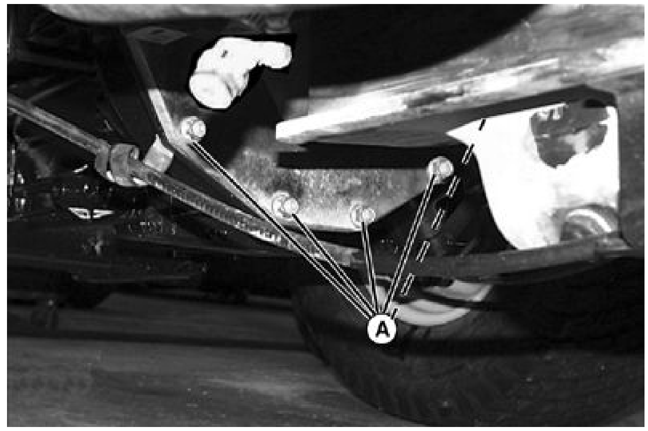
TCAL26002 —UN—15JUN12

RB14256,0000A8C -19-18JUN12-18/18

Install Engine—Gasoline

1. Carefully lower engine into machine.
2. Install bell housing cap screws and nuts (A).

A—Bell Housing Cap Screws

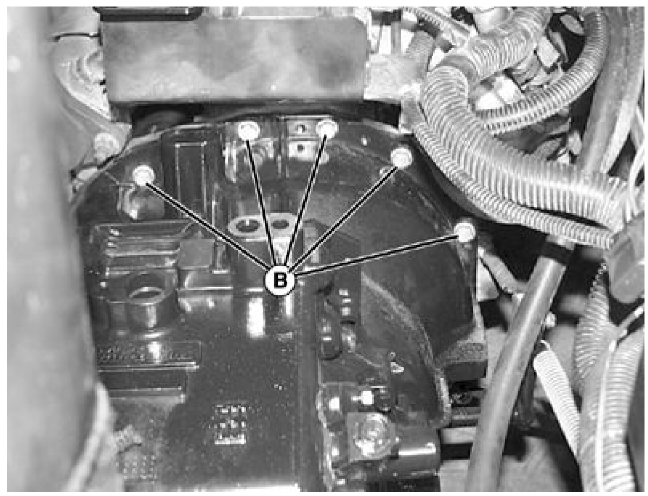


TCAL26003 —UN—15JUN12

RB14256,0000A8D -19-18JUN12-1/18

3. Install cap screws (B) to top of bell housing.

B—Bell Housing Cap Screws Top



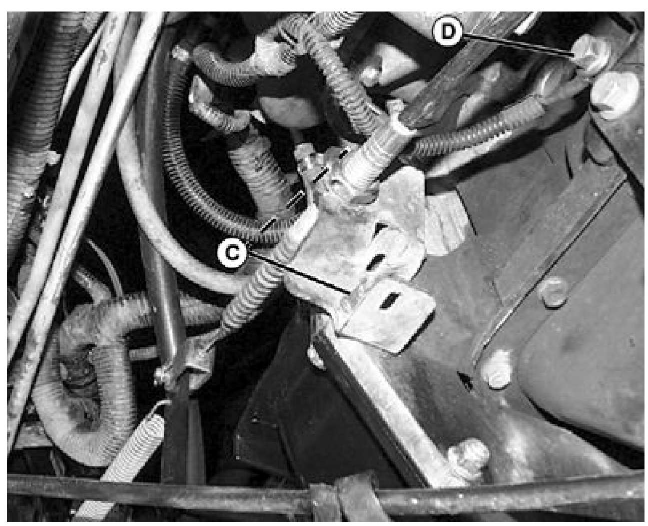
TCAL26004 —UN—15JUN12

RB14256,0000A8D -19-18JUN12-2/18

4. Position clutch cable bracket on engine and secure with cap screws and nuts (C).
5. Connect ground wire to engine block with cap screw (D).

C—Clutch Cable Bracket

D—Cap Screw Securing Ground Wire to Engine Block



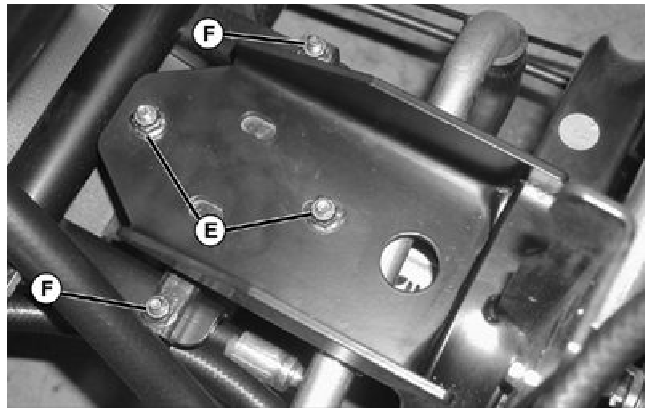
TCAL26005 —UN—15JUN12

Continued on next page

RB14256,0000A8D -19-18JUN12-3/18

6. Raise engine if necessary and install engine isolator with cap screws and nuts (E) and (F).

E—Cap Screws Securing Engine Isolator
F—Engine Isolator

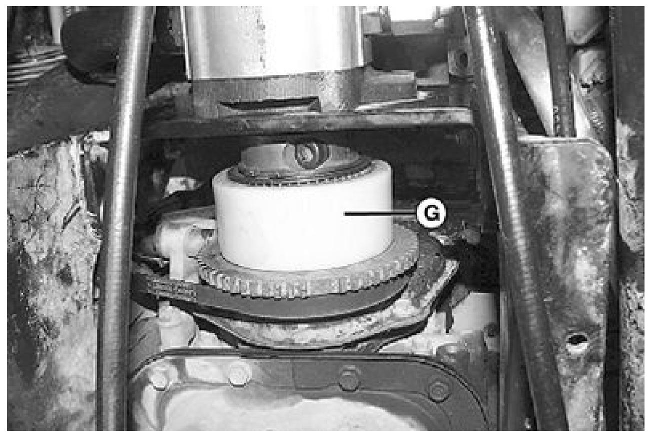


TCAL26006 —UN—15JUN12

RB14256,0000A8D -19-18JUN12-4/18

7. Install coupler (G) onto engine drive.

G—Coupler to Engine Drive

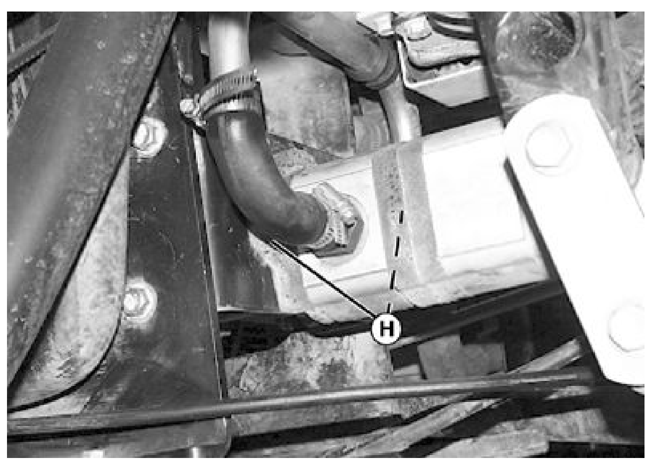


TCAL26007 —UN—15JUN12

RB14256,0000A8D -19-18JUN12-5/18

8. Install hydraulic pump with two cap screws and nuts (H).

H—Cap Screws Securing Hydraulic Pump



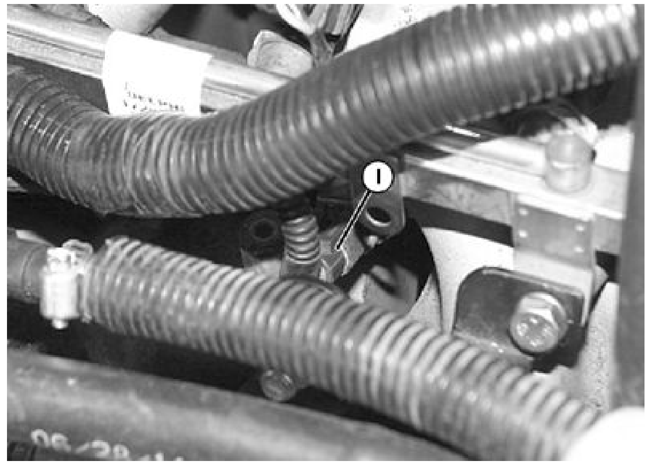
TCAL26008 —UN—15JUN12

Continued on next page

RB14256,0000A8D -19-18JUN12-6/18

9. Connect coolant temperature sensor (I).

I— Coolant Temperature Sensor

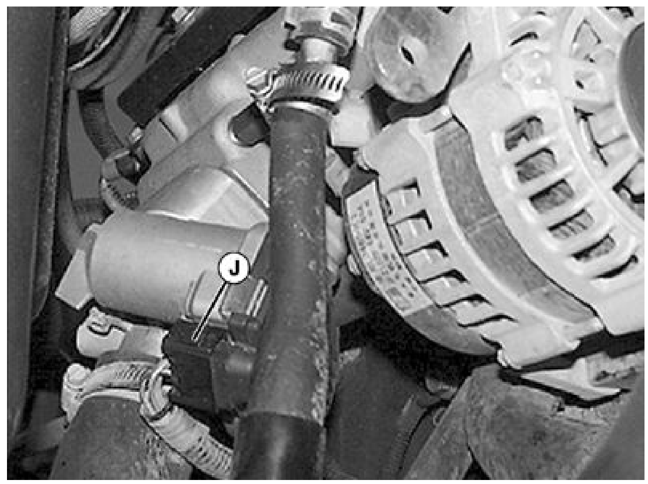


TCAL26009 —UN—15JUN12

RB14256,0000A8D -19-18JUN12-7/18

10. Connect throttle body connector (J).

J— Throttle Body Connector

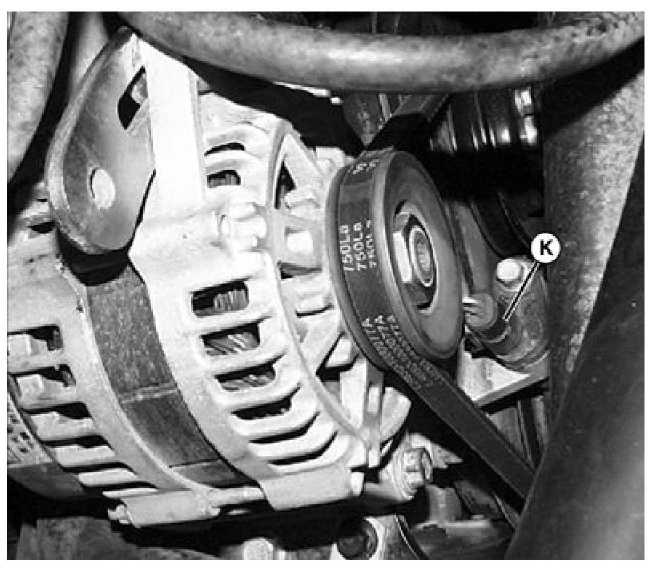


TCAL26010 —UN—15JUN12

RB14256,0000A8D -19-18JUN12-8/18

11. Connect crankshaft position sensor (K).

K—Crankshaft Position Sensor

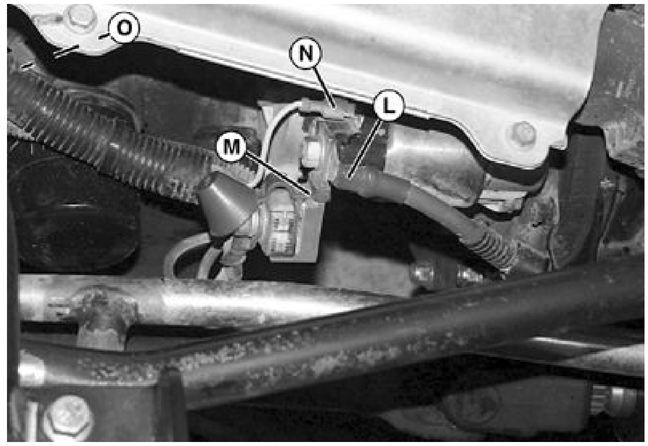


TCAL26011 —UN—15JUN12

Continued on next page

RB14256,0000A8D -19-18JUN12-9/18

12. Connect positive (+) battery cable (L), machine feed (M), and solenoid exciter wire (N) to starter solenoid.
13. Connect oil sending unit (O).



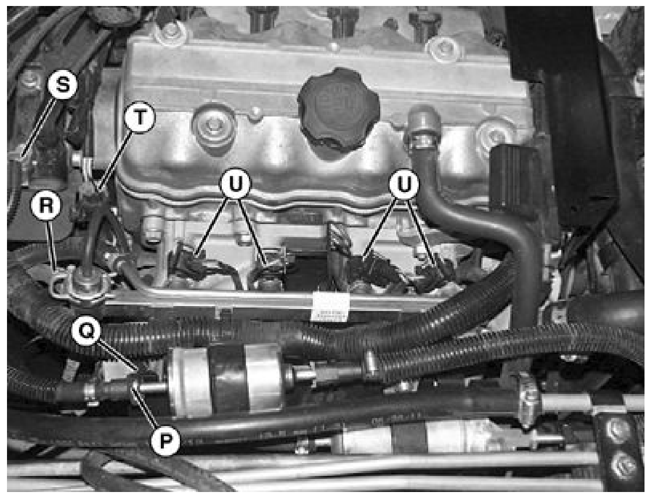
TCAL26012 —UN—15JUN12

L—Positive (+) Battery Cable
M—Machine Feed Wire
N—Solenoid Exciter Wire
O—Oil Sending Unit

RB14256,0000A8D -19-18JUN12-10/18

CAUTION: Gasoline is extremely flammable. DO NOT SMOKE. Always work in a well-ventilated area away from open flame or spark-producing equipment, including equipment that utilizes pilot lights.

14. Connect fuel hose (P) to fuel filter outlet. Connect fuel return hose (R).
15. Connect coil connector (S), EGO connector (T), fuel injector connectors (U) and TMAP sensor connector (Q).

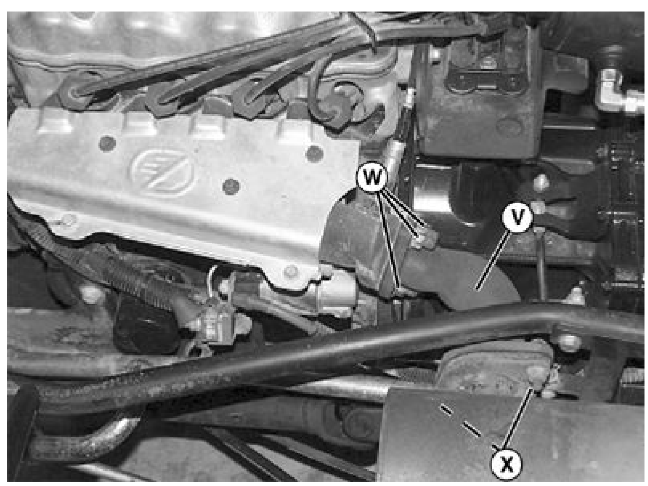


TCAL26013 —UN—15JUN12

P—Fuel Hose to Fuel Filter Oultet
Q—TMAP Sensor Connector
R—Fuel Return Hose
S—Coil Connector
T—EGO Connector
U—Fuel Injector Connectors

RB14256,0000A8D -19-18JUN12-11/18

16. Install exhaust pipe (V). Secure with three nuts (W) and the two cap screws (X).



TCAL26014 —UN—15JUN12

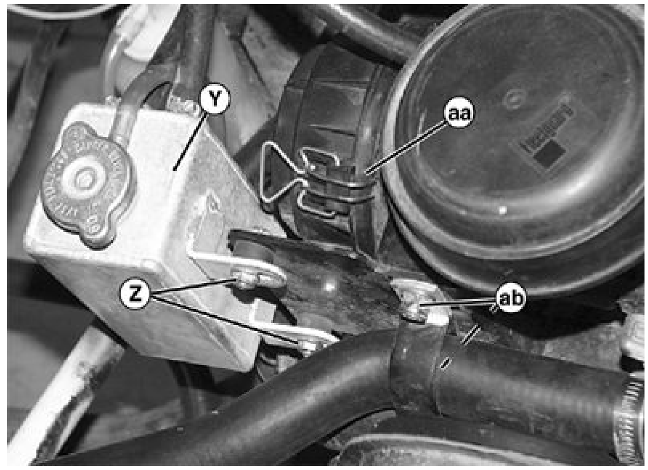
V—Exhaust Pipe
W—Three Nuts Securing Exhaust Pipe
X—Two Cap Screws Securing Exhaust Pipe

Continued on next page

RB14256,0000A8D -19-18JUN12-12/18

17. Install coolant tank (Y) and secure with nuts (Z).
18. Install air cleaner assembly (aa) and secure with two cap screws and nuts (ab).

Y—Coolant Tank
Z—Nuts Securing Coolant Tank
aa—Air Cleaner Assembly
ab—Cap Screws and Nuts Securing Air Cleaner Assembly

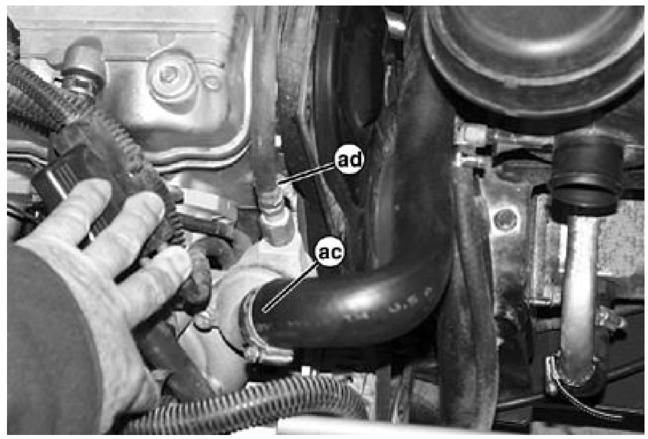


TCAL26015 —UN—15JUN12

RB14256,0000A8D -19-18JUN12-13/18

19. Install upper coolant hose (ac) and coolant bypass hose (ad) to thermostat housing.

ac—Upper Coolant Hose
ad—Coolant Bypass Hose

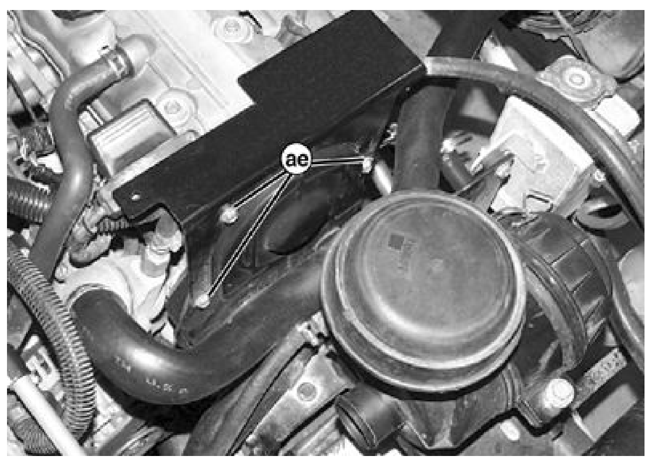


TCAL26016 —UN—15JUN12

RB14256,0000A8D -19-18JUN12-14/18

20. Install front cover with three screws (ae).

ae—Three Screws Securing Front Cover



TCAL26017 —UN—15JUN12

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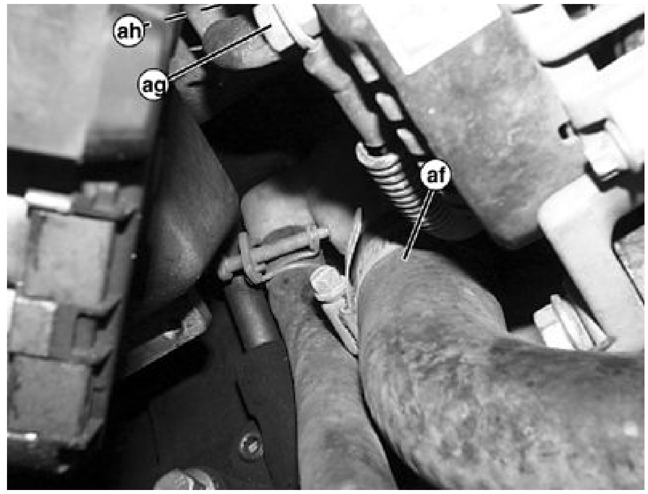
RB14256,0000A8D -19-18JUN12-15/18

21. Install lower coolant hose (af) to engine block outlet.
22. Install large positive wire (ag) and plug (ah) to alternator.

af— Lower Coolant Hose to Engine Block
ag— Large Positive (+) Wire Connected to Alternator
ah— Plug Installed to Alternator



TCAL26018 —UN—15JUN12

RB14256,0000A8D -19-18JUN12-16/18

23. Install air intake tube (ah).

ah— Air Intake Tube Installed

TCAL26019 —UN—15JUN12

Continued on next page

RB14256,0000A8D -19-18JUN12-17/18

24. Install plug in engine block drain and close radiator petcock. Fill engine with approved coolant to proper level.
25. Install skid plate (ai) with cap screw and nut (aj) on each side.

Specifications—Specification

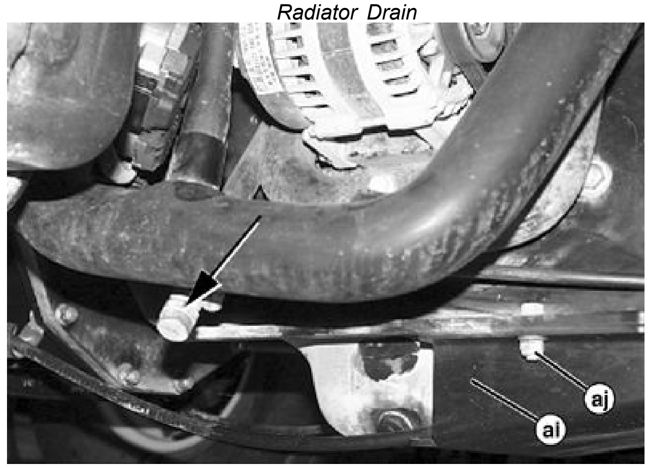
Subframe to Engine Mounting Cap Screw Torque M8	26—31 N·m (19—23 lb.-ft.)
Subframe to Engine Mounting Cap Screw Torque M10	43—49 N·m 32—36 lb.-ft.)

ai— Skid Plate

aj— Cap Screw and Nut Securing Skid Plate

TCAL26020 —UN—15JUN12

Radiator Drain



TCAL26021 —UN—15JUN12

Engine block coolant drain (Arrow)

RB14256,0000A8D -19-18JUN12-18/18

Remove and Install Clutch and Flywheel—Gasoline

RB14256,0000A8E -19-18JUN12-1/8

Clutch Alignment Tool.. JDG1331

Used to align clutch disc.

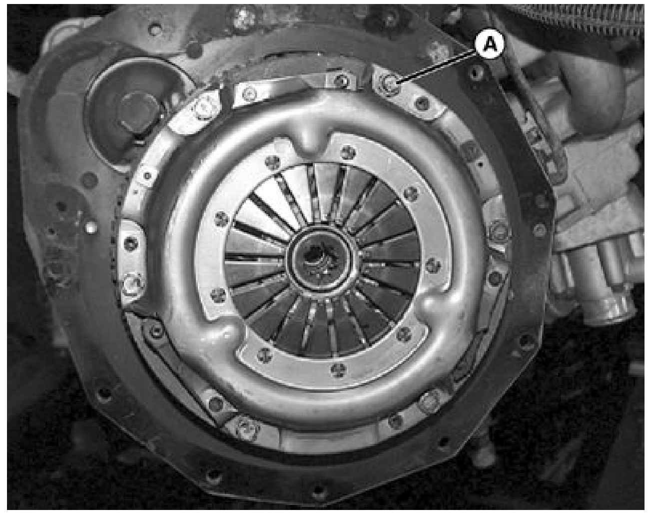
Continued on next page

RB14256,0000A8E -19-18JUN12-2/8

Removal

1. Access clutch by either removing the transaxle or removing the engine. (See Remove and Install Transaxle.)
2. Alternately loosen six cap screws (A) on clutch cover.

A—Cap Screws Securing Clutch Cover

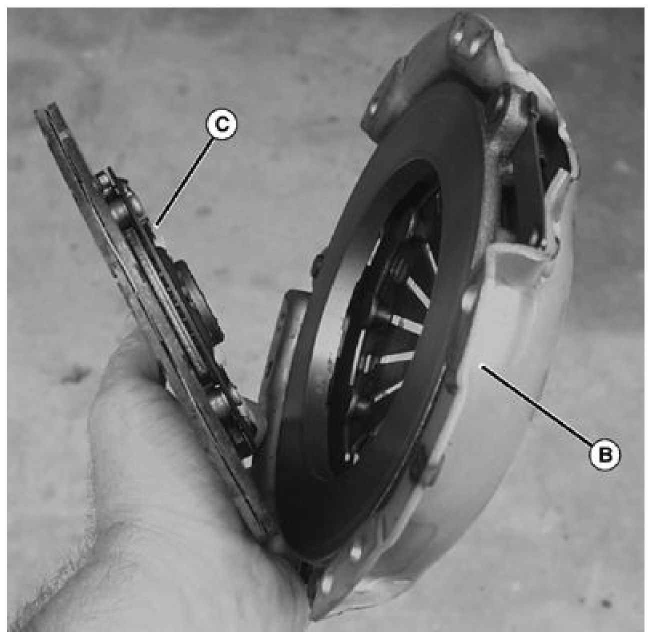


TCAL26022 —UN—15JUN12

RB14256,0000A8E -19-18JUN12-3/8

3. Remove clutch cover (B) and clutch disk (C) from flywheel.

B—Clutch Cover **C—Clutch Disk**



TCAL26023 —UN—15JUN12

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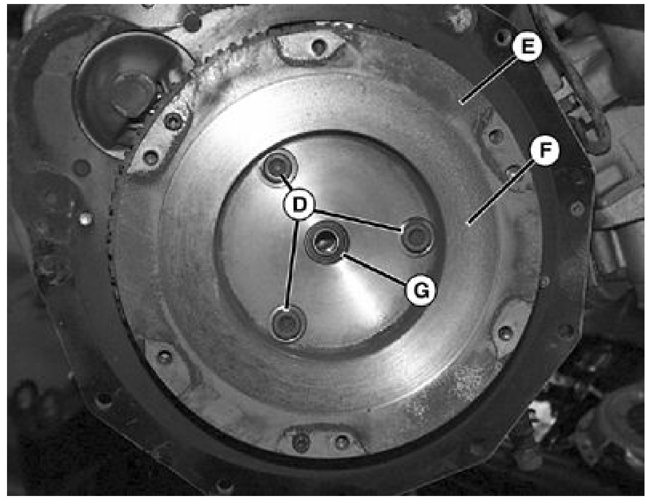
RB14256,0000A8E -19-18JUN12-4/8

4. Remove three socket head cap screws (D) and flywheel adapter plate.
5. Inspect flywheel adapter for cracks or grooves on clutch wear area (F). Check pilot bearing (G) for smooth operation. Replace any worn or damaged parts.

D—Three Socket Head Cap Screws
E—FlyWheel Adapter Plate
F—Clutch Wear Area
G—Pilot Bearing

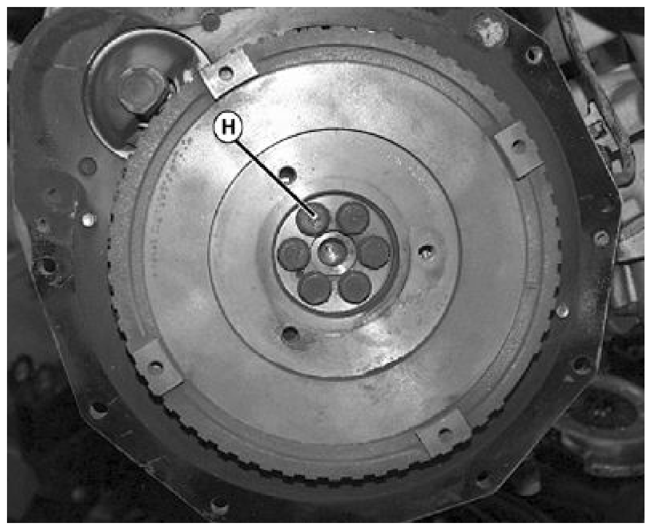


TCAL26024 —UN—15JUN12

RB14256,0000A8E -19-18JUN12-5/8

6. Remove six cap screws (H) and remove flywheel.

H—Six Cap Screws Securing Flywheel

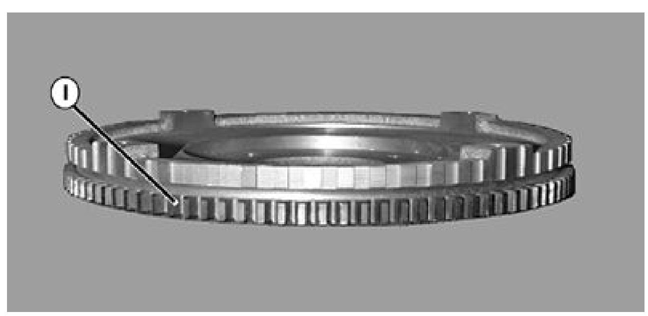


TCAL26025 —UN—15JUN12

RB14256,0000A8E -19-18JUN12-6/8

7. Check ring gear (I) for chips and broken teeth. Replace if worn or damaged.

I— Ring Gear Inspection Area



TCAL26026 —UN—15JUN12

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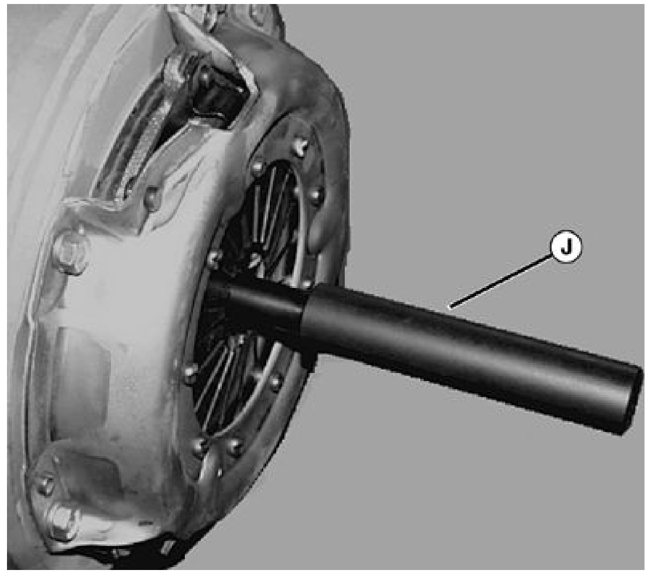
RB14256,0000A8E -19-18JUN12-7/8

Installation

1. Make sure flywheel, crankshaft, and flywheel adapter mating surfaces are clean.
2. Install flywheel and tighten cap screws to specification.
3. Install flywheel adapter and tighten cap screws to specification.
4. Install clutch disk with raised side of hub toward clutch cover. Install clutch cover. Do not tighten cap screws.
5. Using JDG1331 Clutch Alignment Tool (J) or an equivalent, align clutch disk and alternately tighten clutch cover cap screws to specification.

Specifications—Specification

Flywheel Cap Screw Torque	43 N·m (32 lb.-ft.)
Clutch Adapter Plate to Flywheel	61 N·m (45 lb.-ft.)
Clutch Cover Cap Screw Torque	23 N·m (200 lb.-in.)



TCAL26027 —UN—15JUN12

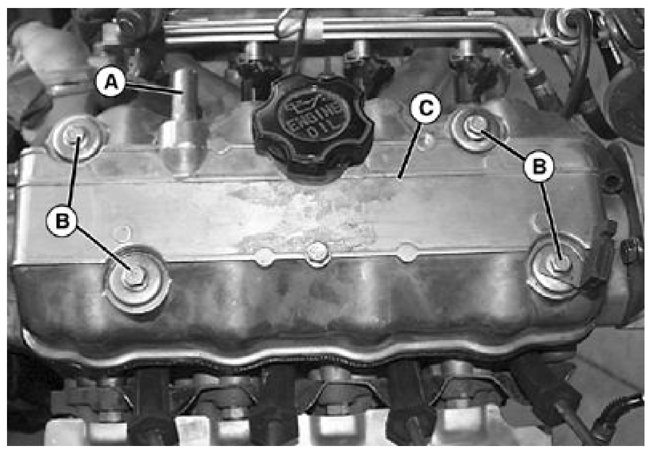
J— JDG1331 Clutch Alignment Tool

RB14256,0000A8E -19-18JUN12-8/8

Remove and Install Rocker Arm Cover—Gasoline

1. Remove crankcase breather tube from breather fitting (A) on rocker cover.
2. Remove the four special cap screws (B) securing cover to cylinder head.
3. Remove rocker cover (C).

A—Crankcase Breather Tube
B—Four Special Cap Screws Securing rocker Cover to Head
C—Rocker Cover

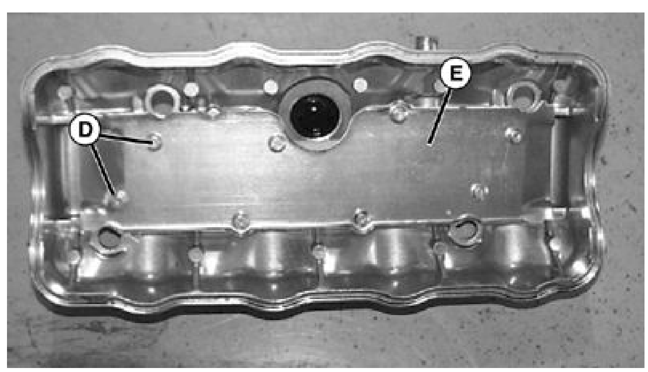


TCAL26028 —UN—15JUN12

RB14256,0000A8F -19-18JUN12-1/3

4. Remove eight cap screws (D) and baffle cover (E).

D—Eight Cap Screws Securing Baffle Cover
E—Baffle Cover



TCAL26029 —UN—15JUN12

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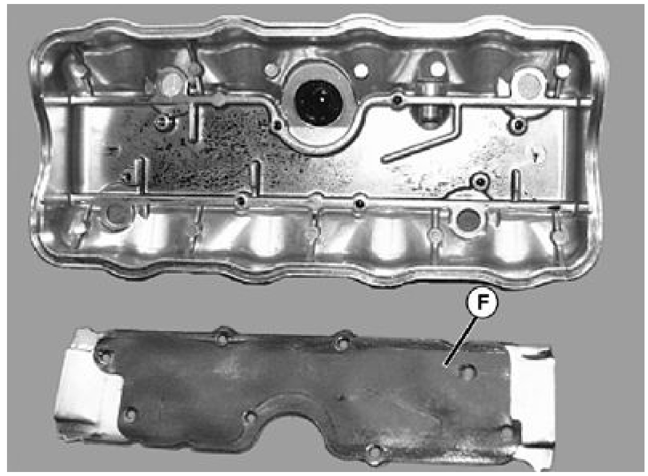
RB14256,0000A8F -19-18JUN12-2/3

5. Clean all parts and remove gasket (F).

Assembly

Assemble in the reverse order of disassembly.

- Install new gasket and breather cover.
- Install new gasket on rocker arm cover and install cover.
- Tighten cap screws to specification.



TCAL26030 —UN—15JUN12

F—Remove Gasket From Baffle Cover

Item	Measurement	Specification
Specifications		
Rocker Cover Cap Screw Torque		6—8 N·m (53—70 lb.-in.)

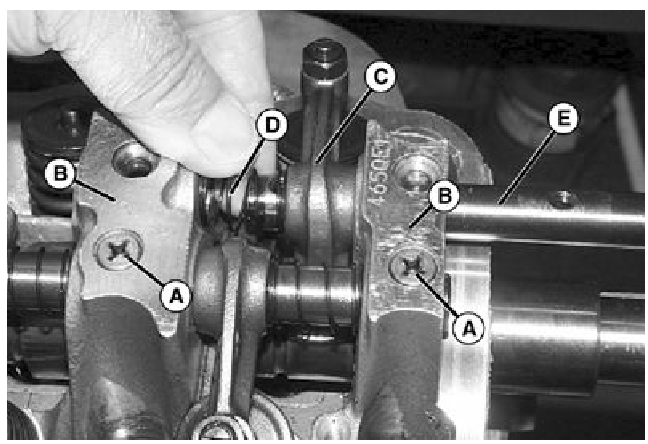
RB14256,0000A8F -19-18JUN12-3/3

Remove Rocker Arms and Push Rods—Gasoline

1. Remove rocker arm cover. (See Remove and Install Rocker Arm Cover—Gasoline.)
2. Remove camshaft end cover from back of cylinder head.
3. Mark location of all parts before disassembly to aid in reassembly.
4. Loosen all rocker arm adjusting jam nuts and back out adjustment screws until there is no pressure on valve train.
5. Remove screws (A) from rocker arm shaft supports (B). Retain rocker arms (C) and springs (D) as rocker shaft (E) is slowly pulled out of cylinder head. Place parts in order on the workbench so they can be assembled in their original positions.
6. Clean and inspect all parts. Replace worn parts.

Specifications—Specification

Rocker Arm Shaft OD ....14.965—14.980 mm (0.589—0.590 in.)



TCAL26031 —UN—15JUN12

There are two rocker arm shafts. Photo shows exhaust side shaft being removed.

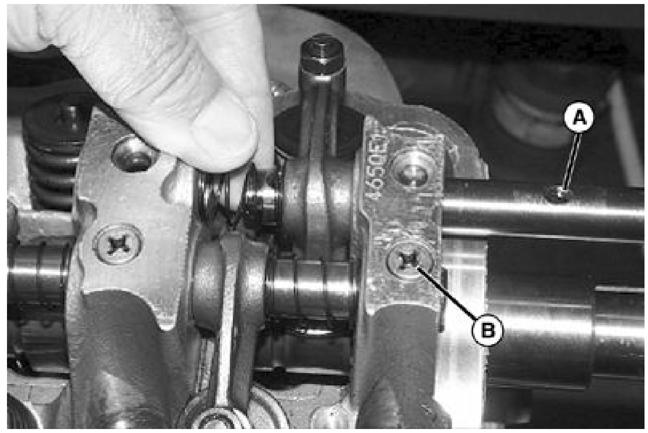
Rocker Arm ID ....14.985—15.005 mm (0.590—0.591 in.)

Rocker Arm-to-Shaft Oil Clearance ....0.005—0.040 mm (0.0001—0.0015 in.)

RB14256,0000A90 -19-17JUN14-1/1

Install Rocker Arms—Gasoline

1. Make sure all rocker arm adjusting screws are backed out until the ends that contact the valves are even with the bottom of the rocker arm.
2. Slowly insert rocker shaft into cylinder head with threaded holes (A) facing straight up to align with holes in rocker arm supports.
3. Install rocker arms (in their original positions as marked) and springs as shaft is inserted.
4. Align threaded holes in shaft with holes in rocker arm supports and install screws (B).
5. Adjust valve clearance. (See Adjust Valve Clearance—Gasoline.)



TCAL26032 —UN—15JUN12

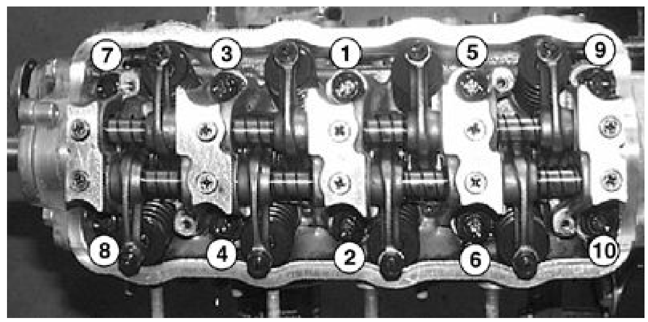
A—Rocker Arm Shaft Threaded Hole **B—Screw Securing Rocker Arm Shaft**

RB14256,0000A91 -19-17JUN14-1/1

Remove and Install Cylinder Head—Gasoline

Removal

1. Park machine safely.
2. Disconnect negative battery cable from battery.
3. Allow engine to cool and drain coolant.
4. Disconnect exhaust pipe from exhaust manifold.
5. Remove coolant hoses from intake manifold.
6. Disconnect fuel injector and coolant temperature sensor wires.
7. Disconnect spark plug wires from spark plugs.
8. Remove rocker arm cover. (See Remove and Install Rocker Arm Cover—Gasoline.)
9. Remove outer timing belt cover, timing belt, sprockets, and inner timing belt cover.
10. Loosen and remove cylinder head bolts in the sequence shown.



TCAL26033 —UN—15JUN12

11. Using lift brackets and hoist, pull head straight up from block.
12. Remove exhaust and intake manifolds. (See Remove and Install Intake Manifold—Gasoline.)
13. Disassemble and inspect cylinder head and valves. (See Recondition Cylinder Head—Gasoline.)

Continued on next page

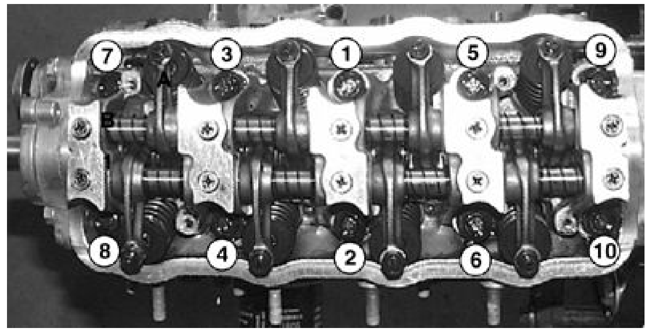
RB14256,0000A92 -19-17JUN14-1/2

Installation

1. Clean all threads in top of cylinder block with a flat bottom tap and blow debris from hole.
2. Clean top of cylinder block and check for flatness.

IMPORTANT: Oil port in gasket (A) must be located over oil passage in cylinder block.

3. Place a new cylinder head gasket on cylinder block with locating pins on front and rear of block inside holes in gasket.
4. Clean threads of cylinder head bolts (B) and dip in clean oil before installing. Install all bolts finger tight before tightening with wrench.
5. Tighten in sequence shown above in two steps of torque from specifications below.



TCAL26034 —UN—15JUN12

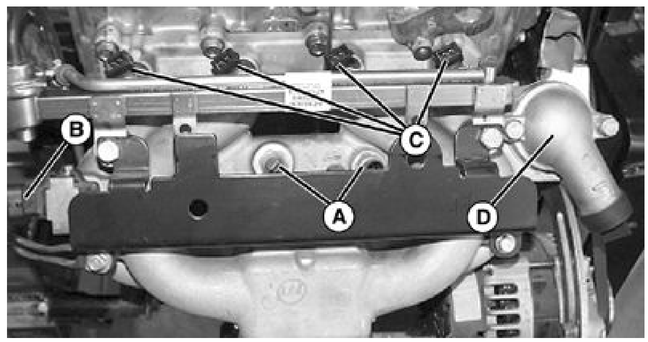
Specifications—Specification

Initial Torque	30.9 N·m (23 lb.-ft.)
Final Torque	43—45 N·m (33—35 lb.-ft.)

RB14256,0000A92 -19-17JUN14-2/2

Remove and Install Intake Manifold—Gasoline

1. Park machine safely.
2. Allow engine to cool and drain coolant.
3. Disconnect wiring from coolant temperature sensors (A), throttle body, TMAP sensor (B), and fuel injectors (C).
4. Disconnect coolant hose from thermostat housing (D).
5. Disconnect air intake hose from throttle body.



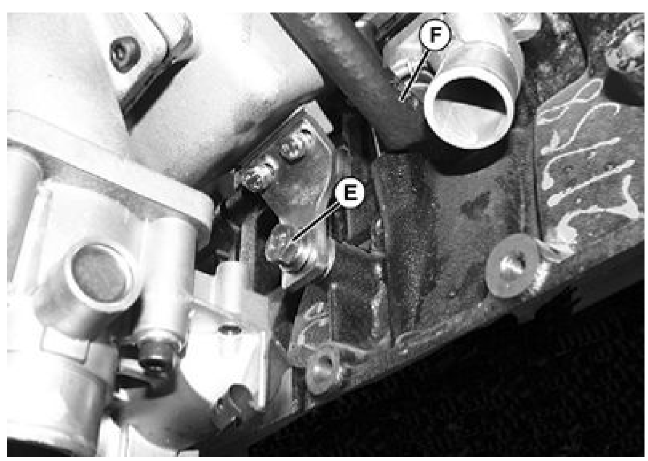
TCAL26035 —UN—15JUN12

A—Coolant Temperature Sensors
B—Throttle Body and TMAP Sensor
C—Fuel Injectors
D—Thermostat Housing

RB14256,0000A93 -19-17JUN14-1/3

6. Remove cap screw (E) from intake manifold support bracket.
7. Disconnect coolant hose (F) from engine coolant inlet.

E—Intake Manifold Support Bracket
F—Coolant Hose from Engine Coolant Inlet



TCAL26036 —UN—15JUN12

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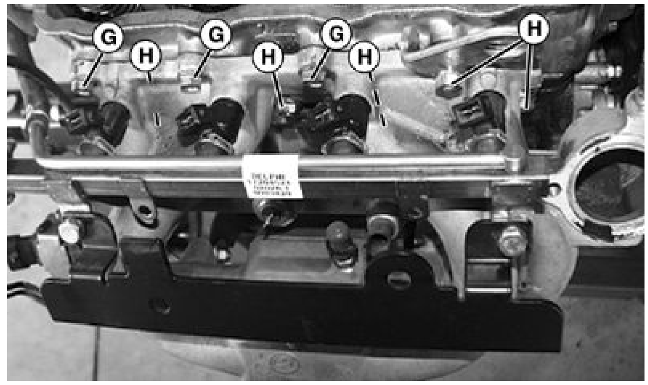
RB14256,0000A93 -19-17JUN14-2/3

8. Remove three intake manifold mounting cap screws (G) and five nuts (H) and remove intake manifold.
9. Remove gasket and clean mating surfaces. Check flange for flatness with straightedge. Check manifold for cracks or damage.
10. Install new gasket and install manifold on cylinder head.
11. Tighten all mounting cap screws to specification.

Specifications—Specification	
Intake Manifold Mounting Surface Warp Not to Exceed	0.10 mm (0.004 in.)
Intake Manifold Cap Screw Torque	21 N·m (185 lb.-in.)



G—Three Cap Screws Securing Intake Manifold
H—Five Nuts Securing Intake Manifold

RB14256,0000A93 -19-17JUN14-3/3

Recondition Cylinder Head—Gasoline

NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

- *JDE138 Valve Spring Compressor*
- *D20020WI Reaming Tool*

Disassembly

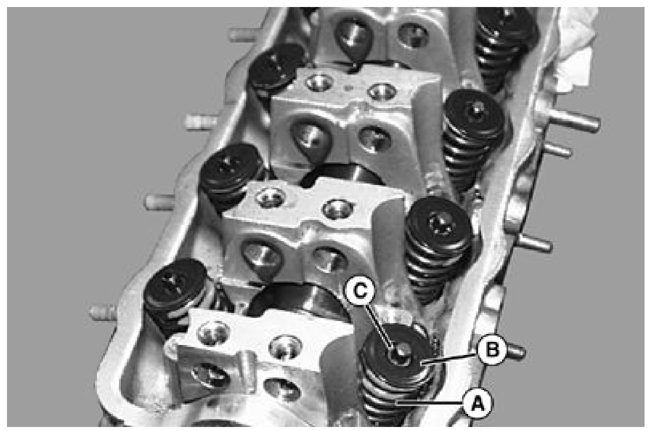
1. If not already done, remove intake and exhaust manifolds.
2. Remove rocker arms. (See Remove Rocker Arms and Push Rods—Gasoline.)
3. Compress valve springs (A) using JDE138 Valve Spring Compressor.

NOTE: It may be necessary to tap on valve spring retainer (B) while initially operating compressor to break retainer free from valve stem.

4. Remove collet halves (C) from valve or retainer.
5. Slowly release compressor and valve spring.
6. Remove valve spring retainer, valve spring, valve, and stem seal from cylinder head.
7. Intake and exhaust valve guides and seats are not replaceable.
8. Inspect all parts for wear or damage. Clean all carbon deposits and measure all parts for proper clearances.

Assembly

1. Lubricate valve stems.



A—Valve Spring
B—Valve Spring Retainer
C—Collet Halves

IMPORTANT: DO NOT reuse stem seals. Used seals will leak.

2. Install new stem seals.
3. Install valves.
4. Use valve spring compressor to compress spring and retainer, and install collets.
5. After each valve has been assembled, tap on top of valve stem with a plastic hammer to seat retainer.

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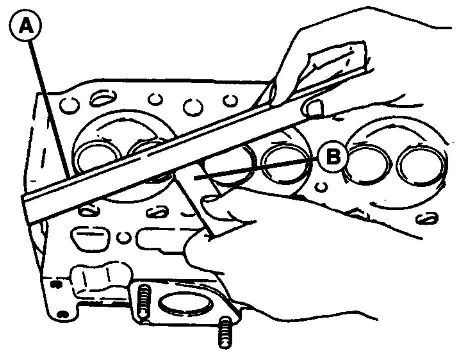
Cylinder Head

- Measure cylinder head flatness. Place a straightedge (A) along each of the four sides and each diagonal. Measure clearance between straightedge and surface between combustion chambers with a feeler gauge (B). If distortion exceeds the wear limit, resurface or replace cylinder head. Remove only enough metal to make cylinder head flat, but do not remove more than specification.

Specification

Cylinder Head Distortion—Out-of-Flat (Maximum)........ 0.10 mm (0.004 in.)



TCAL26039 —UN—15JUN12

A—Straight Edge **B—Feeler Gauge**

RB14256,0000A94 -19-17JUN14-2/12

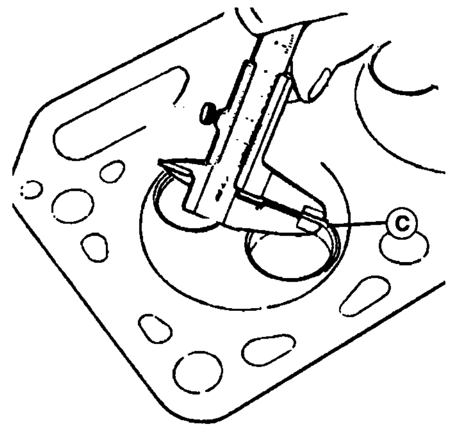
- Measure valve seat width (C).
- If necessary, grind valve seats to meet specifications. (See Valve Seat Grinding in Recondition Cylinder Head—Gasoline.)

Specification

Intake Valve Seat—Width (Maximum)........1.3—1.5 mm (0.051—0.059 in.)

Exhaust Valve Seat—Width (Maximum)........1.3—1.5 mm (0.051—0.059 in.)

C—Valve Seat Width



TCAL26040 —UN—15JUN12

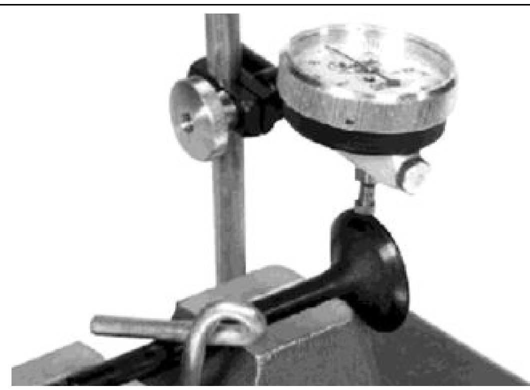
RB14256,0000A94 -19-17JUN14-3/12

Intake and Exhaust Valves

- Check valve for out-of-round, bent, or warped condition using a valve inspection center and dial indicator. Replace valve if runout exceeds specification.

Specification

Intake and Exhaust Valves —Axial Runout (Wobble)........ 0.03 mm (0.001 in.)



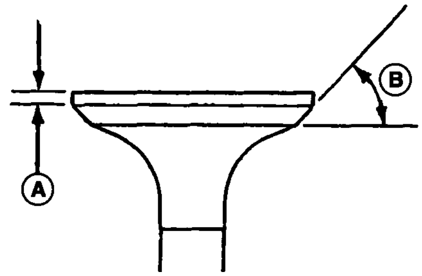
TCAL26041 —UN—15JUN12

Continued on next page RB14256,0000A94 -19-17JUN14-4/12

- If valve faces are worn, burned, or pitted, grind valves to proper face angle (B). If valve face margin (A) is less than specification after grinding, replace valve.

Specification

Intake and Exhaust Valve—Face Angle	45°
Intake Valve Face Margin—Distance	0.8 mm (0.031 in.)
Intake Valve Face Margin—Distance (Wear Limit)	0.6 mm (0.023 in.)
Exhaust Valve Face Margin—Distance	1.2 mm (0.047 in.)
Exhaust Valve Face Margin—Distance (Wear Limit)	0.7 mm (0.027 in.)



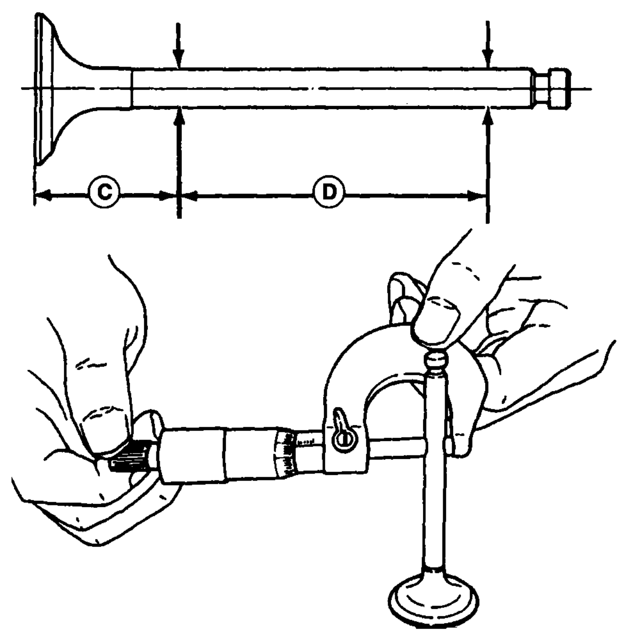
A—Valve Face Angle **B—Valve Margin Angle**

RB14256,0000A94 -19-17JUN14-5/12

- Measure valve stem diameter at the two locations shown above (C and D). Replace valve if measurement is less than wear limit.

Valve Guide Measurement

- Clean valve guides using a valve guide brush.
- Measure valve guide inside diameter.
- If valve guide inside diameter is more than wear limit, determine guide-to-stem clearance (valve guide diameter minus valve stem diameter).
- If clearance on the intake valve exceeds 0.07 mm (0.0027 in.), knurl valve guides using a 7 mm valve guide knurling tool.
- If clearance on the exhaust valve exceeds 0.09 mm (0.0035 in.), knurl valve guides using a 7 mm valve guide knurling tool.
- If clearance exceeds 0.15 mm (0.006 in.), replace cylinder head.
- Ream inside diameter of valve guides using a D20020WI Reaming Tool.



C and D—Area Where to Take Valve Stem Measurement

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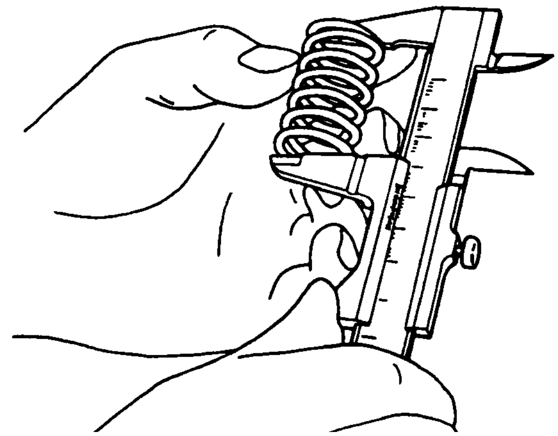
RB14256,0000A94 -19-17JUN14-6/12

Valve Springs

- Measure spring free length. Replace spring if measurement is shorter than minimum specification.

Specification

Valve Spring—Free Length (Nominal)	48.9 mm (1.925 in.)
Valve Spring—Free Length (Minimum)	47.7 mm (1.877 in.)



TCAL26044 —UN—15JUN12

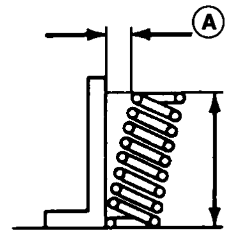
RB14256,0000A94 -19-17JUN14-7/12

- Measure spring inclination. Replace spring if measurement (A) exceeds specification.

Specification

Valve Spring—Inclination Distance (Maximum)	2.0 mm (0.079 in.)

A—Valve Spring Inclination Distance



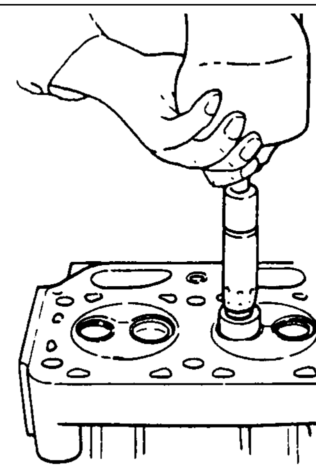
TCAL26045 —UN—15JUN12

RB14256,0000A94 -19-17JUN14-8/12

Valve Seat Grinding

NOTE: LIGHTLY grind valve seats for only a few seconds to avoid excessive valve seat width. If valve guide is to be replaced, always replace guide before grinding valve seat, as seat grinder pilot is centered by guide.

1. Grind intake and exhaust valve seat using a 45° seat grinder. Follow tool manufacturer's instructions.



TCAL26046 —UN—15JUN12

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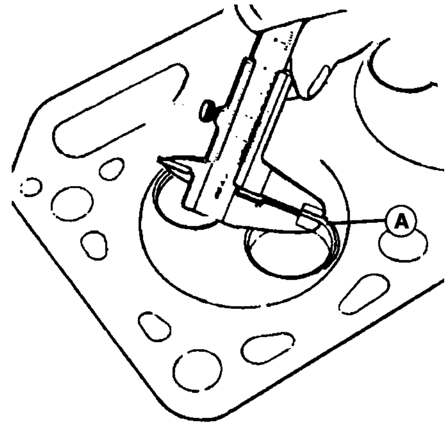
RB14256,0000A94 -19-17JUN14-9/12

2. Measure valve seat width (A) after grinding.
3. If seat width (A) is too wide after grinding, grind lower seat surface (B) using a 75° seat grinder for intake seat or 60° for exhaust seat until width is close to specifications.
4. Grind upper seat surface (C) using a 15° seat grinder until seat width is narrowed to specifications.
5. Valve seating area (D) is 45° for intake and exhaust seat.
6. If valve seats are ground, check contact pattern between the seat and valve with bluing dye.
7. Lap valves. (See Valve Lapping in Recondition Cylinder Head—Gasoline.)

A—Valve Seat Width
B—Lower Seat Surface 75° Intake, 60° Exhaust
C—Upper Seat Surface 15° Both
D—45° Both



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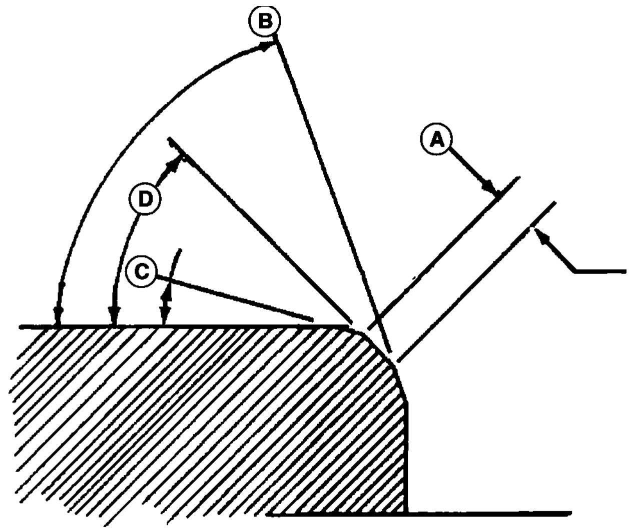


TCAL26048 —UN—15JUN12

RB14256,0000A94 -19-17JUN14-10/12

Valve Lapping

To the valve into the seat:

1. Apply small amount of fine lapping compound to face of valve.
2. Turn valve back and forth to lap valve to seat.

TCAL26049 —UN—15JUN12

Continued on next page

RB14256,0000A94 -19-17JUN14-11/12

3. Lift valve from seat every 8 to 10 strokes. Lap until a uniform ring appears around the surface (A) of the valve face.

4. Wash all parts in solvent to remove lapping compound. Dry parts.

5. Check position of lap mark on valve face. Lap mark must be at or near center of valve face.

Valve Stem OD—Specification

Intake Valve Stem OD—Inclination Distance (Maximum)....................6.965—6.98 mm (0.274—0.275 in.)

Exhaust Valve Stem OD—Inclination Distance (Maximum)....................6.955—6.97 mm (0.274—0.2744 in.)

Valve Guide ID—Inclination Distance (Maximum)....................7.015 mm (0.276 in.)

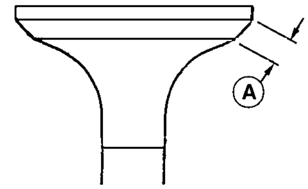
Valve Guide-to-Valve Stem Oil Clearance—Specification

Intake—Inclination Distance (Maximum)....................0.02—0.05 mm (0.0008—0.002 in.)

Exhaust—Inclination Distance (Maximum)....................0.03—0.06 mm (0.001—0.002 in.)

Wear Limit (Intake)—Inclination Distance (Maximum)....................0.07 mm (0.0027 in.)

Wear Limit (Exhaust)—Inclination Distance (Maximum)....................0.09 mm (0.0035 in.)



TCAL26050 —UN—15JUN12

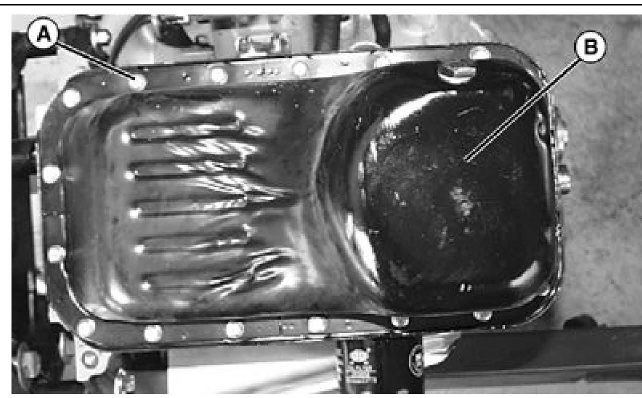
A—Valve Face Lap Ring Surface

RB14256,0000A94 -19-17JUN14-12/12

Remove and Install Oil Pan and Strainer—Gasoline

Removal

1. Remove oil pan cap screws (A) and oil pan (B).



TCAL26051 —UN—15JUN12

A—Oil Pan Cap Screws **B—Oil Pan**

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RB14256,0000A95 -19-18JUN14-1/2

2. Remove cap screws (C) for strainer and remove strainer (D) and O-ring.

Installation

1. Replace O-ring on strainer, and install strainer.
2. Clean gasket mating surfaces and install new pan gasket.
3. Install oil pan. Tighten cap screws to specification.

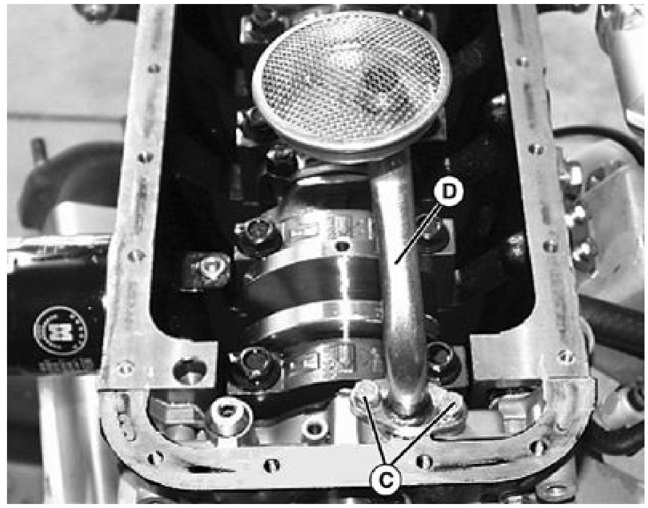
Specification

Oil Pan Cap Screw Torque—Torque....5 N·m (44 lb.-in.)

4. Fill crankcase to proper level with recommended engine oil.

Specification

Engine Crankcase—Capacity (with Filter)....3.2 L (3.4 qt)



TCAL26052 —UN—15JUN12

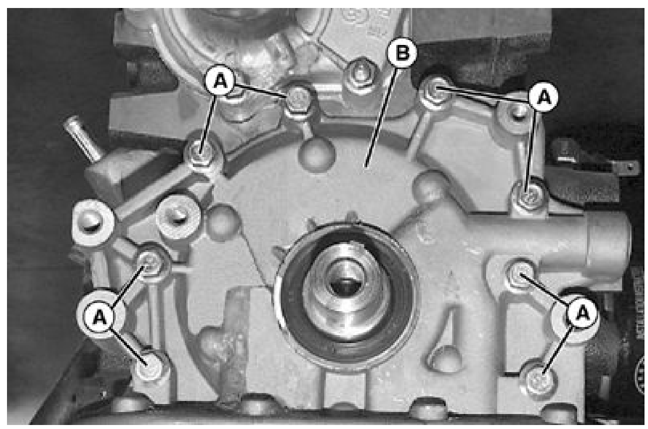
C—Oil Strainer Cap Screws Securing Engine **D—Oil Strainer**

RB14256,0000A95 -19-18JUN14-2/2

Remove and Install Oil Pump—Gasoline

Removal

1. Remove oil pan and strainer. (See Remove and Install Oil Pan and Strainer—Gasoline.)
2. Remove timing belt covers, timing belt, belt tensioner, and sprockets from engine. (See Remove and Install Crankshaft Front Oil Seal—Gasoline.)
3. Remove mounting cap screws (A) and oil pump (B).
4. Inspect all parts for wear or damage. (See Disassembly and Assembly.)



TCAL26053 —UN—15JUN12

A—Mounting Cap Screws **B—Oil Pump**

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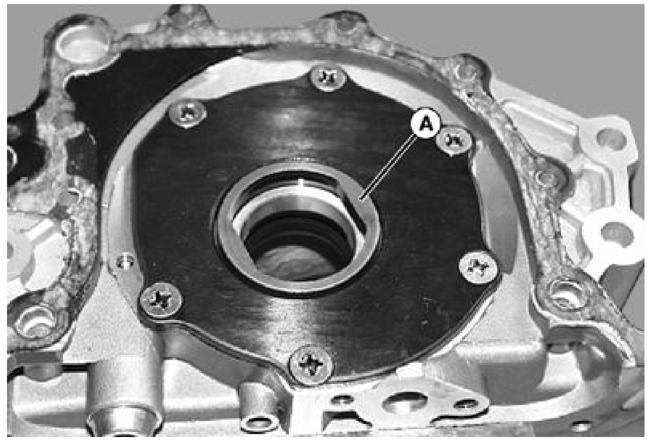
RB14256,0000A96 -19-17JUN14-1/9

Installation

1. Clean all old gasket material from oil pump and engine block.
2. Install a new gasket with a thin layer of oil resistant silicone gasket sealer on each side.
3. Lubricate oil pump gears and crankshaft oil seal.
4. When installing oil pump to engine block, make sure flats (A) on oil pump gear are aligned with flats on crankshaft.
5. Install oil pump.
6. Replace O-ring on strainer and install strainer.
7. Apply sealant to mating surfaces and install oil pan.
8. Tighten cap screws to specification.



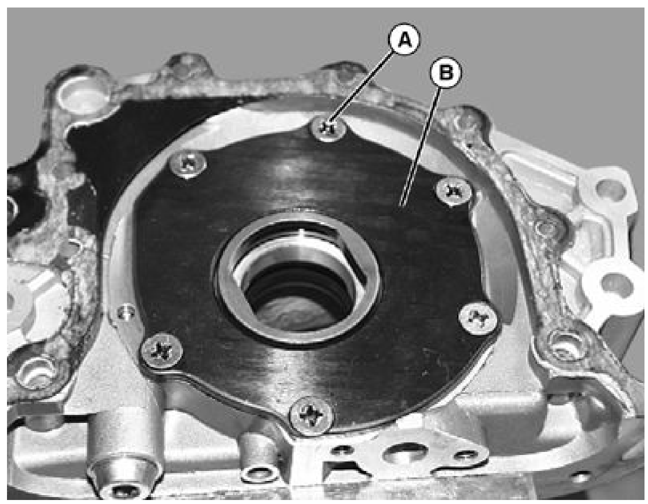
TCAL26054 —UN—15JUN12

A—Flats On Crankshaft to be Aligned With Flats on Oil Pump

RB14256,0000A96 -19-17JUN14-2/9

Disassembly and Assembly

1. Clean all old gasket material from oil pump.
2. Remove six cover screws (A) and cover (B).



TCAL26055 —UN—15JUN12

A—Screw Securing Oil Pump Cover **B—Oil Pump Cover**

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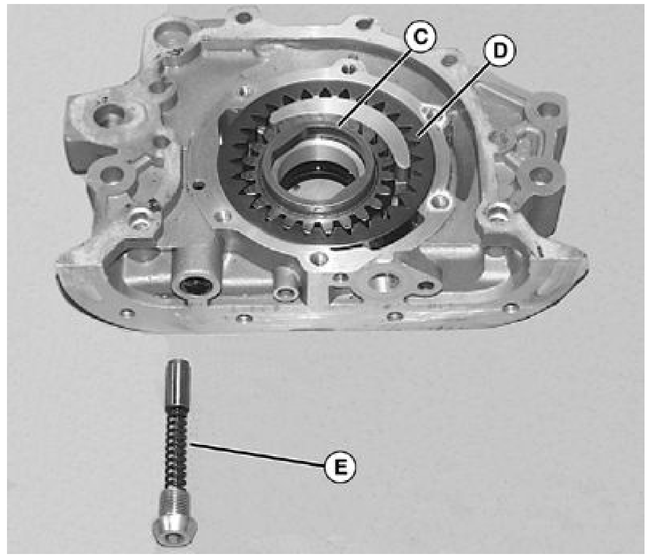
RB14256,0000A96 -19-17JUN14-3/9

3. Remove inner gear (C), outer gear (D), and relief valve assembly (E).
4. Clean all parts in solvent.

C—Inner Gear
D—Outer Gear
E—Relief Valve

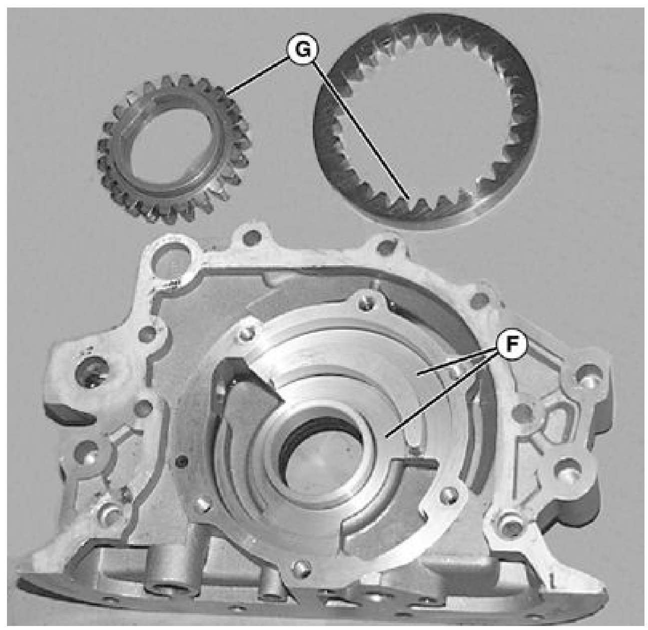


TCAL26056 —UN—15JUN12

RB14256,0000A96 -19-17JUN14-4/9

5. Inspect pump body (F) and inside of gear cover for wear or deep scratches.
6. Inspect gear teeth (G) and sides of gears for wear or damage.

F—Oil Pump Body
G—Oil Pump Gears



TCAL26057 —UN—15JUN12

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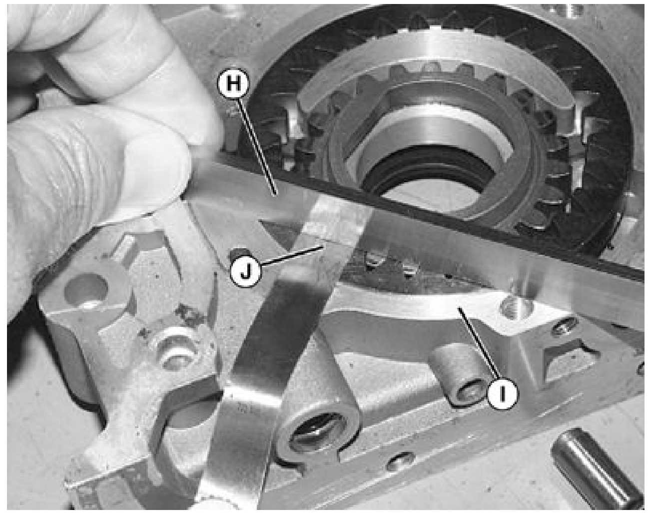
RB14256,0000A96 -19-17JUN14-5/9

7. Place gears back into the pump body. The outer gear has a dot on one side. Install gear with dot facing out. Lay a straightedge (H) across pump housing (I). Use a feeler gauge (J) between straightedge and inner and outer gear to determine gear recess.

H—Straight Edge
I— Oil Pump Housing
J— Feeler Gauge

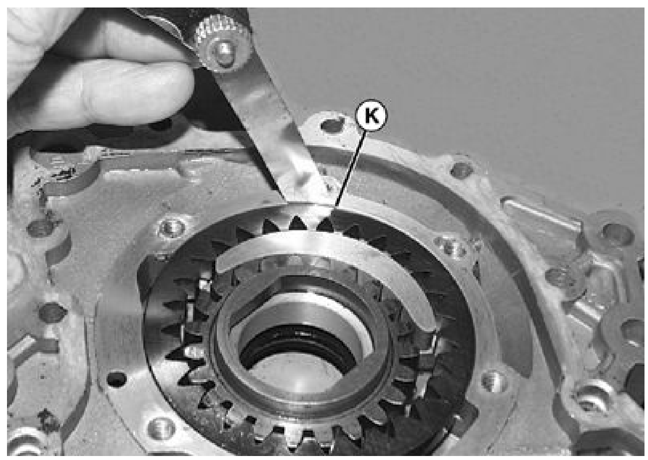


TCAL26058 —UN—15JUN12

RB14256,0000A96 -19-17JUN14-6/9

8. Check outer gear to pump housing clearance (K) with feeler gauge.

K—Area to Check Outer Gear Clearance

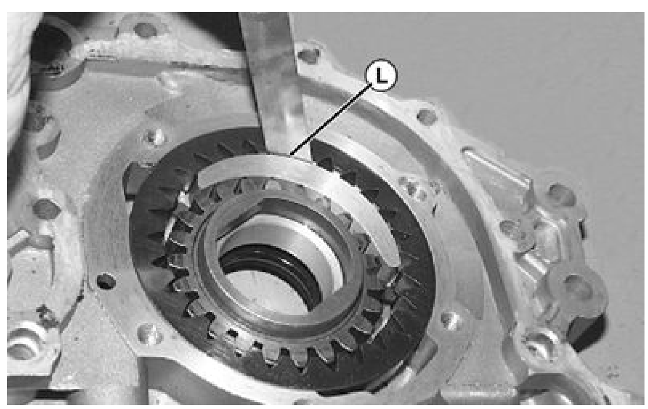


TCAL26059 —UN—15JUN12

RB14256,0000A96 -19-17JUN14-7/9

9. Check outer gear to pump body crescent clearance (L).

L—Checking Outer Gear to Pump Body Crescent Clearance



TCAL26060 —UN—15JUN12

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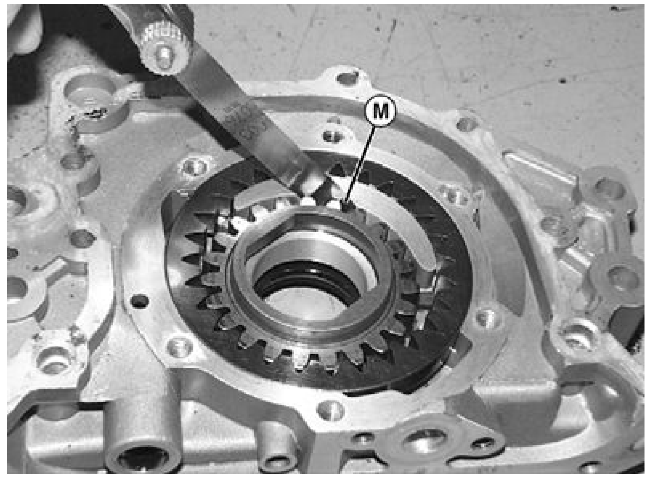
RB14256,0000A96 -19-17JUN14-8/9

10. Check inner gear to pump body crescent (M) with feeler gauge.

11. Oil pump parts are not serviced separately. If any damage is present or any measured clearance is more than wear limit, replace oil pump.

Specifications—Specification

Gear Recess Wear Limit—Capacity (with Filter)	0.17 mm (0.007 in.)
Inner Gear-to-Pump Body Crescent—Capacity (with Filter)	0.6—0.8 mm (0.023—0.031)
Outer Gear-to-Pump Body Crescent Clearance—Capacity (with Filter)	0.25—0.40 mm (0.010—0.016 in.)
Outside of Outer Gear-to-Pump Body Clearance Wear Limit—Capacity (with Filter)	0.3 mm (0.012 in.)



TCAL26061 —UN—15JUN12

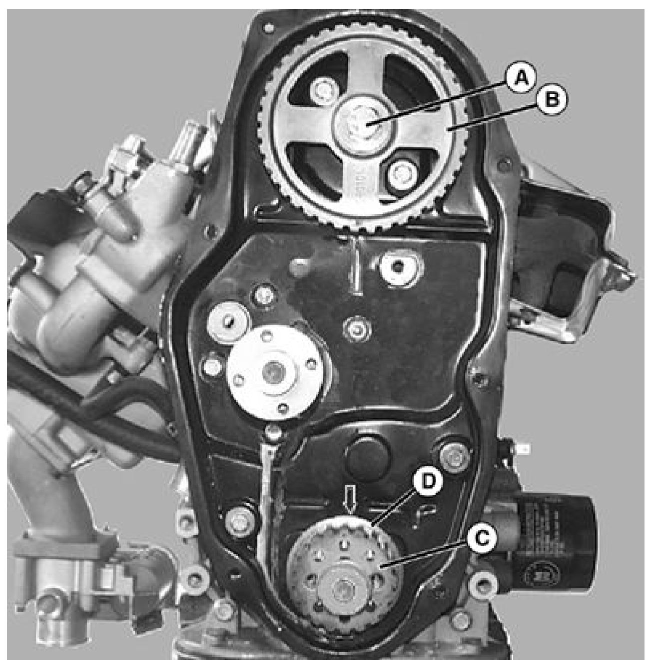
M—Checking Inner Gear to Pump Body Crescent Clearance

RB14256,0000A96 -19-17JUN14-9/9

Remove and Install Crankshaft Front Oil Seal—Gasoline

1. Park machine safely.
2. Remove alternator/coolant pump belt.
3. Remove timing belt and tensioner. (See Timing Belt Removal—Gasoline.)
4. Remove cam sprocket cap screw and washer (A) and sprocket (B).
5. Remove crankshaft sprocket (C) and belt guide (D).

A—Cam Sprocket Cap Screw and Washer
B—Cam Sprocket
C—Crankshaft Sprocket
D—Belt Guide



TCAL26062 —UN—15JUN12

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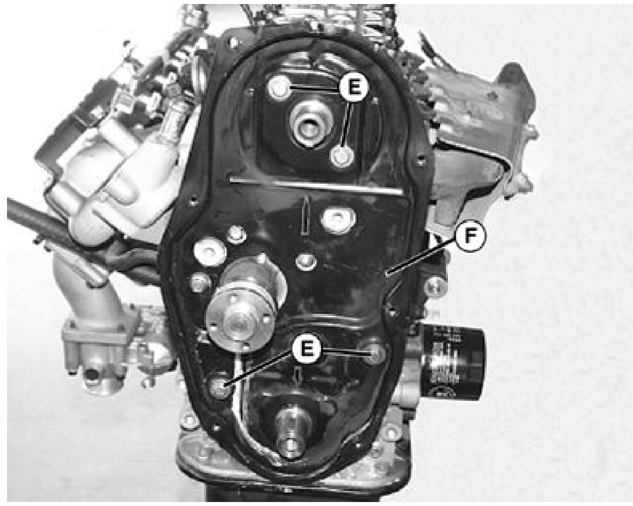
RB14256,0000A97 -19-17JUN14-1/7

6. Remove cap screws (E) and inner belt cover (F).

E—Cap Screws **F—Inner Belt Cover**

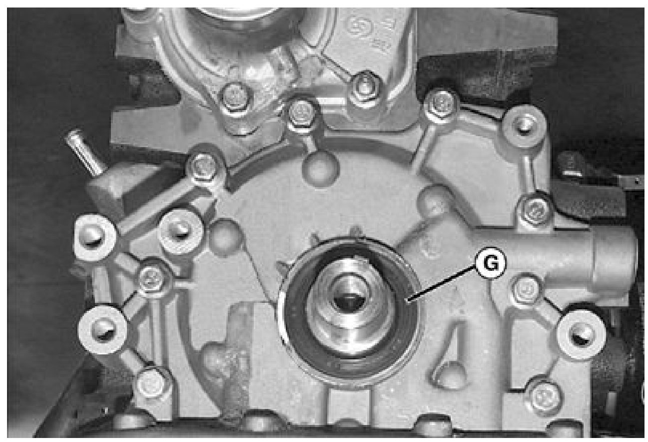


TCAL26063 —UN—15JUN12

RB14256,0000A97 -19-17JUN14-2/7

7. Use a seal removal tool and remove front crankshaft oil seal (G). Use caution to avoid contact with crankshaft.
8. Coat lip of new seal with clean engine oil.
9. Install new oil seal using a driver set. Install seal with lip toward engine. Install seal flush with surface of cover.

G—Front Crankshaft Oil Seal

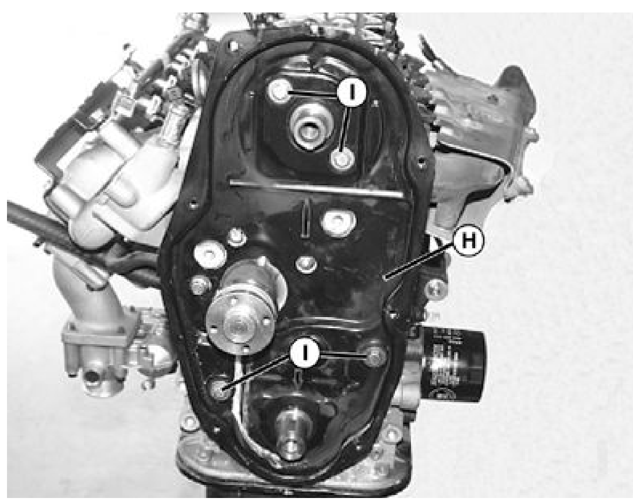


TCAL26064 —UN—15JUN12

RB14256,0000A97 -19-17JUN14-3/7

10. Install inner belt cover (H) and secure with cap screws (I).

I— Cap Screws **H—Inner Belt Cover**



TCAL26065 —UN—15JUN12

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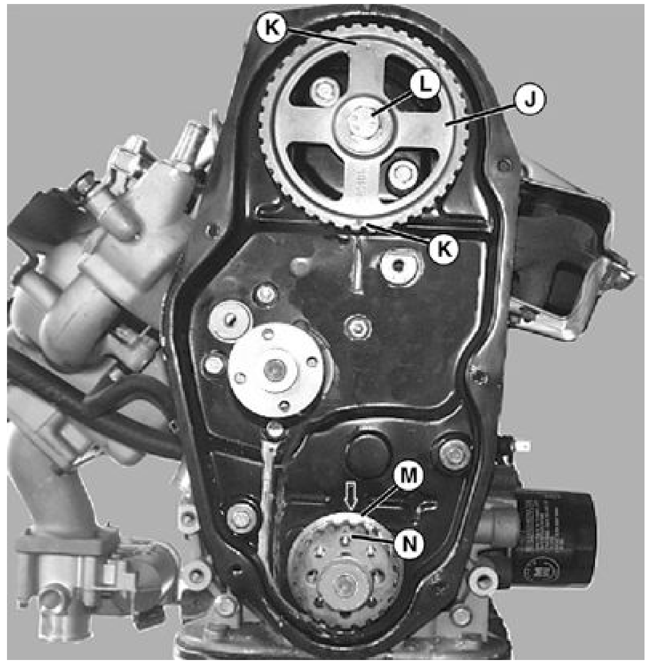
RB14256,0000A97 -19-17JUN14-4/7

11. Make sure key is properly installed in camshaft and install camshaft sprocket (J) with timing marks (K) facing out. Install washer and cap screw (L) and tighten to specification.

12. Install belt guide (M) with OD taper facing away from sprocket. Make sure key is properly installed in crankshaft and install crankshaft sprocket with timing mark (N) facing out.

J— Camshaft Sprocket
K—Timing Mark
L— Cap Screw
M—Belt Guide
N—Timing Mark

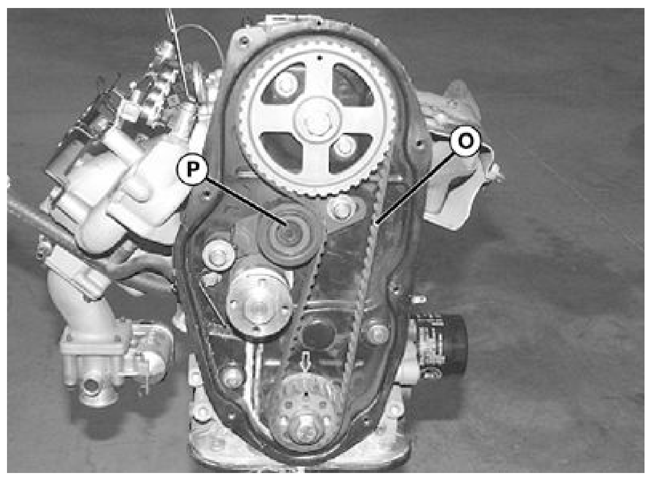


TCAL26066 —UN—15JUN12

RB14256,0000A97 -19-17JUN14-5/7

13. Install timing belt (O) and idler (P). (See Timing Belt Installation—Gasoline.)

O—Timing Belt
P—Idler



TCAL26067 —UN—15JUN12

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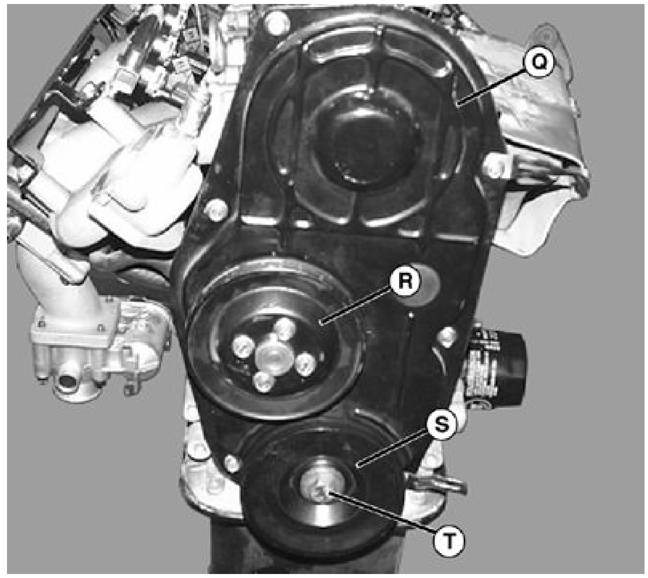
RB14256,0000A97 -19-17JUN14-6/7

14. Install outer timing belt cover (Q).
15. Install coolant pump pulley (R).
16. Line up key in crankshaft with keyway in crankshaft pulley and install crankshaft pulley (S). Secure with washer and cap screw (T) and tighten to specification.

Specifications—Specification

Timing Belt Cover Screws—Capacity (with Filter)	5 N·m (44 lb.-in.)
Camshaft Sprocket Cap Screw Torque—Capacity (with Filter)	55—65 N·m (40—48 lb.-ft.)
Crankshaft Pulley Cap Screw Torque—Capacity (with Filter)	55—65 N·m (40—48 lb.-ft.)



TCAL26068 —UN—15JUN12

Q—Outer Timing Belt Cover
R—Coolant Pump Pulley
S—Crankshaft Pulley
R—Cap Screw

RB14256,0000A97 -19-17JUN14-7/7

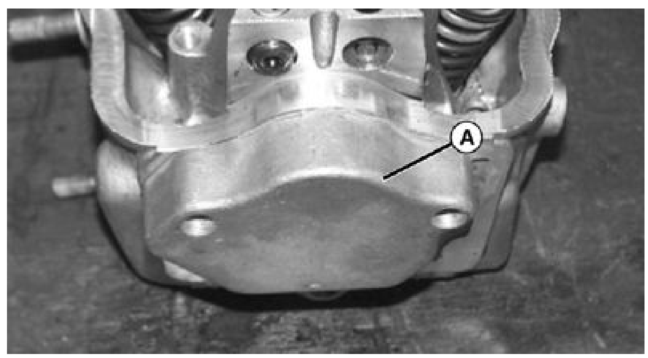
Check Camshaft End Play—Gasoline

Reason

To determine proper side clearance between camshaft gear and camshaft thrust plate, to prevent excessive camshaft-to-camshaft follower wear.

Procedure

1. Remove cap screws and camshaft thrust plate cover (A).



TCAL26069 —UN—15JUN12

A—Camshaft Thrust Plate Cover

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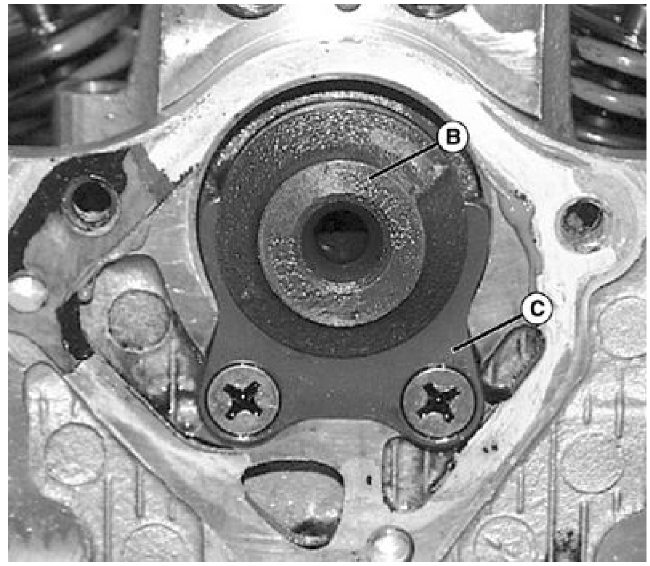
RB14256,0000A98 -19-17JUN14-1/2

2. Fasten dial indicator to cylinder head and position indicator tip on end of camshaft (B).
3. Push camshaft toward the rear as far as possible.
4. Zero the dial indicator.
5. Pull camshaft forward as far as possible and record reading on dial indicator.

Results

If camshaft end play exceeds specification, remove camshaft and inspect thrust plate (C) and camshaft for wear. Replace parts as needed.



TCAL26070 —UN—15JUN12

B—Camshaft **C—Camshaft Inspection Thrust Plate**

Item	Measurement	Specification
Specifications		
Camshaft End Play		0.05—0.15 mm (0.002—0.006 in.)
Camshaft End Play (Max)		0.3 mm (0.012 in.)

RB14256,0000A98 -19-17JUN14-2/2

Remove and Install Camshaft—Gasoline

Number	Name	Use
TY24344 (U.S.) (U.S.)	Form-in-Place Gasket	Seals cam covers.

IMPORTANT: Always replace rocker arms when installing a new camshaft. Always replace camshaft when replacing rocker arms. The components wear as a set, and replacing one will accelerate the wear of the other.

Removal

1. Remove rocker arm cover. (See Remove and Install Rocker Arm Cover—Gasoline.)
2. Remove outer timing belt cover. (See Timing Belt Removal—Gasoline.)
3. Align timing marks.
4. Remove timing belt and camshaft sprocket.
5. Check camshaft end play.
6. Loosen all valve adjuster nuts and screws.
7. Remove front and rear camshaft end covers from cylinder head.

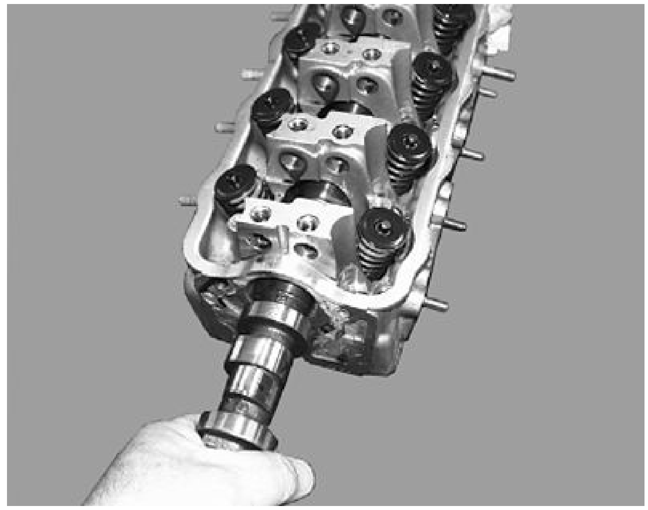
IMPORTANT: DO NOT allow camshaft lobes to hit bearing surfaces while removing camshaft. Machined surfaces can be damaged.

8. Remove rocker arm shafts and rocker arms. (See Remove Rocker Arms and Push Rods—Gasoline.)
9. Inspect all parts for wear or damage. (See Camshaft Inspection in Remove and Install Camshaft—Gasoline.)

Installation

IMPORTANT: DO NOT allow camshaft lobes to hit bearing surfaces while installing camshaft. Machined surfaces can be damaged.

NOTE: Apply clean engine oil on all parts during installation.



TCAL26071 —UN—15JUN12

1. Lubricate and install camshaft into cylinder head, being careful to not allow camshaft lobes to scratch camshaft bearing surfaces.

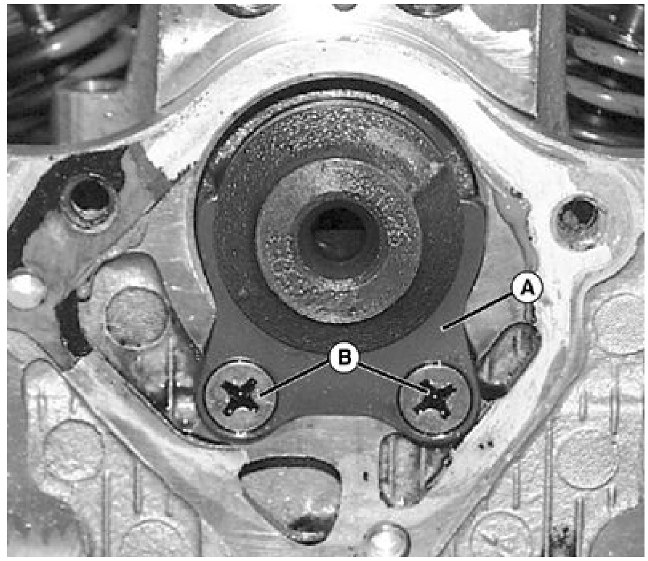
Continued on next page

RB14256,0000A99 -19-17JUN14-1/6

2. Install camshaft thrust plate (A) and screws (B).
3. Install front and rear camshaft end covers with new seal and gaskets.

Camshaft End Play Measurement

Check camshaft end play while camshaft is installed in cylinder block using a dial indicator, as described above. (See Check Camshaft End Play—Gasoline.)



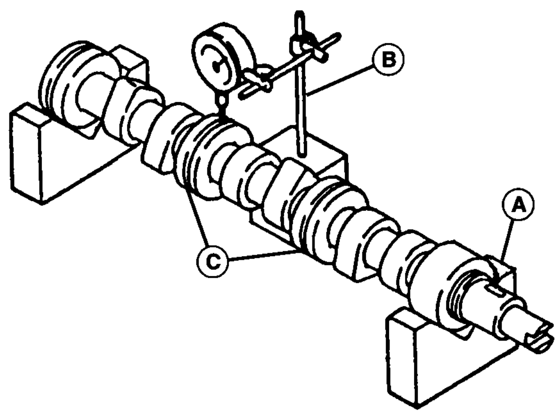
TCAL26072 —UN—15JUN12

A—Camshaft Thrust Plate **B—Screws**

RB14256,0000A99 -19-17JUN14-2/6

Camshaft Inspection

1. Inspect camshaft for bend by using a pair of V-blocks (A) and a dial indicator (B). Turn camshaft slowly and read variation of camshaft bearing journals (C) on indicator. If variation is greater than wear limit, replace camshaft.

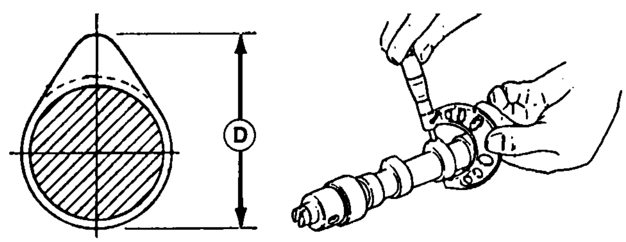


TCAL26073 —UN—15JUN12

A—V-Blocks
B—Dial Indicator
C—Camshaft

RB14256,0000A99 -19-17JUN14-3/6

2. Measure camshaft lobe height (D) using a micrometer. If lobe height is less than wear limit, or if there are chips or scratches in lobes or bearing journals, replace camshaft.



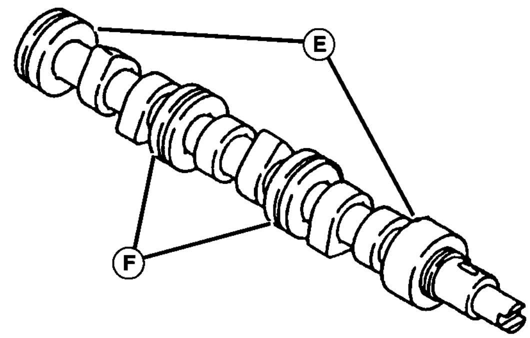
TCAL26074 —UN—15JUN12

D—Camshaft Lobe Measurement Area

Continued on next page

RB14256,0000A99 -19-17JUN14-4/6

3. Measure camshaft end journals (E) and intermediate journals (F) outside diameters.
   - If journal diameters are less than wear limit, replace camshaft.



E—Camshaft End Journals
F—Camshaft Intermediate Journals

Item	Measurement	Specification
Specifications		
Camshaft End Play		0.05—0.15 mm (0.002—0.006 in.)
Camshaft End Play (Max)		0.3 mm (0.012 in.)
Camshaft Bend (Max)		0.00—0.1 mm (0.00—0.0039 in.)
Camshaft Lobe Height		36.152 mm (1.423 in.)
Camshaft Lobe Height Wear Limit		36.1 mm (1.421 in.)
Camshaft Bearing Journals		
Timing Sprocket End (front) Journal OD		43.425—43.450 mm (1.709—1.710 in.)
Second Journal OD		43.625—43.650 mm (1.717—1.718 in.)
Third Journal OD		43.825—43.850 mm (1.725—1.726 in.)
Fourth Journal OD		44.025—44.050 mm (1.733—1.734 in.)
Fifth Journal OD		44.225—44.2450 mm (1.741—1.742 in.)
Camshaft Bores		
Camshaft Bore ID (front)		43.500—43.525 mm (1.7125—1.7135 in.)
Camshaft Second Bore ID		43.700—43.725 mm (1.720—1.721 in.)
Camshaft Third Bore ID		43.900—43.925 mm (1.728—1.729 in.)
Camshaft Fourth Bore ID		44.100—44.125 mm (1.736—1.737 in.)

Continued on next page

RB14256,0000A99 -19-17JUN14-5/6

Item	Measurement	Specification
Camshaft Fifth Bore ID		44.300—44.3125 mm (1.744—1.745 in.)
Camshaft Thrust Plate Cap Screw Torque		11 N·m (96 lb.-in.)

RB14256,0000A99 -19-17JUN14-6/6

Repair Piston and Connecting Rod—Gasoline

RB14256,0000A9A -19-18JUN14-1/3

Ridge Reamer JTO7277

Removes ridge from top of cylinder bore.

RB14256,0000A9A -19-18JUN14-2/3

1. Remove oil pan and strainer tube.
2. Remove cylinder head.
3. Check cylinder bore for ridges. A ridge can damage piston and rings if ridge is not removed. If necessary, remove ridge from top of cylinder bore using a ridge reamer.
4. Measure connecting rod side play. (See Check Connecting Rod Side Play—Gasoline.)
5. Measure connecting rod bearing clearance. (See Check Connecting Rod Bearing Clearance—Gasoline.)

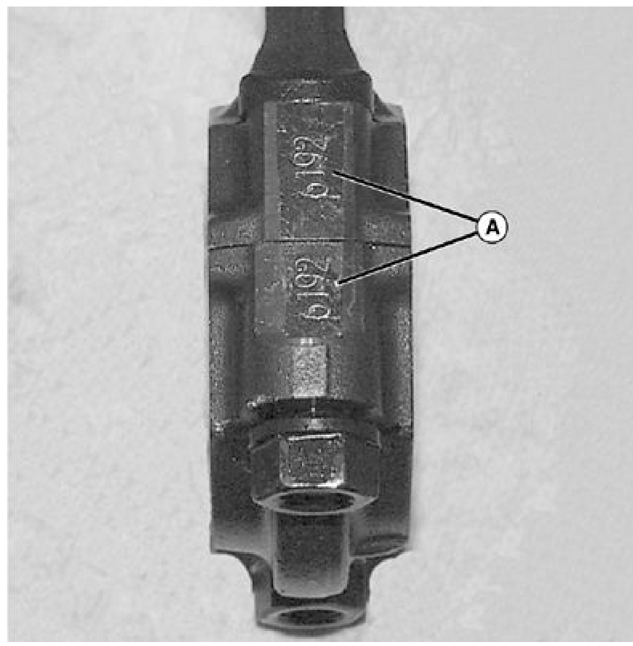
IMPORTANT: Keep connecting rods and caps together. Rods and caps are a matched set. Note matching numbers (A) on each part.

Pistons and cylinders are matched. Pistons must be installed in the cylinders from which they are removed.

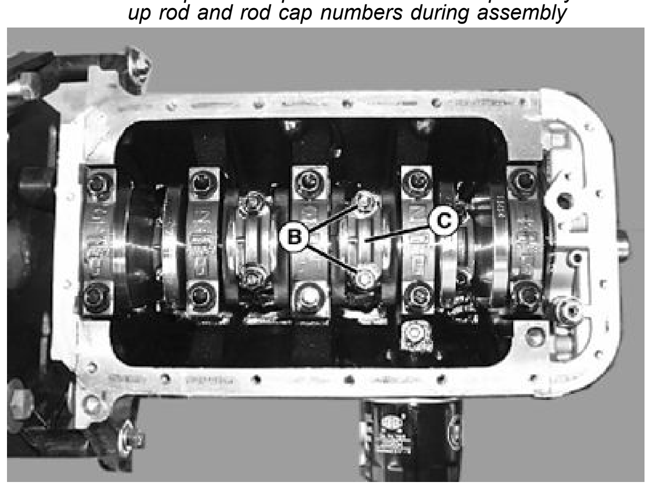
6. Remove two nuts (B), and connecting rod cap (C) on each piston and rod assembly.
7. Mark piston and rod with the corresponding cylinder number so all parts are installed in the same cylinder they were removed from.
8. Push piston and connecting rod out of cylinder bore using a wooden dowel.
9. Disassemble and inspect all parts for wear or damage. (See Inspection and Replacement in Repair Piston—Gasoline.)

B—Two Nuts

C—Connecting Rod Cap

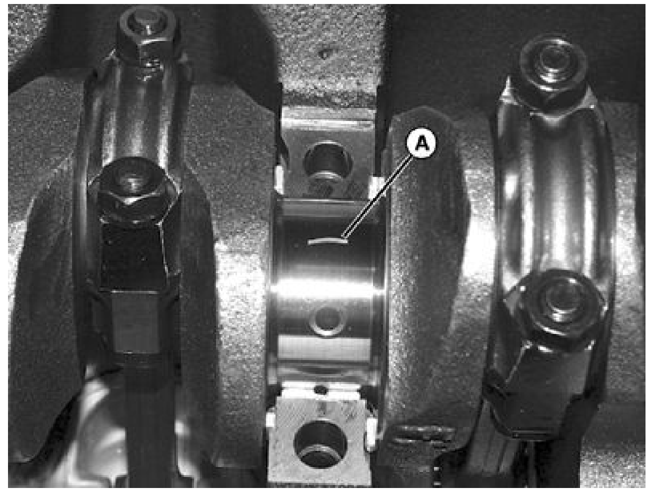


Each connecting rod has matching numbers (A) on the connecting rod and rod cap. Rod caps cannot be mixed up. Always match up rod and rod cap numbers during assembly



RB14256,0000A9A -19-18JUN14-3/3

Check Crankshaft Main Bearing Clearance—Gasoline



A—PLASTIGAGE

Reason

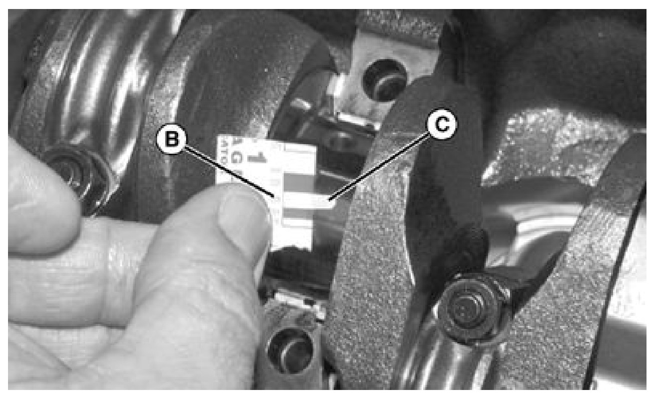
To measure oil clearance between main bearing and crankshaft journal.

Procedure

IMPORTANT: Main bearing caps must be installed on the same main bearing and in the same direction to prevent crankshaft and main bearing damage.

1. Remove main bearing cap.
2. Wipe oil from bearing insert and crankshaft journal.
3. Put a piece of PLASTIGAGE (A), or an equivalent on the crankshaft main bearing journal.
4. Install main bearing cap and cap screws. Tighten cap screws to specification. DO NOT turn crankshaft.
5. Remove cap screws and main bearing cap.

RB14256,0000A9B -19-18JUN14-1/2



B—Envelope **C—PLASTIGAGE**

NOTE: The flattened PLASTIGAGE will be found on either the bearing insert or crankshaft journal.

6. Use the graduation marks on the envelope (B) to compare the width of the flattened PLASTIGAGE (C) at its widest point.
7. Determine main bearing clearance. The number within the graduation marks indicates the bearing clearance in inches or millimeters, depending on which side of the envelope is used.
8. Remove PLASTIGAGE.

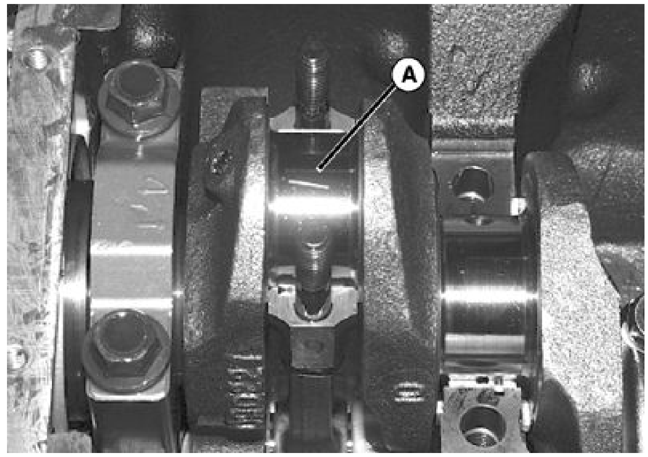
Results

If clearance exceeds specification, measure crankshaft main bearing journals. If bearing journals are within specification, replace bearing inserts.

Item	Measurement	Specification
Specifications		
Main Bearing Cap Screw Torque		43—48 N·m (33—35 lb.-ft.)
Crankshaft Main Bearing Oil Clearance		0.026—0.046 mm (0.001—0.002 in.)
Crankshaft Main Bearing Clearance Wear Limit		0.08 mm (0.0031 in.)

RB14256,0000A9B -19-18JUN14-2/2

Check Connecting Rod Bearing Clearance—Gasoline



TCAL26080 —UN—15JUN12

Reason

To measure oil clearance between connecting rod bearing and crankshaft journal.

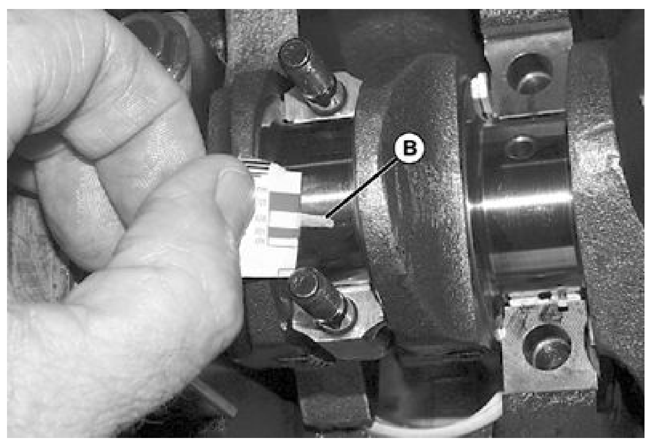
Procedure

IMPORTANT: Connecting rod caps must be installed on the same connecting rod and in the same direction to prevent crankshaft and connecting rod damage.

1. Remove connecting rod cap.
2. Wipe oil from bearing insert and crankshaft journal.
3. Put a piece of Plastigage® (A), or an equivalent, on the rod bearing journal of the crankshaft.
4. Install connecting rod end cap and original nuts. Tighten nuts to specification. DO NOT turn crankshaft.
5. Remove nuts and connecting rod cap.

Plastigage is a trademark of Perfect Circle Corporation

RB14256,0000A9C -19-18JUN14-1/2



TCAL26081 —UN—15JUN12

B—Plastigage®

NOTE: The flattened Plastigage® will be found on either the bearing insert or crankshaft journal.

6. Use the graduation marks on the envelope to compare the width of the flattened Plastigage® (B) at its widest point.
7. Determine bearing clearance. The number within the graduation marks indicates the bearing clearance in inches or millimeters, depending on which side of the envelope is used.
8. Remove Plastigage®.

Results

If clearance exceeds specification, replace bearing inserts.

Item	Measurement	Specification
Specifications		
Connecting Rod Cap Screw Torque		30 N·m (22 lb.-ft.)
Connecting Rod Bearing Oil Clearance		0.020—0.04 mm (0.0008—0.0015 in.)
Connecting Rod Bearing Oil Clearance Wear Limit		0.08 mm (0.003 in.)

RB14256,0000A9C -19-18JUN14-2/2

Check Connecting Rod Side Play—Gasoline

Reason

To determine proper side clearance between the crankshaft and the connecting rod.

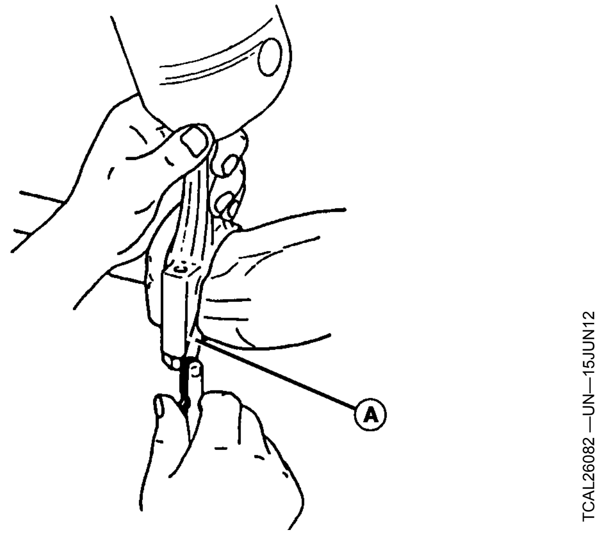
NOTE: The engine must be removed from the machine to perform this test.

Procedure

1. Remove the oil pan and oil pick-up assembly. (See Remove and Install Oil Pan and Strainer—Gasoline.)
2. Insert a feeler gauge (A) between the connecting rod cap and the crankshaft.

Results

If the side play exceeds specification, replace the connecting rod and/or crankshaft.



A—Feeler Gauge

Item	Measurement	Specification
Specifications		
Connecting Rod Side Play (Max)		0.30 mm (0.012 in.)

RB14256,0000A9D -19-18JUN14-1/1

Repair Piston—Gasoline

Installation

1. If new piston rings were installed, deglaze cylinder bore. (See Deglazing in Measure Cylinder Bore—Gasoline.)
2. Install piston rings so piston ring end gaps are staggered 120° apart.

IMPORTANT: Pistons must be installed in cylinders from which they were removed and in the same direction. Be careful not to damage crankshaft rod journal while installing piston.

3. Coat cylinder, piston skirt, rod, and cap bearing surfaces with oil.

IMPORTANT: DO NOT touch bearing insert surfaces. Oil and acid from your finger will corrode the bearing surface.

4. Install bearing inserts on connecting rod and rod cap, aligning tangs with grooves.

IMPORTANT: Connecting rod caps must be installed on the same connecting rods they were removed from.

5. Install ring compressor on piston and install piston and connecting rod into the cylinder from which it was removed.
6. Install the connecting rod caps using matching numbers.
7. Lubricate connecting rod nuts with clean engine oil. Install nuts and tighten to specifications.
8. Install cylinder head. (See Remove and Install Cylinder Head—Gasoline.)
9. Install oil pan and strainer tube. (See Remove and Install Oil Pan and Strainer—Gasoline.)

Disassembly

IMPORTANT: Pistons must be installed on the same connecting rod they were removed from.

- Mark each piston and connecting rod to aid in assembly.
- Piston pin bushing is press fit in connecting rod and is not available separately. If bushing is worn, replace connecting rod.
- Inspect all parts for wear or damage. Replace as necessary.

Assembly

IMPORTANT: Pistons must be installed on the same connecting rod they were removed from.

NOTE: Apply clean engine oil to all parts during assembly.

1. Assemble piston to connecting rod with arrow on top of piston opposite the numbers cast into the side of the rod.
2. Install piston pin and retaining/snap rings.
3. Install oil ring expander in bottom ring groove of piston with ends (K) above either end of piston pin (L).
4. Install oil ring over expander with ring gap (M) opposite (180°) of expander ends.

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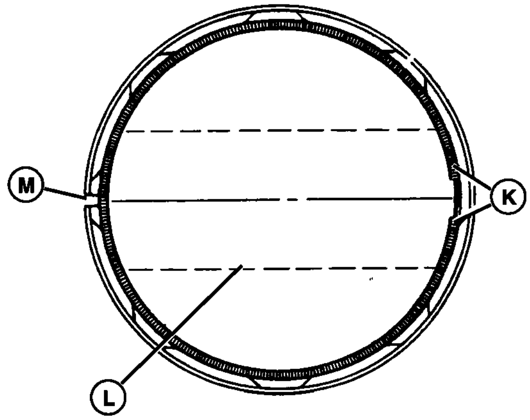
RB14256,0000A9E -19-18JUN14-1/12

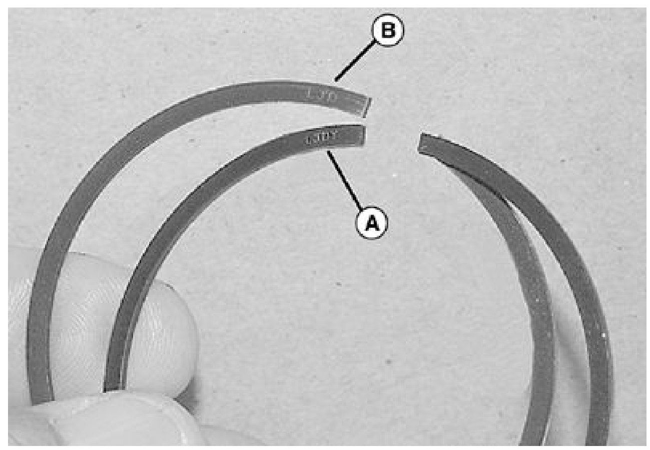


TCAL26083 —UN—15JUN12

K—Oil Ring Expander Ends
L—Piston Pin
M—Oil Ring End Gap

RB14256,0000A9E -19-18JUN14-2/12

5. Install second compression ring, with letters (B) toward top of piston, in the middle groove. Turn ring until gap is 120° away from oil ring gap.
6. Install first compression ring (chrome plated), with letters (A) toward top of piston, in top groove. Turn ring until gap is 120° away from second ring gap.



TCAL26084 —UN—15JUN12

A—First Compression Ring with Letters
B—Second Compression Ring with Letters

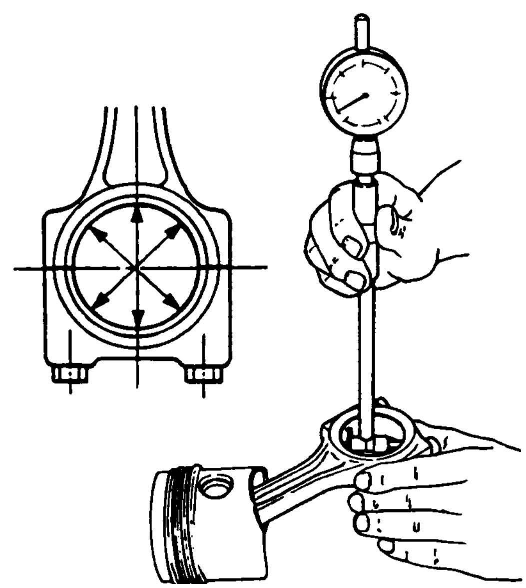
RB14256,0000A9E -19-18JUN14-3/12

Inspection and Replacement

1. Inspect all parts for wear or damage. Replace as necessary.
2. Measure crankshaft connecting rod journal diameter. (See Remove and Install Crankshaft and Main Bearings—Gasoline.)
3. Install connecting rod cap and bearing inserts on connecting rod. Install connecting rod nuts and tighten to specification.
4. Measure connecting rod bearing diameter.

   If bearing diameter exceeds wear limit and crankshaft is within specification, replace bearing inserts.

   If crankshaft journal OD does not meet minimum specification, grind crankshaft connecting rod journals and install undersized bearing inserts, or replace bearing inserts and crankshaft.



TCAL26085 —UN—15JUN12

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RB14256,0000A9E -19-18JUN14-4/12

5. With rings installed on piston, measure piston ring groove clearance. Measure several places around each piston ring.

   If clearance exceeds maximum limit, replace rings or piston.

TCAL26086 —UN—15JUN12

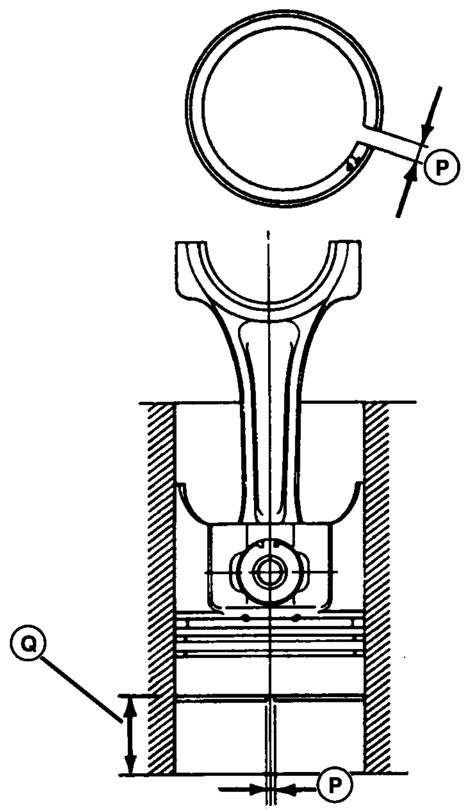
RB14256,0000A9E -19-18JUN14-5/12

6. Measure piston ring end gap (P). Push ring into cylinder bore, using a piston, until ring is approximately 30 mm (1.181 in.) (Q) from bottom of cylinder bore.

   If end gap exceeds wear limit, replace rings.

P—Piston Ring End Gap

Q—Piston Ring Placed 30 mm (1.181 in.) from Bottom of Cylinder Bore



TCAL26087 —UN—15JUN12

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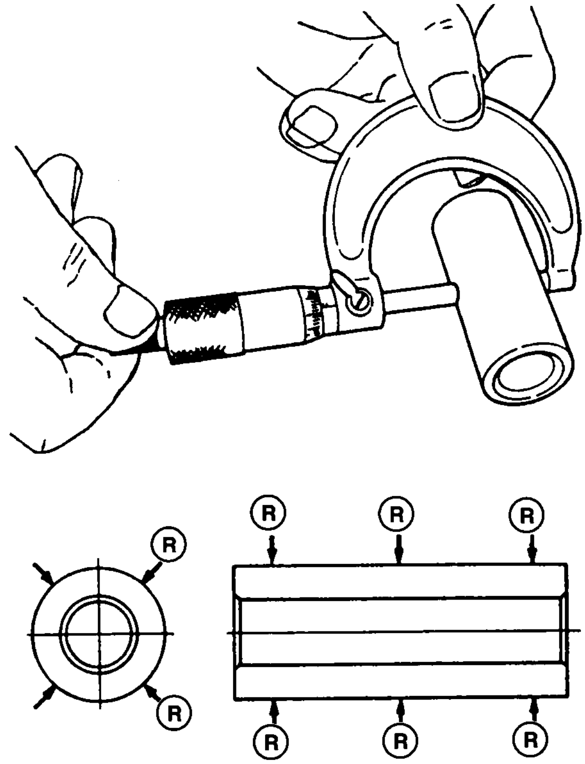
RB14256,0000A9E -19-18JUN14-6/12

7. Measure piston pin diameter. Measure diameter at six places (R).

   If pin diameter is less than wear limit at any measurement, replace pin.

R—Where to Measure Piston Pin Diameter



TCAL26088 —UN—15JUN12

RB14256,0000A9E -19-18JUN14-7/12

8. Measure piston pin bore diameter in two directions, 90° to each other, and at each side of the piston.

   If piston pin bore exceeds wear limit, replace piston.

   If bore clearance (bore ID minus pin OD) exceeds specification, replace piston, piston pin, or both.

TCAL26089 —UN—15JUN12

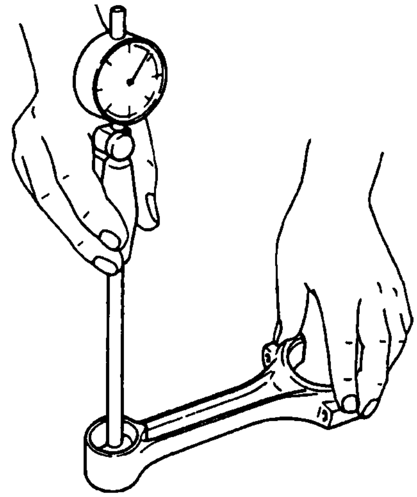
Continued on next page

RB14256,0000A9E -19-18JUN14-8/12

9. Measure piston pin bushing diameter in connecting rod.

   If bushing diameter exceeds wear limit, replace connecting rod.

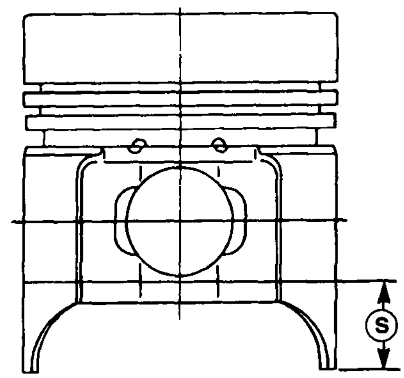
   If bushing clearance (bushing ID minus pin OD) exceeds specification, replace bushing, piston pin, or both.



RB14256,0000A9E -19-18JUN14-9/12

10. Measure piston diameter perpendicular to piston pin bore at distance (S).

    If piston diameter is less than wear limit, install a new piston.



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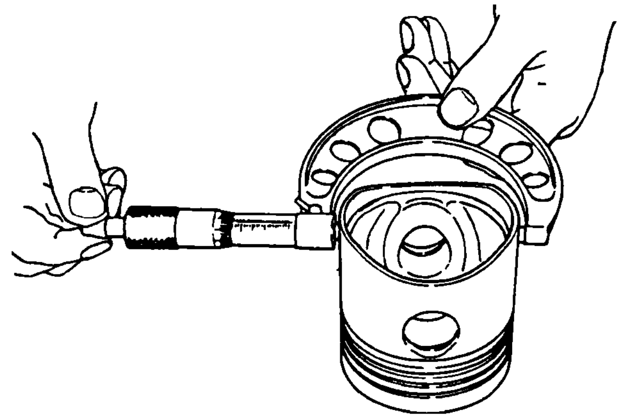
RB14256,0000A9E -19-18JUN14-10/12

11. Measure cylinder bore diameter. (See Measure Cylinder Bore—Gasoline.)



TCAL26092 —UN—15JUN12

Specifications—Specification

Connecting Rod Nut—Capacity (with Filter)....30 N·m (22 lb.-ft.)

Connecting Rod Side Play (Max)—Capacity (with Filter).... 0.3 mm (0.011 in.)

Crankshaft Connecting Rod Journal OD—Capacity (with Filter).... 38 mm (1.496 in.)

Crankshaft Connecting Rod Journal OD Wear Limit—Capacity (with Filter).... 37.976 mm (1.495 in.)

Piston Pin Bushing ID—Capacity (with Filter)....16.003—16.013 mm (0.6300—0. 6304 in.)

Piston Pin-to-Bushing Oil Clearance—Capacity (with Filter)....0.003—0.018 mm (0.0001—0.0007 in.)

Piston Pin-to-Bushing Clearance Wear Limit—Capacity (with Filter).... 0.05 mm (0.0019 in.)

Piston Ring Groove Side Clearance—Specification

Top Piston Ring—Capacity (with Filter)....0.03—0.07 mm (0.0011—0.0027 in.)

Top Piston Ring (Max)—Capacity (with Filter).... 0.12 mm (0.0047 in.)

Second Piston Ring—Capacity (with Filter)....0.02—0.06 mm (0.0007—0.0026 in.)

Second Piston Ring (Max)—Capacity (with Filter).... 0.1 mm (0.0039 in.)

Piston Ring End Gap—Specification

Top Ring End Gap—Capacity (with Filter)....0.15—0.30 mm (0.006—0.012 in.)

Top Ring End Gap (Max)—Capacity (with Filter).... 0.7 mm (0.027 in.)

Second Ring End Gap—Capacity (with Filter)....0.15—0.35 mm (0.006—0.013 in.)

Second Ring End Gap (Max)—Capacity (with Filter).... 0.7 mm (0.027 in.)

Oil Control Ring End Gap—Capacity (with Filter)....0.2-0.7 mm (0.008-0.027 in.)

Oil Control Ring End Gap (Max)—Capacity (with Filter).... 1.8 mm (0.070 in.)

Piston Pin OD—Capacity (with Filter)....15.995—16.00 mm (0.6297—0.6299 in.)

Piston Pin Bore ID—Capacity (with Filter)....16.00—16.014 mm (0.629—0.630 in.)

Piston Pin-to-Bore Clearance—Capacity (with Filter)....0.005—0.018 (0.0002-0.0007 in.)

Piston OD—Capacity (with Filter)....65.465—65.495 mm (2.577—2.578 in.)

Piston Measurement Distance—Capacity (with Filter).... 30 mm (1.2 in.)

Cylinder Bore Wear Limit—Capacity (with Filter).... 66.53 mm (2.58 in.)

Piston-to-Cylinder Clearance—Capacity (with Filter)....0.04—0.05 mm (0.0014—0.0019 in.)

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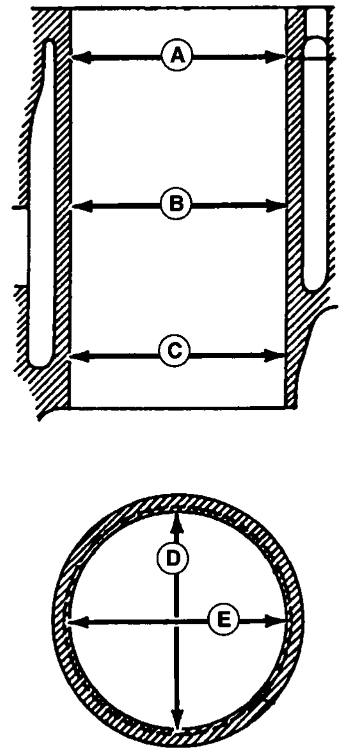
RB14256,0000A9E -19-18JUN14-11/12

RB14256,0000A9E -19-18JUN14-12/12

Measure Cylinder Bore—Gasoline

Inspection

Measure cylinder bore diameter at three positions: top (A), middle (B), and bottom (C). At these three positions, measure in both directions: along crankshaft centerline (E) and in direction of crankshaft rotation (D).



TCAL26093 —UN—15JUN12

Cylinder Bore ID

- If cylinder bore exceeds wear limit, replace cylinder block.
- If clearance (cylinder bore ID minus piston OD) exceeds specification, replace cylinder block, piston, or both.

Deglazing

IMPORTANT: If cylinder bores are to be deglazed with crankshaft installed in engine, put clean shop towels over crankshaft to protect journal and bearing surfaces from any abrasives.

1. Deglaze cylinder bores using a flex-hone with 180 grit stones.

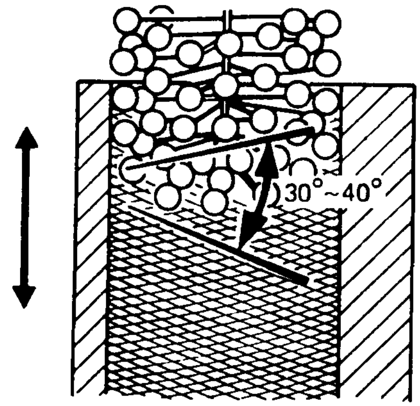
Continued on next page

RB14256,0000A9F -19-18JUN14-1/2

2. Use flex-hone as instructed by manufacturer to obtain a 30-40° crosshatch pattern as shown.

IMPORTANT: DO NOT use gasoline, kerosene, or commercial solvents to clean cylinder bores. Solvents will not remove all abrasives from cylinder walls.

3. Remove excess abrasive residue from cylinder walls using a clean dry rag. Clean cylinder walls using clean white rags and warm soapy water. Continue to clean cylinder until white rags show no discoloration.



TCAL26094 —UN—15JUN12

Item	Measurement	Specification
Specifications		
Cylinder Bore		65.5 mm (2.578 in.)
Cylinder Bore Wear Limit		65.53 mm (2.5799 in.)
Piston-to-Cylinder Clearance (Max)		0.06 mm (0.0023 in.)
Cylinder Roundness		0.00—0.008 mm (0.00—0.0003 in.)
Cylinder Roundness (Max)		0.00—0.008 mm (0.00—0.0003 in.)

RB14256,0000A9F -19-18JUN14-2/2

Remove and Install Crankshaft and Main Bearings—Gasoline

Removal

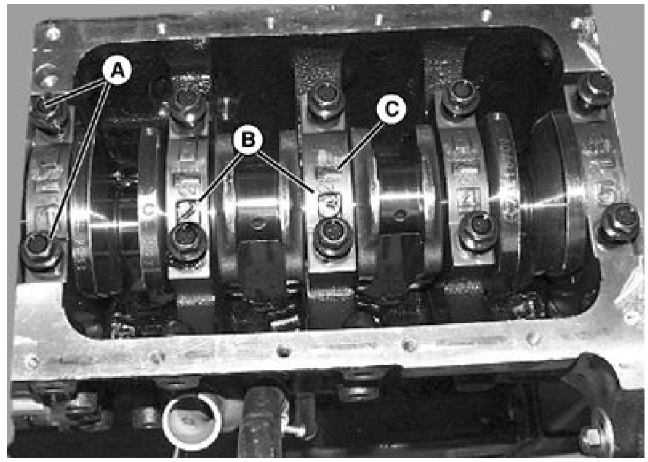
1. Check crankshaft end play.
2. Remove flywheel. (See Remove and Install Clutch and Flywheel—Gasoline.)
3. Remove rear oil seal case. (See Remove and Install Crankshaft Rear Oil Seal—Gasoline.)
4. Remove timing belt cover, timing belt and sprockets, tensioner, inner timing belt cover, and oil pump. (See Remove and Install Oil Pump—Gasoline.)

IMPORTANT: Connecting rod end caps must be installed on the same connecting rods from which they were removed. Note matching numbers on caps and rods.

5. Mark and remove connecting rod nuts and end caps.
6. Check connecting rod bearing clearance. (See Check Connecting Rod Bearing Clearance—Gasoline.)
7. Push pistons and connecting rods away from crankshaft.

IMPORTANT: Main bearing caps must be installed on the same main bearings from which they were removed.

8. Remove main bearing cap screws (A) on each cap and remove caps.



TCAL26095 —UN—15JUN12

Each bearing cap has a raised number 1-5 (B) and an arrow (C). Bearing 1 is at the front (oil pump) end of engine, and bearing 5 is at the flywheel end. The bearing caps are installed 1-5 with the arrows pointing to the front of the engine.

9. Check crankshaft main bearing clearance. (See Check Crankshaft Main Bearing Clearance—Gasoline.)

Continued on next page

RB14256,0000AA0 -19-18JUN14-1/3

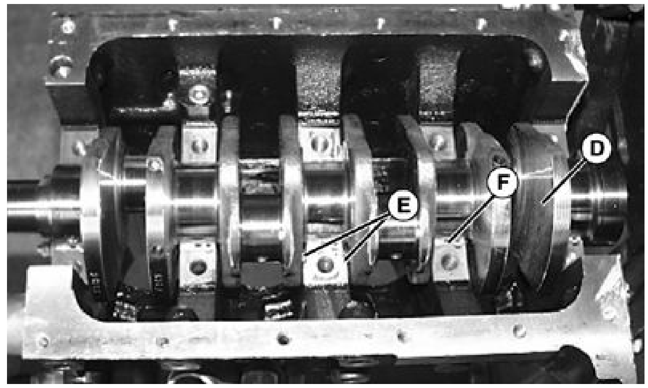
10. Remove crankshaft (D).
11. Remove block thrust bearings (E) and main bearing inserts (F).
12. Inspect all parts for wear or damage.

Installation

IMPORTANT: DO NOT touch bearing insert surfaces. Oil and acid from your finger will corrode the bearing surface.

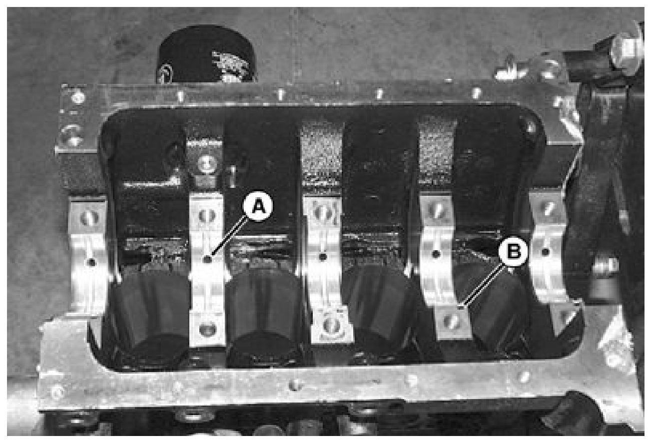
NOTE: Apply clean engine oil on all parts during installation.

1. Install bearing inserts in cylinder block bearing bores, aligning oil holes (A) with holes in block. Align tangs (B) with slots in cylinder block.
2. Apply grease to smooth side of thrust bearing to hold them in place on block. Install block thrust bearings with oil grooves facing away from engine block.
3. Lubricate bearing inserts and install crankshaft.
4. Install bearing inserts in main bearing caps, aligning tangs with slots in caps.
5. Apply grease to smooth side of thrust bearings to hold them in place on engine block during assembly. With oil grooves facing away from block, install thrust bearings on engine block.



TCAL26096 —UN—15JUN12

D—Crankshaft
E—Block Thrust Bearings
F—Main Bearing Inserts



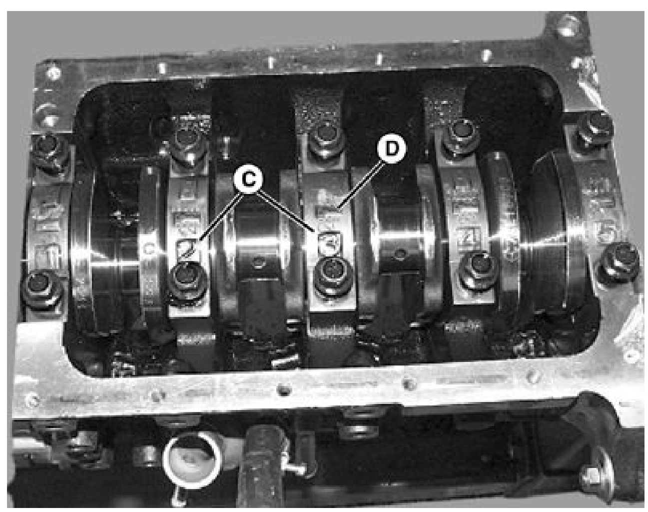
TCAL26097 —UN—15JUN12

RB14256,0000AA0 -19-18JUN14-2/3

6. Install main bearing caps in their original locations with arrows toward front of engine.

IMPORTANT: DO NOT use high-speed power tools or air wrenches to tighten main bearing cap screws.

7. Dip entire main bearing cap screws in clean engine oil. Install cap screws and tighten. DO NOT tighten to specifications.
8. Tighten main bearing cap screws to specifications. When tightening, start at center main bearing cap and work your way out, alternating to the ends. Turn crankshaft by hand after each cap is tightened. If it does not turn easily, disassemble the parts and find the cause.



TCAL26098 —UN—15JUN12

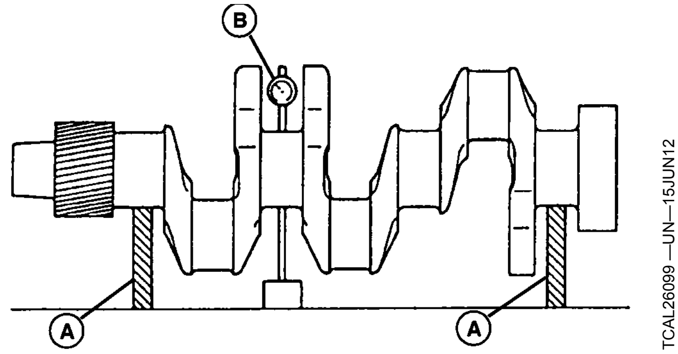
Each bearing cap has a raised number 1-5 (C) and an arrow (D). Bearing 1 is at the front (oil pump) end of engine, and bearing 5 is at the flywheel end. The bearing caps are installed 1-5 with the arrows pointing to the front of the engine.

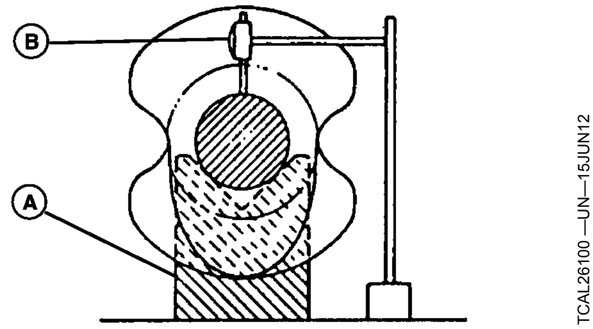
RB14256,0000AA0 -19-18JUN14-3/3

Crankshaft Inspection—Gasoline

Inspection

1. Inspect crankshaft for any obvious wear or damage.
2. Inspect crankshaft for bend using V-blocks (A) and a dial indicator (B). Turn crankshaft slowly and read variation on indicator. If variation is greater than specification, replace crankshaft.



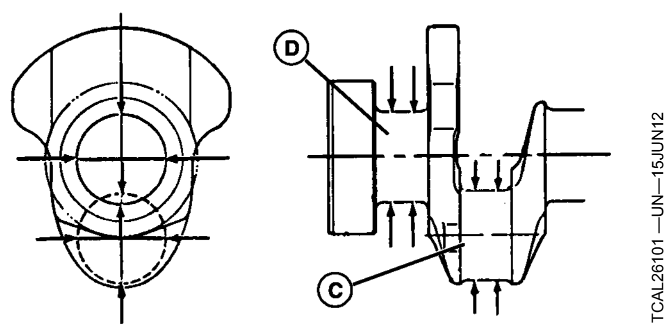


A—V-Blocks **B—Dial Indicator**

RB14256,0000AA1 -19-18JUN14-1/2

3. Measure crankshaft connecting rod journals (C) and main bearing journal (D) diameters. Measure several places around each journal.

   If journal diameter is less than specification, replace crankshaft.
4. Clean and inspect oil passages in main bearing journals, connecting rod journals, and main bearing bores in cylinder block.
5. Inspect crankshaft for cracks or damage. Replace if necessary.



C—Crankshaft Connecting Rod Measurement Area **D—Main Bearing Journal Measurement Area**

Specifications—Specification

Crankshaft Connecting Rod Journal OD—Capacity (with Filter)........37.976—38.000 mm (1.495—1.496 in.)

Crankshaft Main Bearing Journal OD—Capacity (with Filter)........49.97—50 mm (1.967—1.968 in.)

Crankshaft Bend (Max)—Capacity (with Filter)........0.06 mm (0.002 in.)

Main Bearing Cap Screw Torque—Capacity (with Filter)........43—48 N·m (33—35 lb.-ft.)

RB14256,0000AA1 -19-18JUN14-2/2

Remove and Install Crankshaft Rear Oil Seal—Gasoline

Continued on next page

RB14256,0000AA2 -19-18JUN14-1/4

Clutch Alignment Tool.. JDG1331

Used to align clutch disc with pilot bearing.

RB14256,0000AA2 -19-18JUN14-2/4

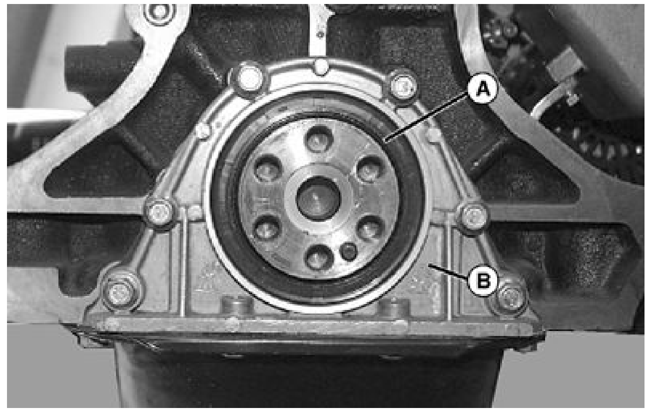
1. Remove engine. (See Remove Engine—Gasoline.)
2. Remove clutch cover, clutch disc, and clutch adapter plate from flywheel. Note longer center hub of clutch disc is facing clutch cover.

IMPORTANT: FLYWHEEL IS HEAVY! Do not remove flywheel mounting cap screws unless flywheel is secure. Use a hoist and lift rings to lift flywheel from crankshaft.

3. Remove six flywheel cap screws and remove flywheel.

NOTE: It is not necessary to remove oil seal case to remove oil seal.

4. Carefully pry oil seal (A) from oil seal case (B).
5. Replace oil seal using a driver set. Install seal with lip toward cylinder block. Install seal flush with surface of oil seal case.



TCAL26102 —UN—15JUN12

A—Crankshaft Rear Oil Seal **B—Oil Seal Case**

RB14256,0000AA2 -19-18JUN14-3/4

Remove and Install Rear Oil Seal Case (Clutch and Flywheel Removed)

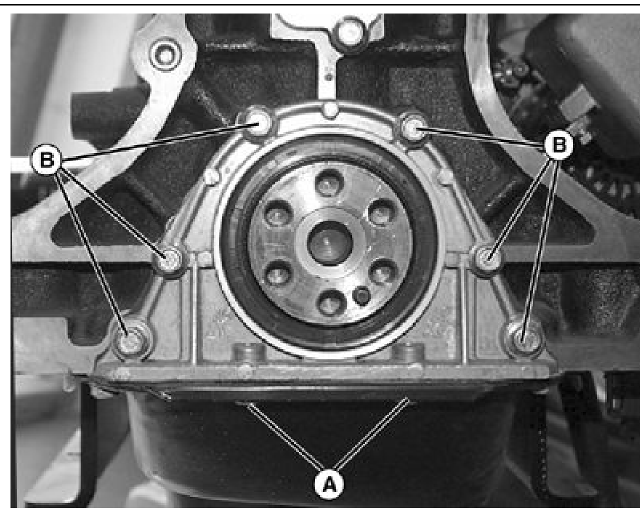
NOTE: It is not necessary to remove oil seal case to remove oil seal.

1. Remove two cap screws (A) securing oil pan to oil seal case.
2. Remove six cap screws (B) securing oil seal case-to-cylinder block.
3. Pry oil seal case from engine block and remove oil seal.
4. Clean all old gasket material from oil seal case, engine block, and oil pan.
5. Apply a bead of John Deere form in place gasket on oil pan. Install new gasket and oil seal case on engine block and tighten cap screws.
6. Install clutch and flywheel. (See Remove and Install Clutch and Flywheel—Gasoline.)
7. Install engine. (See Install Engine—Gasoline.)

Specifications—Specification

Flywheel Mounting Cap Screw Torque—Capacity (with Filter)....................43 N·m (32 lb.-ft.)

Clutch Cover Cap Screw Torque—Capacity (with Filter)....................28 N·m (20 lb.-ft.)



TCAL26103 —UN—15JUN12

A—Two Cap Screws **B—Six Cap Screws**

Clutch Adapter Plate Cap Screw Torque—Capacity (with Filter)....................61 N·m (45 lb.-ft.)

RB14256,0000AA2 -19-18JUN14-4/4

Section 40
Engine-Diesel

Contents

Continued on next page

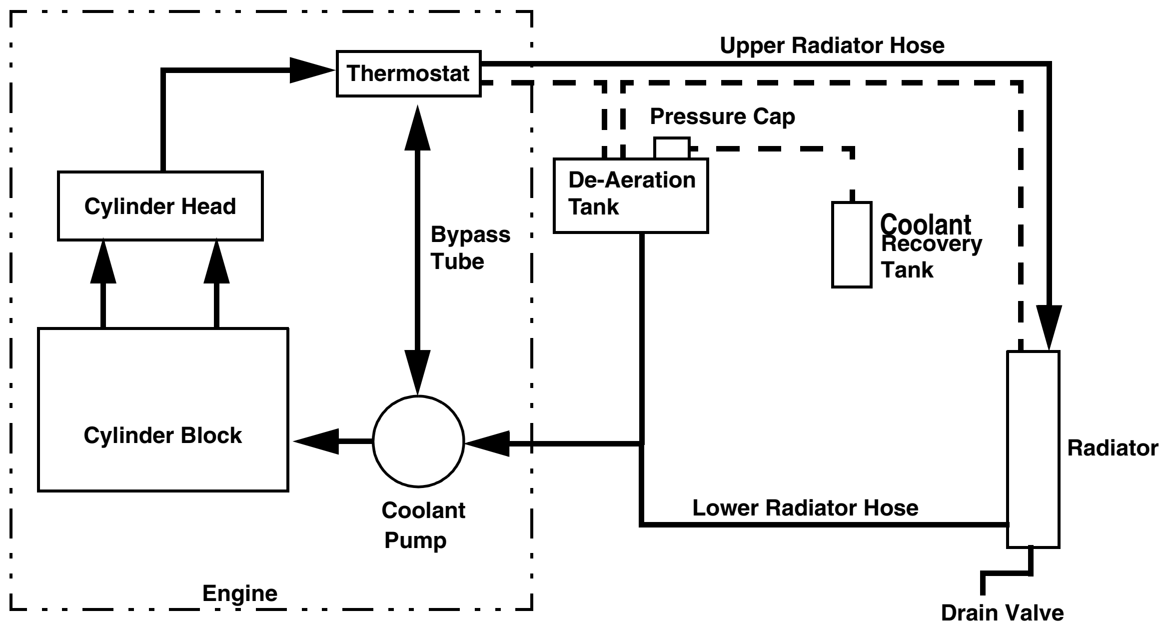
Continued on next page

Specifications

Machine Model Used On	2030A	
Engine:		
Make	Yanmar	
Engine Model	3TNV76	3TNV80F-NCJUV
Type	4 Cycle	
Direction of Rotation	Counterclockwise (viewed from flywheel)	
Oil Capacity (with filter)	2.70 L (2.80 qt)	3.45 L (3.65 qt)
Coolant Capacity		
Bore	76.01—76.02 mm (2.9925—2.9929 in)	80.010—80.020 mm (3.1500—3.1504 in)
Stroke	76 mm (2.992 in)	84 mm (3.31 in)
Cylinders	3	
Valves	Overhead	
Firing Order	1-3-2	
Displacement	1.115 L (68.03 in³)	1.267 L (77.3 in³)
Governor	Centrifugal	
Cooling	Liquid with pump and radiator	
Fuel Filter	Replaceable element fuel water separator	

RB14256,000081C -19-30SEP16-1/1

Cooling System Theory of Operation



TCAL26104 —UN—15JUN12

Function

The cooling system allows the engine to rise to full operating temperature when engine is started cold, but keeps the engine from overheating once the engine reaches operating temperature.

When operating temperature has been reached, coolant is circulated from the hot engine to the radiator to prevent engine overheating. The cooling system is pressurized, which raises the boiling point of the coolant and allows more heat to be carried away from the engine.

Theory of Operation

The cooling system includes the following components:

Radiator, upper and lower coolant hoses, pressure cap, de-aeration tank, coolant recovery tank, coolant pump, thermostat, electric fan, and drain valve.

When the engine is started cold, the thermostat is closed. The impeller type coolant pump pulls coolant from the cylinder head and through the bypass tube (located inside the coolant pump housing). The coolant pump then pushes the coolant into the cylinder block water jacket. The coolant absorbs heat from the cylinder walls, and is then pushed up into the cylinder head and sucked back into the coolant pump. This provides a fast warm-up period, as engine heat is retained and evenly distributed throughout the engine.

Once the engine has reached operating temperature, the thermostat opens and the hot coolant from the cylinder head passes through the thermostat to the radiator. As coolant flows through the tubes of the radiator core, heat is transferred from the coolant to the air stream being drawn through the core by the electric fan. When the coolant reaches the bottom of the radiator, it is sucked through the lower radiator hose into the coolant pump and pushed back into the cylinder block. The de-aeration tank accepts water from the lower radiator hose. The de-aeration tank also allows air to accumulate and be purged during operation and when filling the system.

When coolant system pressure exceeds 88.3 ± 14.7 kPa (12.8 ± 2.2 psi), the spring in the pressure cap is pushed open to allow coolant to discharge into the coolant recovery tank. Any air in the system is purged through the de-aeration tank and cap. After shutdown, when engine is cooling, a vacuum is produced in the cooling system, and coolant is drawn back out of the coolant recovery tank through a small valve in the bottom of the pressure cap.

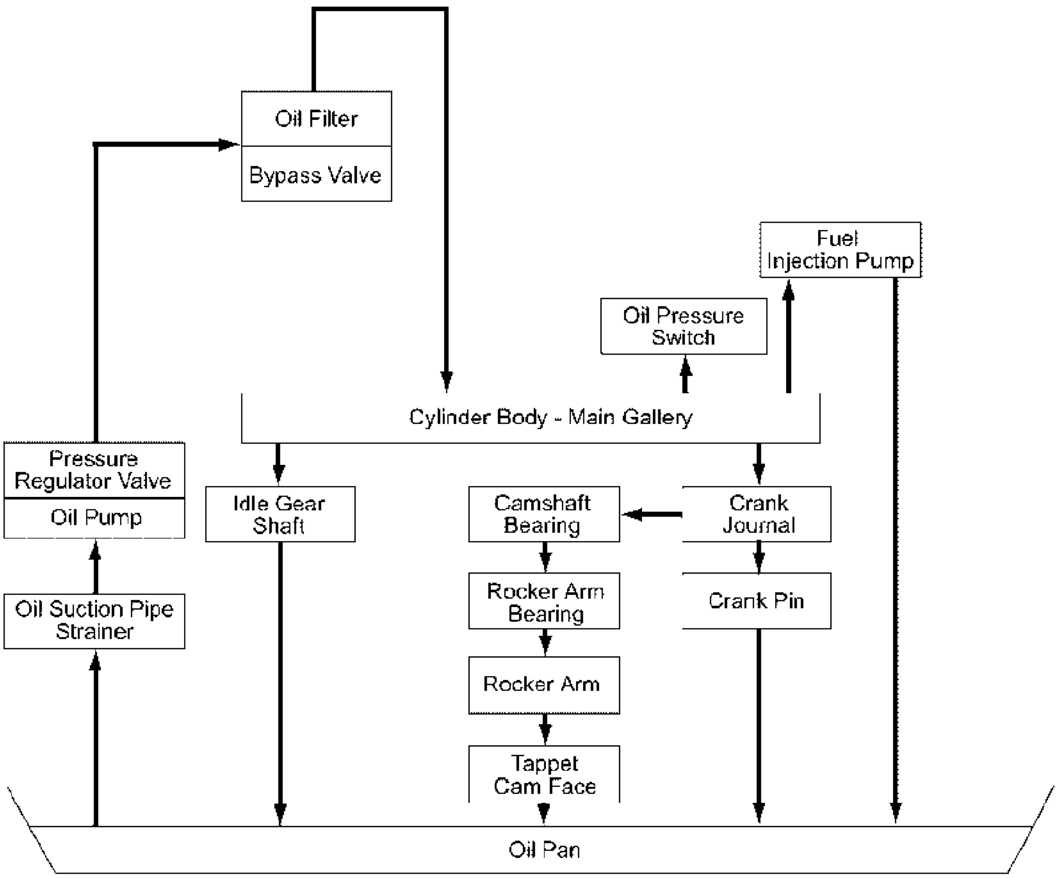
The fan draws air through a removable debris guard on the front of the radiator, through the radiator and hydraulic oil cooler (if equipped).

Two electrical coolant temperature sensors are located in the coolant pump housing. One operates the temperature gauge on the dashboard. The other operates the electric fan and the coolant temperature warning lamp.

The radiator can be drained through a drain valve on the bottom of the radiator. The coolant recovery tank can be drained by simply lifting it out of its holder and pouring it out.

RB14256,0000820 -19-18JUN12-1/1

Lubrication System Theory of Operation



TCAL26105 —UN—15JUN12

Function

A full pressure system lubricates engine parts with clean oil.

Theory of Operation

The pressure lubrication system consists of an oil strainer, a positive displacement crankshaft-driven pump with oil pressure regulating valve, full flow oil filter, and an electrical oil pressure warning switch.

The oil pump is under the timing gear cover and is driven by the crankshaft. The oil pump draws oil from the oil pan through the strainer and suction tube and regulates oil pressure with the built-in oil pressure regulating valve. The oil is then pumped through an oil passage to the oil filter and through the engine block main oil galley.

From the main oil galley, oil is pushed to the crankshaft main bearing journals and idler gear shaft. Drilled cross-passages in the crankshaft distribute the oil from the main bearings to the connecting rod bearing journals.

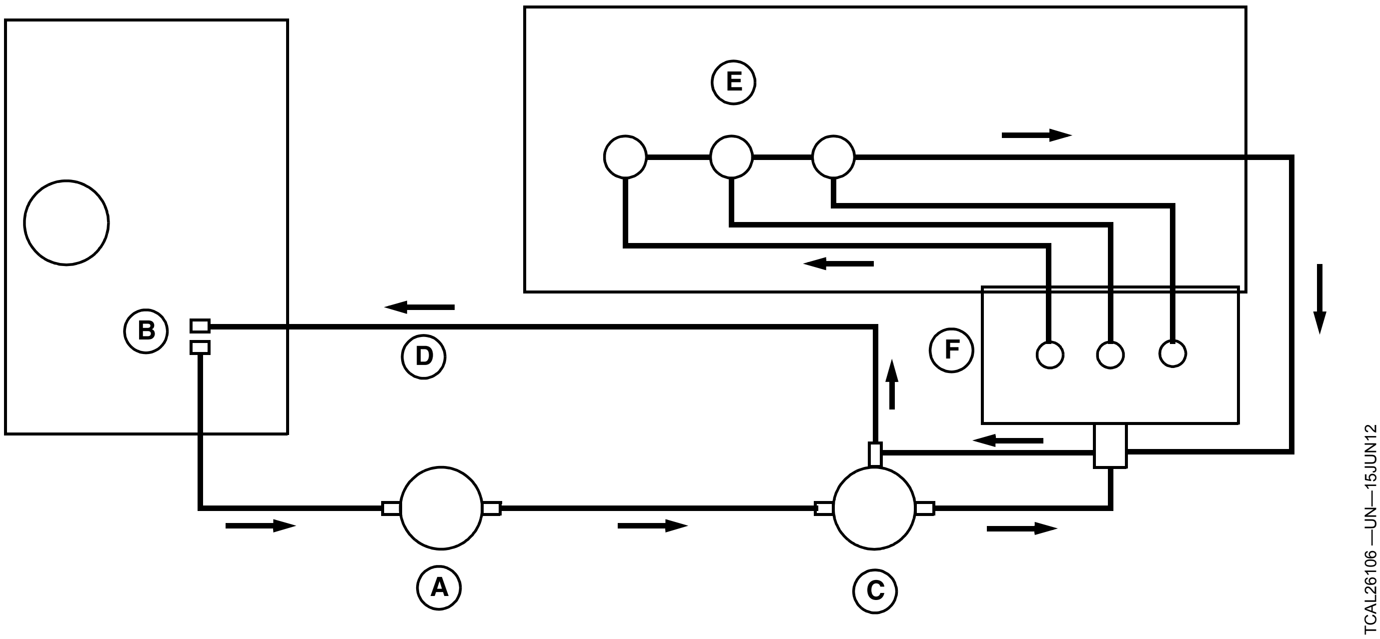
Lube oil holes in the main bearing oil grooves send oil through drilled passages to the camshaft bearings.

A drilled passage from the rear camshaft bearing through the cylinder block and cylinder head supplies lubricating oil to the rocker arm shaft. The hollow shaft distributes oil to the rocker arms, tappets and valves.

If oil pressure drops below specification, a pressure switch activates the engine oil pressure light to alert the operator to shut down the engine.

RB14256,0000821 -19-18JUN12-1/1

Fuel System Theory of Operation



A—Transfer Pump
B—Fuel Tank
C—Fuel Filter
D—Return Hose
E—Injectors
F—Injection Pump

Function

The fuel system supplies clean fuel to injection pump and nozzles, and circulates unused fuel back to the tank. An instrument-panel-mounted electric fuel gauge shows the operator the amount of fuel remaining.

Theory of Operation

The electric transfer pump (A) draws fuel from the fuel tank (B) and supplies fuel to the fuel filter (C). Fuel flows from the outlet on the fuel tank to the combination bowl fuel filter/water separator/fuel shutoff valve (C). The filter is self priming and excess air is returned to the tank through a return hose (D). Excess fuel is returned from the fuel filter to the tank.

Excess leak-off fuel from the injectors (E) is returned to the fuel injection pump (F).

The engine speed is controlled by the throttle pedal and/or hand throttle lever. The throttle linkage is connected to the injection pump/governor control lever.

The fuel shutoff solenoid has two coils inside; one pull-in and one hold-in coil. The hold-in coil is energized whenever the key switch is in the ON or START position. The pull-in coil is energized only when in the START position and oil pressure switch closed.

The fuel shutoff solenoid controls the flow of fuel inside the injection pump. When the solenoid is energized (ignition key to START and RUN position), the solenoid pulls in and the allows fuel to be pumped to the injectors. When the key is turned OFF, return springs on the shutoff shaft extend the solenoid, moving the shutoff linkage to the shutoff position.

When the key switch is turned OFF, the fuel shutoff solenoid stops the flow of fuel inside the fuel injector pump by forcing the governor rack linkage to a no-fuel position, causing the fuel injector pump to stop suppling fuel to the injectors.

The injection pump meters fuel as determined by the governor and delivers it at high pressure to the injection nozzles. The injection nozzle prevents flow until high pressure is reached, opening the valve and spraying atomized fuel into the pre-combustion swirl chamber. Injection lines have trapped fuel inside whenever injection is not taking place.

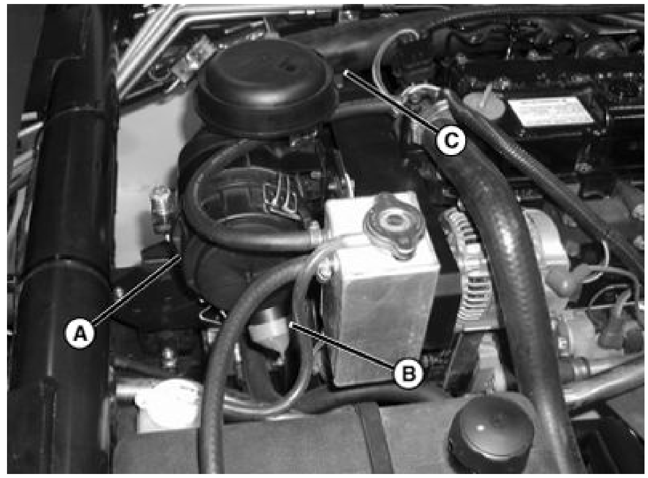
A small amount of fuel leaks past the nozzle valve to lubricate the fuel injection nozzle. This leakage combines with excess fuel from the injection pump and is returned to tank. Any air in the fuel system is bled out with return fuel to the fuel tank.

A float-type fuel level sensor mounted on the top of the tank drives an instrument-panel-mounted gauge, informing the operator of the fuel level.

RB14256,0000822 -19-18JUN12-1/1

Air Intake System Theory of Operation

A—Air Cleaner Housing
B—Unloader Valve
C—Outlet Tube



TCAL26107 —UN—15JUN12

RB14256,0000823 -19-18JUN12-1/3

D—Primary Air Filter Element

TCAL26108 —UN—15JUN12

Continued on next page

RB14256,0000823 -19-18JUN12-2/3

Function

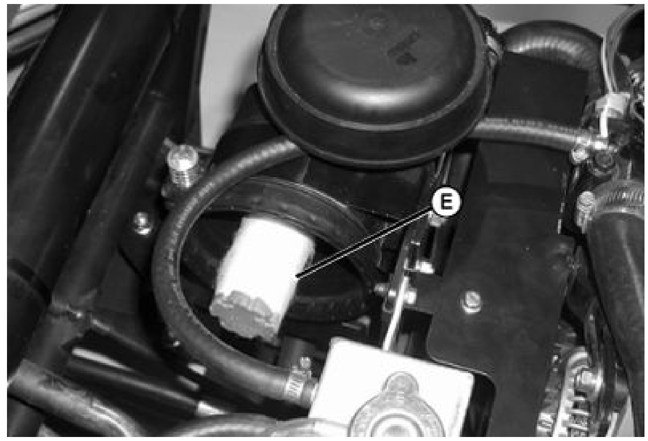
The air intake system filters air needed for combustion. The system components include: Air cleaner housing (A), unloader valve (B), outlet tube (C) and clamps. Contained in the air cleaner housing are the primary air filter element (D) and secondary air filter element (E).

Theory of Operation

Air enters the air filter inlet tube and into the air filter housing, and is directed into the side of a shield. This starts a high-speed centrifugal motion of air which continues around the element until it reaches the far end of the air filter housing, to an unloader valve.

Most of the dust is separated from the air by centrifugal force that causes heavy dust particles to enter the opening at the top of the unloader valve. The remaining air enters the primary air filter element. The primary filter element filters the larger dirt particles before the air enters the secondary air filter element. The finer dirt particles are filtered in the secondary air filter before the air enters the intake manifold.

The dirt that is deposited in the unloader valve is removed by the rubber diaphragm at the base of the air cleaner.



TCAL26109 —UN—15JUN12

E—Secondary Air Filter Element

When the engine is running, a pulsing action is created in the intake system by each intake stroke of the engine. This pulsing action causes the rubber diaphragm to open and close, thus emptying the unloader valve. The operator can squeeze the valve to let the large particles out.

RB14256,0000823 -19-18JUN12-3/3

Use of Dielectric Grease

Whenever non-sealed harness connectors on the machine are disconnected, apply dielectric grease to the ends before reassembling. Clean excess grease from the connector. Do not use grease on sealed connectors.

CAUTION: The engine may start to rotate at any time. Keep hands away from all moving parts when testing.

Coolant in the radiator is extremely hot during operation.

RB14256,0000824 -19-18JUN12-1/1

Symptom: Engine Will Not Start

RB14256,0000825 -19-18JUN12-1/19

Engine Will Not Start

RB14256,0000825 -19-18JUN12-2/19

Step 1	Starting procedure being used is correct for conditions?	**YES:** Go to next step. **NO:** Use correct procedure for conditions. See the Operator's Manual.

RB14256,0000825 -19-18JUN12-3/19

Step 2	Battery 12.7 VDC or higher?	**YES:** Go to next step. **NO:** Charge and check battery.

RB14256,0000825 -19-18JUN12-4/19

Step 3	No open circuits in wiring?	**YES:** Go to next step. **NO:** Repair or replace as needed.

RB14256,0000825 -19-18JUN12-5/19

Step 4	Starting motor functioning properly?	**YES:** Go to next step. **NO:** Repair or replace starting motor.

RB14256,0000825 -19-18JUN12-6/19

Step 5	Correct type of fuel being used?	**YES:** Go to next step. **NO:** Drain and replace fuel.

RB14256,0000825 -19-18JUN12-7/19

Step 6	Engine oil of correct viscosity and type?	**YES:** Go to next step. **NO:** Replace engine oil with oil of proper viscosity and type. Replace oil filter.

RB14256,0000825 -19-18JUN12-8/19

Step 7	No water in fuel?	**YES:** Go to next step. **NO:** Drain and replace fuel.

Continued on next page

RB14256,0000825 -19-18JUN12-9/19

Step 8	Fuel filter not clogged?	**YES:** Go to next step. **NO:** Replace fuel filter.

RB14256,0000825 -19-18JUN12-10/19

Step 9	No air leak in fuel system?	**YES:** Go to next step. **NO:** Repair fuel system.

RB14256,0000825 -19-18JUN12-11/19

Step 10	Fuel lines not plugged, pinched or cracked?	**YES:** Go to next step. **NO:** Repair or replace fuel lines as needed.

RB14256,0000825 -19-18JUN12-12/19

Step 11	Correct volume of fuel supplied to injection pump?	**YES:** Go to next step. **NO:** Replace fuel pump.

RB14256,0000825 -19-18JUN12-13/19

Step 12	Intake and/or exhaust valve clearance correct?	**YES:** Go to next step. **NO:** Adjust valve clearance. (See Adjust Valve Clearance.)

RB14256,0000825 -19-18JUN12-14/19

Step 13	Intake and/or exhaust valve not seized?	**YES:** Go to next step. **NO:** Replace valve and check valve guide. (See Recondition Cylinder Head—3TNV76 or Disassemble and Assemble Cylinder Head and Valves—3TNV80F.)

RB14256,0000825 -19-18JUN12-15/19

Step 14	Piston rings not broken or seized?	**YES:** Go to next step. **NO:** Replace rings. Check piston and cylinder. (See Remove and Install Piston and Connecting Rod—3TNV76 or Remove and Install Piston and Connecting Rod—3TNV80F.)

Continued on next page

RB14256,0000825 -19-18JUN12-16/19

Step 15	Piston rings, piston or cylinder not worn?	**YES:** Go to next step. **NO:** Replace piston and/or rings; bore or hone cylinder. (See Remove and Install Piston and Connecting Rod—3TNV76 or Remove and Install Piston and Connecting Rod—3TNV80F. See Cylinder Bore—3TNV76 or Inspect Cylinder Bore—3TNV80F.)

RB14256,0000825 -19-18JUN12-17/19

Step 16	Crankshaft pin or bearing not seized?	**YES:** Go to next step. **NO:** Regrind crankshaft and replace bearings. (See Crankshaft and Main Bearings—3TNV76 or Remove and Install Crankshaft and Main Bearings—3TNV80F.)

RB14256,0000825 -19-18JUN12-18/19

Step 17	Is injection pump timing correct?	**NO:** (See Injection Pump Static Timing.)

RB14256,0000825 -19-18JUN12-19/19

Symptom: Engine Starts but Does Not Continue Running—No Exhaust Smoke

RB14256,0000826 -19-18JUN12-1/10

Engine Starts but Does Not Continue Running—No Exhaust Smoke

RB14256,0000826 -19-18JUN12-2/10

Step 1	Correct type of fuel being used?	**YES:** Go to next step. **NO:** Drain and replace fuel.

RB14256,0000826 -19-18JUN12-3/10

Step 2	Engine oil of proper viscosity and type?	**YES:** Go to next step. **NO:** Replace engine oil and filter with oil of proper viscosity and type.

RB14256,0000826 -19-18JUN12-4/10

Step 3	Fuel filter not clogged?	**YES:** Go to next step. **NO:** Replace fuel filter.

RB14256,0000826 -19-18JUN12-5/10

Step 4	No air leak in fuel system?	**YES:** Go to next step. **NO:** Repair fuel system.

Continued on next page

RB14256,0000826 -19-18JUN12-6/10

Step 5	Fuel lines not plugged, pinched or cracked?	**YES:** Go to next step. **NO:** Repair or replace fuel lines as needed.

RB14256,0000826 -19-18JUN12-7/10

Step 6	Correct volume of fuel supplied to injection pump?	**YES:** Go to next step. **NO:** Replace fuel pump.

RB14256,0000826 -19-18JUN12-8/10

Step 7	Correct volume of fuel supplied to injection pump?	**YES:** Go to next step. **NO:** Replace fuel pump.

RB14256,0000826 -19-18JUN12-9/10

Step 8	Valve clearance correct?	**NO:** Adjust valve clearance. (See Adjust Valve Clearance.)

RB14256,0000826 -19-18JUN12-10/10

Symptom: Engine Starts but Does Not Continue Running—Excess Exhaust Smoke

RB14256,0000827 -19-18JUN12-1/8

Engine Starts but Does Not Continue Running—Excess Exhaust Smoke

RB14256,0000827 -19-18JUN12-2/8

Step 1	Correct type of fuel being used?	**YES:** Go to next step. **NO:** Drain and replace fuel.

RB14256,0000827 -19-18JUN12-3/8

Step 2	No water in fuel?	**YES:** Go to next step. **NO:** Drain and replace fuel.

RB14256,0000827 -19-18JUN12-4/8

Step 3	Fuel filter not clogged?	**YES:** Go to next step. **NO:** Replace fuel filter.

RB14256,0000827 -19-18JUN12-5/8

Step 4	Intake and/or exhaust valve not seized?	**YES:** Go to next step. **NO:** Repair as necessary. (See Recondition Cylinder Head—3TNV76 or Disassemble and Assemble Cylinder Head and Valves—3TNV80F.)

Continued on next page RB14256,0000827 -19-18JUN12-6/8

Step 5	Piston rings not broken or seized?	**YES:** Go to next step. **NO:** Replace rings. Check piston and cylinder. (See Remove and Install Piston and Connecting Rod—3TNV76 or Remove and Install Piston and Connecting Rod—3TNV80F. See Cylinder Bore—3TNV76 or Inspect Cylinder Bore—3TNV80F.)

RB14256,0000827 -19-18JUN12-7/8

Step 6	Piston rings, piston or cylinder not worn?	**NO:** Replace piston and/or rings, bore or hone cylinder. (See Remove and Install Piston and Connecting Rod—3TNV76 or Remove and Install Piston and Connecting Rod—3TNV80F. See Cylinder Bore—3TNV76 or Inspect Cylinder Bore—3TNV80F.)

RB14256,0000827 -19-18JUN12-8/8

Symptom: Low Engine Output—Exhaust Color NORMAL

RB14256,0000828 -19-18JUN12-1/11

Low Engine Output—Exhaust Color NORMAL

RB14256,0000828 -19-18JUN12-2/11

Step 1	Correct type of fuel being used?	**YES:** Go to next step. **NO:** Drain and replace fuel.

RB14256,0000828 -19-18JUN12-3/11

Step 2	Fuel filter not clogged?	**YES:** Go to next step. **NO:** Replace fuel filter.

RB14256,0000828 -19-18JUN12-4/11

Step 3	Fuel lines not clogged, cracked or pinched?	**YES:** Go to next step. **NO:** Clean or replace fuel lines.

RB14256,0000828 -19-18JUN12-5/11

Step 4	No air leakage into fuel system?	**YES:** Go to next step. **NO:** Repair fuel supply system.

Continued on next page RB14256,0000828 -19-18JUN12-6/11

Step 5	Proper volume of fuel to injection pump?	**YES:** Go to next step. **NO:** Check or replace fuel pump.

RB14256,0000828 -19-18JUN12-7/11

Step 6	Intake and exhaust valve clearance correct?	**YES:** Go to next step. **NO:** Adjust valve clearance. (See Adjust Valve Clearance.)

RB14256,0000828 -19-18JUN12-8/11

Step 7	Intake or exhaust valves not leaking compression?	**YES:** Go to next step. **NO:** Grind valves and seats. (See Recondition Cylinder Head—3TNV76 or Disassemble and Assemble Cylinder Head and Valves—3TNV80F.)

RB14256,0000828 -19-18JUN12-9/11

Step 8	Intake or exhaust valves not seized?	**YES:** Go to next step. **NO:** Replace valve and check valve guide. (See Recondition Cylinder Head—3TNV76 or Disassemble and Assemble Cylinder Head and Valves—3TNV80F.)

RB14256,0000828 -19-18JUN12-10/11

Step 9	Cylinder head gasket not leaking compression?	**NO:** Replace head gasket. (See Remove and Install Cylinder Head—3TNV76 or Remove and Install Cylinder Head and Valves—3TNV80F.) Resurface head and block if necessary.

RB14256,0000828 -19-18JUN12-11/11

Symptom: Low Engine Output—Exhaust Color WHITE

RB14256,0000829 -19-18JUN12-1/12

Low Engine Output—Exhaust Color WHITE

RB14256,0000829 -19-18JUN12-2/12

Step 1	Correct type of fuel?	**YES:** Go to next step. **NO:** Drain and replace fuel.

Continued on next page RB14256,0000829 -19-18JUN12-3/12

Step 2	No water in fuel?	**YES:** Go to next step. **NO:** Drain and replace fuel.

RB14256,0000829 -19-18JUN12-4/12

Step 3	Even volume of fuel being injected?	**YES:** Go to next step. **NO:** Repair or replace fuel injection pump or fuel injectors.

RB14256,0000829 -19-18JUN12-5/12

Step 4	Proper spray pattern from injectors?	**YES:** Go to next step. **NO:** Clean or replace fuel injection nozzles. (See Remove, Inspect, and Install Fuel Injection Nozzle—3TNV76 or Remove, Inspect, and Install Fuel Injection Nozzle—3TNV80F.)

RB14256,0000829 -19-18JUN12-6/12

Step 5	Intake or exhaust valve stems not worn?	**YES:** Go to next step. **NO:** Replace valve guides and valves. (See Recondition Cylinder Head—3TNV76 or Disassemble and Assemble Cylinder Head and Valves—3TNV80F.)

RB14256,0000829 -19-18JUN12-7/12

Step 6	Is injection pump timing correct?	**YES:** Go to next step. **NO:** Time injection pump. (See Injection Pump Static Timing.)

RB14256,0000829 -19-18JUN12-8/12

Step 7	Piston rings installed correctly?	**YES:** Go to next step. **NO:** Install piston rings correctly. (See Remove and Install Piston and Connecting Rod—3TNV76 or Remove and Install Piston and Connecting Rod—3TNV80F.)

Continued on next page

RB14256,0000829 -19-18JUN12-9/12

Step 8	Piston ring ends staggered?	**YES:** Go to next step. **NO:** Stagger piston ring ends. (See Remove and Install Piston and Connecting Rod—3TNV76 or Remove and Install Piston and Connecting Rod—3TNV80F.)

RB14256,0000829 -19-18JUN12-10/12

Step 9	Piston, rings, or cylinder not worn?	**YES:** Go to next step. **NO:** Replace pistons and rings; bore or hone cylinders. (See Remove and Install Piston and Connecting Rod—3TNV76 or Remove and Install Piston and Connecting Rod—3TNV80F. See Cylinder Bore—3TNV76 or Inspect Cylinder Bore—3TNV80F.)

RB14256,0000829 -19-18JUN12-11/12

Step 10	Piston rings not broken or seized?	**NO:** Replace rings. Replace pistons if damaged. Bore cylinder if damaged. (See Remove and Install Piston and Connecting Rod—3TNV76 or Remove and Install Piston and Connecting Rod—3TNV80F. See Cylinder Bore—3TNV76 or Inspect Cylinder Bore—3TNV80F.)

RB14256,0000829 -19-18JUN12-12/12

Symptom: Low Engine Output—Exhaust Color BLACK

RB14256,000082A -19-18JUN12-1/13

Low Engine Output - Exhaust Color BLACK

RB14256,000082A -19-18JUN12-2/13

Step 1	Is engine NOT being run under high-altitude or high-temperature conditions?	**YES:** Go to next step. **NO:** Reduce load.

RB14256,000082A -19-18JUN12-3/13

Step 2	Correct type of fuel?	**YES:** Go to next step. **NO:** Drain and replace fuel.

Continued on next page RB14256,000082A -19-18JUN12-4/13

Step 3	Air filter elements not clogged?	**YES:** Go to next step. **NO:** Clean or replace air filter elements.

RB14256,000082A -19-18JUN12-5/13

Step 4	Exhaust pipe not clogged?	**YES:** Go to next step. **NO:** Clean exhaust pipe.

RB14256,000082A -19-18JUN12-6/13

Step 5	Engine running cool enough?	**YES:** Go to next step. **NO:** Adjust fan belt tension. Check thermostat. (See Test Thermostat Opening.) Replace if faulty.

RB14256,000082A -19-18JUN12-7/13

Step 6	Cooling system filled to correct level?	**YES:** Go to next step. **NO:** Check for leaks and fill system to correct level.

RB14256,000082A -19-18JUN12-8/13

Step 7	Correct volume of fuel being injected?	**YES:** Go to next step. **NO:** Replace faulty fuel injection pump or fuel injectors.

RB14256,000082A -19-18JUN12-9/13

Step 8	Correct pattern from fuel injectors?	**YES:** Go to next step. **NO:** Clean or replace fuel injection nozzles. (See Remove, Inspect, and Install Fuel Injection Nozzle—3TNV76 or Remove, Inspect, and Install Fuel Injection Nozzle—3TNV80F.)

RB14256,000082A -19-18JUN12-10/13

Step 9	Is injection pump timing correct?	**YES:** Go to next step. **NO:** Time injection pump. (See Injection Pump Static Timing.)

RB14256,000082A -19-18JUN12-11/13

Step 10	Intake or exhaust valves not leaking compression?	**YES:** Go to next step. **NO:** Grind valves and seats. (See Recondition Cylinder Head—3TNV76 or Disassemble and Assemble Cylinder Head and Valves—3TNV80F.)

Continued on next page

RB14256,000082A -19-18JUN12-12/13

Step 11	Intake or exhaust valve not seized?	**NO:** Replace valve and check valve guide. (See Recondition Cylinder Head—3TNV76 or Disassemble and Assemble Cylinder Head and Valves—3TNV80F.)

RB14256,000082A -19-18JUN12-13/13

Symptom: Exhaust Color WHITE Under Load

RB14256,000082B -19-18JUN12-1/11

Exhaust Color WHITE Under Load

RB14256,000082B -19-18JUN12-2/11

Step 1	Correct type of fuel?	**YES:** Go to next step. **NO:** Drain and replace fuel.

RB14256,000082B -19-18JUN12-3/11

Step 2	No water in fuel?	**YES:** Go to next step. **NO:** Drain and replace fuel.

RB14256,000082B -19-18JUN12-4/11

Step 3	Engine not running too cool?	**YES:** Go to next step. **NO:** Check thermostat. (See Test Thermostat Opening.) Replace if faulty.

RB14256,000082B -19-18JUN12-5/11

Step 4	Correct volume of fuel being injected?	**YES:** Go to next step. **NO:** Replace faulty fuel injection pump.

RB14256,000082B -19-18JUN12-6/11

Step 5	Correct pattern from fuel injectors?	**YES:** Go to next step. **NO:** Clean or replace fuel injection nozzles. (See Remove, Inspect, and Install Fuel Injection Nozzle—3TNV76 or Remove, Inspect, and Install Fuel Injection Nozzle—3TNV80F.)

RB14256,000082B -19-18JUN12-7/11

Step 6	Is injection pump timing correct?	**YES:** Go to next step. **NO:** Time injection pump. (See Injection Pump Static Timing.)

Continued on next page

RB14256,000082B -19-18JUN12-8/11

Step 7	Piston rings installed correctly?	**YES:** Go to next step. **NO:** Install piston rings correctly. (See Remove and Install Piston and Connecting Rod—3TNV76 or Remove and Install Piston and Connecting Rod—3TNV80F.)

RB14256,000082B -19-18JUN12-9/11

Step 8	Pistons, rings or cylinders not worn?	**YES:** Go to next step. **NO:** Replace pistons and rings; bore or hone cylinders. (See Remove and Install Piston and Connecting Rod—3TNV76 or Remove and Install Piston and Connecting Rod—3TNV80F. See Cylinder Bore—3TNV76 or Inspect Cylinder Bore—3TNV80F.)

RB14256,000082B -19-18JUN12-10/11

Step 9	Piston rings not broken or seized?	**NO:** Replace rings. Replace pistons if damaged. Bore cylinder if damaged. (See Remove and Install Piston and Connecting Rod—3TNV76 or Remove and Install Piston and Connecting Rod—3TNV80F. See Cylinder Bore—3TNV76 or Inspect Cylinder Bore—3TNV80F.)

RB14256,000082B -19-18JUN12-11/11

Symptom: Exhaust Color BLACK Under Load

RB14256,000082C -19-18JUN12-1/12

Exhaust Color BLACK Under Load

RB14256,000082C -19-18JUN12-2/12

Step 1	Is engine NOT being run under high-altitude or high-temperature conditions?	**YES:** Go to next step. **NO:** Reduce load.

RB14256,000082C -19-18JUN12-3/12

Step 2	Correct type of fuel?	**YES:** Go to next step. **NO:** Drain and replace fuel.

Continued on next page

RB14256,000082C -19-18JUN12-4/12

Step 3	Air filter elements not clogged?	**YES:** Go to next step. **NO:** Clean or replace air filter elements.

RB14256,000082C -19-18JUN12-5/12

Step 4	Exhaust pipe not clogged?	**YES:** Go to next step. **NO:** Clean exhaust pipe.

RB14256,000082C -19-18JUN12-6/12

Step 5	Even volume of fuel being injected?	**YES:** Go to next step. **NO:** Replace faulty fuel injection pump or fuel injectors.

RB14256,000082C -19-18JUN12-7/12

Step 6	Correct volume of fuel being injected?	**YES:** Go to next step. **NO:** Replace faulty fuel injection pump or fuel injectors.

RB14256,000082C -19-18JUN12-8/12

Step 7	Proper spray pattern from injectors?	**YES:** Go to next step. **NO:** Clean or replace fuel injection nozzles. (See Remove, Inspect, and Install Fuel Injection Nozzle—3TNV76 or Remove, Inspect, and Install Fuel Injection Nozzle—3TNV80F.)

RB14256,000082C -19-18JUN12-9/12

Step 8	Is injection pump timing correct?	**YES:** Go to next step. **NO:** Time injection pump. (See Injection Pump Static Timing.)

RB14256,000082C -19-18JUN12-10/12

Step 9	Intake or exhaust valves not leaking compression?	**YES:** Go to next step. **NO:** Grind valves and seats. (See Recondition Cylinder Head—3TNV76 or Disassemble and Assemble Cylinder Head and Valves—3TNV80F.)

Continued on next page

RB14256,000082C -19-18JUN12-11/12

Step 10	Intake or exhaust valves not seized?	**NO:** Replace valve and check valve guide. (See Recondition Cylinder Head—3TNV76 or Disassemble and Assemble Cylinder Head and Valves—3TNV80F.)

RB14256,000082C -19-18JUN12-12/12

Symptom: Exhaust Temperature Too High

RB14256,000082D -19-18JUN12-1/9

Exhaust Temperature Too High

RB14256,000082D -19-18JUN12-2/9

Step 1	Cooling system filled to correct level?	**YES:** Go to next step. **NO:** Check for leaks and fill system to correct level.

RB14256,000082D -19-18JUN12-3/9

Step 2	Engine running cool enough?	**YES:** Go to next step. **NO:** Adjust fan belt tension. Check thermostat. (See Test Thermostat Opening.) Replace if faulty.

RB14256,000082D -19-18JUN12-4/9

Step 3	Exhaust pipe not clogged?	**YES:** Go to next step. **NO:** Clean exhaust pipe.

RB14256,000082D -19-18JUN12-5/9

Step 4	Correct volume of fuel being injected?	**YES:** Go to next step. **NO:** Replace faulty fuel injection pump or fuel injectors.

RB14256,000082D -19-18JUN12-6/9

Step 5	Intake or exhaust valve clearance correct?	**YES:** Go to next step. **NO:** Adjust valve clearance. (See Adjust Valve Clearance.)

RB14256,000082D -19-18JUN12-7/9

Step 6	Intake or exhaust valves not leaking compression?	**NO:** Grind valves and seats. (See Recondition Cylinder Head—3TNV76 or Disassemble and Assemble Cylinder Head and Valves—3TNV80F.)

Continued on next page

RB14256,000082D -19-18JUN12-8/9

Step 7	Piston rings not broken or seized?	**NO:** Replace rings. Replace pistons if damaged. Bore cylinder if damaged. (See Remove and Install Piston and Connecting Rod—3TNV76 or Remove and Install Piston and Connecting Rod—3TNV80F. See Cylinder Bore—3TNV76 or Inspect Cylinder Bore—3TNV80F.)

RB14256,000082D -19-18JUN12-9/9

Symptom: Engine Runs Rough—Misfiring

RB14256,000082E -19-18JUN12-1/11

Engine Runs Rough—Misfiring

RB14256,000082E -19-18JUN12-2/11

Step 1	No water in fuel?	**YES:** Go to next step. **NO:** Drain and replace fuel.

RB14256,000082E -19-18JUN12-3/11

Step 2	Intake or exhaust valve clearance correct?	**YES:** Go to next step. **NO:** Adjust valve clearance. (See Adjust Valve Clearance.)

RB14256,000082E -19-18JUN12-4/11

Step 3	Correct volume of fuel being injected?	**YES:** Go to next step. **NO:** Replace faulty fuel injection pump or fuel injectors.

RB14256,000082E -19-18JUN12-5/11

Step 4	Is injection pump timing correct?	**YES:** Go to next step. **NO:** Time injection pump. (See Injection Pump Static Timing.)

RB14256,000082E -19-18JUN12-6/11

Step 5	Backlash of timing gear not excessive?	**YES:** Go to next step. **NO:** Repair gears as needed.

Continued on next page

RB14256,000082E -19-18JUN12-7/11

Step 6	Combustion chambers clean of foreign matter?	**YES:** Go to next step. **NO:** Clean combustion chambers. (See Remove and Install Cylinder Head—3TNV76 or Remove and Install Cylinder Head and Valves—3TNV80F.)

RB14256,000082E -19-18JUN12-8/11

Step 7	Intake or exhaust valves not leaking compression?	**YES:** Go to next step. **NO:** Grind valves and seats. (See Recondition Cylinder Head—3TNV76 or Disassemble and Assemble Cylinder Head and Valves—3TNV80F.)

RB14256,000082E -19-18JUN12-9/11

Step 8	Intake or exhaust valves not seized?	**YES:** Go to next step. **NO:** Replace valve and check valve guide. (See Recondition Cylinder Head—3TNV76 or Disassemble and Assemble Cylinder Head and Valves—3TNV80F.)

RB14256,000082E -19-18JUN12-10/11

Step 9	Piston rings not broken or seized?	**NO:** Replace rings. Replace pistons if damaged. Bore cylinder if damaged. (See Remove and Install Piston and Connecting Rod—3TNV76 or Remove and Install Piston and Connecting Rod—3TNV80F. See Cylinder Bore—3TNV76 or Inspect Cylinder Bore—3TNV80F.)

RB14256,000082E -19-18JUN12-11/11

Symptom: Engine Runs Rough—Uneven Combustion Sound

RB14256,000082F -19-18JUN12-1/9

Engine Runs Rough—Uneven Combustion Sound

RB14256,000082F -19-18JUN12-2/9

Step 1	Correct type of fuel being used?	**YES:** Go to next step. **NO:** Drain and replace fuel.

Continued on next page RB14256,000082F -19-18JUN12-3/9

Step 2	No water in fuel?	**YES:** Go to next step. **NO:** Drain and replace fuel. Check fuel filter.

RB14256,000082F -19-18JUN12-4/9

Step 3	Intake and exhaust valve clearance correct?	**YES:** Go to next step. **NO:** Adjust valve clearance. (See Adjust Valve Clearance.)

RB14256,000082F -19-18JUN12-5/9

Step 4	Even volume of fuel being injected?	**YES:** Go to next step. **NO:** Replace faulty fuel injection pump or fuel injectors.

RB14256,000082F -19-18JUN12-6/9

Step 5	Proper spray pattern from injectors?	**YES:** Go to next step. **NO:** Clean or replace fuel injection nozzles. (See Remove, Inspect, and Install Fuel Injection Nozzle—3TNV76 or Remove, Inspect, and Install Fuel Injection Nozzle—3TNV80F.)

RB14256,000082F -19-18JUN12-7/9

Step 6	Air filter elements not clogged?	**YES:** Go to next step. **NO:** Clean or replace air filter elements.

RB14256,000082F -19-18JUN12-8/9

Step 7	Exhaust pipe not clogged?	**NO:** Clean exhaust pipe.

RB14256,000082F -19-18JUN12-9/9

Symptom: Engine Runs Rough—Engine Surges DURING IDLING

RB14256,0000830 -19-18JUN12-1/8

Engine Runs Rough—Engine Surges DURING IDLING

RB14256,0000830 -19-18JUN12-2/8

Step 1	No water in fuel?	**YES:** Go to next step. **NO:** Drain and replace fuel. Check fuel filter.

Continued on next page RB14256,0000830 -19-18JUN12-3/8

Step 2	Even volume of fuel injected?	**YES:** Go to next step. **NO:** Replace faulty fuel injection pump or fuel injectors.

RB14256,0000830 -19-18JUN12-4/8

Step 3	Intake and exhaust valve clearance correct?	**YES:** Go to next step. **NO:** Adjust valve clearance. (See Adjust Valve Clearance.)

RB14256,0000830 -19-18JUN12-5/8

Step 4	Proper spray pattern from injectors?	**YES:** Go to next step. **NO:** Clean or replace fuel injection nozzles. (See Remove, Inspect, and Install Fuel Injection Nozzle—3TNV76 or Remove, Inspect, and Install Fuel Injection Nozzle—3TNV80F.)

RB14256,0000830 -19-18JUN12-6/8

Step 5	Intake or exhaust valves not seized?	**YES:** Go to next step. **NO:** Replace valve and check valve guide. (See Recondition Cylinder Head—3TNV76 or Disassemble and Assemble Cylinder Head and Valves—3TNV80F.)

RB14256,0000830 -19-18JUN12-7/8

Step 6	Piston rings not broken or seized?	**NO:** Replace rings. Replace pistons if damaged. Bore cylinder if damaged. (See Remove and Install Piston and Connecting Rod—3TNV76 or Remove and Install Piston and Connecting Rod—3TNV80F. See Cylinder Bore—3TNV76 or Inspect Cylinder Bore—3TNV80F.)

RB14256,0000830 -19-18JUN12-8/8

Symptom: Engine Runs Rough—Engine Surges UNDER LOAD

RB14256,0000831 -19-18JUN12-1/6

Engine Runs Rough—Engine Surges UNDER LOAD

Continued on next page

RB14256,0000831 -19-18JUN12-2/6

Step 1	No water in fuel?	**YES:** Go to next step. **NO:** Drain and replace fuel. Check fuel filters.

RB14256,0000831 -19-18JUN12-3/6

Step 2	Even volume of fuel injected?	**YES:** Go to next step. **NO:** Replace faulty fuel injection pump or fuel injectors.

RB14256,0000831 -19-18JUN12-4/6

Step 3	Proper spray pattern from injectors?	**YES:** Go to next step. **NO:** Clean or replace fuel injection nozzles. (See Remove, Inspect, and Install Fuel Injection Nozzle—3TNV76 or Remove, Inspect, and Install Fuel Injection Nozzle—3TNV80F.)

RB14256,0000831 -19-18JUN12-5/6

Step 4	Piston rings not broken or seized?	**NO:** Replace rings. Replace pistons if damaged. Bore cylinder if damaged. (See Remove and Install Piston and Connecting Rod—3TNV76 or Remove and Install Piston and Connecting Rod—3TNV80F. See Cylinder Bore—3TNV76 or Inspect Cylinder Bore—3TNV80F.)

RB14256,0000831 -19-18JUN12-6/6

Symptom: Engine Runs Rough—Excessive Engine Vibration

RB14256,0000832 -19-18JUN12-1/7

Engine Runs Rough—Excessive Engine Vibration

RB14256,0000832 -19-18JUN12-2/7

Step 1	Even volume of fuel injected?	**YES:** Go to next step. **NO:** Replace faulty fuel injection pump or fuel injectors.

Continued on next page

RB14256,0000832 -19-18JUN12-3/7

Step 2	Proper spray pattern from injectors?	**YES:** Go to next step. **NO:** Clean or replace fuel injection nozzles. (See Remove, Inspect, and Install Fuel Injection Nozzle—3TNV76 or Remove, Inspect, and Install Fuel Injection Nozzle—3TNV80F.)

RB14256,0000832 -19-18JUN12-4/7

Step 3	Piston rings not broken or seized?	**YES:** Go to next step. **NO:** Replace rings. Replace pistons if damaged. Bore cylinder if damaged. (See Remove and Install Piston and Connecting Rod—3TNV76 or Remove and Install Piston and Connecting Rod—3TNV80F. See Cylinder Bore—3TNV76 or Inspect Cylinder Bore—3TNV80F.)

RB14256,0000832 -19-18JUN12-5/7

Step 4	Crankshaft pin or bearing not worn or seized?	**YES:** Go to next step. **NO:** Regrind crankshaft and replace bearings. (See Crankshaft and Main Bearings—3TNV76 or Remove and Install Crankshaft and Main Bearings—3TNV80F.)

RB14256,0000832 -19-18JUN12-6/7

Step 5	Connecting rod bolts torqued properly?	**NO:** Replace damaged components. (See Remove and Install Piston and Connecting Rod—3TNV76 or Remove and Install Piston and Connecting Rod—3TNV80F.)

RB14256,0000832 -19-18JUN12-7/7

Symptom: Excessive Fuel Consumption

RB14256,0000833 -19-18JUN12-1/6

Excessive Fuel Consumption

Continued on next page RB14256,0000833 -19-18JUN12-2/6

Step 1	Engine not running too cool?	**YES:** Go to next step. **NO:** Check thermostat. (See Test Thermostat Opening.) Replace if faulty.

RB14256,0000833 -19-18JUN12-3/6

Step 2	Correct volume of fuel being injected?	**YES:** Go to next step. **NO:** Replace faulty fuel injection pump or fuel injectors.

RB14256,0000833 -19-18JUN12-4/6

Step 3	Correct pattern from fuel injectors?	**YES:** Go to next step. **NO:** Clean or replace fuel injection nozzles. (See Remove, Inspect, and Install Fuel Injection Nozzle—3TNV76 or Remove, Inspect, and Install Fuel Injection Nozzle—3TNV80F.)

RB14256,0000833 -19-18JUN12-5/6

Step 4	Intake or exhaust valves not leaking compression?	**NO:** Grind valves and seats. (See Recondition Cylinder Head—3TNV76 or Disassemble and Assemble Cylinder Head and Valves—3TNV80F.)

RB14256,0000833 -19-18JUN12-6/6

Symptom: Excessive Oil Consumption

RB14256,0000834 -19-18JUN12-1/8

Excessive Oil Consumption

RB14256,0000834 -19-18JUN12-2/8

Step 1	Engine oil of correct viscosity and type?	**YES:** Go to next step. **NO:** Replace engine oil with oil of proper viscosity and type. Replace oil filter.

RB14256,0000834 -19-18JUN12-3/8

Step 2	No external or internal oil leak?	**YES:** Go to next step. **NO:** Repair as needed.

Continued on next page RB14256,0000834 -19-18JUN12-4/8

Step 3	Intake or exhaust valve stems not worn?	**YES:** Go to next step. **NO:** Replace valve guides and valves. (See Recondition Cylinder Head—3TNV76 or Disassemble and Assemble Cylinder Head and Valves—3TNV80F.)

RB14256,0000834 -19-18JUN12-5/8

Step 4	Piston rings installed correctly and properly staggered?	**YES:** Go to next step. **NO:** Install piston rings correctly. (See Remove and Install Piston and Connecting Rod—3TNV76 or Remove and Install Piston and Connecting Rod—3TNV80F.)

RB14256,0000834 -19-18JUN12-6/8

Step 5	Pistons, rings or cylinders not worn?	**YES:** Go to next step. **NO:** Replace pistons and rings; bore or hone cylinders. (See Remove and Install Piston and Connecting Rod—3TNV76 or Remove and Install Piston and Connecting Rod—3TNV80F. See Cylinder Bore—3TNV76 or Inspect Cylinder Bore—3TNV80F.)

RB14256,0000834 -19-18JUN12-7/8

Step 6	Piston rings not broken or seized?	**NO:** Replace rings. Check piston and cylinder. (See Remove and Install Piston and Connecting Rod—3TNV76 or Remove and Install Piston and Connecting Rod—3TNV80F.)

RB14256,0000834 -19-18JUN12-8/8

Symptom: Fuel Oil in Crankcase

RB14256,0000835 -19-18JUN12-1/6

Fuel Oil in Crankcase

RB14256,0000835 -19-18JUN12-2/6

Step 1	Correct volume of fuel being injected?	**YES:** Go to next step. **NO:** Replace faulty fuel injection pump or fuel injectors.

Continued on next page

RB14256,0000835 -19-18JUN12-3/6

Step 2	Intake or exhaust valve not seized or broken?	**YES:** Go to next step. **NO:** Replace valve and check valve guide. (See Recondition Cylinder Head—3TNV76 or Disassemble and Assemble Cylinder Head and Valves—3TNV80F.)

RB14256,0000835 -19-18JUN12-4/6

Step 3	Piston rings not broken or seized?	**YES:** Go to next step. **NO:** Replace rings. Check piston and cylinder. (See Remove and Install Piston and Connecting Rod—3TNV76 or Remove and Install Piston and Connecting Rod—3TNV80F. See Cylinder Bore—3TNV76 or Inspect Cylinder Bore—3TNV80F.)

RB14256,0000835 -19-18JUN12-5/6

Step 4	Pistons rings, piston or cylinders not worn?	**NO:** Replace pistons and rings; bore or hone cylinders. (See Remove and Install Piston and Connecting Rod—3TNV76 or Remove and Install Piston and Connecting Rod—3TNV80F. See Cylinder Bore—3TNV76 or Inspect Cylinder Bore—3TNV80F.)

RB14256,0000835 -19-18JUN12-6/6

Symptom: Coolant in Crankcase

RB14256,0000836 -19-18JUN12-1/4

Coolant in Crankcase

RB14256,0000836 -19-18JUN12-2/4

Step 1	Cylinder head gasket not leaking?	**YES:** Go to next step. **NO:** Replace head gasket. Resurface head and block if necessary. (See Remove and Install Cylinder Head—3TNV76 or Remove and Install Cylinder Head and Valves—3TNV80F.)

Continued on next page

RB14256,0000836 -19-18JUN12-3/4

Step 2	Is cylinder block not cracked?	**NO:** Replace cylinder block.

RB14256,0000836 -19-18JUN12-4/4

Symptom: Low Oil Pressure

RB14256,0000837 -19-18JUN12-1/9

Low Oil Pressure

RB14256,0000837 -19-18JUN12-2/9

Step 1	Oil at correct level?	**YES:** Go to next step. **NO:** Add oil.

RB14256,0000837 -19-18JUN12-3/9

Step 2	Engine oil of correct viscosity and type?	**YES:** Go to next step. **NO:** Replace engine oil with oil of proper viscosity and type. Replace oil filter.

RB14256,0000837 -19-18JUN12-4/9

Step 3	No external or internal oil leak?	**YES:** Go to next step. **NO:** Repair as needed.

RB14256,0000837 -19-18JUN12-5/9

Step 4	Oil pressure regulator valve not worn or damaged?	**YES:** Go to next step. **NO:** Clean or replace regulator valve.

RB14256,0000837 -19-18JUN12-6/9

Step 5	Crankshaft pin or bearing not worn?	**YES:** Go to next step. **NO:** Regrind crankshaft and replace bearings. (See Crankshaft and Main Bearings—3TNV76 or Remove and Install Crankshaft and Main Bearings—3TNV80F.)

RB14256,0000837 -19-18JUN12-7/9

Step 6	Connecting rod bolts torqued properly?	**YES:** Go to next step. **NO:** Replace damaged components. Tighten to correct specification.

RB14256,0000837 -19-18JUN12-8/9

Step 7	Is engine not worn excessively?	**NO:** Repair engine as needed.

RB14256,0000837 -19-18JUN12-9/9

Symptom: Engine Is Overheating

Continued on next page

RB14256,0000838 -19-18JUN12-1/11

Engine Is Overheating

RB14256,0000838 -19-18JUN12-2/11

Step 1	Is engine NOT being run under high-altitude or high-temperature conditions?	**YES:** Go to next step. **NO:** Reduce load on engine.

RB14256,0000838 -19-18JUN12-3/11

Step 2	Cooling system filled to correct level?	**YES:** Go to next step. **NO:** Check for leaks and fill system to correct level.

RB14256,0000838 -19-18JUN12-4/11

Step 3	Is radiator clear of debris?	**YES:** Go to next step. **NO:** Clean radiator fins.

RB14256,0000838 -19-18JUN12-5/11

Step 4	Is radiator core free from blockage?	**YES:** Go to next step. **NO:** Clean or replace radiator.

RB14256,0000838 -19-18JUN12-6/11

Step 5	Is fan operating correctly?	**YES:** Go to next step. **NO:** Adjust fan belt tension.

RB14256,0000838 -19-18JUN12-7/11

Step 6	Is thermostat operating correctly?	**YES:** Go to next step. **NO:** Check thermostat. (See Test Thermostat Opening.) Replace if faulty.

RB14256,0000838 -19-18JUN12-8/11

Step 7	Is lower radiator hose not collapsed?	**YES:** Go to next step. **NO:** Replace lower radiator hose.

RB14256,0000838 -19-18JUN12-9/11

Step 8	Is cylinder head gasket not leaking?	**YES:** Go to next step. **NO:** Replace head gasket. Resurface head and block if necessary. (See Remove and Install Cylinder Head—3TNV76 or Remove and Install Cylinder Head and Valves—3TNV80F and Recondition Cylinder Head—3TNV76 or Disassemble and Assemble Cylinder Head and Valves—3TNV80F.)

Continued on next page

RB14256,0000838 -19-18JUN12-10/11

Step 9	Is cylinder block not cracked?	**NO:** Replace cylinder block.

RB14256,0000838 -19-18JUN12-11/11

Symptom: Low Engine Coolant Temperature

RB14256,0000839 -19-18JUN12-1/3

Low Engine Coolant Temperature

RB14256,0000839 -19-18JUN12-2/3

Step 1	Is thermostat operating correctly?	**NO:** Check thermostat. (See Test Thermostat Opening.) Replace if faulty.

RB14256,0000839 -19-18JUN12-3/3

Symptom: Low Compression

RB14256,000083A -19-18JUN12-1/6

Low Compression

RB14256,000083A -19-18JUN12-2/6

Step 1	Intake or exhaust valves not leaking compression?	**YES:** Go to next step. **NO:** Grind valves and seats. (See Recondition Cylinder Head—3TNV76 or Disassemble and Assemble Cylinder Head and Valves—3TNV80F.)

RB14256,000083A -19-18JUN12-3/6

Step 2	Intake or exhaust valve not seized?	**YES:** Go to next step. **NO:** Replace valve guides and valves. (See Recondition Cylinder Head—3TNV76 or Disassemble and Assemble Cylinder Head and Valves—3TNV80F.)

RB14256,000083A -19-18JUN12-4/6

Step 3	Pistons, rings or cylinders not worn or seized?	**YES:** Go to next step. **NO:** Replace pistons and rings; bore or hone cylinders. (See Remove and Install Piston and Connecting Rod—3TNV76 or Remove and Install Piston and Connecting Rod—3TNV80F. See Cylinder Bore—3TNV76 or Inspect Cylinder Bore—3TNV80F.)

Continued on next page RB14256,000083A -19-18JUN12-5/6

Step 4	Piston rings installed correctly and properly staggered?	**NO:** Install piston rings correctly. (See Remove and Install Piston and Connecting Rod—3TNV76 or Remove and Install Piston and Connecting Rod—3TNV80F.)

RB14256,000083A -19-18JUN12-6/6

Starting Motor Diagnostics

CAUTION: The engine may start to rotate at any time. Keep hands away from moving parts when testing.

IMPORTANT: If starting motor continues to run after turning ignition switch to OFF position, disconnect negative (-) lead from battery as soon as possible.

NOTE: To test specific electrical components, see Electrical section and refer to either Diagnostics or Tests and Adjustments for further guidance.

RB14256,000083B -19-18JUN12-1/1

Symptom: Starter Does Not Rotate

RB14256,000083C -19-19JUN14-1/7

Starter Does Not Rotate

RB14256,000083C -19-19JUN14-2/7

Step 1	Is there a click sound from starter solenoid?	**YES:** Go to next step. **NO:** Check that all starting conditions are met.

RB14256,000083C -19-19JUN14-3/7

Step 2	Are battery cables clean and tight?	**YES:** Go to next step. **NO:** Tighten or clean as necessary.

RB14256,000083C -19-19JUN14-4/7

Step 3	Is battery fully charged? (See Battery Load Test.)	**YES:** Go to next step. **NO:** Charge battery. (See Battery Charge.)

RB14256,000083C -19-19JUN14-5/7

Step 4	Does crankshaft rotate freely?	**YES:** Go to next step. **NO:** Repair engine as needed.

RB14256,000083C -19-19JUN14-6/7

Step 5	Are starting circuit and key switch working correctly?	**YES:** Go to next step. **NO:** Repair as necessary. (See System: Starting and Fuel Shutoff Solenoid Circuit (Operator OFF Seat) Diagnosis—Diesel Engine.)

RB14256,000083C -19-19JUN14-7/7

Symptom: Starter Rotates Slowly

RB14256,000083D -19-12JUN14-1/6

Starter Rotates Slowly

RB14256,000083D -19-12JUN14-2/6

Step 1	Are battery cables clean and tight?	**YES:** Go to next step. **NO:** Tighten or clean as necessary.

RB14256,000083D -19-12JUN14-3/6

Step 2	Is battery fully charged? (See Battery Load Test.)	**YES:** Go to next step. **NO:** Charge battery. (See Battery Charge.)

RB14256,000083D -19-12JUN14-4/6

Step 3	Does crankshaft rotate freely?	**YES:** Go to next step. **NO:** Repair engine as needed.

RB14256,000083D -19-12JUN14-5/6

Step 4	Are starting motor and solenoid functioning correctly? (See Starting Motor Solenoid Test. See Starting Motor Amperage Draw Test.)	**NO:** Replace starting motor. (See Remove and Install Starting Motor—3TNV76 or Remove and Install Starting Motor—3TNV80F.)

RB14256,000083D -19-12JUN14-6/6

Symptom: Starter Rotates but Does Not Crank

RB14256,000083E -19-18JUN12-1/3

Starter Rotates but Does Not Crank

RB14256,000083E -19-18JUN12-2/3

Step 1	Does the pinion mesh with ring gear?	**NO:** Faulty starter drive. Replace. **NO:** Check for worn pinion or ring gear, and incorrect starting motor alignment.

RB14256,000083E -19-18JUN12-3/3

Specifications

Item	Measurement	Specification
Diesel Engines		
Alternator-Fan and Coolant Pump Drive Belt	Deflection @ 98 N (22 lbf)	10—15 mm (0.40—.060 in)
3TNV76 & 3TNV80F-NCJUV Cylinder Compression		
Cylinder Compression @ 250 rpm	Pressure	3432 ± 98 kPa (498 ± 14 psi)
Cylinder Compression @ 250 RPM (Minimum)	Pressure	2746 ± 98 kPa (398 ± 14 psi)
Difference Between Cylinders @ 250 RPM (Maximum)	Pressure	197—294 kPa (29—43 psi)
Idle Speeds		
Fast Idle Speed (3TNV76)	RPM	3450 ± 50 rpm
Fast Idle Speed (3TNV80F)	RPM	3415 ± 25 rpm
Slow Idle	Speed	1250 ± 50 rpm
Valve	Clearance	0.15—0.25 mm (0.006—0.010 in.)
Rocker Arm Cover Nut	Torque	18 N·m (160 lb·in)
Valve	Lift	8.8 mm (0.350 in.)
Connecting Rod Cap Screw Torque	Torque	23—28 N·m (204—248 lb·in)
Connecting Rod Side Play	Clearance	0.20—0.40 mm (0.008—0.016 in.)
3TNV76 & 3TNV80F Connecting Rod		
Cap Screw	Torque	23—28 N·m (17—20 lb·ft)
3TNV76 & 3TNV80F Connecting Rod-to-Crankshaft		
Connecting Rod-to-Crankshaft Journal Oil	Clearance	0.030—0.060 mm (0.001—0.002 in.)
3TNV76 Connecting Rod-to-Crankshaft Journal Oil (Wear Limit)	Clearance	0.11 mm (0.004 in.)
3TNV80F Connecting Rod-to-Crankshaft Journal Oil (Wear Limit)	Clearance	0.15 mm (0.006 in.)
3TNV76 & 3TNV80F Crankshaft		
Crankshaft	End Play	0.11—0.25 mm (0.004—0.010 in.)
Crankshaft	End Play—Wear Limit	0.28 mm (0.011 in.)

Continued on next page BS62576,000179C -19-30SEP16-1/3

Item	Measurement	Specification
3TNV76 Crankshaft		
Main Bearing Cap Screw	Torque	76—82 N·m (56—60 lb·ft)
3TNV80F Crankshaft		
Main Bearing Cap Screw	Torque	79—83 N·m (58—61 lb·ft)
3TNV76Crankshaft		
Main Bearing-to-Crankshaft Journal Oil	Clearance	0.120 mm (0.005 in.)
3TNV80F Crankshaft		
Main Bearing-to-Crankshaft Journal Oil	Clearance	0.040—0.090 mm (0.002—0.004 in.)
Main Bearing-to-Crankshaft Journal Oil	Clearance—Wear Limit	0.25 mm (0.010 in.)
3TNV76 Camshaft		
Camshaft	End Play (Wear Limit)	0.25 mm (0.098 in.)
3TNV80F Camshaft		
Camshaft	End Play	0.050—0.150 mm (0.002—0.006 in.)
Camshaft	End Play (Wear Limit)	0.25 mm (0.098 in.)
3TNV76 and 3TNV80F Timing Gear		
Timing Gear	Backlash	0.06—0.12 mm (0.0024—0.0047 in.)
Timing Gear	Backlash—Limit	0.14 mm (0.0055 in.)
Thermostat—Begins to Open	Temperature	70° C (158° F)
Thermostat—Fully Open	Temperature	85° C (184° F)
Thermostat	Lift (Opening Height)	8 mm (0.310 in.)
Cooling System Test	Maximum Pressure	97 kPa (14 psi)
Cooling System Test	Minimum Pressure (After 15 Seconds)	88 ± 15 kPa (12.8 ± 2.2 psi)
Radiator Cap	Opening Pressure	88 kPa (12.8 psi)
3TNV76 Engine		
Fast Idle	Speed	3450 ± 25 rpm
Engine Oil @ 3450 rpm	Pressure	290—441 kPa (42—64 psi)
Engine Oil @ 1250 rpm	Pressure	60 kPa (9 psi)

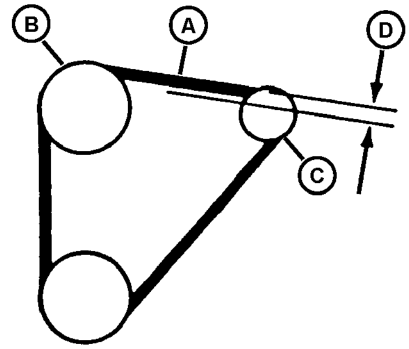
Continued on next page

BS62576,000179C -19-30SEP16-2/3

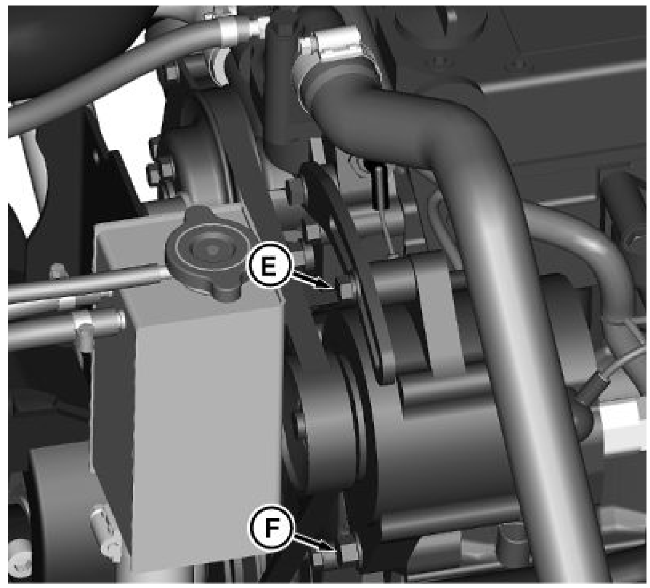
Item	Measurement	Specification
3TNV80F Engine		
Fast Idle	Speed	3215 ± 25 rpm
Engine Oil @ 3210 rpm	Pressure	240—350 kPa (35—51 psi)
Pressurize the air intake system	Pressure	34—69 kPa (5—10 psi)
Fuel Transfer Pump	Pressure	21.5—37.3 kPa (3.1—5.4 psi)
Fuel Transfer Pump Flow Volume (Min in 1 Minute)	Flow Rate	400 mL (13.5 oz)
Fuel Injection Nozzle		
New Nozzle Opening Pressure (5 Hrs. or Less Usage)		12 800—13 800 kPa (1856.5—2001.5 psi)
Used Nozzle Opening Pressure		12 300—13 300 kPa (1784—1929 psi)
Leakage at Just Below Minimum Opening Pressure		No leakage for 5 sec (minimum)
Chatter and Spray Pattern at Opening Pressure		
Slow Hand Lever Movement (at Opening)		Chatter sound
Slow Hand Lever Movement		Fine stream, 5—10° spray pattern
Fast Hand Lever Movement		Fine atomized spray, 5—10° spray pattern

BS62576,000179C -19-30SEP16-3/3

Adjust Alternator—Fan and Coolant Pump Drive Belts



TCAL28317 —UN—28JUN12



TCT011266 —UN—23MAY14

A—Midpoint
B—Fan or Coolant Pump Pulley
C—Alternator or Idler Pulley
D—Belt Deflection
E—Bolt
F—Bolt

Reason

To keep proper tension on the belt to drive the coolant pump and the alternator. To prevent shortened belt and bearing life.

Special or Required Tools

- JDG529 or JDST28 Belt Tension Gage

Check Belt Tension

1. Park machine safely. (See "Park Machine Safely" in the Safety section.)
2. Raise hood.
3. Disconnect negative (-) battery cable.
4. Check belt tension:
   - **Alternator-Fan Belt:** Apply approximately 98 N (22 lb.-force) to the belt at the midpoint (A) between the fan pulley (B) and the alternator pulley (C). Check belt deflection (D) using JDG529 or JDST28 Belt Tension Gage and a straightedge, compare to specification.
   - **Coolant Pump Belt:** Apply approximately 98 N (22 lb.-force) to the belt at the midpoint (A) between the coolant pump pulley (B) and the idler pulley (C). Check belt deflection (D) using JDG529 or JDST28 Belt Tension Gage and a straightedge, compare to specification.

Diesel Engines—Specification

Alternator-Fan and Coolant Pump Drive Belt —Deflection @ 98 N (22 lb.-force)	10—15 mm (0.40—.060 in.)

Check Results

If deflection is not within specification, adjust belt.

Adjust Alternator-Fan Belt

1. Loosen bolt (E) and nut (F).
2. Apply force to the alternator housing until tension is correct.
3. Tighten bolt and nut.

Adjust Coolant Pump Belt

1. Loosen idler pulley mounting bolts.
2. Apply force to pulley (near belt) until tension is correct.
3. Tighten bolts.

Results

Both belts must meet specifications.

BS62576,00017E9 -19-22MAY14-1/1

Test Cylinder Compression

Reason

To determine the condition of the pistons, rings, cylinder walls, and valves.

Special or Required Tools

- JT01682 Compression Gauge Assembly
- JDG472 Adapter (3TNV76)JDG560 Adapter (3TNV80F)

Procedure

1. Remove injection nozzles.
2. Remove heat protector from end of injector, and install on JDG472 or JDG560 Adapter (A) depending on engine model.
3. Install JT01682 Compression Gauge Assembly (B) and adapter.
4. Disconnect fuel control solenoid connector.

IMPORTANT: Avoid Damage! DO NOT overheat starting motor during test.

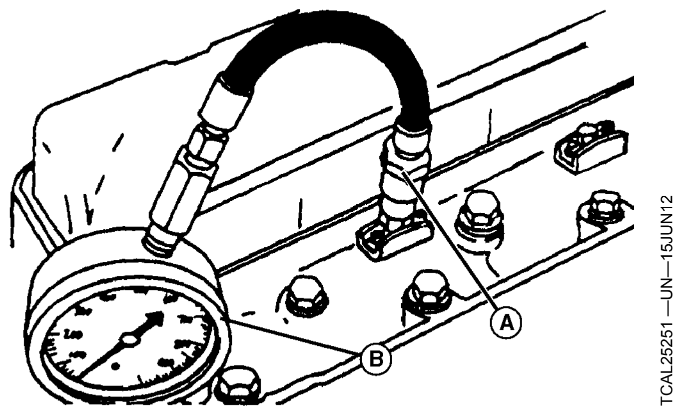
5. Crank the engine for 5 seconds with the starting motor. Minimum cranking speed is 250 rpm.
6. Record the pressure reading for each cylinder.

Results

- If pressure reading is below specification, squirt clean engine oil into cylinders through injector ports and repeat test.

3TNV76 & 3TNV80F Cylinder Compression—Specification

Cylinder Compression @
250 RPM—Pressure..3432 ± 98 kPa
(498 ± 14 psi)



A—Adapter **B—Compression Gauge Assembly**

Cylinder Compression
@ 250 RPM
(Minimum)—Pressure..2746 ± 98 kPa
(398 ± 14 psi)
Difference Between
Cylinders @ 250 RPM
(Maximum)—Pressure... 197—294 kPa
(29—43 psi)

NOTE: Pressure listed is for 300 meters (1000 ft) above sea level. Reduce specification an additional 4% for each 300 meters (1000 ft) of altitude above this level.

- If pressure increases significantly, check piston, rings, and cylinder walls for wear or damage.
- If pressure does not increase significantly after retest, check for leaking valves, valve seats, or cylinder head gasket.

BS62576,00017EA -19-22MAY14-1/1

Adjust Throttle Linkage

Reason

To ensure that throttle linkage and foot pedal linkage are adjusted correctly, and allows full fast idle and slow idle position of governor throttle lever.

Special or Required Tools

- JT05719 Digital Tachometer

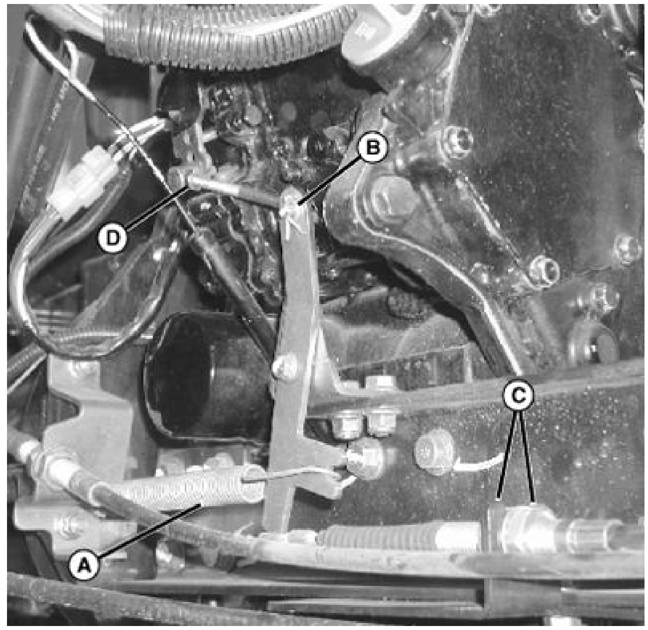
Procedure

1. Park machine on level surface, turn key switch off, shift transmission to neutral, and lock park brake.
2. Place a small piece of reflective tape on outside edge of crankshaft pulley.
3. Start engine and run for 5 minutes or until engine is at operating temperature.
4. With engine running, depress throttle pedal all the way to the floor and check engine speed using JT05719 Digital Tachometer.
5. If fast idle is not within specifications, shut engine off.

Specification

Specification	
Fast Idle Speed (3TNV76)—RPM	3450 ± 50 rpm
Fast Idle Speed (3TNV80F)—RPM	34515 ± 25 rpm

6. Disconnect spring (A).
7. Remove cotter pin and washer (B) from throttle adjustment pin, and disconnect from governor lever.
8. Push throttle pedal to the floor. If pedal will not go all the way to the floor, loosen jam nuts (C) and adjust cable.



TCAL26111 —UN—15JUN12

3TNV76 Shown. 3TNV80F Similar.

A—Spring
B—Washer
C—Jam Nuts
D—Locknut

9. With accelerator pedal on floor, hold governor throttle lever to fast idle position and check alignment of adjustment pin and hole in lever.
10. If pin does not align with hole in throttle lever, loosen locknut (D) on adjustment pin and adjust until pin aligns with hole in throttle lever.
11. Install washer and cotter pin onto throttle rod adjusting pin and tighten locknut.

BS62576,00017FB -19-30SEP16-1/1

Adjust Slow Idle

Reason

To achieve proper slow idle rpm setting. Provides adequate rpm to keep the engine running smoothly without stalling.

Special or Required Tools

- JT05801 Inductive Electronic Tachometer

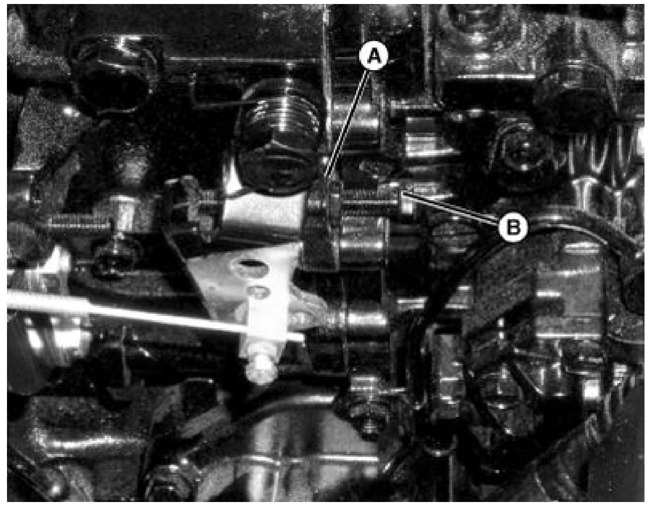
Procedure

NOTE: Make sure the air cleaner is clean and not restricted. Replace the air cleaner element as necessary.

1. Place a small piece of reflective tape on the crankshaft pulley.
2. Start the engine and run for 5 minutes to attain operating temperature.
3. Move the throttle lever to slow idle position.
4. Use JT05801 Inductive Electronic Tachometer to check engine speed at the crankshaft pulley.
5. Visually check that the injection pump throttle lever is against slow idle stop screw.

Results

- If the slow idle rpm is not according to specifications, loosen the nut (A) and turn the slow idle stop screw (B) clockwise to increase the engine speed, or counterclockwise to decrease the engine speed, until the slow idle speed is correct. After adjustment, tighten the nut.



TCAL25252 —UN—15JUN12

3TNV80F Shown. 3TNV76 Similar.

A—Nut **B—Slow Idle Stop Screw**

Specification

Slow Idle—Speed..1250 ± 50 rpm

BS62576,00017EB -19-20OCT15-1/1

Adjust Fast Idle

CAUTION: The FAST idle adjustment is pre-set by the engine manufacturer to comply with strict California Air Resources Board/Environmental Protection Agency (CARB/EPA) emissions requirements and is NOT adjustable. Tampering with the FAST idle adjustment may result in severe fines or penalties.

IMPORTANT: DO NOT attempt to adjust the FAST idle setting. It is NOT adjustable.

If it is determined that either the fuel injection pump or governor assembly are in need of repair, they must be replaced ONLY as a complete assembly. Only an authorized factory trained technician is allowed to remove and install these assemblies. If replacement is necessary, remove and install the fuel injection pump as a complete assembly.

Special or Required Tools

- JT05719 Digital Tachometer or JT07270 Digital Pulse Tachometer

Because the FAST idle speed is NOT adjustable, the throttle cable adjustment becomes very critical to proper engine operation. Therefore, first MAKE SURE that the throttle cable obtains its full range of motion, stop-to-stop, before performing any diagnostic procedures.

CAUTIONS

NOTE: ANY TAMPERING with the following items could put the engine out of EPA compliance and you could be subject to a fine of up to $25,000 a day for every day unit is out of EPA compliance.

- Torque capsule is NOT adjustable on diesel engines.
- High speed is NOT adjustable on diesel engines.
- Injection pump timing should not be changed.

Fast Idle Check Procedure

1. Park machine on a level surface, turn key switch off, shift transmission to neutral, and lock park brake.
2. Place a small piece of reflective tape on crankshaft pulley.

NOTE: Make sure air cleaner is clean and not restricted. Replace air cleaner element as necessary.

3. Start engine and run for 5 minutes to obtain normal operating temperature.
4. Move throttle pedal to fast idle position.
5. Use JT05719 Digital Tachometer to check engine speed at crankshaft pulley.

Results

- If fast idle speed does not meet specifications, adjust throttle cable as needed. (See Adjust Throttle Linkage.)

Specification	
Fast Idle Speed (3TNV76)—RPM	3450 ± 50 rpm
Fast Idle Speed (3TNV80F)—RPM	3415 ± 25 rpm

- If engine still does not meet fast idle speed specifications, have injection pump inspected by an EPA authorized diesel service (ADS) center.

BS62576,00017FC -19-30SEP16-1/1

Adjust Valve Clearance

Reason

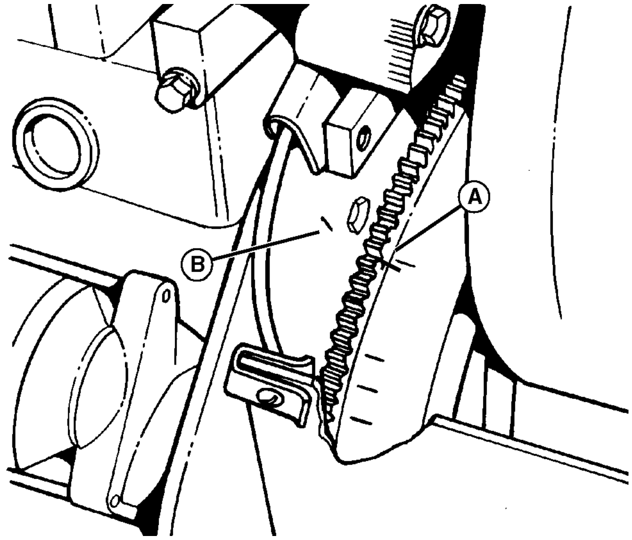
To set valve clearance for proper engine operation.

Procedure

CAUTION: Avoid Injury! Be sure ignition key is OFF before attempting to turn engine by hand.

NOTE: The engine must be cool (room temperature) before the valve clearance is checked.

1. Disconnect negative cable from battery.
2. Remove rocker arm cover. (See Remove and Install Intake Manifold/Rocker Arm Cover—3TNV76 or Remove and Install Rocker Arm Cover—3TNV80F.)
3. Remove flywheel cover from starter side of engine.
4. Turn crankshaft pulley counterclockwise, as viewed from flywheel end, until No. 1 cylinder top dead center (TDC) mark (A) on flywheel aligns with index mark (B) on flywheel plate.
5. Try to move rocker arms and/or push rods for No. 1 cylinder:
   - If the rocker arms and push rods are loose, the piston is at TDC on the compression stroke. Go to step 8.



A—No. 1 Cylinder Top Dead Center (TDC) Mark **B—Index Mark**

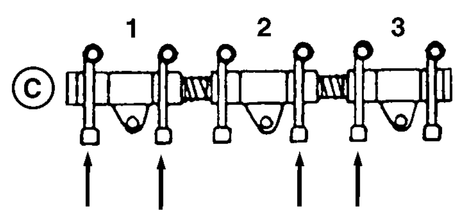
- If the rocker arms and/or push rods are not loose, rotate the flywheel one revolution (360°), and recheck the rocker arms and push rods.

BS62576,00017EC -19-21MAY14-1/5

6. Measure and adjust valve clearance (if necessary) on the valves (arrows) with No. 1 piston at TDC of the compression stroke. No. 1 piston is at the flywheel end (C). Valve clearance should be at specifications.

Specification

Valve—Clearance..0.15—0.25 mm (0.006—0.010 in.)



C—Flywheel End

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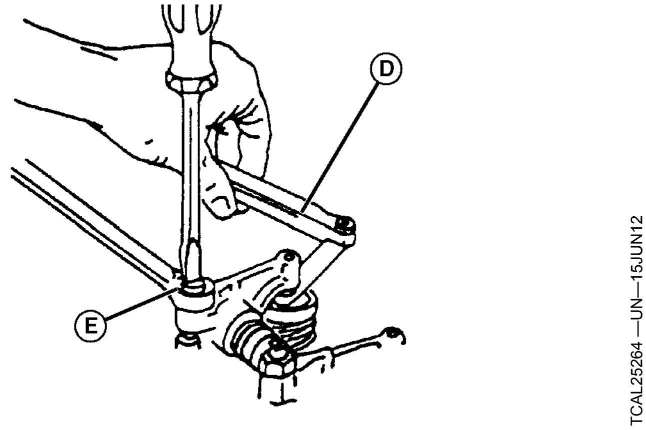
BS62576,00017EC -19-21MAY14-2/5

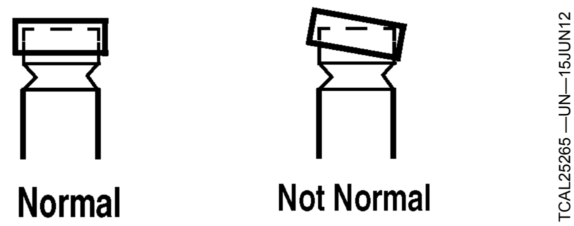
7. If valve clearance is not at specifications, loosen the locknut and turn the adjusting screw (E) until the blade of the feeler gauge (D) can be inserted between the rocker arm and valve cap. Hold the adjusting screw while tightening the locknut.
8. Recheck the valve clearance after tightening the locknut.



D—Feeler Gauge **E—Adjusting Screw**

BS62576,00017EC -19-21MAY14-3/5

9. Check that the valve cap on the valve stem remained seated on the valve and inside the valve spring retainer.
10. Turn crankshaft pulley one revolution (360°) and align No. 1 cylinder top dead center (TDC) mark on flywheel with index mark on flywheel plate. This puts the piston in No. 1 cylinder at TDC of the exhaust stroke.



BS62576,00017EC -19-21MAY14-4/5

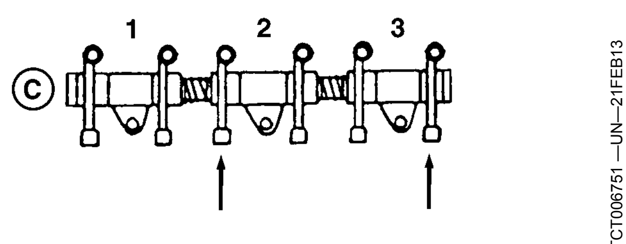
11. Measure and adjust valve clearance (if necessary) on the valves (arrows) with No. 1 piston at TDC on the exhaust stroke..
12. Install flywheel cover.
13. Install rocker arm cover. Tighten rocker arm cover nuts to specifications.

Specification

Rocker Arm Cover Nut—Torque....18 N·m (160 lb.-in.)

Results

If valve clearance cannot be adjusted to specification, check rocker arm assembly for wear or damage.



C—Flywheel End

BS62576,00017EC -19-21MAY14-5/5

Check Valve Lift

Reason

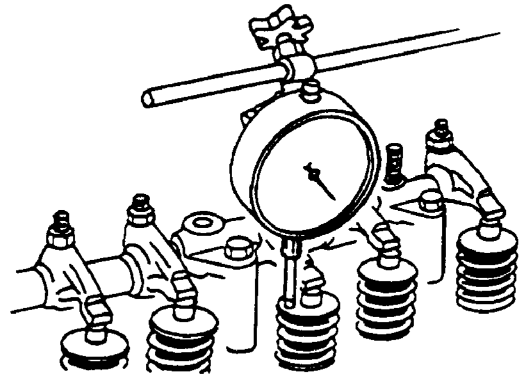
Check wear on cam lobes, followers, and/or push rods.

Procedure

1. Remove the rocker arm cover. (See Remove and Install Intake Manifold/Rocker Arm Cover—3TNV76 or Remove and Install Rocker Arm Cover—3TNV80F.)
2. Adjust the valve clearance. (See Adjust Valve Clearance.)
3. Fasten the dial indicator to the engine and position the indicator tip on the valve retainer. The valve must be fully closed and the rocker arm must move freely.
4. Zero the dial indicator.
5. Manually turn the crankshaft pulley clockwise (viewed from flywheel end).
6. Observe the dial indicator as the valve is moved to the full open position and compare with specification. Repeat for each valve.

Specification

Valve—Lift.. 8.8 mm (0.350 in.)



TCAL25267 —UN—15JUN12

Results

- The valve lift should be the same for all valves. If one or more valves have less travel than the others, remove and inspect the camshaft, followers, and push rods. (See Camshaft—3TNV76 or Remove and Install Camshaft—3TNV80F.) If the camshaft, followers, and push rods are within specification, remove and inspect the cylinder head. (See Remove and Install Cylinder Head—3TNV76 or Remove and Install Cylinder Head and Valves—3TNV80F.)

BS62576,00017ED -19-22MAY14-1/1

Check Connecting Rod Side Play

Reason

To determine proper side clearance between the crankshaft and the connecting rod.

NOTE: Connecting Rod Side Play Check may be performed with crankshaft and connecting rod installed or removed from cylinder block. If performing check with crankshaft and connecting rod installed in block, go directly to step 2.

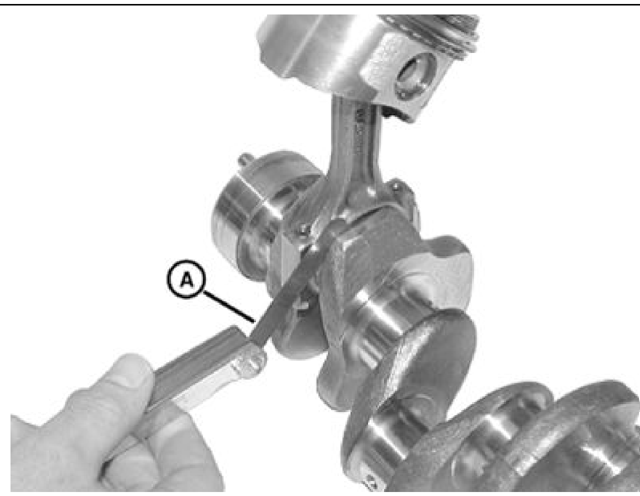
IMPORTANT: Connecting rod caps must be installed on the same connecting rod and in the same direction to prevent crankshaft and connecting rod damage.

1. Install connecting rod on crankshaft. Tighten connecting rod cap screws to specification.

Specification

Connecting Rod Cap Screw Torque—Torque... 23—28 N·m (204—248 lb.-in.)

2. Hold connecting rod to one side of journal.
3. Measure connecting rod side play using a feeler gauge (A). Replace connecting rod and crankshaft, as necessary, if side play exceeds specification.



TCAL26238 —UN—15JUN12

A—Feeler Gauge

Specification

Connecting Rod Side Play—Clearance..0.20—0.40 mm (0.008—0.016 in.)

BS62576,00017EE -19-22MAY14-1/1

Check Connecting Rod Bearing Clearance

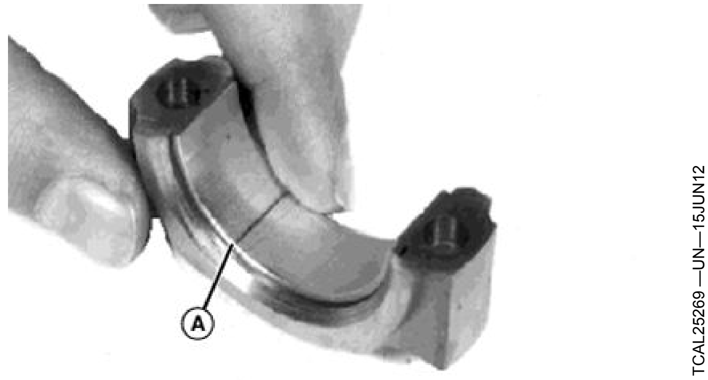
Reason

To measure oil clearance between connecting rod bearing and crankshaft journal.

Procedure

IMPORTANT: Avoid Damage! The connecting rod caps must be installed on the same connecting rod and in the same direction to prevent crankshaft and connecting rod damage.

1. Remove the connecting rod cap.
2. Wipe oil from the bearing insert and the crankshaft journal.
3. Put a piece of Plastigage® (A), or an equivalent, along the width of the bearing insert approximately 6 mm (0.25 in.) off center.
4. Turn the crankshaft approximately 30° from bottom dead center.
5. Install the connecting rod end cap and original rod end cap screws. Tighten the rod end cap screws to specification.



A—Plastigage® Strip

3TNV76 & 3TNV80F Connecting Rod—Specification

Cap Screw—Torque..23—28 N·m
(17—20 lb.-ft.)

NOTE: The flattened Plastigage® will be found on either the bearing insert or crankshaft journal.

6. Remove the rod end cap screws and the connecting rod cap.

BS62576,00017EF -19-22MAY14-1/2

7. Use the graduation marks on the envelope (C) to compare the width of the flattened Plastigage® (B) at its widest point. The number within the graduation marks indicates the bearing clearance in inches or millimeters, depending on which side of the envelope is used.
8. Measure the connecting rod bearing oil clearance.
9. Remove the Plastigage®.

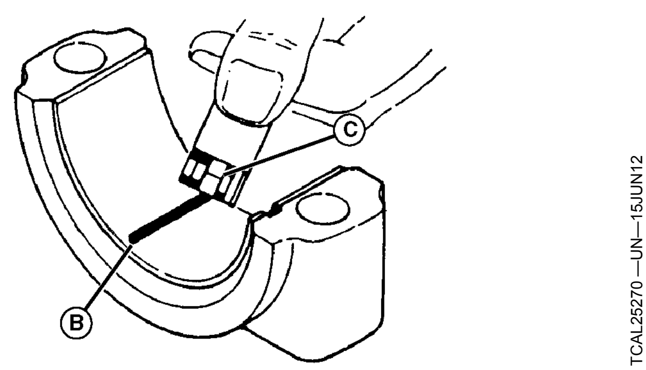
Results

- If the clearance exceeds the wear limit specification, replace the bearing inserts.

3TNV76 & 3TNV80F Connecting Rod-to-Crankshaft—Specification

Connecting Rod-to-Crankshaft Journal Oil—Clearance..0.030—0.060 mm
(0.001—0.002 in.)

3TNV76 Connecting Rod-to-Crankshaft Journal Oil (Wear Limit)—Clearance..0.11 mm
(0.004 in.)

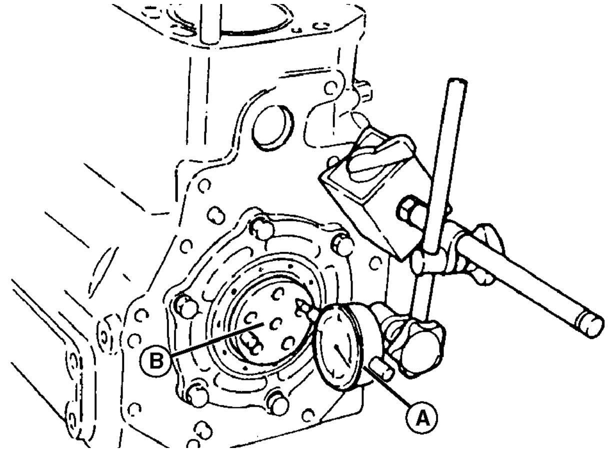


B—Flattened Plastigage® Strip C—Envelope

3TNV80F Connecting Rod-to-Crankshaft Journal Oil (Wear Limit)—Clearance.. 0.15 mm
(0.006 in.)

BS62576,00017EF -19-22MAY14-2/2

Check Crankshaft End Play



A—Dial Indicator B—Crankshaft

Reason

To determine proper side clearance between the crankshaft and the engine block.

Procedure

NOTE: Crankshaft end play can be measured at front end or rear end of crankshaft. Procedure is performed from the rear end. The flywheel is removed to show detail.

1. Fasten the dial indicator (A) to engine and position indicator tip on end of crankshaft (B).

IMPORTANT: Avoid Damage! Do not use excessive force when moving crankshaft to avoid damaging bearings.

2. Push the crankshaft toward rear as far as possible.
3. Zero the dial indicator.
4. Using a bar, gently pry the crankshaft as far forward as possible.

3TNV76 & 3TNV80F Crankshaft—Specification

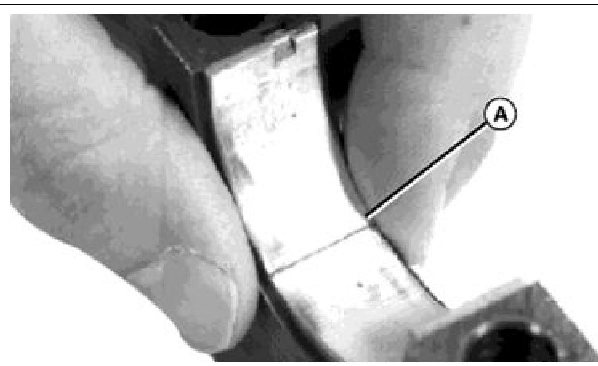
Crankshaft—End Play	0.11—0.25 mm (0.004—0.010 in.)
Crankshaft—End Play—Wear Limit	0.28 mm (0.011 in.)

Results

- If the end play exceeds specifications, replace the thrust bearings.

BS62576,00017F0 -19-22MAY14-1/1

Check Crankshaft Main Bearing Clearance



A—Plastigage® Strip

Reason

To measure oil clearance between main bearing and crankshaft journal.

Procedure

IMPORTANT: Avoid Damage! Main bearing caps must be installed on the same main bearing and in the same direction to prevent crankshaft and main bearing damage.

1. Remove the main bearing cap.
2. Wipe oil from the bearing insert and the crankshaft journal.
3. Put a piece of Plastigage® (A), or an equivalent, along the width of the bearing insert approximately **6 mm (0.25 in.)** off center.
4. Install the main bearing cap and cap screws. Tighten the cap screws to specification.

3TNV76 Crankshaft—Specification

Main Bearing Cap Screw—Torque	76—82 N·m (56—60 lb.-ft.)

3TNV80F Crankshaft—Specification

Main Bearing Cap Screw—Torque	79—83 N·m (58—61 lb.-ft.)

NOTE: The flattened Plastigage® will be found on either the bearing insert or crankshaft journal.

5. Remove the cap screws and main bearing caps.

Continued on next page

BS62576,00017F1 -19-22MAY14-1/2

6. Use the graduation marks (C) on the envelope to compare the width of the flattened Plastigage® (B) at its widest point. The number within the graduation marks indicates the bearing clearance in inches or millimeters, depending on which side of the envelope is used.
7. Remove Plastigage®.

Results

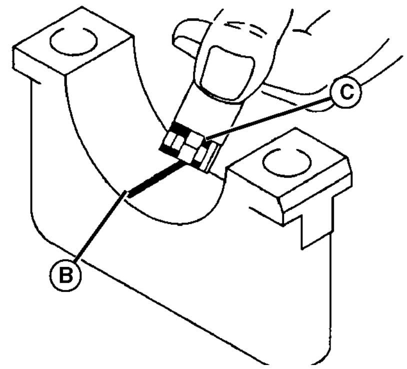
- If the clearance exceeds the wear limit specification, replace the bearing inserts.

3TNV76Crankshaft—Specification

Main Bearing-to-Crankshaft Journal Oil—Clearance	0.120 mm (0.005 in.)

3TNV80F Crankshaft—Specification

Main Bearing-to-Crankshaft Journal Oil—Clearance	0.040—0.090 mm (0.002—0.004 in.)



B—Flattened Plastigage® Strip C—Envelope

Main Bearing-to-Crankshaft Journal Oil—Clearance—Wear Limit	0.25 mm (0.010 in.)

BS62576,00017F1 -19-22MAY14-2/2

Check Camshaft End Play

Reason

To determine proper side clearance between camshaft gear end journal and thrust plate.

Procedure

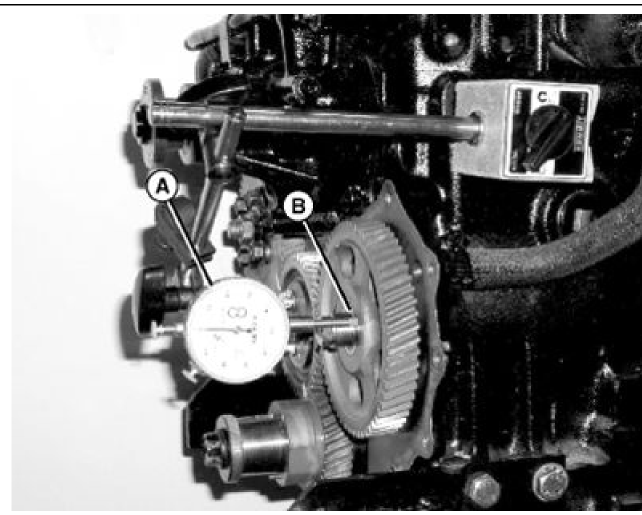
1. Remove the timing gear cover. (See Remove and Install Timing Gear Cover—3TNV76 or Remove and Install Timing Gear Cover—3TNV80F.)
2. Fasten the dial indicator (A) to the engine and position indicator tip on end of camshaft (B).
3. Push the camshaft toward the rear as far as possible.
4. Zero the dial indicator.
5. Pull the camshaft forward as far as possible.

Results

- If the end play exceeds specifications, remove the camshaft and replace the thrust plate. (See Camshaft—3TNV76 or Remove and Install Camshaft—3TNV80F.)

3TNV76 Camshaft—Specification

Camshaft—End Play (Wear Limit)	0.25 mm (0.098 in.)



A—Dial Indicator B—Camshaft

3TNV80F Camshaft—Specification

Camshaft—End Play	0.050—0.150 mm (0.002—0.006 in.)
Camshaft—End Play (Wear Limit)	0.25 mm (0.098 in.)

BS62576,00017F2 -19-22MAY14-1/1

Check Timing Gear Backlash

Reason

To check for wear between meshing gears, resulting in excessive noise and poor engine performance.

Procedure

Measure the backlash between meshing gears.

Results

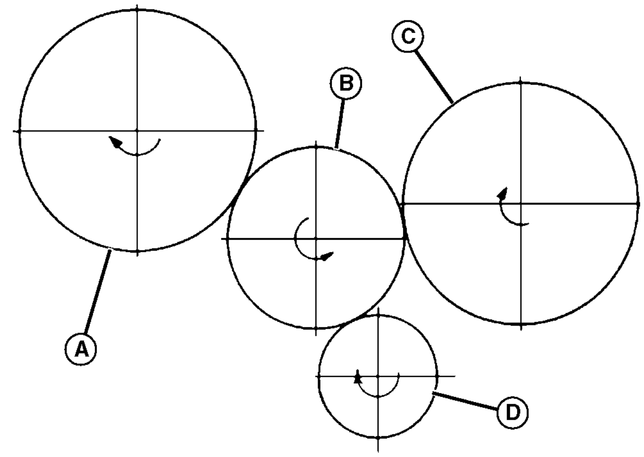
If the backlash exceeds specifications, replace meshing gears as a set:

- Fuel Injection Pump Gear (A)
- Idler Gear (B)
- Camshaft Gear (C)
- Crankshaft Gear (D)

3TNV76 and 3TNV80F Timing Gear—Specification

Timing Gear—Backlash....0.06—0.12 mm (0.0024—0.0047 in.)

Timing Gear—Backlash—Limit....0.14 mm (0.0055 in.)



TCAL25275 —UN—15JUN12

A—Fuel Injection Pump Gear
B—Idler Gear
C—Camshaft Gear
D—Crankshaft Gear

BS62576,00017F3 -19-21MAY14-1/1

Test Thermostat Opening

Reason

To determine opening temperature of thermostat.

Procedure

CAUTION: Avoid Injury! DO NOT allow thermostat or thermometer to rest against the side or bottom of glass container when heating water. Either may rupture if overheated.

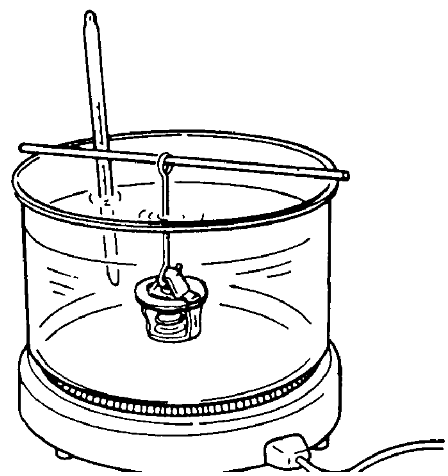
1. Suspend the thermostat and a thermometer in a container of water.
2. Heat and stir the water. Observe the opening action of the thermostat as the water heats up.
3. Remove the thermostat and observe the closing action as it cools.

Results

Thermostat opening temperature, fully open temperature, and lift height should meet specifications.

Specification

Thermostat—Begins to Open—Temperature....70°C (158°F)



TCAL25278 —UN—15JUN12

Thermostat—Fully Open—Temperature....85°C (184°F)

Thermostat—Lift (Opening Height)....8 mm (0.310 in.)

BS62576,00017F4 -19-21MAY14-1/1

Test Cylinder Leakdown

Reason

To determine if compression pressure is leaking from cylinder.

Special or Required Tools

- Adapter

Procedure

1. With the coolant at the proper level and the radiator cap tight, run the engine for 5 minutes to bring it to operating temperature.
2. Remove the recovery tank cap.
3. Check for bubbles coming from the overflow hose at the bottom of the tank.
4. If bubbles are present, isolate the source of the compression leak.
   a. Remove the injection nozzles.
   b. Install JDG560 Adapter in the injection port of the cylinder to be tested.
   c. Move the piston to the bottom of the stroke with intake and exhaust valves closed.
   d. Connect the hose from a compressed air source to the adapter.
   e. Apply shop air pressure into the cylinder.
   f. Check for bubbles in the recovery tank or air escaping from the muffler, air cleaner, or oil fill opening.
   g. Repeat for each cylinder.

Results

- If bubbles are present in the recovery tank, check for cracks in the cylinder head and block. Check for a damaged head gasket.
- If air escapes from the muffler, check for a worn exhaust valve.
- If air escapes from the air cleaner, check for a worn intake valve.
- If air escapes from the engine oil fill, check for worn piston rings.

BS62576,00017F5 -19-21MAY14-1/1

Test Cooling System Pressure

Reason

Inspect the cooling system for leaks.

Special or Required Tools

- D05104ST Cooling System Pressure Pump
- JDG692 Radiator Pressure Test Kit (Adapters)

Procedure

1. Remove cap and attach pressure pump to radiator.
2. Apply pressure according to specifications. DO NOT exceed maximum pressure specification.

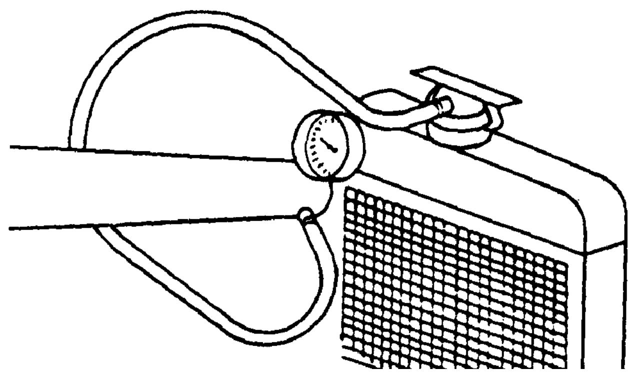
Specification

Cooling System Test—Maximum Pressure.......97 kPa (14 psi)

3. Check for leaks throughout the cooling system. The pressure should not go below the minimum pressure specification for at least 15 seconds.

Specification

Cooling System Test—Minimum Pressure (After 15 Seconds).......88 ± 15 kPa (12.8 ± 2.2 psi)



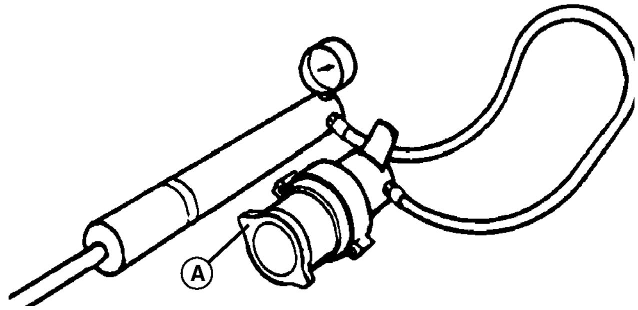
TCAL25280 —UN—15JUN12

Results

- If pressure decreases, check for leaks. Repair leaks or replace parts as necessary.
- If the pressure test still indicates leakage after all external leaks have been stopped, a defective head gasket, cracked block, or cylinder head may be the cause.

BS62576,00017F6 -19-21MAY14-1/1

Test Radiator Pressure Cap



A—Radiator Cap

Reason

Test the radiator cap for operating in the correct pressure range.

Special or Required Tools

- D05104ST Cooling System Pressure Pump
- JDG692 Radiator Pressure Test Kit (Adapters)

Procedure

1. Install the radiator cap (A) on the pressure pump.
2. Apply pressure. Pressure valve in the cap should open at specification.

Specification	
Radiator Cap —Opening Pressure	88 kPa (12.8 psi)

Results

- If the cap leaks, tighten and test again. Replace the cap if pressure is not within specification.

BS62576,00017F7 -19-21MAY14-1/1

Test Engine Oil Pressure

Reason

To determine if engine bearings or lubrication system components are worn.

Special or Required Tools

- JT03017 Hose Assembly
- JT05577 Pressure Gauge 689 kPa (100 psi)
- JT03349 Connector

Procedure

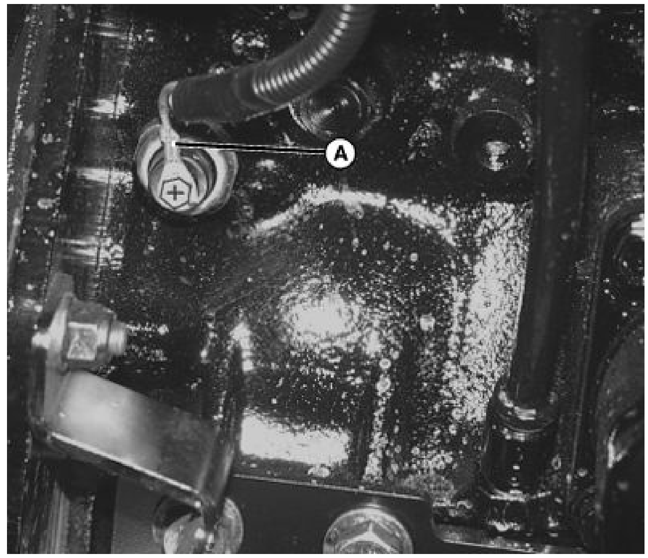
1. Park vehicle in neutral, engine off, and park brake locked.
2. Access engine.
3. Remove wire (A) to oil pressure switch.
4. Unscrew oil pressure switch from block.
5. Install JT03349 Connector into block.
6. Connect JT03017 Hose Assembly and JT05577 Pressure Gauge.

IMPORTANT: Turn off engine if no oil pressure is present.

7. Start engine. If pressure reading is below 69 kPa (10 psi), STOP ENGINE.
8. Run engine approximately five minutes to heat oil, then check oil pressure at fast idle.

Results

- If oil pressure is not within specifications, inspect oil pressure regulating valve parts for wear or damage. (See Oil Pump—3TNV76 or Inspect Oil Pump—3TNV80F.)



TCAL26131 —UN—15JUN12

3TNV76 shown. 3TNV80F is similar.

A—Wire

3TNV76 Engine—Specification

Fast Idle—Speed	3450 ± 25 rpm
Engine Oil @ 3450 RPM—Pressure	290-441 kPa (42-64 psi)
Engine Oil @ 1250 RPM—Pressure	60 kPa (9 psi)

3TNV80F Engine—Specification

Fast Idle—Speed	3415 ± 25 rpm
Engine Oil @ 3215 RPM—Pressure	240—350 kPa (35—51 psi)

- If oil pressure does not increase, engine may be worn beyond specifications.

BS62576,00017F8 -19-30SEP16-1/1

Leak Test Air Intake System

Reason

Check for leaks in the air intake system.

A—Air Filter Restriction Indicator

TCAL26120 —UN—15JUN12

Continued on next page

BS62576,00017FD -19-23MAY14-1/2

Procedure

1. Park machine safely.
2. Access engine.
3. Remove the air filter restriction indicator (A) and install the test fitting (for 3TNV76). Remove hose from fitting (B) on air cleaner (3TNV80F). Install test fitting.
4. Connect the air pressure regulator to manifold using the hose and fitting from air cleaner.
5. Remove the air cleaner cover and the main filter element.
6. Put a large plastic bag into and over end of main filter element. Install the main filter element and cover.
7. Pressurize the air intake system to specification. If the air intake system cannot be pressurized, turn the engine slightly to close valves.

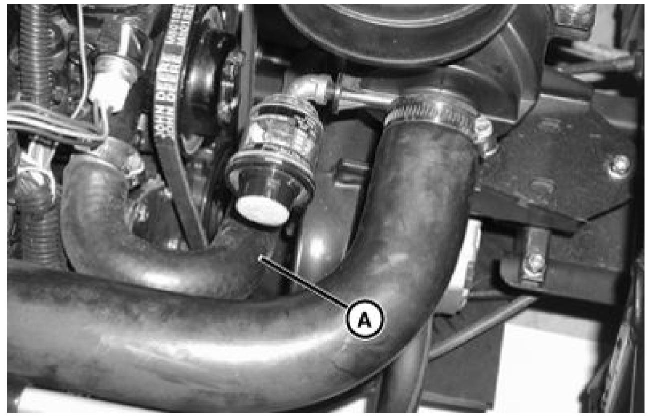
Specification	
Pressurize the air intake system—Pressure	34—69 kPa (5—10 psi)

8. Spray a soap solution over all the connections from the air cleaner to the intake manifold and check for leaks.

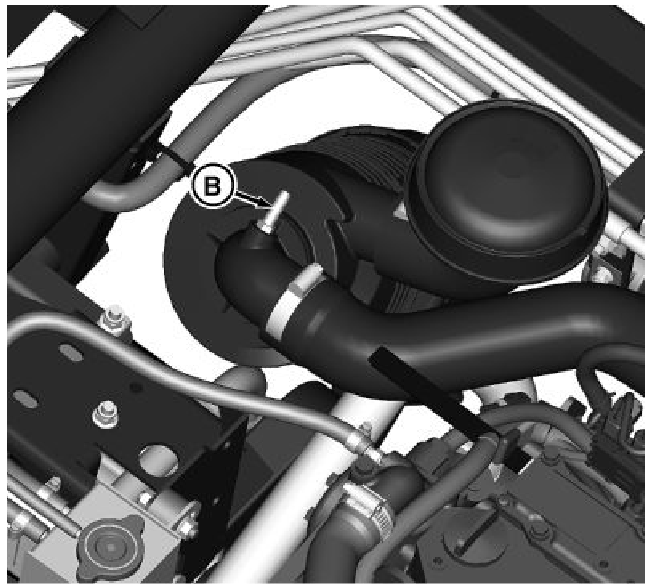
Results

Find leaks and repair or replace parts as necessary.

A—Air Filter Restriction Indicator **B—Fitting**



TCAL26119 —UN—15JUN12



TCT011267 —UN—23MAY14

3TNV80F Shown.

BS62576,00017FD -19-23MAY14-2/2

Bleed Fuel System

Reason

Any time the fuel system has been opened up for service (lines disconnected or filter removed), it is necessary to bleed air from the system.

Procedure

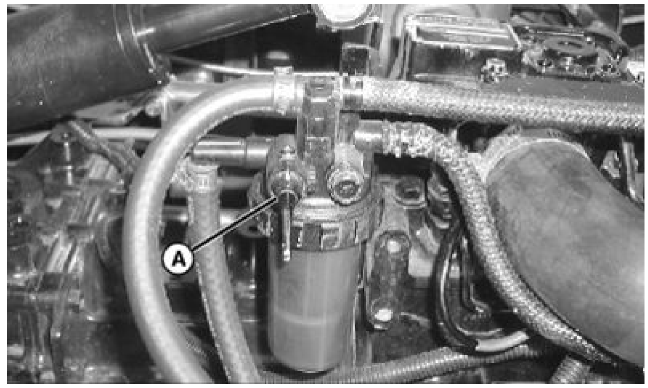
NOTE: The engine is equipped with an automatic air venting system, which makes the fuel system self-bleeding.

1. Park machine on a level surface, not on a slope.
2. Lock park brake.

CAUTION: Avoid Injury! Fuel vapors are explosive and flammable:

- **Shut engine off before filling fuel tank.**
- **Do not smoke while handling fuel.**
- **Keep fuel away from flames or sparks.**
- **Fill fuel tank outdoors or in well ventilated area.**
- **Clean up spilled fuel immediately.**
- **Use clean approved non-metal container to prevent static electric discharge.**
- **Use clean approved plastic funnel without screen or filter to prevent static electric discharge.**

3. Ensure fuel is in the fuel tank. Add fuel if necessary.
4. Open fuel shutoff valve (A).



TCAL26121 —UN—15JUN12

A—Fuel Shutoff Valve

5. Turn key to RUN position for 2 minutes prior to starting engine. The fuel pump will pressurize the fuel and remove any air in the system.
6. Start engine. If engine will not start, repeat previous step.

BS62576,00017FE -19-22MAY14-1/1

Test Fuel Transfer Pump Pressure

Reason

To determine fuel pump operating pressure.

Special or Required Tools

- JDG356 Fuel Pump Pressure Test Kit

Procedure

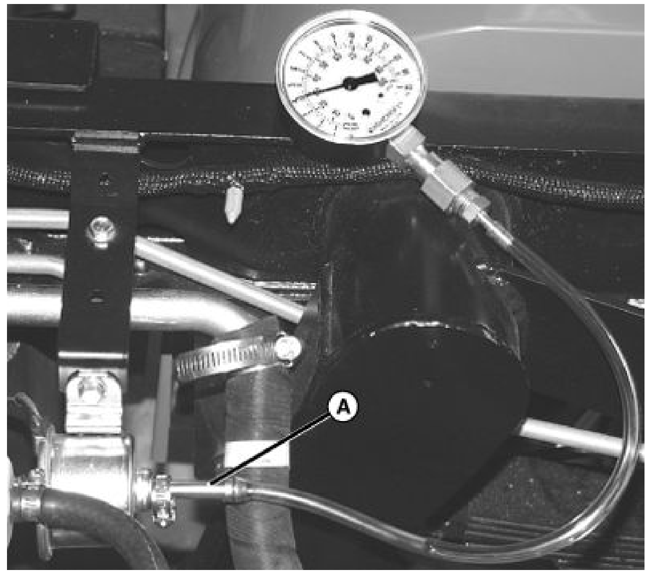
1. Park unit on level surface, park brake locked, transmission in neutral, engine off.
2. Access engine.
3. Disconnect fuel supply hose from fuel pump outlet.
4. Install test gauge as shown to outlet end of fuel pump (A).
5. Turn key switch to ON position and note reading on gauge.

Results

If pressure is not within specification, replace fuel pump.

Specification

Fuel Transfer Pump—Pressure............ 21.5—37.3 kPa (3.1—5.4 psi)



TCAL26122 —UN—15JUN12

A—Outlet End of Fuel Pump

BS62576,0001797 -19-15FEB16-1/1

Test Fuel Transfer Pump Flow

Reason

To determine fuel transfer pump output volume.

Procedure

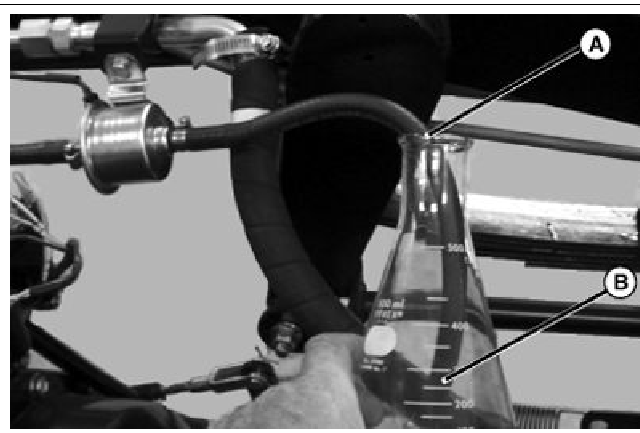
1. Park unit on level surface, park brake locked, transmission in neutral, engine off.
2. Access engine.
3. Disconnect fuel supply hose (A) from fuel filter.
4. Place hose in graduated container (B). Turn key switch to ON position for 30 seconds.

Results

If fuel volume is below specification, replace fuel transfer pump.

Specification

Fuel Transfer Pump Flow Volume (Min in 1 Minute)—Flow Rate............ 400 mL (13.5 oz)



TCAL26123 —UN—15JUN12

A—Fuel Supply Hose **B—Graduated Container**

BS62576,0001798 -19-13JUN14-1/1

Test Fuel Injection System

CAUTION: Avoid Injury! DO NOT attempt to adjust the fuel injection pump timing. For most engine problems, the fuel injection pump timing will not have to be adjusted. If the engine performed well at one time, then performance dropped, the fuel injection timing is NOT the problem. Fuel injection timing, once set by the engine manufacturer, should NOT change during the life of the engine.

IMPORTANT: Avoid Damage! Fuel injection pump timing should NOT change during the life of the engine unless the pump has been altered illegally, or there is excessive wear to the injection pump camshaft lobes and lifters.

First check the fuel quality, fuel supply, fuel injectors, air intake system, and engine compression in all cylinders before considering fuel injection timing problems.

If all other possibilities have been ruled out and it is determined that the fuel injection pump and/or governor assembly are in need of repair, they must be replaced together as a complete assembly ONLY.

Only an authorized factory trained technician is allowed to remove and install these assemblies.

Reason

To stop fuel flow to the cylinders (one at a time), while engine is running, to determine what effect that cylinder has on overall engine performance.

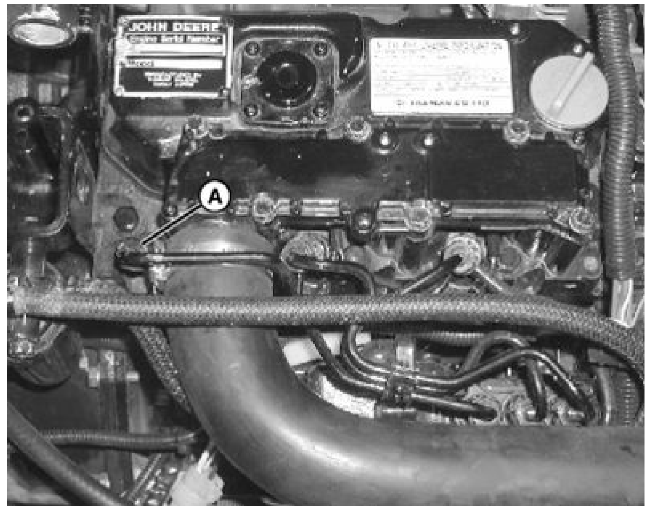
Procedure

1. Park machine on level surface, turn key switch off, shift transmission to neutral, and lock park brake.
2. Access engine. Remove air cleaner hose to intake manifold.

CAUTION: This test will cause diesel fuel to be released from fuel system. Injection pump is capable of producing extremely high pressure. Eye protection must be worn. Do not open fuel injector connectors more than 1/8 of a turn. Do not place hands near injectors during test. Do not allow any debris to enter intake manifold during test. Do not smoke.

Escaping fluid under pressure can penetrate the skin causing serious injury. Avoid the hazard by relieving pressure before disconnecting high-pressure lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body from high-pressure fluids.

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



TCAL26124 —UN—15JUN12

A—Nut

3. Start engine and run at slow idle.
4. Using two open end wrenches, loosen nut (A) on one high-pressure fuel injector line, either at the injector nozzle or at injection pump, while holding lower nut stationary with second wrench. Loosen nut only 1/8 of a turn (45°).
5. Listen for engine speed to drop and exhaust noise to change.
6. Tighten nut and allow engine to return to original speed before loosening next cylinder's fuel line nut.
7. Compare sound and speed of each cylinder as it is disabled.
8. Tighten fuel line nuts and stop engine.

Results

- When fuel flow is stopped to a cylinder, engine RPM should drop, engine should begin to vibrate and run rough, and exhaust noise will be uneven until fuel flow is restored.

If test produces the results described above, but engine performance remains poor, test the following:

- Clogged air cleaner elements, leaking air filter outlet hoses or clamps.
- Restriction in exhaust system.
- Presence of coolant or diesel fuel in crankcase oil.

If defeating a single cylinder has no effect on overall engine performance, test the following:

Continued on next page

BS62576,0001799 -19-13JUN14-1/2

- Fuel injector nozzle opening pressure, spray pattern, and leakage and for that cylinder (See "Test Fuel Injection Nozzle" on page 100).
- Cylinder compression or cylinder leakage test.
- Fuel transfer pump pressure.
- Fuel shutoff solenoid is opening fully.
- Fuel control and governor linkage flyweights allowing full fuel flow to injection pump.
- Injection pump timing correct.

If the above test results are within specifications, remove injection pump and have tested at an Authorized Diesel Service (ADS) Center.

BS62576,0001799 -19-13JUN14-2/2

Test Fuel Injection Nozzle

Reason

To determine opening pressure, leakage, and chatter and spray patterns of fuel injection nozzle.

Special or Required Tools

- D01109AA Diesel Fuel Injection Nozzle Tester
- D01110AA Adapter Set
- 23622 Straight Adapter

Connections

IMPORTANT: Use clean, filtered diesel fuel when testing injection nozzles for best results.

Connect fuel injection nozzle to D01109AA Diesel Fuel Injection Nozzle Tester using parts from D01110AA Adapter Set and 23622 Straight Adapter.

Pressure Test Procedure

Test fuel injection nozzle opening pressure following the nozzle tester manufacturer's instructions. Compare to specification.

Pressure Test Results

If pressure reading does not meet specification, disassemble injection nozzle and inspect nozzle assembly for contamination or stuck valve. (See Remove, Inspect, and Install Fuel Injection Nozzle—3TNV76 or Remove, Inspect, and Install Fuel Injection Nozzle—3TNV80F.) If necessary, add or remove shims to change opening pressure.

Leakage Test Procedure

Test fuel injection nozzle leakage following the nozzle tester manufacturer's instructions.

1. Dry nozzle completely using a lint-free cloth.
2. Pressurize nozzle to just below minimum opening pressure and hold.

TCAL26125 —UN—15JUN12

3. Watch for leakage from nozzle spray orifice. Keep track of time elapsed before leakage begins. Compare to specification.

Leakage Test Results

If leakage time does not meet specification, disassemble injection nozzle and inspect nozzle assembly for contamination. Replace nozzle assembly if necessary. (See Remove, Inspect, and Install Fuel Injection Nozzle—3TNV76 or Remove, Inspect, and Install Fuel Injection Nozzle—3TNV80F.)

Chatter and Spray Pattern Test Procedure

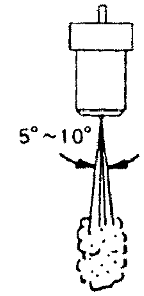
Test fuel injection nozzle chatter and spray pattern following the nozzle tester manufacturer's instructions.

1. Pressurize nozzle until nozzle opening pressure is reached.
2. Listen for "chatter" sound and watch spray pattern.

Continued on next page

BS62576,000179A -19-13JUN14-1/3

Chatter and Spray Pattern Test Results

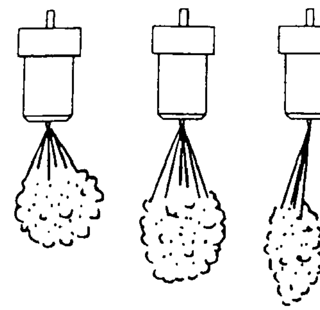


TCAL26126 —UN—15JUN12

Correct spray pattern.

BS62576,000179A -19-13JUN14-2/3

- If nozzle chatter or spray pattern does not meet specifications, disassemble injection nozzle and inspect nozzle assembly for contamination. Inspect valve seating surface. Replace nozzle assembly if necessary. (See Remove, Inspect, and Install Fuel Injection Nozzle—3TNV76 or Remove, Inspect, and Install Fuel Injection Nozzle—3TNV80F.)
- If there is excessive difference in spray angle or injection angle, incomplete atomizing, or sluggish starting/stopping of injection, disassemble injection nozzle and inspect nozzle assembly for contamination. Replace nozzle assembly if necessary. (See Remove, Inspect, and Install Fuel Injection Nozzle—3TNV76 or Remove, Inspect, and Install Fuel Injection Nozzle—3TNV80F.)



TCAL26127 —UN—15JUN12

Incorrect spray patterns.

Specifications

Item	Measurement	Specification
Fuel Injection Nozzle		
New Nozzle Opening Pressure (5 Hrs. or Less Usage)		12 800-13 800 kPa (1856.5-2001.5 psi)
Used Nozzle Opening Pressure		12 300-13 300 kPa (1784-1929 psi)
Leakage at Just Below Minimum Opening Pressure		No leakage for 5 sec (minimum)
Chatter and Spray Pattern at Opening Pressure		
Slow Hand Lever Movement (at Opening)		Chatter sound
Slow Hand Lever Movement		Fine stream, 5-10° spray pattern
Fast Hand Lever Movement		Fine atomized spray, 5-10° spray pattern

BS62576,000179A -19-13JUN14-3/3

Injection Pump Static Timing

CAUTION: DO NOT attempt to adjust the fuel injection pump timing. For most engine problems, the fuel injection pump timing will not have to be adjusted. If the engine performed well at one time, then performance dropped, the fuel injection timing is NOT the problem. Fuel injection timing, once set by the engine manufacturer, should NOT change during the life of the engine.

NOTE: Fuel injection pump timing should NOT change during the life of the engine unless the pump has been altered illegally, or there is excessive wear to the injection pump camshaft lobes and lifters.

Check these items FIRST as possible cause of engine problem:

- Fuel quality. Go to a higher octane rated fuel.
- Check compression. A new engine with low compression and non-seated rings will not fire as cleanly as an older engine with seated rings. Engine must be broken in.
- Check for dirty injector. Crack individual injector fuel lines and note performance change. Test suspect injectors.
- Verify glow plug circuit is working correctly.
- Check throttle cable adjustment. Reference proper procedure.
- Check for plugged fuel filter.
- Check fuel transfer pump pressure.

IMPORTANT: If all other possibilities have been ruled out and it is determined that the fuel injection pump and/or governor assembly are in need of repair, they must be replaced together as a complete assembly ONLY.

Only an authorized factory trained technician is allowed to remove and install these assemblies.

- Have pump tested by an EPA Authorized Diesel Service (ADS) Center. When reinstalling an injection pump sent out for service, use the same thickness of shim that was removed. Shim thickness is 0.8 mm (0.031 in.).

BS62576,000179B -19-13JUN14-1/1

Specifications

Item	Measurement	Specification
Alternator		
Rotor Slip Ring (Min)	Diameter	14 mm (0.55 in.)
Exposed Brush Length (Min)	Height	4.5 mm (0.17 in.)
Exposed Brush Length (Max)	Height	10.5 mm (0.41 in.)
Pulley Nut	Torque	69 N·m (51 lb.-ft.)
Camshaft		
Camshaft (Wear Limit)	End Play	0.25 mm (0.010 in.)
Camshaft Bend Wear Limit	Axial Runout (Wobble)	0.05 mm (0.002 in.)
Camshaft Lobe Wear Limit	Height	33.89 mm (1.334 in.)
Bearing-to-Camshaft Gear Housing End Journal Clearance (Wear Limit)	Clearance	0.245 mm (0.010 in.)
Bearing-to-Camshaft Intermediate Journals Clearance (Wear Limit)	Clearance	0.225 mm (0.009 in.)
Bearing-to-Camshaft Flywheel End Journal Clearance (Wear Limit)	Clearance	0.195 mm (0.008 in.)
Cam Follower OD Wear Limit	Diameter	20.91 mm (0.823 in.)
Cam Follower Bore ID Wear Limit	ID	21.04 mm (0.828 in.)
Follower-to-Bore Oil Clearance Wear Limit	Clearance	0.13 mm (0.005 in.)
Gear Housing and Flywheel End Journal OD Wear Limit	Diameter	39.905 mm (1.571 in.)
Intermediate Journal OD Wear Limit	Diameter	39.875 mm (1.570 in.)
Gear Housing End Bearing Wear Limit	ID	40.150 mm (1.581 in.)
Clutch Cover		
Clutch Cover Cap Screw	Torque	23 N·m (200 lb.-in.)
Clutch Cover Cap Screw Final	Torque	28 N·m (20 lb.-ft.)
Connecting Rod		
Connecting Rod Cap Screw Torque	Torque	23—28 N·m (17—20 lb.-ft.)
Connecting Rod Bearing	ID	41.982—42.002 mm (1.653—1.654 in.)

Continued on next page

BS62576,00017AB -19-20JUN14-1/6

Item	Measurement	Specification
Connecting Rod Bearing Oil Clearance Wear Limit	Clearance	0.11 mm (0.004 in.)
Bushing ID Wear Limit	ID	22.07 mm (0.869 in.)
Crankshaft		
Crank Hub Cap Screw	Torque	113—123 N·m (83—90 lb.-ft.)
Main Bearing Standard Oil	Clearance	0.020—0.050 mm (0.001—0.002 in.)
Main Bearing Oil Wear Limit	Clearance	0.120 mm (0.005 in.)
Main Bearing Cap Screw	Torque	76—82 N·m (56—60 lb.-ft.)
Crankshaft Bend (Maximum)	Axial Runout (Wobble)	0.02 mm (0.001 in.)
Crankshaft Connecting Rod Journal Standard OD	Diameter	41.95—41.96 mm (1.6517—1.652 in.)
Crankshaft Connecting Rod Journal OD Wear Limit	Diameter	41.90 mm (1.650 in.)
Crankshaft Main Bearing Journal Standard OD	Diameter	46.95—46.96 mm (1.848—1.849 in.)
Crankshaft Main Bearing Journal OD Wear Limit	Diameter	46.90 mm (1.847 in.)
Cylinder Bore		
Standard Size Cylinder Bore Standard ID	ID	76.01—76.02 mm (2.9925—2.9929 in.)
Standard Size Cylinder Bore ID Wear Limit	ID	76.20 mm (3.000 in.)
Cylinder Standard Roundness	Roundness	0.00—0.01 mm (0.0000—0.0004 in.)
Cylinder Standard Taper	Taper	0.00—0.01 mm (0.0000—0.0004 in.)
Cylinder Roundness Wear Limit	Roundness	0.03 mm (0.001 in.)
Cylinder Taper Wear Limit	Taper	0.03 mm (0.001 in.)
Oversize Cylinder Bore Standard ID	ID	76.26—76.27 mm (3.0025—3.0029 in.)
Oversize Cylinder Bore ID Wear Limit	ID	76.45 mm (3.010 in.)
Piston-to-Cylinder Bore	Clearance	0.03—0.05 mm (0.001—0.002 in.)
Cylinder Head		
Initial	Torque	27—29 N·m (20—22 lb.-ft.)

Continued on next page

BS62576,00017AB -19-20JUN14-2/6

Item	Measurement	Specification
Final	Torque	54—58 N·m (40—43 lb.-f.t)
Cylinder Head Wear Limit	Out-of-Flat	0.15 mm (0.006 in.)
Piston-to-Cylinder Head	Clearance	0.75—0.89 mm (0.029—0.035 in.)
Cylinder Head Allowable Removed Material (Maximum)	Thickness	0.20 mm (0.008 in.)
Engine Mounting		
Engine-to-Subframe Mounting Cap Screw	Torque	75 N·m (55 lb.-ft.)
Exhaust		
Exhaust Manifold Cap Screw	Torque	25.5 N·m (19 lb.-ft.)
Muffler Flange Nut Torque	Torque	25 N·m (221 lb.-in.)
Flywheel		
Flywheel Mounting Cap Screw Torque	Torque	84 N·m (62 lb.-ft.)
Fuel Injection Nozzle		
Injection Nozzle Torque	Torque	49—59 N·m (36—43 lb-ft)
Leak-Off Fitting Nut Torque	Torque	24—33 N·m (18—24 lb-ft)
Separator Plate Contact Surface	Thickness	0.10 mm (0.004 in.)
Nozzle Fitting Torque		29—49 N·m (21—36 lb-ft)
Glow Plug		
Glow Plug	Torque	15—20 N·m (132—177 lb.-in.)
Idle Gear		
Idler Gear Shaft Standard OD		36.95—36.975 mm (1.455—1.456 in.)
Idler Gear Shaft OD Wear Limit	Diameter	36.90 mm (1.453 in.)
Idler Gear Bushing Standard ID		37.00—37.025 mm (1.457—1.458 in.)
Idler Gear Bushing Wear Limit	ID	37.07 mm (1.4596 in.)
Oil Clearance		0.025—0.075 mm (0.001—0.003 in.)
Oil Clearance Wear Limit	Clearance	0.175 mm (0.007 in.)

Continued on next page

BS62576,00017AB -19-20JUN14-3/6

Item	Measurement	Specification
Injection Pump		
Injection Pump Mounting Nut Torque	Torque	23—28 N·m (17—21 lb.-ft.)
Injection Pump Drive Gear Nut Torque	Torque	59—69 N·m (44—51 lb.-ft.)
High-Pressure Line Nut Torque	Torque	29—34 N·m (22—25 lb.-ft.)
Oil Pump		
Outer Rotor-to-Housing Clearance Wear Limit	Clearance	0.30 mm (0.012 in.)
Inner Rotor Tip-to-Outer Rotor Tip Clearance (Maximum)	Clearance	0.16 mm (0.006 in.)
Rotor-to-Pump Housing Side Clearance Wear Limit	Clearance	0.12 mm (0.005 in.)
Inner Rotor Shoulder Diameter	Diameter	45.98—46.00 mm (1.810—1.811 in.)
Inner Rotor Pilot Hole Diameter	Diameter	46.13—46.18 mm (1.816—1.818 in.)
Inner Rotor-to-Pilot Hole Oil Clearance Wear Limit	Clearance	0.25 mm (0.010 in.)
Piston		
Piston Pin OD Wear Limit	OD	21.965 mm (0.865 in.)
Pin-to-Bushing Clearance Wear Limit	Clearance	0.105 mm (0.004 in.)
Standard Size Piston OD Wear Limit	OD	75.910 mm (2.989 in.)
Oversize Piston OD Wear Limit	OD	76.160 mm (2.999 in.)
Bore ID Wear Limit	ID	22.04 mm (0.868 in.)
Diameter Measuring Point Distance (A)	Distance	22—25 mm (0.866—0.984 in.)
Piston Rings		
Top Piston Ring Thickness Wear Limit	Thickness	1.45 mm (0.057 in.)
Middle Piston Ring Thickness Wear Limit	Thickness	1.41 mm (0.0555 in.)
Oil Control Ring Thickness Wear Limit	Thickness	2.95 mm (0.116 in.)
Top Piston Ring Groove Side Clearance	Clearance	0.06—0.10 mm (0.002—0.004 in.)
Middle Piston Ring Groove Side Clearance	Clearance	0.013—0.165 mm (.0005—0.0065 in.)
Oil Control Ring Groove Side Clearance	Clearance	0.020—0.060 mm (0.0008—0.0024 in.)

Continued on next page

BS62576,00017AB -19-20JUN14-4/6

Item	Measurement	Specification
Top Piston Ring Standard End Gap	Gap	0.15—0.30 mm (0.006—0.012 in.)
Top Piston Ring End Gap Wear Limit	Gap	0.39 mm (0.015 in.)
Middle Piston Ring Standard End Gap	Gap	0.18—0.33 mm (0.007—0.013 in.)
Middle Piston Ring End Gap Wear Limit	Gap	0.42 mm (0.0165 in.)
Oil Control Ring Standard End Gap	Gap	0.20—0.45 mm (0.008—0.018 in.)
Oil Control Ring End Gap Wear Limit	Gap	0.54 mm (0.021 in.)
Push Rods		
Push Rod Bend	Radial Runout	0.00—0.03 mm (0.000—0.001 in.)
Rocker Arms		
Rocker Arm Assembly Cap Screw	Torque	26 N·m (226 lb.-in.)
Rocker Arm Shaft Wear Limit	OD	11.94 mm (0.4701 in.)
Rocker Arm Wear Limit	ID	12.07 mm (0.475 in.)
Rocker Arm Oil Wear Limit	Clearance	0.13 mm (0.005 in.)
Starting Motor		
Starting Motor Cap Screw	Torque	24 N·m (216 lb.-in.)
Field Coil Brush Length Minimum	Length	10.5 mm (0.413 in.)
Exposed Brush Length (Min)	Height	4.50 mm (0.17 in.)
Exposed Brush Length (Max)	Height	10.50 mm (0.41 in.)
Field Coil Brush Length Minimum	Length	10.50 mm (0.413 in.)
Timing Gear		
Timing Gear Clearance (Wear Limit)	Backlash	0.14 mm (0.0055 in.)
Valves		
Valve Recession (Both)	Depth	0.4—0.6 mm (0.0157—0.0236 in.)
Valve Recession Wear Limit (Both)	Depth	0.9 mm (0.035 in.)
Valve Guide-to-Valve Stem Oil Wear Limit (Both)	Clearance	0.17 mm (0.007 in.)

Continued on next page

BS62576,00017AB -19-20JUN14-5/6

Item	Measurement	Specification
Intake Valve Face	Angle	30°
Exhaust Valve Face	Angle	45°
Intake Valve Face Margin	Thickness	0.90—1.1 mm (0.035—0.043 in.)
Exhaust Valve Face Margin	Thickness	1.0—1.2 mm (0.039—0.047 in.)
Valve Face Margin Wear Limit	Thickness	0.50 mm (0.020 in.)
Intake Valve Stem	Diameter	5.960—5.975 mm (0.2346—0.2352 in.)
Exhaust Valve Stem	Diameter	5.945—5.960 mm (0.2341—0.2346 in.)
Valve Stem Wear Limit (Both)	Diameter	5.90 mm (0.232 in.)
Intake Valve Guide-to-Valve Stem Standard Oil	Clearance	0.025—0.052 mm (0.001—0.002 in.)
Exhaust Valve Guide-to-Valve Stem Standard Oil	Clearance	0.040—0.067 mm (0.002—0.003 in.)
Valve Guide		
Valve Guide Standard	ID	6.00—6.01 mm (0.236—0.237 in.)
Valve Guide Wear Limit	ID	6.08 mm (0.239 in.)
Valve Guide	Height	9.8—10.0 mm (0.386—0.394 in.)
Valve Seat		
Valve Seat	Width	Must Be Less Than Valve Face Width
Intake Valve Seat	Angle	30°
Exhaust Valve Seat	Angle	45°
Valve Spring		
Spring	Free Length	37.8 mm (1.488 in.)
Spring Inclination (Maximum)	Distance	1.3 mm (0.051 in.)
Valve Stem Seal		
Valve Stem Seal	Height	10.9—11.2 mm (0.429—0.441 in.)

BS62576,00017AB -19-20JUN14-6/6

Service Equipment and Tools

NOTE: Order tools according to information given in the SERVICEGARD™ Catalog. Some tools may be available from a local supplier.

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BS62576,00017AD -19-19JUN14-1/10

Lifting Bracket (2 used)..JT01748

Used to remove cylinder head from block.

BS62576,00017AD -19-19JUN14-2/10

Valve Spring Compressor......................................JDE138

Used to remove valves.

BS62576,00017AD -19-19JUN14-3/10

Valve Guide Driver.. JDG10500

Used to remove valve guides from cylinder head.

BS62576,00017AD -19-19JUN14-4/10

Valve Guide Installer.. JDG10501

Used to install valve guides to cylinder head.

BS62576,00017AD -19-19JUN14-5/10

Valve Seal Installer JDG10503

Used to install valve seal on guides.

BS62576,00017AD -19-19JUN14-6/10

Lifting Brackets (2 used).......................................JT01748

Used with hoist to remove flywheel from crankshaft.

BS62576,00017AD -19-19JUN14-7/10

Clutch Alignment Tool.. JDG1331

Used to install clutch.

BS62576,00017AD -19-19JUN14-8/10

Magnetic Follower Holder Kit............................D15001NU

Used to hold cam followers away from camshaft.

BS62576,00017AD -19-19JUN14-9/10

Nozzle Cleaning Kit JDF13

Used to clean fuel injection nozzles.

BS62576,00017AD -19-19JUN14-10/10

Other Material

Number	Name	Use
PM38657(U.S.)/PM38625Canada (U.S.)	John Deere High-Flex Form-in-Place Gasket	Applied to seal case-to-engine block mating surfaces before installing seal case.
PM38657 (U.S.)/LOCTITE® PM38625 (Canada) (U.S.)	John Deere High-Flex Form-in-Place Gasket	Applied to timing cover before installation.
PM37477 (U.S.)/PM38622 (Canada) (U.S.)	Thread Lock and Sealer (Medium Strength)	Applied to threads of oil pressure regulator cap and oil pump cover screws before installation.
T43512 Medium Strength Thread Lock (U.S.)	Thread Lock and Sealer (Medium Strength)	Applied to threads of oil pressure regulator cap and oil pump cover screws before installation.
PM38657 (U.S.)/LOCTITE® PM38628(Canada) (U.S.)	John Deere High-Flex Form-in-Place Gasket	Applied to camshaft bore plug before reinstallation.
TY16021 John Deere (U.S.)	High-Flex Form-in-Place Gasket	Used on rear camshaft plug to seal and hold in place.
PM38657 (U.S.)/PM38628(Canada) (U.S.)	John Deere High-Flex Form-in-Place Gasket	Applied to timing gear housing before installation.
TY16021 (U.S.)	John Deere High-Flex Form-in-Place Gasket	Applied to timing gear housing before installation.

BS62576,00017AE -19-19JUN14-1/1

Remove and Install Alternator Belt—3TNV76

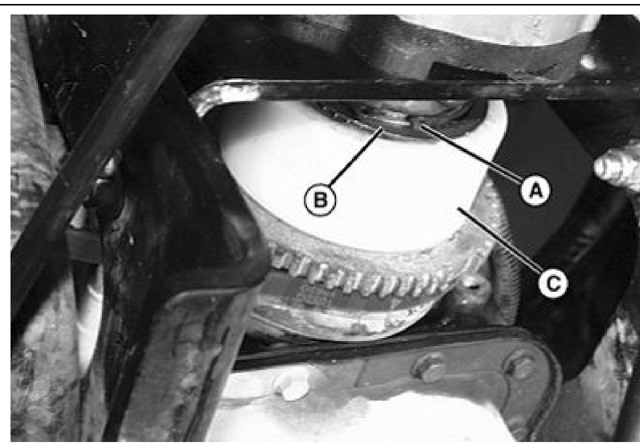
Removal

CAUTION: Entanglement in a belt or sheave can cause serious injury. Stop engine and wait for all moving parts to stop.

1. Park machine with the park brake locked, transmission in neutral and engine off.
2. Raise attachment to service position. Install lift cylinder safety support.

NOTE: The removal of the skid plate may ease access to hydraulic coupler.

3. Remove snap ring (A).
4. Slide washer (B) forward.
5. Slide coupler (C) forward.



TCAL26132 —UN—15JUN12

A—Snap Ring
B—Washer
C—Coupler

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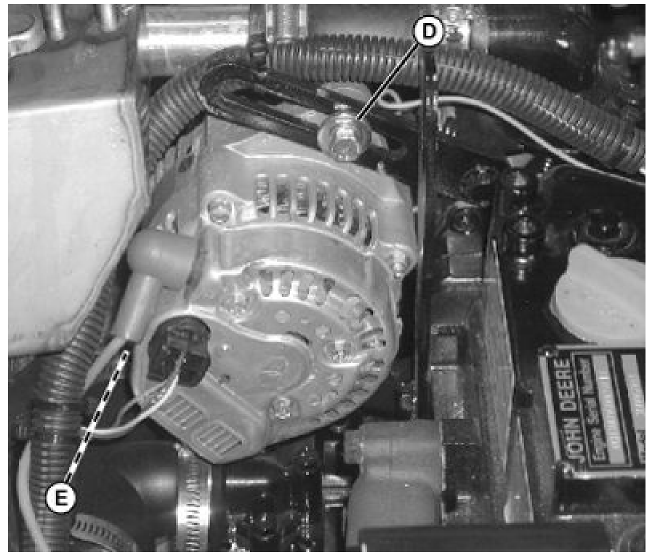
RB14256,0000851 -19-24APR14-1/2

6. Loosen alternator adjustment cap screw (D) and alternator mounting cap screw (E).
7. Apply inward pressure to the alternator housing.
8. Remove worn belt from both the alternator and engine sheaves.

Installation

1. Install and route new belt around sheaves.
2. Apply outward pressure to the alternator housing.
3. Tighten adjustment cap screw and then the mounting cap screw.
4. Check belt tension:
   - Apply thumb pressure to the belt approximately halfway between the sheaves. Belt should deflect inward approximately 10 mm (3/8 in.).
5. Install and tighten hardware as required.
6. Slide coupler and washer rearward.
7. Replace coupler snap ring.

NOTE: Install skid plate if removed for access.



TCAL26133 —UN—15JUN12

D—Adjustment Cap Screw **E—Mounting Cap Screw**

8. Remove lift cylinder safety support.
9. Lower attachment and return vehicle to service.

RB14256,0000851 -19-24APR14-2/2

Remove and Install Air Filter Restriction Indicator—3TNV76

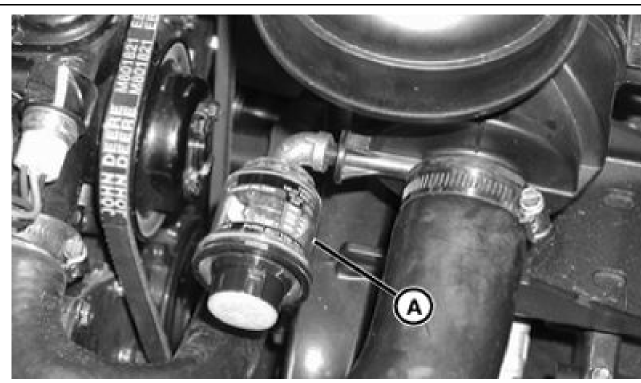
Removal

1. Park unit with park brake locked, transmission in neutral, and engine off.
2. Raise attachment to service position. Install lift cylinder safety support.
3. Remove air restriction indicator (A).
4. Inspect housing for cracks or other damage. Replace as needed.

Installation

Installation is done in reverse order of removal.

- Install air restriction indicator onto adapter until snug.



TCAL26134 —UN—15JUN12

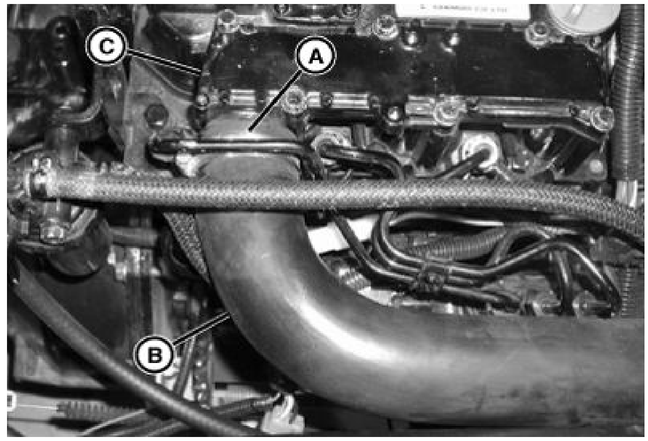
A—Air Restriction Indicator

RB14256,0000852 -19-24APR14-1/1

Remove and Install Air Cleaner Assembly—3TNV76

Removal

1. Park unit with park brake locked, transmission in neutral, and engine off.
2. Raise attachment to service position. Install lift cylinder safety support.
3. Loosen hose clamp (A).
4. Remove hose (B) from intake manifold (C).

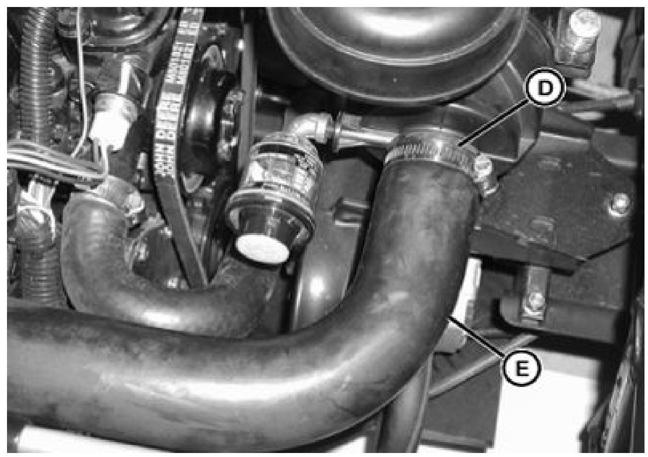


TCAL26135 —UN—15JUN12

A—Hose Clamp
B—Hose
C—Intake Manifold

RB14256,0000853 -19-18JUN12-1/3

5. Loosen hose clamp (D).
6. Remove hose from air cleaner assembly (E).



TCAL26136 —UN—15JUN12

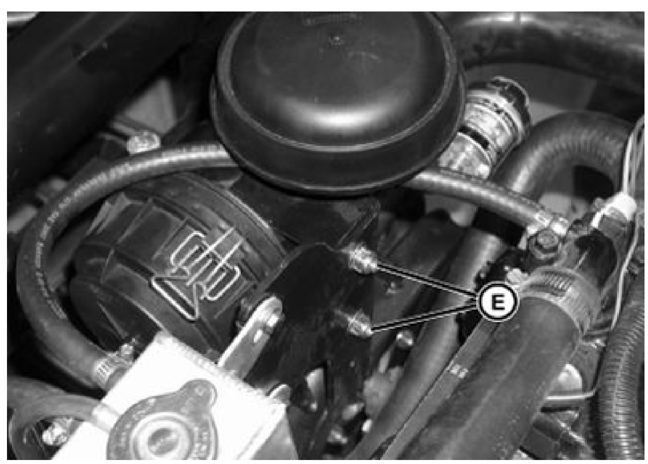
D—Hose Clamp
E—Air Cleaner Assembly

RB14256,0000853 -19-18JUN12-2/3

7. Remove flange head cap screws and nuts (E).
8. Remove air cleaner assembly.
9. Inspect all parts for wear or damage. Replace as needed.
10. Inspect hose for cracking or damage. Replace as needed.

Installation

Installation is done in reverse order of removal.



TCAL26137 —UN—15JUN12

E—Flange Head Cap Screws and Nuts

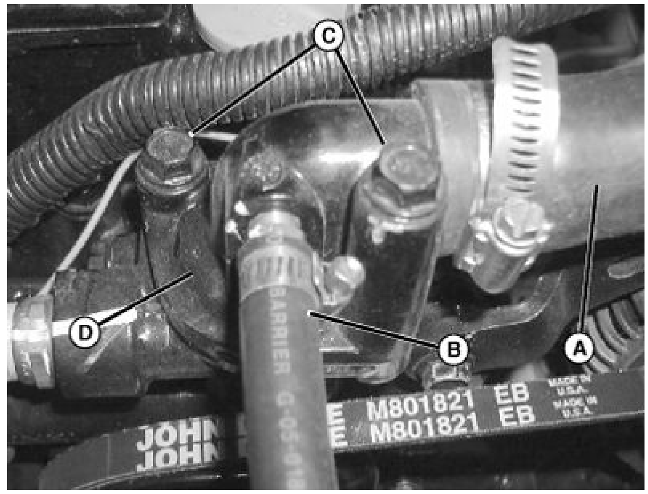
RB14256,0000853 -19-18JUN12-3/3

Remove and Install Thermostat—3TNV76

Removal

CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns. Shut off engine. Remove filler cap only when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing cap.

1. Park unit with park brake locked, transmission in neutral, and engine off.
2. Raise attachment to service position. Install lift cylinder safety support.
3. Allow engine to cool before attempting to service cooling system.
4. Loosen radiator cap to first stop to relieve pressure. Remove radiator cap.
5. Drain coolant from radiator/engine into container large enough to hold full capacity of cooling system.
6. Loosen clamp and remove radiator hose (A) from thermostat housing.
7. Loosen clamp and remove bypass hose (B) from thermostat housing.



TCAL26138 —UN—15JUN12

A—Upper Hose
B—Bypass Hose
C—Cap Screws
D—Housing

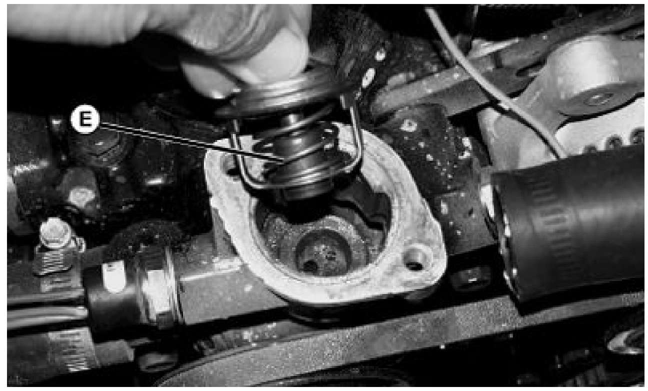
8. Remove two cap screws (C) holding thermostat housing to coolant pump. Remove housing (D).

Continued on next page

RB14256,0000854 -19-24APR14-1/2

NOTE: **Thermostat is offset and only fits in one direction. Note position of thermostat before removal.**

9. Remove thermostat (E).
10. Test or replace thermostat. (See <u>Test Thermostat Opening</u>.)



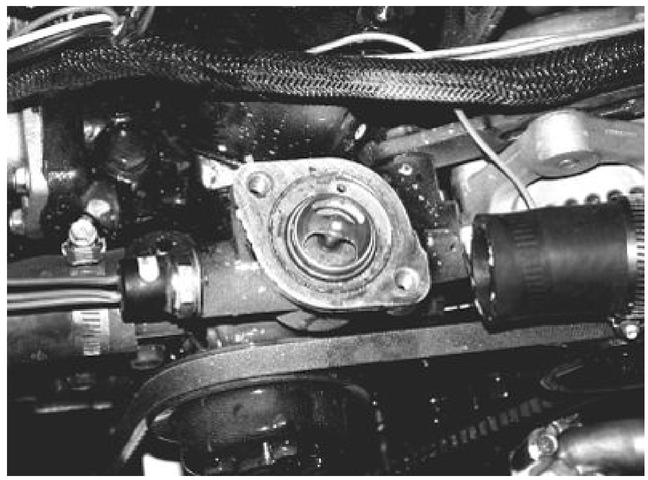
TCAL26139 —UN—15JUN12

E—Thermostat

Installation

Installation is done in reverse order of removal.

- Install thermostat in housing with spring end inside coolant pump.
- When installing thermostat, install as shown with spring facing down. Thermostat is offset and only fits in one direction. Make sure it is installed as removed and fits down in recess.
- Place gasket over thermostat and place cover over thermostat on coolant pump. Securely tighten cap screws.
- Fill cooling system to specifications.
- Start engine and watch coolant level in radiator. Add coolant if necessary to bring coolant level up to filler neck.



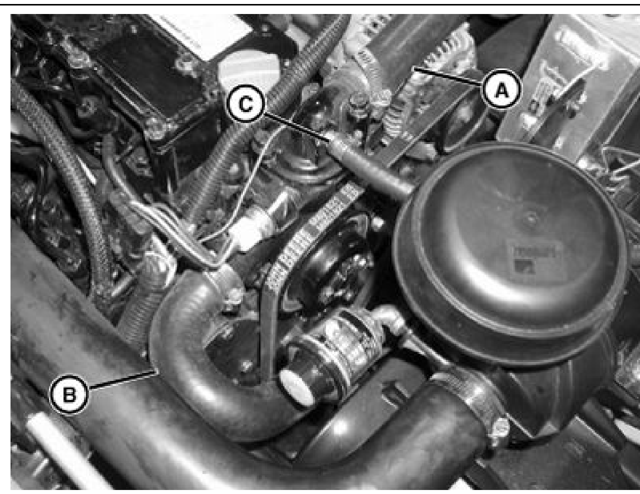
TCAL26140 —UN—15JUN12

RB14256,0000854 -19-24APR14-2/2

Remove and Install Coolant Pump (Thermostat Included)—3TNV76

Removal

1. Park machine safely. See the “Safety Section”.
2. Allow engine to cool and pressure in cooling system to drop before working on coolant pump.
3. **Remove upper (A) and lower (B) hoses from coolant pump.**
4. Remove bypass hose (C) from thermostat housing.



TCAL26141 —UN—15JUN12

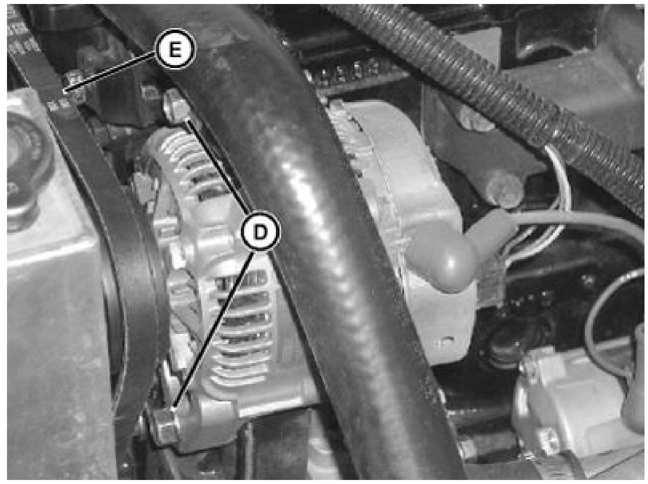
A—Upper Hose
B—Lower Hose
C—Bypass Hose

Continued on next page

RB14256,0000855 -19-24APR14-1/3

5. Loosen alternator mounting cap screws (D) and remove alternator belt (E) from upper sheave and alternator.
6. Remove the four cap screws from the water pump sheave.
7. Remove upper sheave.

D—Mounting Cap Screws **E—Alternator Belt**



TCAL26142 —UN—15JUN12

RB14256,0000855 -19-24APR14-2/3

NOTE: It is not necessary to remove engine to remove coolant pump. Engine shown removed for picture clarity only.

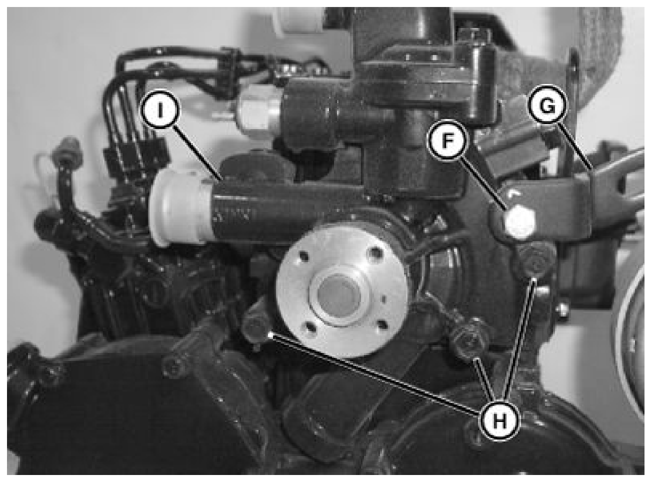
8. Remove cap screw (F) and move alternator bracket (G) aside.
9. Remove coolant pump cap screws (H).
10. Remove coolant pump (I).

Installation

Installation is done in the reverse order of removal.

NOTE: Replace O-ring on coolant pump before installing. Used O-rings will leak.

- Remove gasket residue from mating surfaces of coolant pump and timing gear cover. Use a new gasket and O-ring for installation.
- If the coolant pump is being replaced, install coolant temperature sensors and thermostat. (See Replace Coolant Temperature Sensors—3TNV76.)
- Adjust coolant pump-alternator drive belt tension. (See Adjust Alternator—Fan and Coolant Pump Drive Belts.)



TCAL26143 —UN—15JUN12

F—Cap Screw
G—Alternator Bracket
H—Coolant Pump Cap Screws
I— Coolant Pump

RB14256,0000855 -19-24APR14-3/3

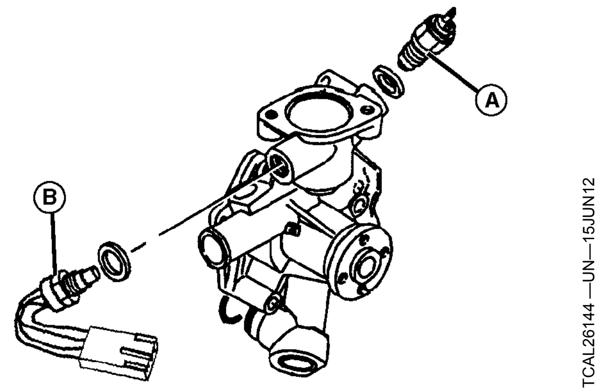
Replace Coolant Temperature Sensors—3TNV76

Replacement

1. Open engine drain valve to drain coolant level to below coolant sensor level.
2. Disconnect wiring leads.

NOTE: Sensor (A) is for temperature gauge. Sensor (B) is for over-temperature indicator light and cooling fan.

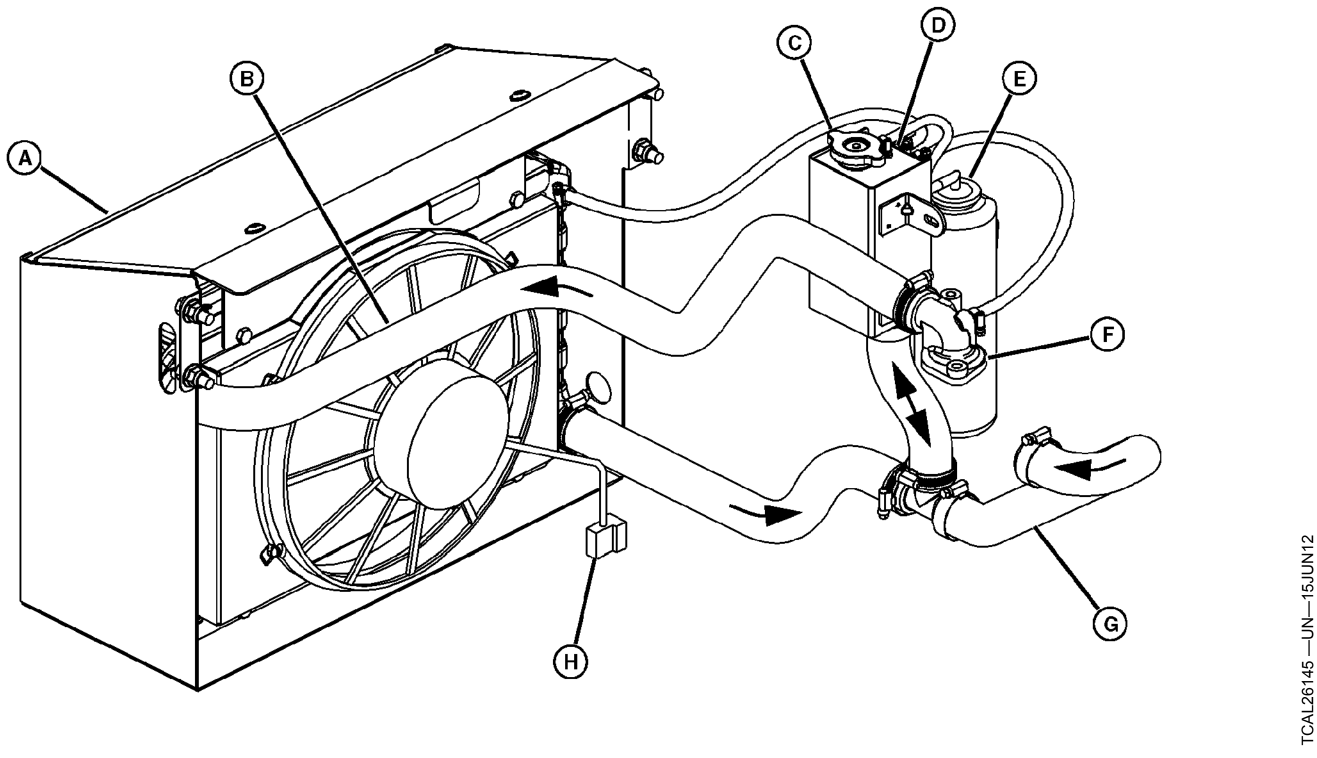
3. Remove sensors and copper washers.
4. Test sensors. (See Engine Coolant Temperature Sensor Test.)
5. Installation is done in reverse order of removal. Replace copper washers.



A—Sensor **B—Sensor**

RB14256,0000856 -19-24APR14-1/1

Cooling System Hose Routing—3TNV76



A—Radiator
B—Upper Radiator Hose
C—Pressure Cap
D—De-Aeration Tank
E—Coolant Recovery Tank
F—Engine Thermostat Housing
G—Lower Radiator Hose (Suction Line to Engine Coolant Pump)
H—Electric Fan Connector

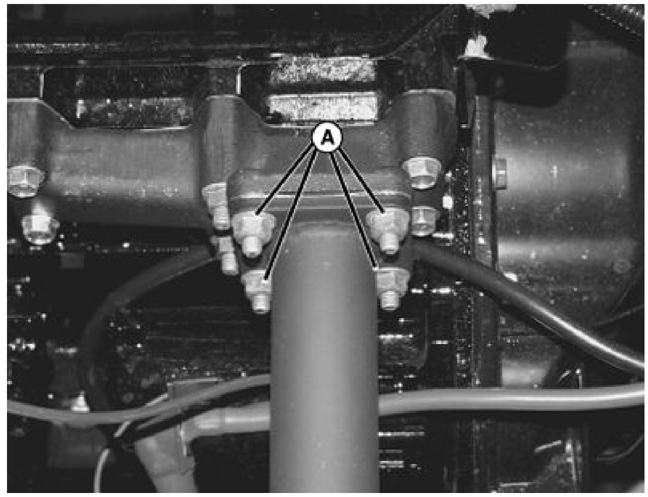
RB14256,0000857 -19-24APR14-1/1

Remove and Install Muffler—3TNV76

Removal

CAUTION: To prevent possible burns, allow engine to cool before removing muffler.

1. Park unit with park brake locked, transmission in neutral, and engine off.
2. Raise attachment to service position. Install lift cylinder safety support.
3. Allow muffler to cool, or wear protective gloves before working on muffler. Access muffler.
4. Remove tailpipe hanger clamp near rear axle and clamp from muffler outlet. Remove tailpipe.
5. Remove four nuts (A) holding muffler to exhaust manifold.



TCAL26146 —UN—15JUN12

A—Four Nuts

RB14256,0000858 -19-24APR14-1/2

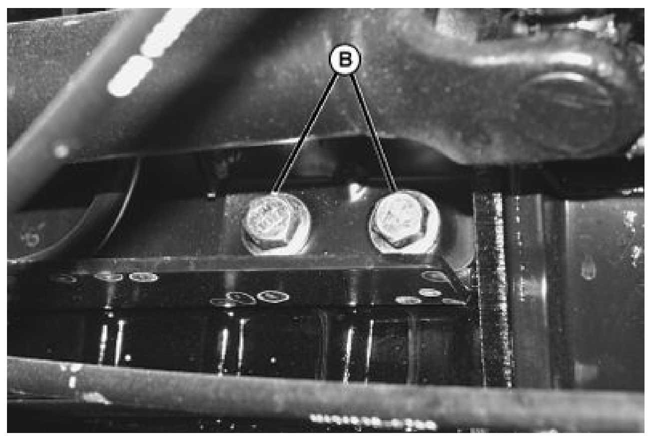
6. Remove cap screws (B) from lower muffler support, and remove muffler from engine.

Installation

Installation is done in reverse order of removal.

- Clean sealing surfaces of muffler flange and exhaust manifold.
- Install new gasket on exhaust manifold.
- Securely tighten muffler-to-manifold nuts.

B—Cap Screws



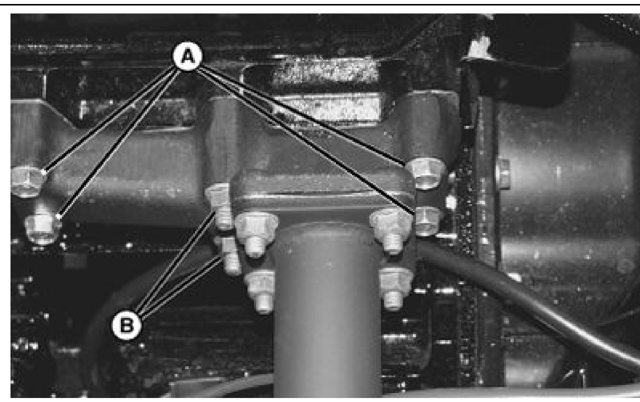
TCAL26147 —UN—15JUN12

RB14256,0000858 -19-24APR14-2/2

Remove and Install Exhaust Manifold—3TNV76

1. Remove muffler and gasket. (See Remove and Install Muffler—3TNV76.)
2. Remove four cap screws (A) and two nuts (B) holding exhaust manifold to cylinder head.
3. Remove manifold. Check for cracks or warpage.
4. Clean gasket mating surfaces. Install new gasket.
5. Install manifold. Tighten cap screws and nuts to specification.

Specification	
Exhaust Manifold Cap Screw—Torque	25.5 N·m (19 lb.-ft.)



TCAL26148 —UN—15JUN12

A—Cap Screws **B—Nuts**

RB14256,0000859 -19-24APR14-1/1

Remove and Install Intake Manifold/Rocker Arm Cover—3TNV76

Removal

NOTE: If the rocker arm cover is to be removed with the engine removed, go directly to step 3.

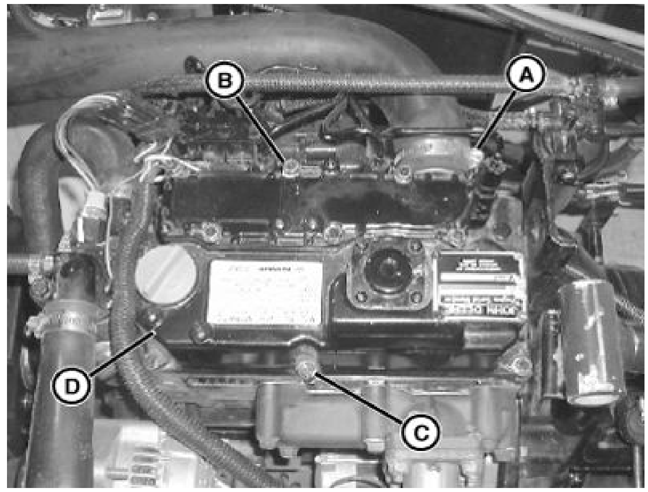
1. Park unit with park brake locked, transmission in neutral, and engine off.
2. Raise attachment to service position. Install lift cylinder safety support.
3. Remove hose clamp and hose (A).
4. Remove six long (B) and three short (C) cap screws securing cover to cylinder head.
5. Remove the rocker arm cover (D).

Installation

IMPORTANT: Do not overtighten the cap screws securing rocker arm cover to engine.

Installation done in reverse order of removal.

- Clean the cylinder head surface and install the rocker arm cover to the cylinder head.



TCAL26149 —UN—15JUN12

A—Hose
B—Six Long Cap Screws
C—Three Short Cap Screws
D—Rocker Arm Cover

- Inspect the rocker arm cover O-ring before reinstalling the rocker arm cover. Replace if damaged.
- Inspect the intake cover gasket before reinstalling. Replace if damaged.
- Securely tighten the cap screws.

RB14256,000085A -19-24APR14-1/1

Remove and Install Glow Plug—3TNV76

Removal

1. Park machine safely. See the “Safety Section”.
2. Remove intake manifold/rocker arm cover. (See Remove and Install Intake Manifold/Rocker Arm Cover—3TNV76.)
3. Remove nut, lock washer, and flat washer (A) from each glow plug.
4. Remove wiring harness (B).
5. Remove glow plugs (C).
6. Test glow plugs. (See Glow Plug Test.)

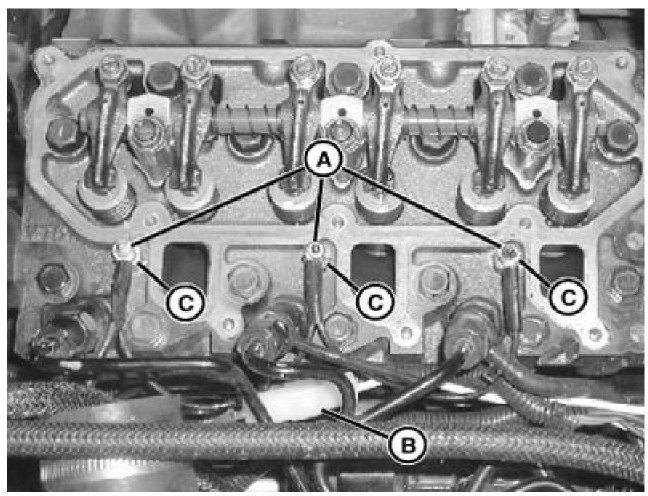
Installation

Installation is done in reverse order of removal.

- Tighten glow plugs to specifications.

Specification

Glow Plug—Torque..15—20 N·m
(132—177 lb.-in.)



TCAL26150 —UN—15JUN12

A—Flat Washer
B—Wiring Harness
C—Glow Plugs

RB14256,000085B -19-24APR14-1/1

Remove and Install Rocker Arm Assembly—3TNV76

Removal

1. Remove intake manifold/rocker arm cover. (See Remove and Install Intake Manifold/Rocker Arm Cover—3TNV76.)
2. Remove rocker arm assembly mounting cap screws. (See Disassemble and Assemble Rocker Arm Assembly—3TNV76.)

IMPORTANT: Note placement of valve caps and push rods for reassembly. Valve caps and push rods MUST be reinstalled in the same positions as removed.

3. Pull rocker arm assembly straight up off cylinder head.
4. Remove valve caps and push rods if needed.

Installation

IMPORTANT: Be sure valve caps are in place on end of valve stems before installing rocker arms. Valve caps and push rods must be reinstalled in same locations as removed.

1. Install valve caps and push rods if removed.
2. Align rocker arm supports with cylinder head. Align rockers with valve stems and push rods.
3. Install mounting cap screws on rocker arm supports and evenly tighten to pull rocker assembly to head. Tighten cap screws to specification.

Specification

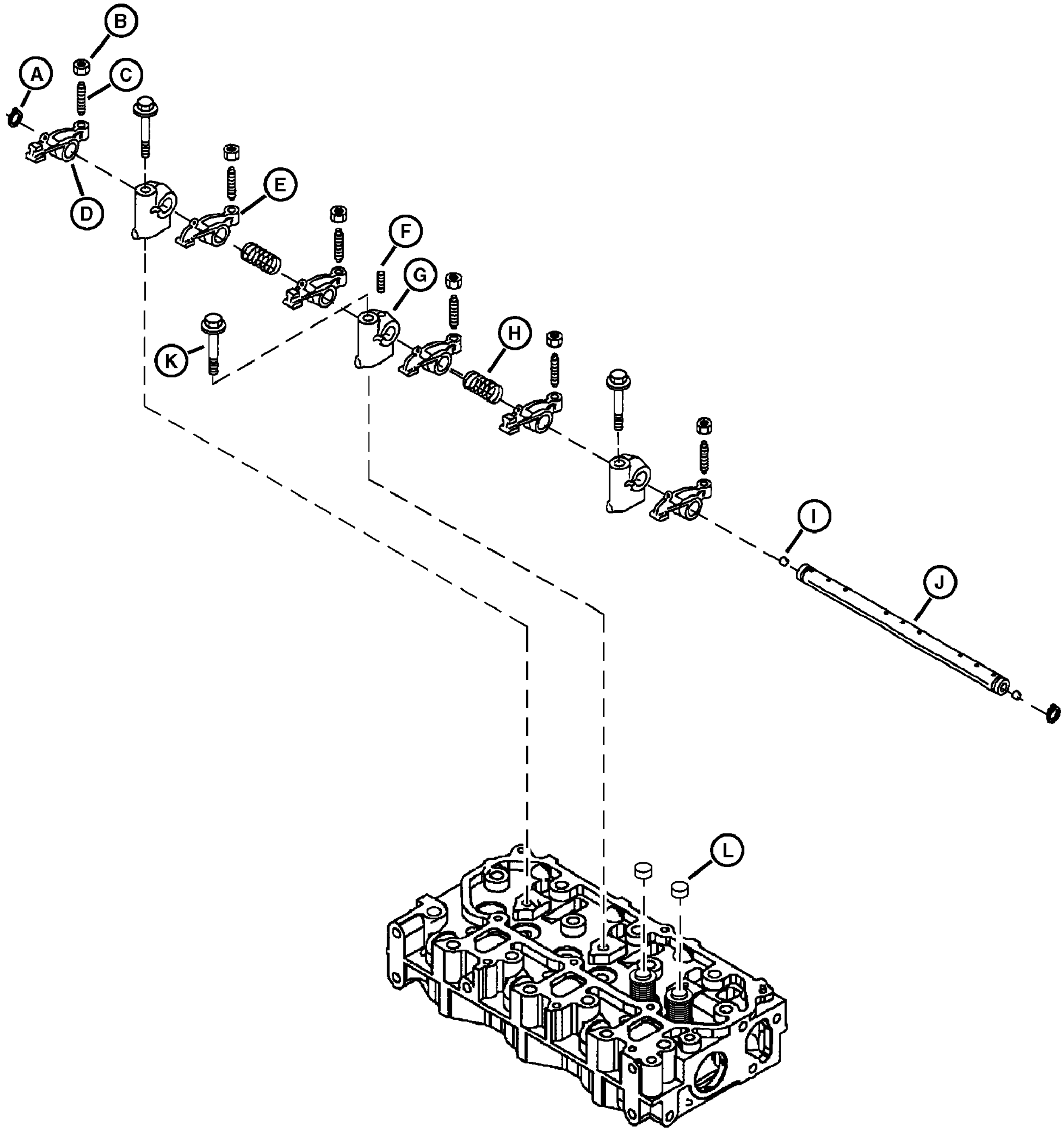
Rocker Arm Assembly
Cap Screw—Torque....................26 N·m
(226 lb.-in.)

4. Adjust valve clearance. (See Adjust Valve Clearance.)
5. Install intake manifold/rocker arm cover. (See Remove and Install Intake Manifold/Rocker Arm Cover—3TNV76.)

RB14256,000085C -19-24APR14-1/1

Disassemble and Assemble Rocker Arm Assembly—3TNV76

Disassembly



A—Retaining Ring (2 used)
B—Nut (6 used)
C—Stud (6 used)
D—Rocker Arm (3 used)
E—Rocker Arm (3 used)
F—Set Screw
G—Rocker Arm Support (3 used)
H—Spring (2 used)
I— Ball (2 used)
J—Shaft
K—Cap Screw (3 used)
L—Valve Stem Cap (6 used)

1. Mark all parts for location before disassembly to aid assembly.

NOTE: The rocker arm shaft fits tightly in the rocker arm supports. Clamp the support in a padded vise, then twist and pull out on rocker arm shaft to remove.

2. Remove end retaining rings and slide components off rocker shaft.

3. Remove set screw from center support. Remove rocker shaft from center support.

Continued on next page

RB14256,000085D -19-24APR14-1/6

4. Clean all parts of varnish and oil.

RB14256,000085D -19-24APR14-2/6

Rocker Arm Inspection

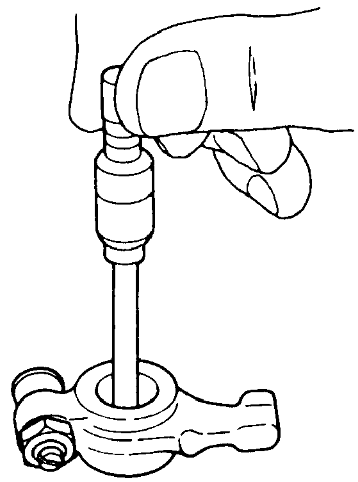
TCAL26152 —UN—15JUN12

1. Measure outer diameter of rocker arm shaft at each rocker arm location. Replace rocker arm shaft if measurement is less than specification.

Specification

Rocker Arm Shaft Wear
Limit—OD....................11.94 mm
(0.4701 in.)

RB14256,000085D -19-24APR14-3/6



TCAL26153 —UN—15JUN12

2. Measure inside diameter of rocker arms. Replace rocker arms if inner diameter is more than specification.

Specification

Rocker Arm Wear
Limit—ID.................... 12.07 mm
(0.475 in.)

3. If shaft and arm oil clearance (arm ID minus shaft OD) exceeds wear limit, replace all parts.

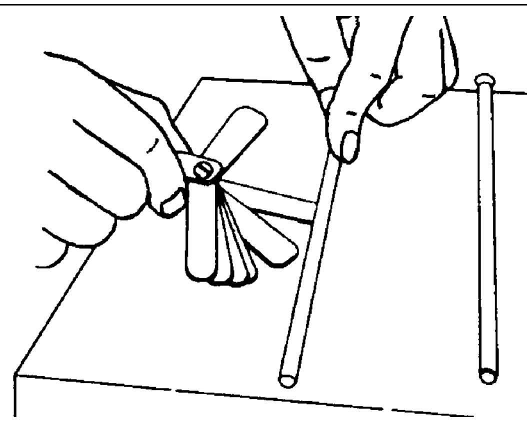
Specification

Rocker Arm Oil Wear
Limit—Clearance.................... 0.13 mm
(0.005 in.)

4. Check the rocker arm-to-valve stem cap contact surface for wear. Replace rocker arm and/or valve stem cap if worn.

RB14256,000085D -19-24APR14-4/6

Push Rod Inspection



TCAL26154 —UN—15JUN12

1. Lay push rod on flat surface and roll while checking for a gap under center of rod. Use feeler gauge to check specification.

Specification

Push Rod Bend—Radial
Runout....................0.00—0.03 mm
(0.000—0.001 in.)

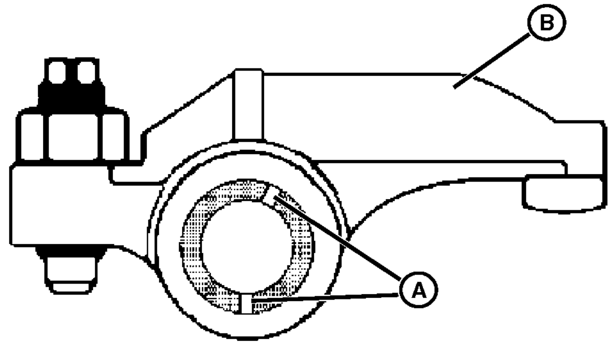
2. Check the surface of the adjusting screw that contacts the push rod for wear. Replace push rod and/or adjusting screw if worn.

Continued on next page

RB14256,000085D -19-24APR14-5/6

Assembly

NOTE: Ensure the lubrication holes (A) in the rocker arm shaft are in the correct orientation to the rocker arms (B).



1. Assemble rocker arm shaft into center support, aligning set screw hole in support with hole in rocker arm shaft.
2. Install remaining parts of rocker arm assembly in location as noted in disassembly.

A—Lubrication Holes **B—Rocker Arm**

RB14256,000085D -19-24APR14-6/6

Remove and Install Cylinder Head—3TNV76

Special or Required Tools

- JT01748 Lifting Bracket (2 used)

Removal

1. Park machine safely. See the “Safety Section”.
2. Remove fuel filter/water separator. (See Remove and Install Fuel Filter and Water Separator Assembly—3TNV76.)
3. Allow engine to cool, and cooling system pressure to return to zero. Drain coolant from engine and radiator.
4. Remove muffler. (See Remove and Install Muffler—3TNV76.)
5. Remove upper and lower radiator hoses from coolant pump.
6. Disconnect wiring from coolant temperature sensors.
7. Remove upper alternator bracket and belt from coolant pump.

CAUTION: Escaping fluid under high pressure can penetrate the skin and cause serious injury. Avoid the hazard by relieving pressure before connecting hydraulic or other lines. Tighten all connections before applying pressure.

- **Search for leaks with a piece of cardboard. Protect hands and body from high pressure fluids.**
- **If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available from Deere & Company Medical Department in Moline, Illinois, U.S.A. In the United States and Canada only, this information may be obtained by calling 1-800-822-8262.**

IMPORTANT: When removing injection lines, always use a backup wrench.

8. Remove coolant pump. (See Remove and Install Coolant Pump (Thermostat Included)—3TNV76.)
9. Remove high-pressure fuel lines and fuel leak-off line running from fuel injection pump to nozzles.
10. Remove intake manifold/rocker arm cover. (See Remove and Install Intake Manifold/Rocker Arm Cover—3TNV76.)
11. Disconnect glow plug wiring harness from engine harness.
12. Remove rocker arm assembly, push rods, and valve caps from cylinder head. (See Remove and Install Rocker Arm Assembly—3TNV76.)
13. Remove exhaust manifold. (See Remove and Install Exhaust Manifold—3TNV76.)
14. Remove cylinder head cap screws in the order shown.
15. Using lift brackets and hoist, pull head straight up from block.
16. Disassemble and inspect cylinder head and valves. (See Recondition Cylinder Head—3TNV76.)

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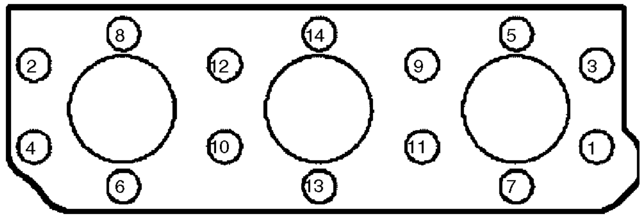
RB14256,000085E -19-24APR14-1/3



TCAL26156 —UN—15JUN12

Top of drawing is exhaust manifold side.

RB14256,000085E -19-24APR14-2/3

Installation

1. Clean all threads in top of cylinder block with a flat bottom tap and blow debris from hole.
2. Clean top of cylinder block and check for flatness.

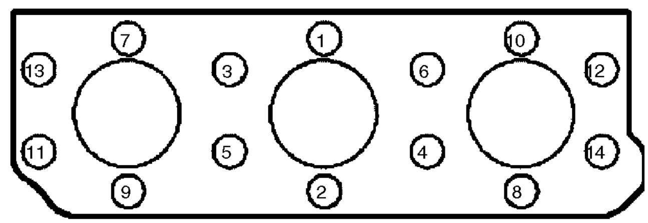
IMPORTANT: If cylinder head was resurfaced, check piston-to-cylinder head clearance.

3. Place a new cylinder head gasket on cylinder block with locating pins on front and rear of block inside holes in gasket. If cylinder head was resurfaced, check piston-to-cylinder head clearance. (See Measure Piston-to-Cylinder Head Clearance—3TNV76.)
4. Clean threads of cylinder head cap screws and dip in clean oil before installing. Install all cap screws finger tight before tightening with wrench.

IMPORTANT: Cylinder head mounting cap screws must be checked for proper torque after 50 hours of engine operation.

5. Tighten cylinder head cap screws to specification in sequence shown above in two steps of torque from specifications.

Specification	
Initial—Torque	27—29 N·m (20—22 lb.-ft.)
Final—Torque	54—58 N·m (40—43 lb.-f.t)



TCAL26157 —UN—15JUN12

Top of drawing is exhaust manifold side.

6. Install exhaust manifold. (See Remove and Install Exhaust Manifold—3TNV76.)
7. Install rocker arm assembly, push rods, and valve caps. (See Remove and Install Rocker Arm Assembly—3TNV76.)
8. Install intake manifold/rocker arm cover. (See Remove and Install Intake Manifold/Rocker Arm Cover—3TNV76.)
9. Connect fuel lines, radiator hoses, and wires.
10. Install coolant pump. (See Remove and Install Coolant Pump (Thermostat Included)—3TNV76.)
11. Install muffler. (See Remove and Install Muffler—3TNV76.)
12. Install upper alternator bracket and belt. (See Remove and Install Alternator Belt—3TNV76.)

RB14256,000085E -19-24APR14-3/3

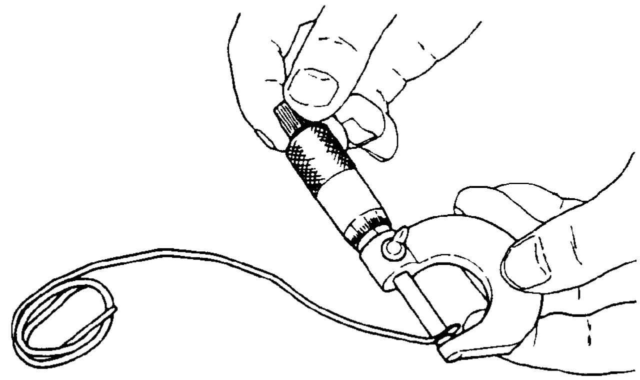
Measure Piston-to-Cylinder Head Clearance—3TNV76

Procedure

1. Place three 10 mm (0.4 in.) long pieces of 1.5 mm (0.06 in.) diameter soft wire in three positions on the flat part of the piston head.
2. Install the cylinder head and old gasket. Install cylinder head cap screws and tighten in proper sequence. (See Remove and Install Cylinder Head—3TNV76.)
3. Slowly turn the crankshaft one complete revolution.
4. Remove the cylinder head and gasket.
5. Measure the thickness of the flattened section of each piece of wire. Calculate the average thickness of the wires to obtain the piston-to-cylinder head clearance specification.

Specification

Piston-to-Cylinder Head—Clearance..0.75—0.89 mm (0.029—0.035 in.)


TCAL26158 —UN—15JUN12

6. If clearance is less than specification, replace cylinder head. (See Remove and Install Cylinder Head—3TNV76.)

RB14256,000085F -19-24APR14-1/1

Recondition Cylinder Head—3TNV76

Special or Required Tools

- JDE138 Valve Spring Compressor
- JDG10500 Valve Guide Driver
- JDG10501 Valve Guide Installer
- JDG10503 Valve Seal Installer

NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

Disassembly/Assembly

1. Check valve recession before disassembly.

Specification

Valve Recession (Both)—Depth....................0.4—0.6 mm (0.0157—0.0236 in.)

Valve Recession Wear Limit (Both)—Depth.................... 0.9 mm (0.035 in.)

2. Compress valve springs (A) using JDE138 Valve Spring Compressor.

NOTE: It may be necessary to tap on valve spring retainers (C) while initially operating compressor to break retainers free from collet halves (B).

3. Remove collet halves (B) from retainers.
4. Slowly release compressor and valve springs.

IMPORTANT: Do not reuse stem seals (D). Used seals will leak.

5. Remove valve springs, retainers (C), stem seals (D), and valves (G or H) from head (F).

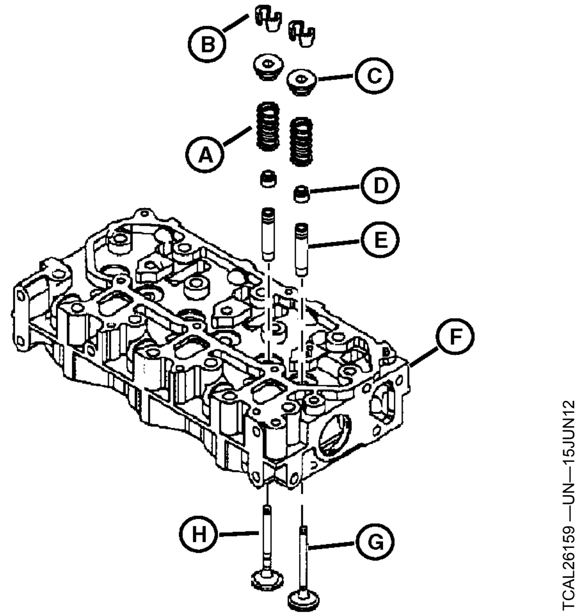
NOTE: Valve seats are not replaceable.

6. Intake and exhaust valve guides (E) are press fit. Remove guides only if replacement is necessary.
7. Inspect all parts for wear or damage. Clean all carbon deposits and measure all parts for proper clearances.

Specification

Valve Recession Wear Limit (Both)—Depth.................... 0.9 mm (0.035 in.)

Cylinder Head Wear Limit—Out-of-Flat.................... 0.15 mm (0.006 in.)



A—Valve Springs
B—Collet Halves
C—Valve Spring Retainers
D—Stem Seals
E—Valve Guides
F—Head
G—Valves
H—Valves

Valve Face Margin Wear Limit—Thickness.................... 0.50 mm (0.020 in.)

Valve Stem Wear Limit (Both)—OD.................... 5.90 mm (0.232 in.)

Valve Guide—Height....................9.8—10.0 mm (0.386—0.394 in.)

Valve Spring —Free Length.................... 37.8 mm (1.488 in.)

Valve Spring Inclination (Maximum)—Distance.................... 1.3 mm (0.051 in.)

Valve Seat—Width.................... Must Be Less Than Valve Face Width

Valve Guide Wear Limit—ID.................... 6.08 mm (0.239 in.)

Valve Guide-to-Valve Stem Oil Wear Limit (Both)—Clearance.................... 0.17 mm (0.007 in.)

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RB14256,0000860 -19-24APR14-1/14

IMPORTANT: Intake and exhaust valve stem seals must be installed to the proper height.

Identify seals by the color of the seal spring:

- **White spring seals are intake seals.**
- **Black spring seals are exhaust seals.**

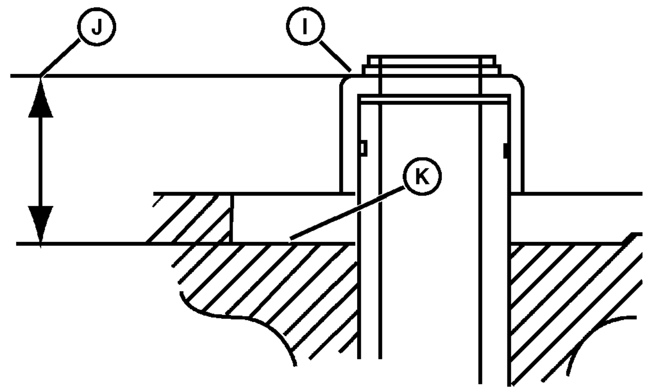
Ensure seals are installed correctly.

8. Apply oil to lip of valve stem seal. Install seal to valve guide using JDG10503 Valve Stem Seal Installer. Push seal down until installer touches valve spring seat. Check that top of the seal (I) is projecting the specified height (J) from the valve spring seat (K) in the cylinder head.

Specification

Valve Stem Seal—Height.................................10.9—11.2 mm (0.429—0.441 in.)

9. Apply clean engine oil on intake and exhaust valve stems and install valves.
10. Install valve spring and retainer.
11. Use valve spring compressor to compress spring and retainer, and install collets as removed.
12. Repeat for all valves.
13. After valves have been assembled, tap on top of valve stems with a plastic hammer to seat retainers.
14. Measure valve recession if new valves were installed.



I— Top of the Seal
J— Specified Height
K—Valve Spring Seat

Specification

Valve Recession (Both)—Clearance.................................0.4—0.6 mm (0.0157—0.0236 in.)

Valve Recession Wear Limit (Both)—Clearance.................................0.9 mm (0.035 in.)

Inspection/Replacement

Before inspection, thoroughly clean all components of carbon or dirt.

RB14256,0000860 -19-24APR14-2/14

Cylinder Head

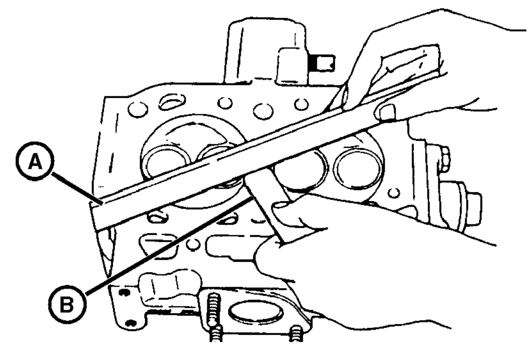
1. Measure cylinder head flatness. Place a straightedge (A) along each of the four sides and each diagonal. Measure clearance between straightedge and gasket surface with a feeler gauge (B).
2. If distortion exceeds the wear limit, resurface or replace cylinder head. Remove only enough metal to make cylinder head flat, but do not remove more than maximum amount specified.

Specification

Cylinder Head Wear Limit—Out-of-Flat.................................0.15 mm (0.006 in.)

Cylinder Head Allowable Removed Material (Maximum)—Thickness.................................0.20 mm (0.008 in.)

3. Inspect for cracks or other damage.
4. Inspect condition of valve seats.
5. If cylinder head was resurfaced, measure valve recession.



A—Straightedge
B—Feeler gauge

Specification

Valve Recession (Both)—Depth.................................0.4—0.6 mm (0.0157—0.0236 in.)

Valve Recession Wear Limit (Both)—Depth.................................0.9 mm (0.035 in.)

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RB14256,0000860 -19-24APR14-3/14

Intake and Exhaust Valves

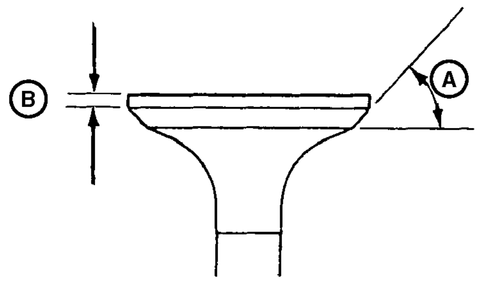
1. Check valve for out-of-round, bent, or warped condition using a valve inspection center and dial indicator. Replace valve if necessary.

RB14256,0000860 -19-24APR14-4/14

2. If valve faces are worn, burned, or pitted, grind valves to proper face angle (A). If valve face margin (B) is less than specification after grinding, replace valve.

Specification

Intake Valve
Face—Angle....................30°
Exhaust Valve
Face—Angle....................45°
Intake Valve Face
Margin—Thickness....................0.90—1.1 mm
(0.035—0.043 in.)
Exhaust Valve Face
Margin—Thickness....................1.0—1.2 mm
(0.039—0.047 in.)
Valve Face Margin Wear
Limit—Thickness.................... 0.50 mm
(0.020 in.)



A—Face Angle **B—Face Margin**

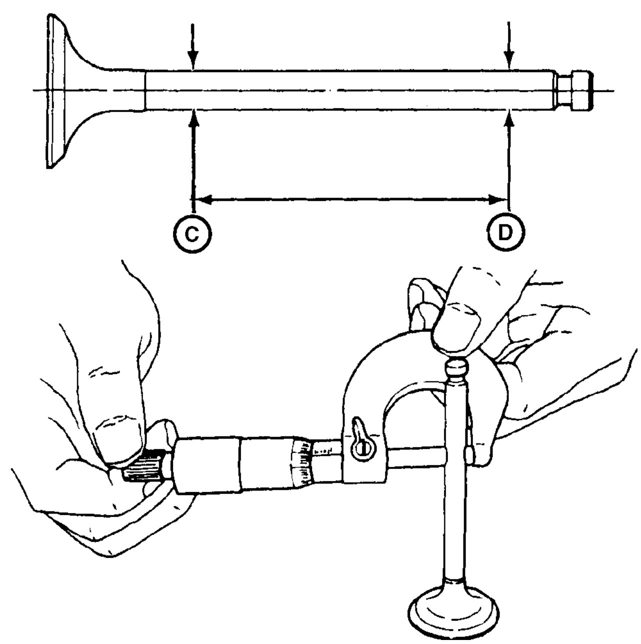
RB14256,0000860 -19-24APR14-5/14

3. Measure valve stem diameter at the two locations (C and D) shown above. Replace valve if measurement exceeds wear limit.

Specification

Intake Valve
Stem—Diameter....................5.960—5.975 mm
(0.2346—0.2352 in.)
Exhaust Valve
Stem—Diameter....................5.945—5.960 mm
(0.2341—0.2346 in.)
Valve Stem Wear Limit
(Both)—Diameter.................... 5.90 mm
(0.232 in.)

C—Measurement Location **D—Measurement Location**



Continued on next page RB14256,0000860 -19-24APR14-6/14

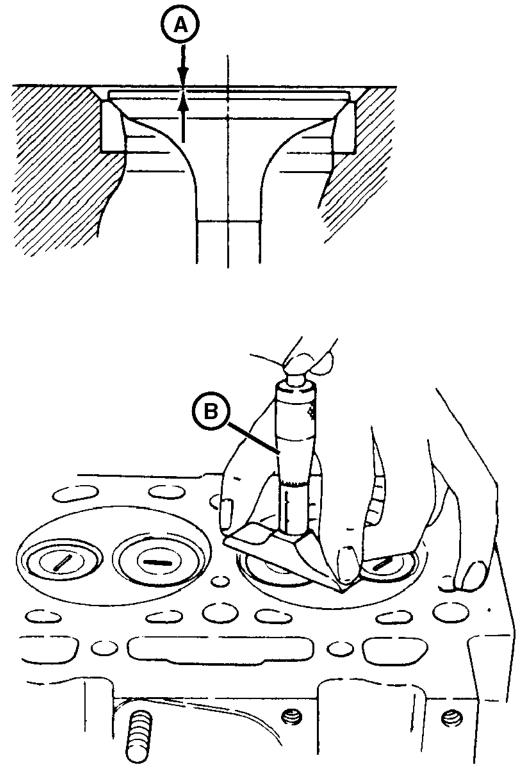
Valve Recession Measurement

Measure valve recession (A) using a depth gauge (B). Replace valve or cylinder head if measurement exceeds wear limit.

Specification

Valve Recession Wear
Limit (Both)—Depth.. 0.9 mm
(0.035 in.)

A—Valve Recession **B—Depth Gauge**



TCAL26165 —UN—15JUN12

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RB14256,0000860 -19-24APR14-7/14

Valve Guide Measurement

1. Clean valve guides using a valve guide brush.
2. Measure valve guide inside diameter using a ball or telescoping snap gauge.

Specification

Valve Guide Standard—ID........6.00—6.01 mm (0.236—0.237 in.)
Valve Guide Wear Limit—ID........6.08 mm (0.239 in.)

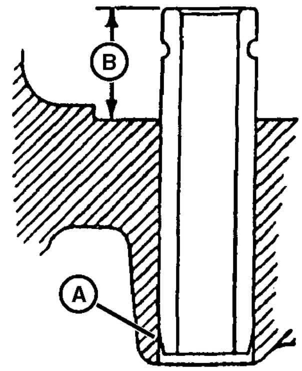
- If valve guide inside diameter exceeds wear limit, replace guide.
- If valve guide inside diameter is less than wear limit, determine guide-to-stem clearance (valve guide diameter minus valve stem diameter).

Specification

Intake Valve Guide-to-Valve Stem Standard Oil—Clearance........0.025—0.052 mm (0.001—0.002 in.)
Exhaust Valve Guide-to-Valve Stem Standard Oil—Clearance........0.040—0.067 mm (0.002—0.003 in.)
Valve Guide-to-Valve Stem Oil Wear Limit (Both)—Clearance........0.17 mm (0.007 in.)

- If clearance exceeds replacement specification, replace valve guide.
- Remove valve guides using JDG10500 Valve Guide Driver.

3. Install valve guides with tapered end (A) down using JDG10501 Valve Guide Installer. Push valve guides down until driver touches valve spring seat. Check that tops of valve guides are projecting the specified height (B) from the valve spring seat in the cylinder head.



TCAL26166 —UN—15JUN12

A—Tapered End
B—Specified Height

Specification

Valve Guide—Height........9.8—10.0 mm (0.386—0.394 in.)

4. Ream inside diameter of valve guides using a 6 mm valve guide reamer.

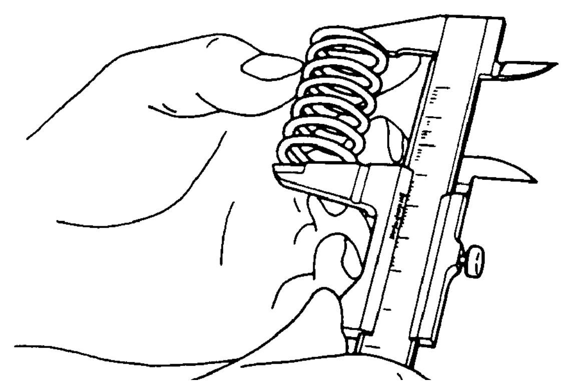
RB14256,0000860 -19-24APR14-8/14

Valve Springs

1. Measure spring free length. Replace spring if measurement exceeds specification.

Specification

Spring—Free Length........37.8 mm (1.488 in.)



TCAL26167 —UN—15JUN12

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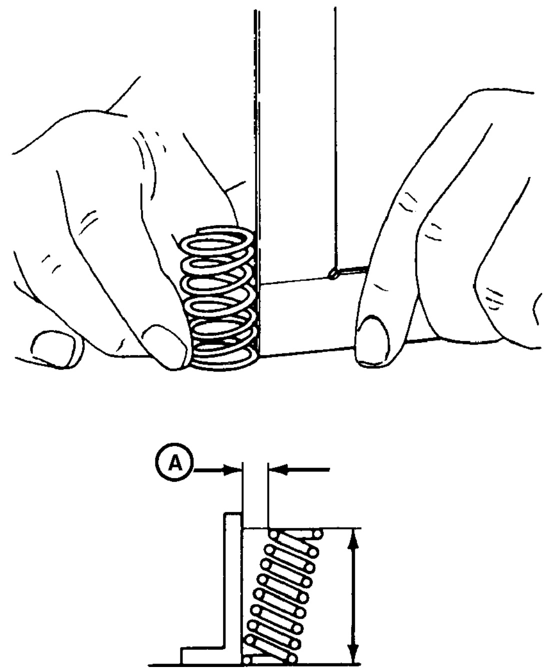
RB14256,0000860 -19-24APR14-9/14

2. Measure spring inclination (A). Replace spring if measurement exceeds specification.

Specification

Spring Inclination (Maximum)—Distance	1.3 mm (0.051 in.)

A—Spring Inclination



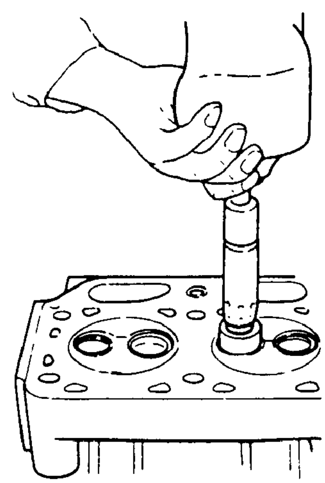
TCAL26168 —UN—15JUN12

RB14256,0000860 -19-24APR14-10/14

Valve Seat Grinding

NOTE: Lightly grind valve seats for only a few seconds to avoid excessive valve seat width. If valve guide is to be replaced, always replace guide before grinding valve seat, as seat grinder pilot is centered by guide.

1. Grind intake valve seat using a 30° seat grinder, and exhaust valve seat using a 45° seat grinder. Follow tool manufacturer's instructions.



TCAL26169 —UN—15JUN12

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RB14256,0000860 -19-24APR14-11/14

2. Measure valve seat width (A) after grinding. Seat width must be less than valve face width.

3. If seat (A) is too wide after grinding, grind lower seat surface (B) using a 70° seat grinder until seat width is close to specifications.

Specification

Valve Seat—Width....................... Must Be Less Than Valve Face Width

4. Grind upper seat surface (C) using a 15° seat grinder until seat width is narrowed to specification.

5. Valve seat angle (D) should be to specification.

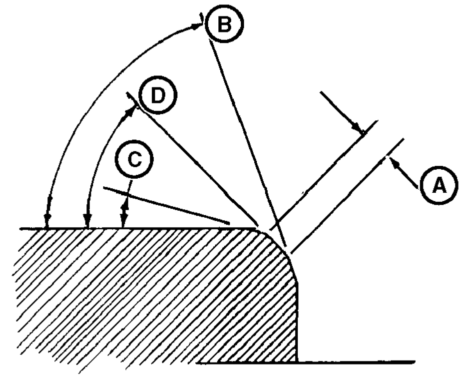
Specification

Intake Valve Seat—Angle..30°
Exhaust Valve Seat—Angle..45°

NOTE: If valve recession exceeds maximum specification, replace cylinder head.

Specification

Valve Recession Wear Limit (Both)—Depth.. 0.9 mm (0.035 in.)



A—Valve Seat Width
B—Lower Seat Surface
C—Upper Seat Surface
D—Valve Seat Angle

6. If valve seats are ground, measure valve recession and check contact pattern between the seat and valve with bluing dye.

7. Lap valves.

RB14256,0000860 -19-24APR14-12/14

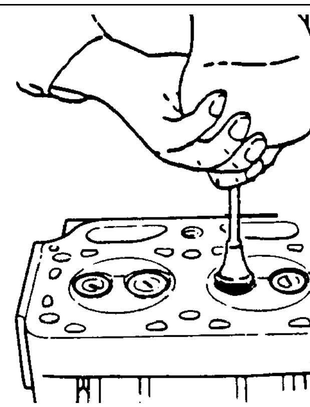
Valve Lapping

NOTE: Use a rubber-type lapping tool for valves without a lapping tool groove slit.

If seat does not make proper contact, lap the valve into the seat.

1. Apply small amount of fine lapping compound to face of valve.

2. Turn valve to lap valve to seat.



RB14256,0000860 -19-24APR14-13/14

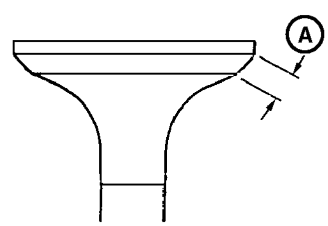
3. Lift valve from seat every 8 to 10 strokes. Lap until a uniform ring appears around the surface of the valve face (A).

4. Wash all parts in solvent to remove lapping compound. Dry parts.

5. Check position of lap mark on valve face. Lap mark must be on or near center of valve face.

A—Surface Of The Valve Face

TCAL26172 —UN—15JUN12



RB14256,0000860 -19-24APR14-14/14

Remove and Install Engine—3TNV76

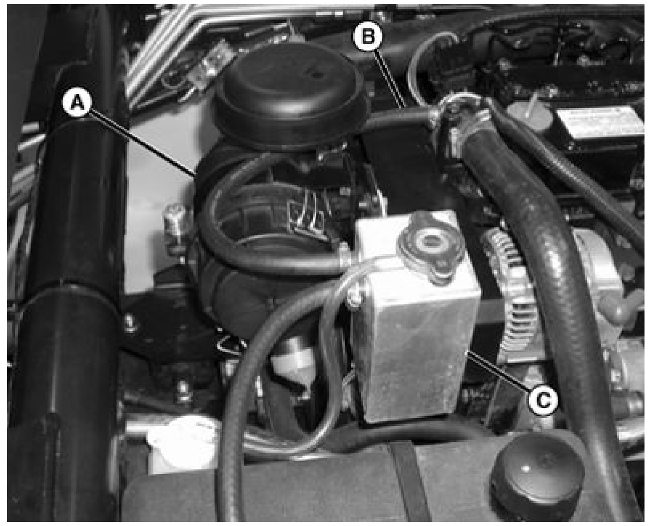
Special or Required Tools

- JT01748 Lifting Brackets (2 used)

Removal

CAUTION: USE CAUTION AROUND MOVING PARTS. STOP engine. Remove ignition key. Wait for all moving parts to STOP.

1. Park vehicle on a hard, level surface. Lock park brake.
2. Stop engine. Cycle hydraulic valves to release any hydraulic pressure.
3. Disconnect negative (-) cable from the battery.
4. Remove cargo box or any attachments that may be limiting engine access.
5. Remove air filter assembly (A). (See Remove and Install Air Cleaner Assembly—3TNV76.)
6. Drain coolant from radiator. Remove upper radiator hose from thermostat housing and lower radiator hose assembly.



TCAL26173 —UN—15JUN12

A—Air Filter Assembly
B—Hose
C—Pressure Tank

7. Disconnect hose (B) from thermostat housing and remove pressure tank (C).

RB14256,0000861 -19-24APR14-1/6

8. Secure hydraulic cylinder away from work area.
9. Remove muffler. (See Remove and Install Muffler—3TNV76.)

TCAL26174 —UN—15JUN12

Continued on next page

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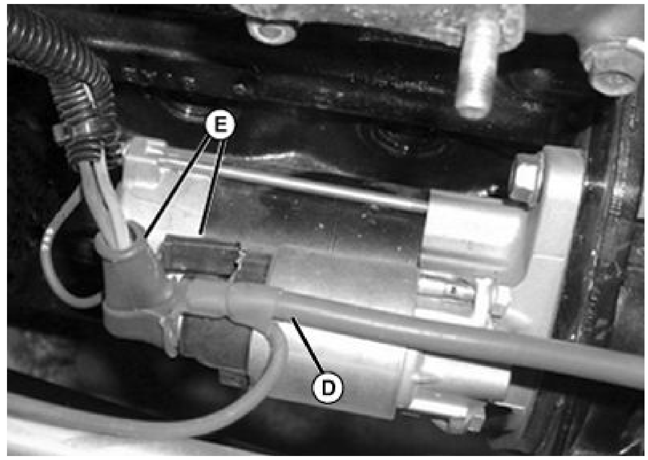
10. Disconnect positive (+) battery cable (D) and exciter wires (E) from starting motor solenoid.
11. Disconnect positive wire and plug from alternator.
12. Disconnect the ground wire, neutral switch and speed sensor from the transaxle.
13. Disconnect glow plugs, coolant temperature sensor, fan/over-temperature switch, fuel shutoff solenoid and engine oil pressure switch from the engine.
14. Move harness out from the work area to prevent damage and to ease engine removal.
15. Disconnect line from bottom of the steering pump. Install caps and plugs.
16. Disconnect suction tube from top of the steering pump.



TCAL26175 —UN—15JUN12

D—Battery Cable **E—Sensing Wires**

RB14256,0000861 -19-24APR14-3/6

17. Turn the fuel shutoff valve on the fuel filter/water separator to the closed position.
18. Disconnect fuel supply (F) and return (G) hoses from the fuel filter/water separator. Label hoses to avoid confusion during assembly. Plug each end of hose.
19. Disconnect throttle linkage.
20. Remove skid plate from engine subframe.
21. Support front of transaxle and support engine with hoist while removing cap screws from bell housing.

NOTE: It is not necessary to remove starter from backplate.

22. Remove nuts from starter mounting cap screws.

TCAL26176 —UN—15JUN12

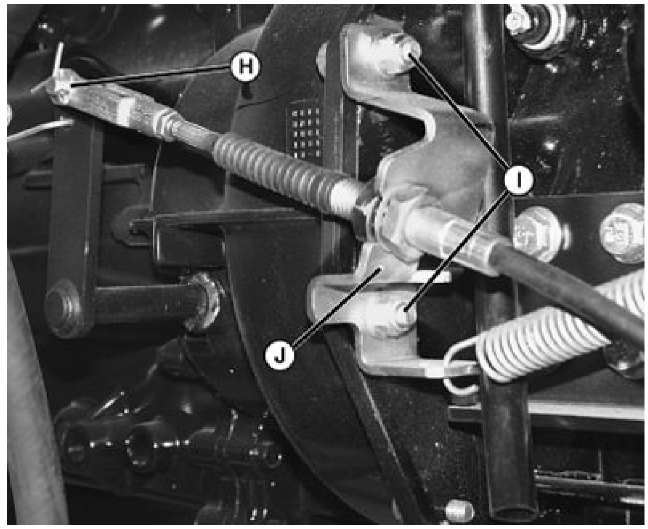
Fuel filter/water separator shown in the open position.

F—Fuel Supply **G—Return**

Continued on next page RB14256,0000861 -19-24APR14-4/6

23. Remove pin (H) from clutch lever. Remove cap screws (I) and clutch cable bracket (J).

H—Pin
I— Cap Screws
J— Clutch Cable Bracket



TCAL26177 —UN—15JUN12

RB14256,0000861 -19-24APR14-5/6

24. Remove nuts (K) from the subframe isolator.
25. Remove subframe from engine.
26. Slide engine forward and raise from machine.

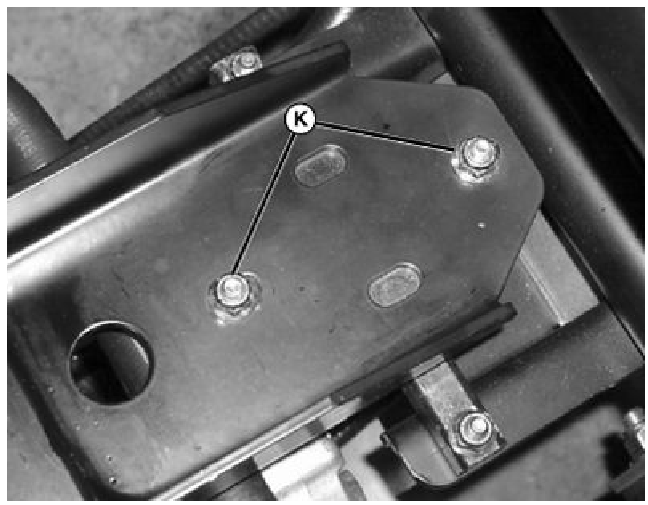
Installation

Installation is the reverse of removal.

1. Tighten subframe to engine mounting cap screws to specification.

Specification
Engine-to-Subframe Mounting Cap Screw—Torque..75 N·m (55 lb.-ft.)

2. Attach throttle and clutch linkage.
3. Attach fuel lines to fuel filter/water separator.
4. Connect all engine wiring harness connectors.
5. Connect remaining engine harness connectors and ground wire to transaxle.
6. Attach battery positive (+) cable and solenoid exciter wires to starting motor solenoid.
7. Clean muffler flange and exhaust manifold surfaces of any old gasket material. Install a new muffler gasket.
8. Install muffler flange nuts and tighten to specification.



TCAL26178 —UN—15JUN12

K—Nuts

Specification
Muffler Flange Nut Torque—Torque..25 N·m (221 lb.-in.)

9. Service engine oil, coolant and hydraulic tank to proper levels. Use fluids of correct specifications.
10. Attach negative (-) cable to battery.

RB14256,0000861 -19-24APR14-6/6

Remove and Install Clutch and Flywheel—3TNV76

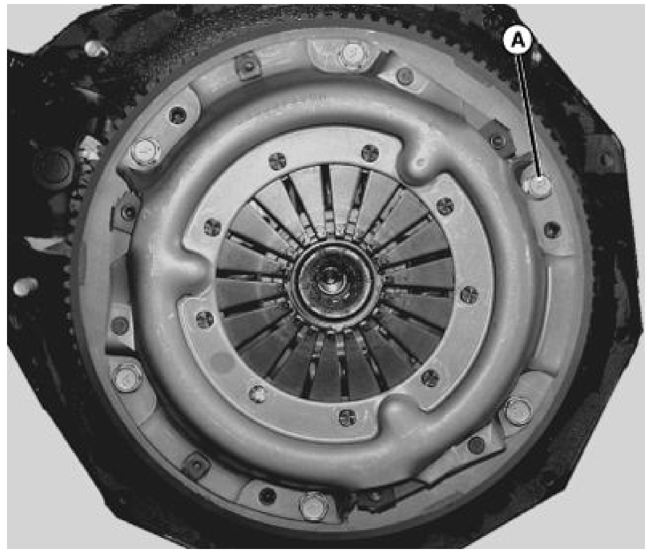
Special or Required Tools

- JDG1331 Clutch Alignment Tool

Procedure

1. Remove engine. (See Remove and Install Engine—3TNV76.)
2. Alternately loosen cap screws (A) on clutch cover.

A—Cap Screws

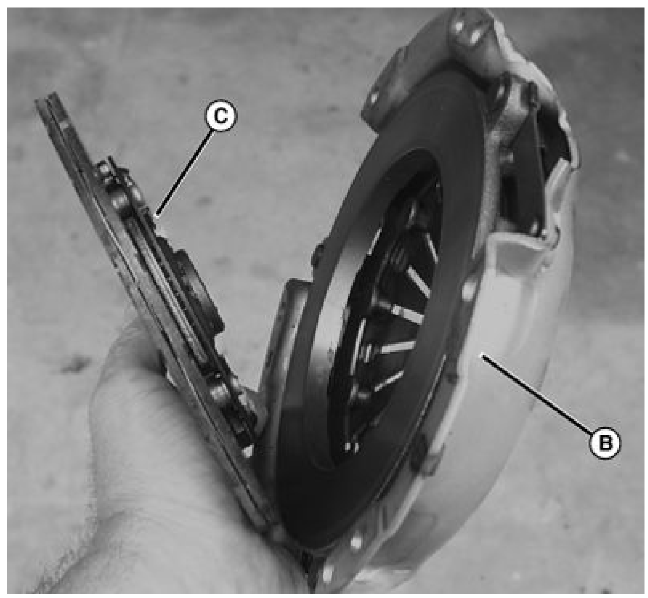


TCAL26179 —UN—15JUN12

RB14256,0000862 -19-24APR14-1/4

3. Remove clutch cover (B) and clutch disc (C) from flywheel.

B—Clutch Cover **C—Clutch Disc**



TCAL26180 —UN—15JUN12

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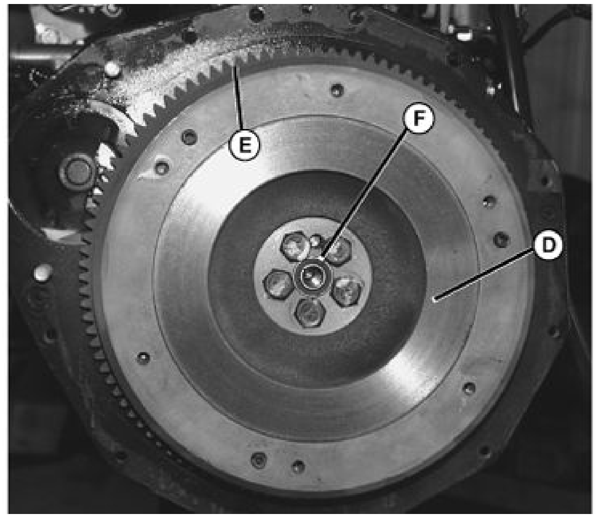
RB14256,0000862 -19-24APR14-2/4

CAUTION: FLYWHEEL IS HEAVY! Do not remove flywheel mounting cap screws unless flywheel is secure. Use a hoist and lift rings to lift flywheel from crankshaft.

4. Remove flywheel.
5. Inspect flywheel for cracks or grooves on clutch wear area (D). Check ring gear (E) for chips and broken teeth. Check pilot bearing (F) for smooth operation. Replace parts as necessary.



TCAL26181 —UN—15JUN12

D—Clutch Wear Area
E—Ring Gear
F—Pilot Bearing

RB14256,0000862 -19-24APR14-3/4

Installation

1. Make sure flywheel and crankshaft mating surfaces are clean.
2. Install flywheel and tighten cap screws to specification.

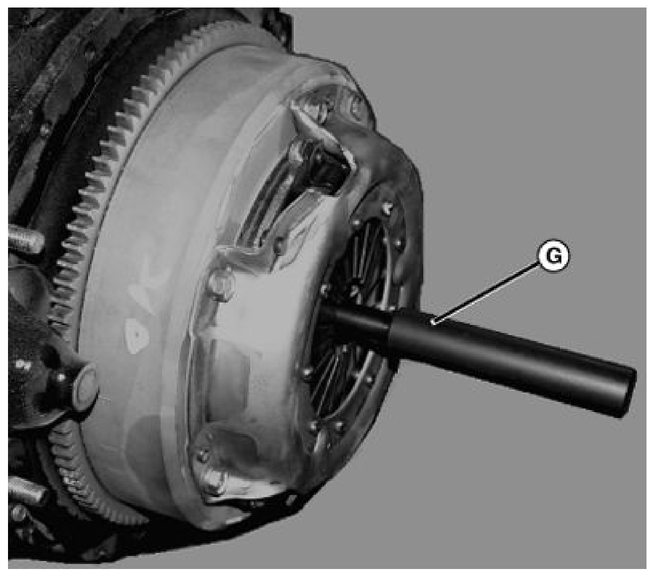
Specification

Flywheel Mounting Cap Screw Torque—Torque....84 N·m (62 lb.-ft.)

3. Install clutch disk with raised side of hub toward clutch cover. Install clutch cover. Do not tighten cap screws.
4. Using JDG1331 Clutch Alignment Tool (G) or an equivalent, align clutch disk and alternately tighten clutch cover cap screws to specification.

Specification

Clutch Cover Cap Screw—Torque....23 N·m (200 lb.-in.)



TCAL26182 —UN—15JUN12

G—JDG1331 Clutch Alignment Tool

RB14256,0000862 -19-24APR14-4/4

Remove and Install Crankshaft Rear Oil Seal—3TNV76

Special or Required Tools

- JDG1331 Clutch Alignment Tool

1. Remove engine. (See Remove and Install Engine—3TNV76.)

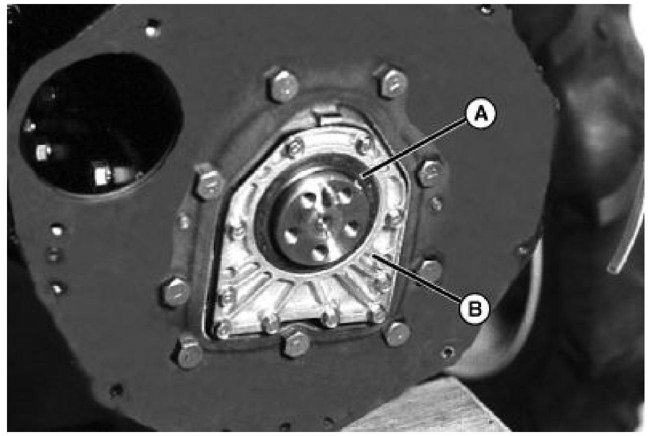
CAUTION: FLYWHEEL IS HEAVY! Do not remove flywheel mounting cap screws unless flywheel is secure. Use a hoist and lift rings to lift flywheel from crankshaft.

2. Remove flywheel. (See Remove and Install Clutch and Flywheel—3TNV76.)

NOTE: It is not necessary to remove oil seal case to remove oil seal.

3. Carefully pry oil seal (A) from oil seal case (B).

NOTE: If oil seal has worn a groove in crankshaft at oil seal contact point, seal can be installed 3 mm (0.120 in.) deeper into oil seal case.



TCAL26184 —UN—15JUN12

A—Oil Seal **B—Oil Seal Case**

4. Replace oil seal using a driver set. Install seal with lip toward cylinder block. Install seal flush with surface of oil seal case.

RB14256,0000864 -19-24APR14-1/2

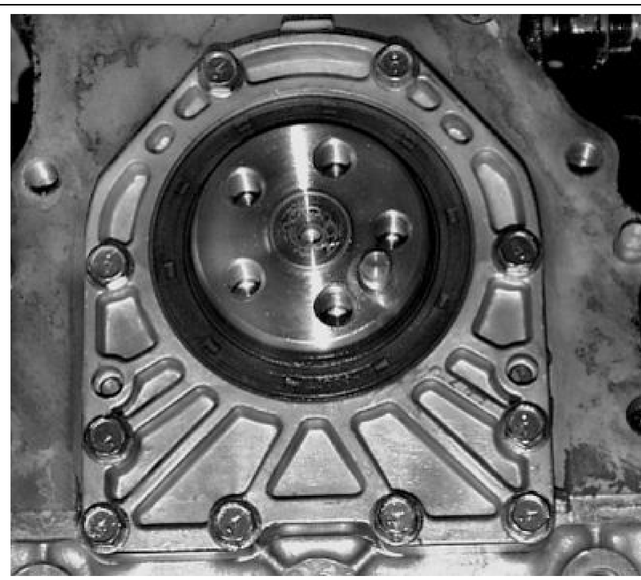
Rear Oil Seal Case Removal and Installation

1. Remove oil seal case-to-cylinder block cap screws.
2. Pry oil seal case from engine block.
3. Clean all old gasket material from oil seal case and engine block.
4. Install seal case with form-in-place gasket sealer on mating surfaces to engine block.
5. Install new oil seal after oil seal case is installed.
6. Install flywheel onto crankshaft, aligning crankshaft pin into flywheel mounting flange. Tighten mounting bolts to specification.

Specification

Flywheel Mounting Cap Screw—Torque....84 N·m (62 lb.-ft.)

7. Install clutch plate with longer center hub facing out.
8. Install clutch cover over clutch plate, lining up locating pin on flywheel. Loosely install six mounting bolts through clutch cover and into flywheel. Using a JDG1331 Clutch Alignment Tool, align clutch plate with pilot bearing. Tighten clutch cover bolts alternately in two equal steps to final torque specified.



TCAL26185 —UN—15JUN12

Specification

Clutch Cover Cap Screw Final—Torque....28 N·m (20 lb.-ft.)

9. Install engine. (See Remove and Install Engine—3TNV76.)

RB14256,0000864 -19-24APR14-2/2

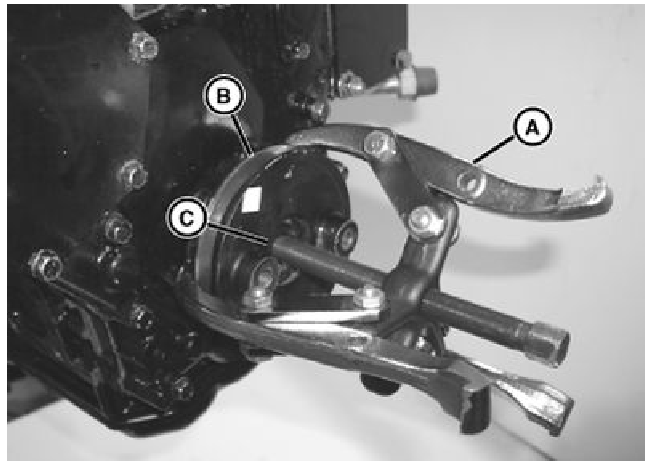
Crankshaft Front Oil Seal—3TNV76

Procedure

1. Park machine with engine off and park brake on.
2. Remove engine. (See Remove and Install Engine—3TNV76.)
3. Remove alternator belt. (See Remove and Install Alternator Belt—3TNV76.)

CAUTION: Crank hub may suddenly release when removing. Injury can occur when crank hub releases. Keep the surrounding area of the crank hub clear of personnel.

4. Remove crank hub cap screw, washer and O-ring.
5. Install puller (A) to crank hub (B) using a thread protector (C) for the crankshaft end.
6. Remove crank hub.



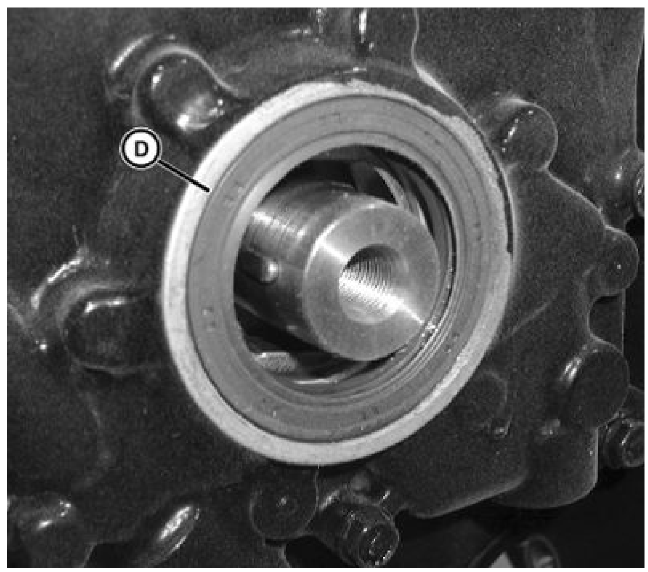
TCAL26186 —UN—15JUN12

A—Puller
B—Crank Hub
C—Thread Protector

RB14256,0000865 -19-24APR14-1/4

7. Carefully pry oil seal (D) from timing gear cover.
8. Install new oil seal using a bushing, bearing, and seal driver set. Install seal with lip toward engine. Install seal flush with surface of cover.
9. Coat lip of seal with clean engine oil.

D—Oil Seal



TCAL26187 —UN—15JUN12

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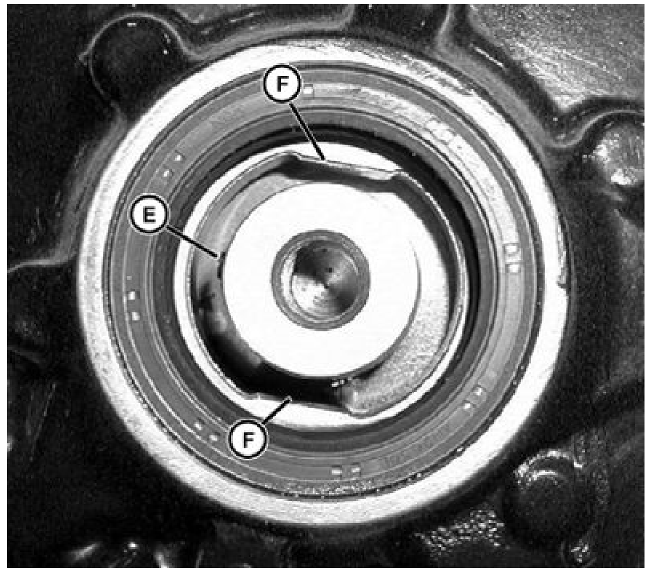
RB14256,0000865 -19-24APR14-2/4

10. Align keyway and flats on crank hub with key in crankshaft (E) and flats (F) of oil pump gear and install crank hub.

E—Crankshaft
F—Flats
G—Oil Pump Gear



TCAL26188 —UN—15JUN12

RB14256,0000865 -19-24APR14-3/4

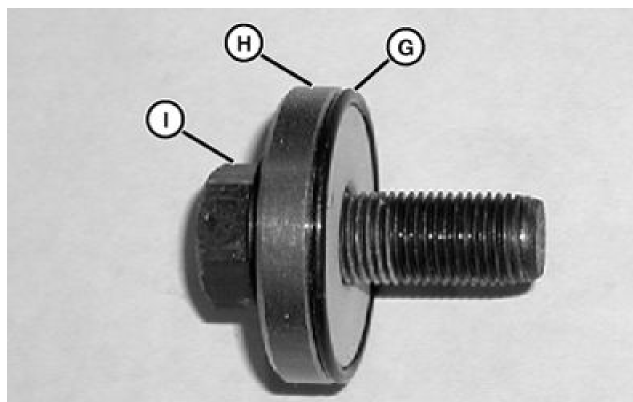
NOTE: Applying a small amount of petroleum jelly to the O-ring will hold it in position for assembly.

11. Install a new O-ring (G) to the shoulder of the crank hub washer (H).
12. Assemble crank hub washer to cap screw (I) with O-ring facing away from cap screw head.
13. Install assembled cap screw, washer and O-ring to crank hub.
14. Tighten cap screw to specification.

Specification

Crank Hub Cap Screw
Torque—Torque.. 113—123 N·m (83—90 lb.-ft.)

15. Install alternator belt. (See Remove and Install Alternator Belt—3TNV76.)



TCAL26189 —UN—15JUN12

G—O-ring
H—Crank Hub Washer
I— Cap Screw

RB14256,0000865 -19-24APR14-4/4

Oil Pan, Crankcase Extension and Pickup Tube—3TNV76

Removal

1. Drain engine oil into a suitable container.
2. Remove oil pan cap screws (A).

IMPORTANT: DO NOT use a screwdriver to pry oil pan from crankcase extension. Oil pan or crankcase extension may be damaged.

3. Carefully tap on oil pan (B) with a soft-faced mallet to loosen oil pan from engine block.
4. Remove cap screws (C) from pickup tube.
5. Remove oil pickup tube (D) and discard O-ring. Replace O-ring before installation.
6. Remove crankcase extension cap screws (E).

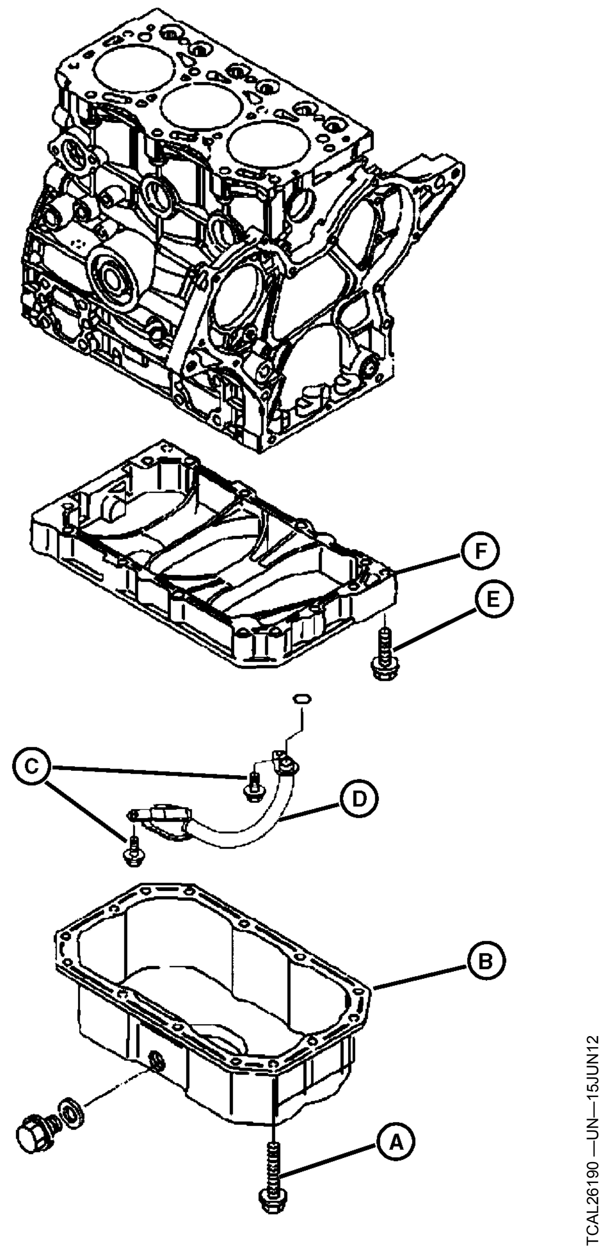
IMPORTANT: DO NOT use a screwdriver to pry crankcase extension from engine block. Crankcase extension or engine block may be damaged.

7. Carefully tap on crankcase extension (F) with a soft-faced mallet to loosen crankcase extension from engine block.
8. Remove sealant residue from oil pan, crankcase extension, and engine block mating surfaces.

Installation

Installation is done in reverse order of removal.

- Apply RTV silicone sealant to sealing surfaces.
- Replace pickup tube O-ring before installation.
- Securely tighten cap screws.
- Fill engine to proper level with oil of correct specifications.



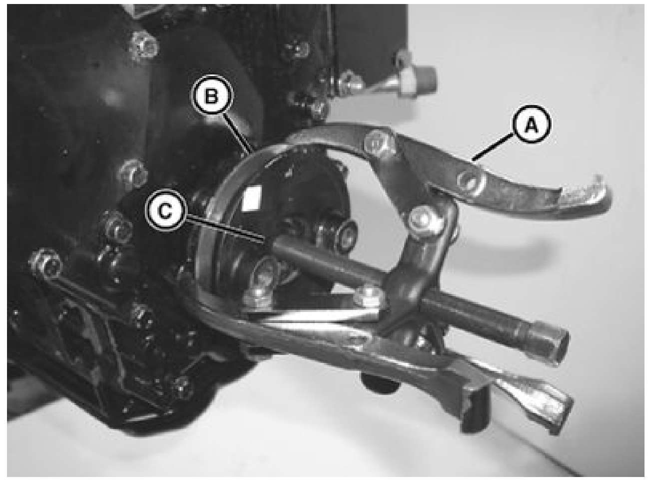
A—Oil Pan Cap Screws
B—Oil Pan
C—Cap Screws
D—Oil Pickup Tube
E—Crankcase Extension Cap Screws
F—Crankcase Extension

RB14256,0000866 -19-24APR14-1/1

Remove and Install Timing Gear Cover—3TNV76

Removal

Number	Name	Use
PM38657 (U.S.)/LOCTITE® PM38625 (Canada) (U.S.)	John Deere High-Flex Form-in-Place Gasket	Applied to timing cover before installation.



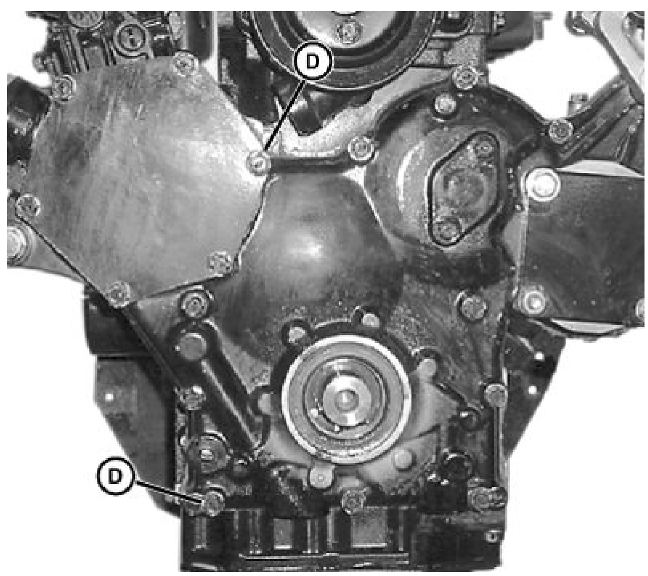
1. Remove engine. (See Remove and Install Engine—3TNV76.)
2. Remove alternator. (See Remove and Install Alternator—3TNV76.)

CAUTION: Crank hub may suddenly release when removing. Injury can occur when crank hub releases. Keep the surrounding area of the crank hub clear of personnel.

3. Remove crank hub cap screw, washer and O-ring.
4. Install puller (A) to crank hub (B) using a thread protector (C) for the crankshaft end.
5. Remove crank hub.

A—Puller
B—Crank Hub
C—Thread Protector

RB14256,0000867 -19-24APR14-1/4



D—Sixteen Timing Gear Cover Mounting Cap Screws

6. Remove sixteen timing gear cover mounting cap screws (D).

IMPORTANT: Use extreme care in removal of cover. Cover is aluminum and easily damaged, broken or bent by prying. DO NOT hammer on cover at any time.

7. Remove timing gear cover.
8. Clean all old gasket material from timing gear cover and timing gear cover housing on block. Discard O-rings between cover and timing gear housing.

Installation

Installation is done in the reverse order of removal.

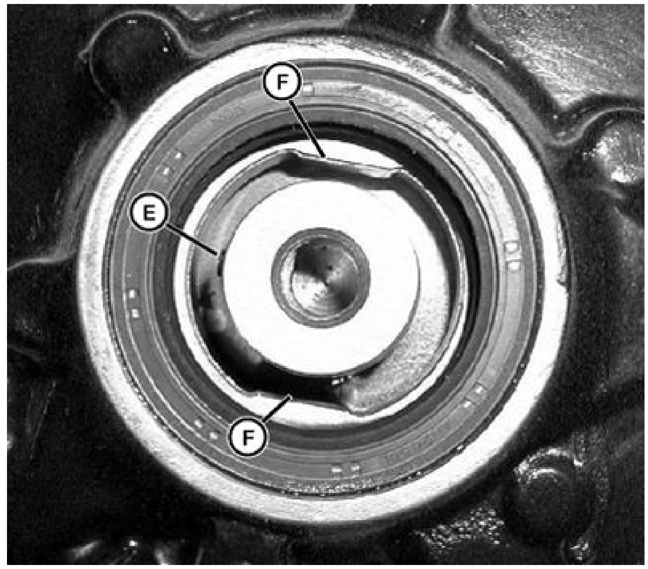
1. Apply a thin bead of TY16021 John Deere High-Flex Form-in-Place Gasket to timing gear cover prior to installation.
2. Replace O-rings between cover and timing gear housing.
3. Tighten all timing gear cover mounting cap screws.
4. Coat lip of crankshaft seal with clean engine oil.

Continued on next page

RB14256,0000867 -19-24APR14-2/4

5. Align keyway and flats on crank hub with key in crankshaft (E) and flats (F) of oil pump gear and install crank hub.

E—Crankshaft **F—Flats**



TCAL26193 —UN—15JUN12

RB14256,0000867 -19-24APR14-3/4

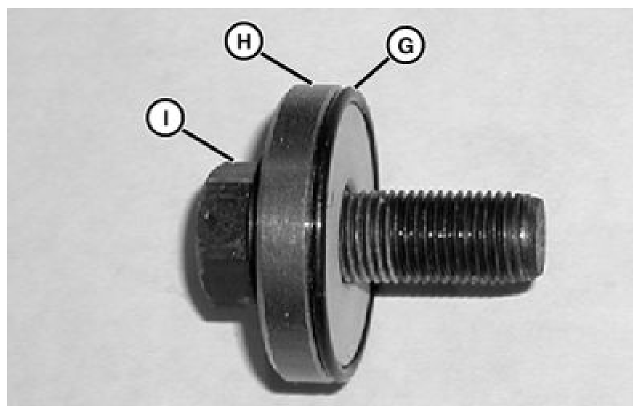
NOTE: Applying a small amount of petroleum jelly to the O-ring will hold it in position for assembly.

6. Install a new O-ring (G) to the shoulder of the crank hub washer (H).
7. Assemble crank hub washer to cap screw (I) with O-ring facing away from cap screw head.
8. Install assembled cap screw, washer and O-ring to crank hub.
9. Tighten crank hub cap screw to specification.

Specification

Crank Hub Cap Screw—Torque.. 113—123 N·m (83—90 lb.-ft.)

10. Adjust belt tension. (See Remove and Install Alternator Belt—3TNV76.)



TCAL26194 —UN—15JUN12

G—O-ring
H—Crank Hub Washer
I— Cap Screw

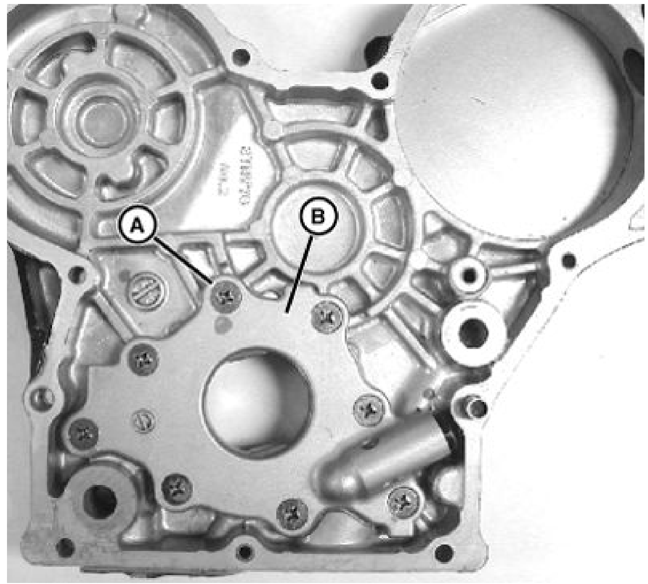
RB14256,0000867 -19-24APR14-4/4

Oil Pump—3TNV76

Disassembly

Number	Name	Use
PM37477 (U.S.)/PM38622 (Canada) (U.S.)	Thread Lock and Sealer (Medium Strength)	Applied to threads of oil pressure regulator cap and oil pump cover screws before installation.

1. Remove timing gear cover. (See Remove and Install Timing Gear Cover—3TNV76.)
2. Remove eight mounting screws (A).
3. Remove oil pump cover (B).

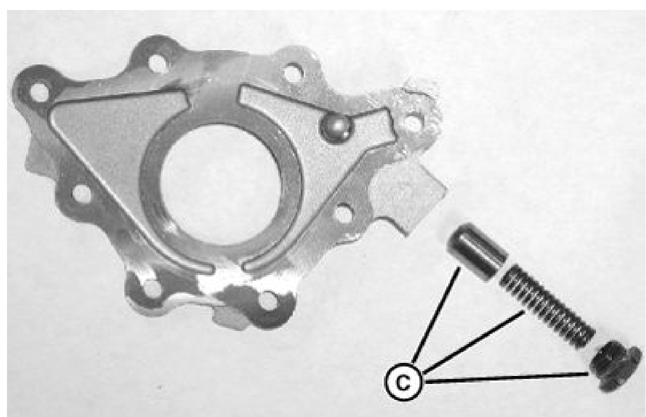


TCAL26195 —UN—15JUN12

A—Eight Mounting Screws **B—Oil Pump Cover**

RB14256,0000868 -19-24APR14-1/6

4. Remove oil pressure regulator (C) from pump cover.
5. Inspect all pump parts for wear or damage.



TCAL26196 —UN—15JUN12

C—Oil Pressure Regulator

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RB14256,0000868 -19-24APR14-2/6

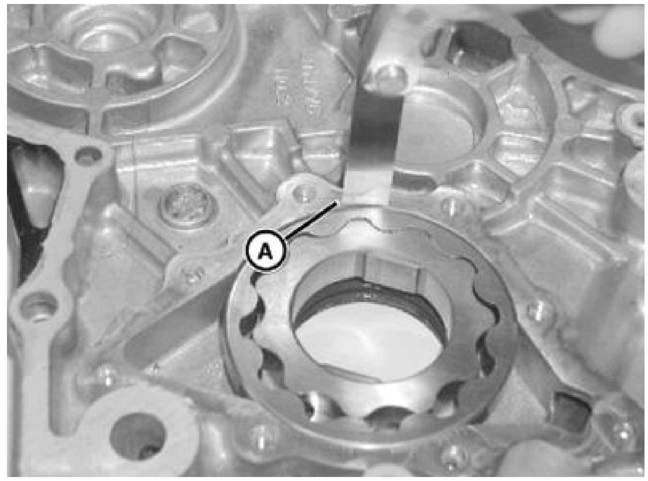
Inspection

1. Measure outer rotor-to-housing clearance (A) using a feeler gauge. If the clearance is more than the wear limit, replace entire assembly.

Specification

Outer Rotor-to-Housing Clearance Wear Limit—Clearance.. 0.30 mm (0.012 in.)

A—Rotor-To-Housing Clearance



TCAL26197 —UN—15JUN12

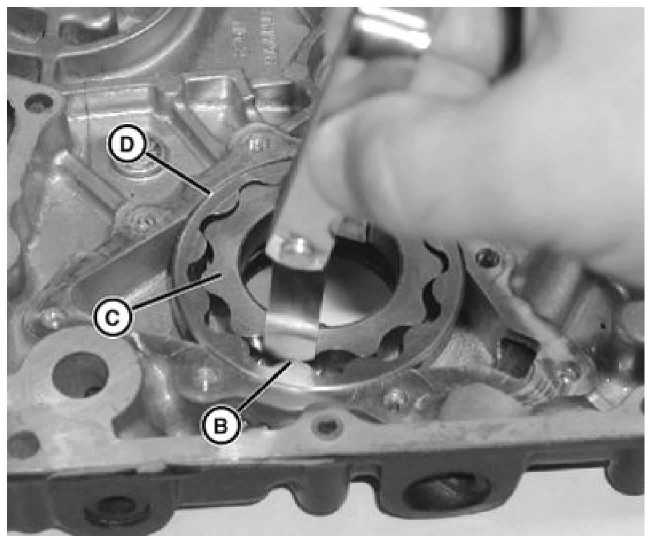
RB14256,0000868 -19-24APR14-3/6

2. Check clearance (B) between the tip of the inner rotor (C) and tip of the outer rotor (D). If the clearance is more than the wear limit, replace entire assembly.

Specification

Inner Rotor Tip-to-Outer Rotor Tip Clearance (Maximum)—Clearance.. 0.16 mm (0.006 in.)

B—Clearance
C—Tip Of The Inner Rotor
D—Tip Of The Outer Rotor



TCAL26198 —UN—15JUN12

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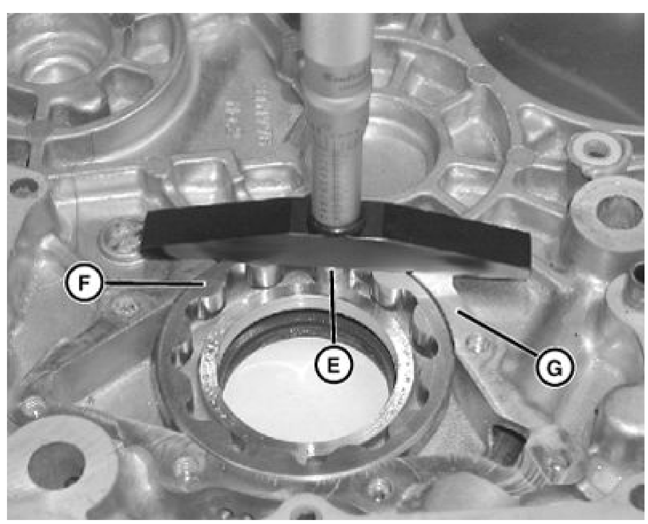
3. Using a depth gauge (E), check side clearance of outer rotor between top of rotor (F) and mounting surface of oil pump cover (G). If rotor side clearance is beyond wear limit, replace entire assembly.

Specification

Rotor-to-Pump Housing Side Clearance Wear Limit—Clearance.. 0.12 mm (0.005 in.)

E—Depth Gauge
F—Top Of Rotor
G—Mounting Surface Of Oil Pump Cover



TCAL26199 —UN—15JUN12

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RB14256,0000868 -19-24APR14-5/6

4. Measure and record inner rotor shoulder diameter (H). If shoulder diameter is less than specification, replace entire assembly.

Specification

Inner Rotor Shoulder
Diameter—Diameter..45.98—46.00 mm
(1.810—1.811 in.)

5. Measure and record inner rotor pilot hole diameter (I). If pilot hole diameter is more than specification, replace entire assembly.

Specification

Inner Rotor Pilot Hole
Diameter—Diameter..46.13—46.18 mm
(1.816—1.818 in.)

6. If inner rotor-to-pilot hole oil clearance (pilot hole ID minus rotor shoulder OD) exceeds wear limit, replace entire assembly.

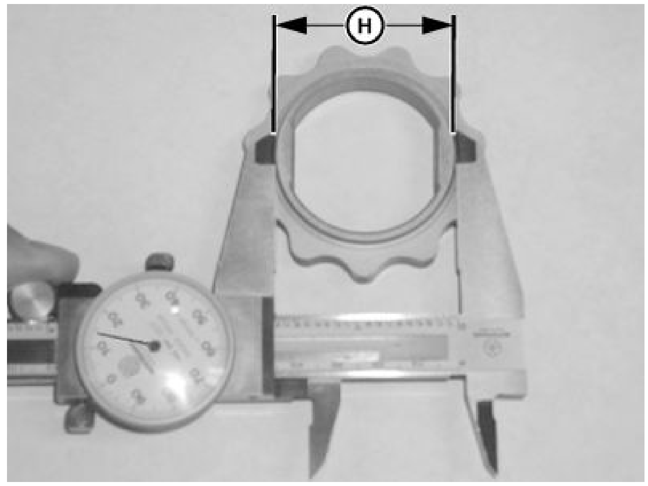
Specification

Inner Rotor-to-Pilot Hole
Oil Clearance Wear
Limit—Clearance... 0.25 mm
(0.010 in.)

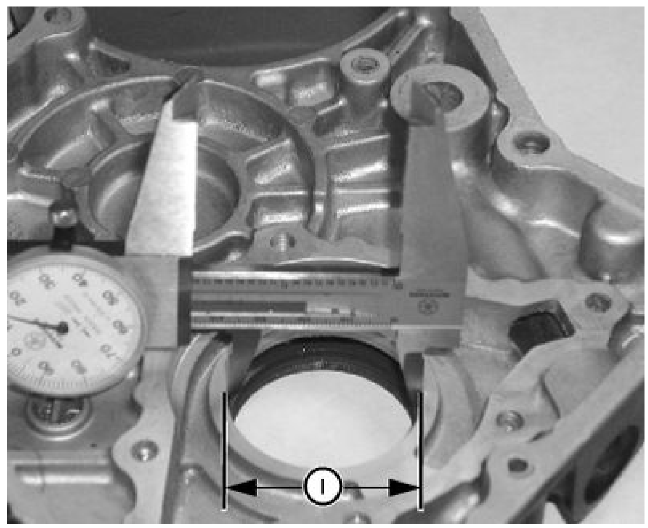
7. Inspect oil pump cavity for excessive wear or damage. Replace entire assembly if cavity is damaged.

Assembly

1. Coat all parts with clean engine oil.
2. Install outer rotor into housing assembly.
3. Install inner rotor into housing with shoulder seated into pilot hole of housing. Ensure that top surface of inner rotor is flush with top surface of outer rotor.
4. Apply T43512 Medium Strength Thread Lock to oil pressure regulator cap and install oil pressure regulator to pump cover.
5. Apply medium strength thread lock to pump cover screws and install oil pump cover. Tighten screws to specification.



TCAL26200 —UN—15JUN12



TCAL26201 —UN—15JUN12

H—Inner Rotor Shoulder Diameter
I— Inner Rotor Pilot Hole Diameter

6. Install timing gear cover. (See Remove and Install Timing Gear Cover—3TNV76.)

RB14256,0000868 -19-24APR14-6/6

Camshaft—3TNV76

IMPORTANT: Always replace camshaft followers when installing a new camshaft. Always replace camshaft when replacing camshaft followers. The components wear as a set and replacing only one will accelerate the wear of the other.

Special or Required Tools

- D15001NU Magnetic Follower Holder Kit

Number	Name	Use
PM38657 (U.S.)/LOCTITE® PM38628(Canada) (U.S.)	John Deere High-Flex Form-in-Place Gasket	Applied to camshaft bore plug before reinstallation.

Camshaft Removal

1. Remove engine. (See Remove and Install Engine—3TNV76.)
2. Remove rocker arm assembly and push rods. (See Remove and Install Rocker Arm Assembly—3TNV76.)
3. Remove timing gear cover. (See Remove and Install Timing Gear Cover—3TNV76.)
4. Check camshaft end play.

Specification

Camshaft (Wear Limit)—End Play........ 0.25 mm (0.010 in.)

5. Check backlash of timing gears.

Specification

Timing Gear Clearance (Wear Limit)—Backlash........ 0.14 mm (0.0055 in.)

NOTE: If camshaft is being removed with cylinder head installed, use a magnetic follower holder tool, or turn engine until oil pan is upward, to hold cam followers away from camshaft.

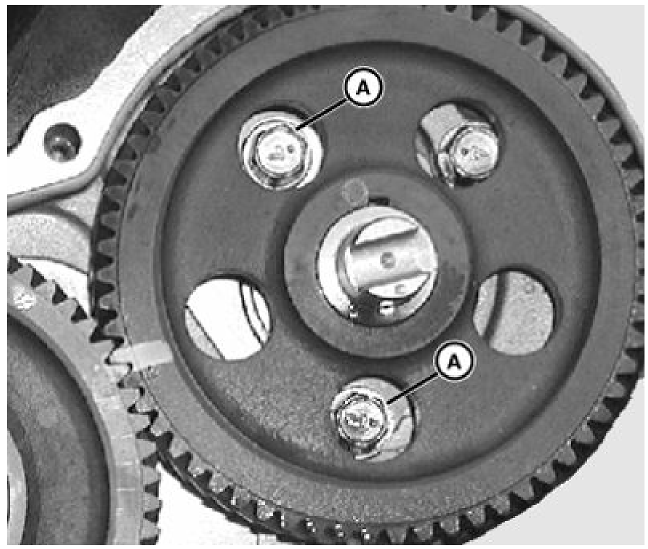
6. Hold cam followers away from camshaft using D15001NU Magnetic Follower Holder Kit or equivalent.

NOTE: Due to the odd number of teeth on the idler gear, timing marks will align only periodically.

7. Rotate the crankshaft and align all timing marks.

IMPORTANT: Do not allow camshaft lobes to hit bearing surfaces while removing camshaft. Machined surfaces can be damaged.

8. Remove two thrust plate mounting cap screws (A) and remove the camshaft with the thrust plate.



TCAL26202 —UN—15JUN12

A—Cap Screws

9. Inspect all parts for wear or damage.

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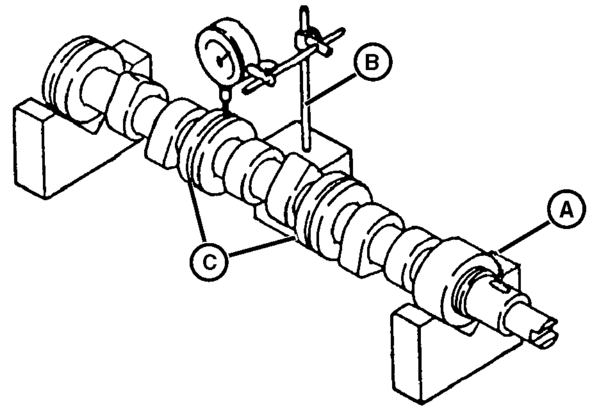
Camshaft Inspection

IMPORTANT: Camshaft gear shown removed for clarity purposes. Camshaft gear is a shrink fit. Do not remove gear unless camshaft or gear are out of specification or damaged.

1. Inspect camshaft for bend by using a pair of V-blocks (A) and a dial indicator (B). Turn camshaft slowly and read variation of camshaft bearing journals (C) on indicator. If variation is greater than wear limit, replace camshaft.

Specification

Camshaft Bend Wear Limit—Axial Runout (Wobble)........ 0.05 mm (0.002 in.)



TCAL26203 —UN—15JUN12

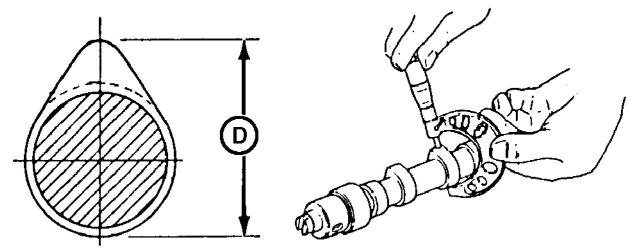
A—Pair Of V-Blocks
B—Dial Indicator
C—Camshaft Bearing Journals

RB14256,0000869 -19-24APR14-2/12

2. Measure camshaft lobe height (D) using a micrometer. If lobe height is less than wear limit, or if there are chips or scratches in lobes or bearing journals, replace camshaft.

Specification

Camshaft Lobe Wear Limit—Height........ 33.89 mm (1.334 in.)



TCAL26204 —UN—15JUN12

D—Camshaft Lobe Height

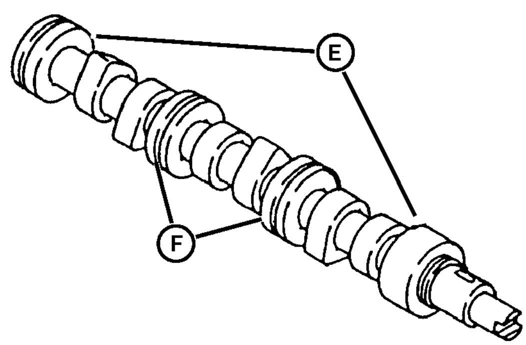
RB14256,0000869 -19-24APR14-3/12

3. Measure camshaft end journals (E) and intermediate journals (F) outside diameters. If any journal diameters are less than wear limit, replace camshaft.

Specification

Gear Housing and Flywheel End Journal OD Wear Limit—Diameter........ 39.905 mm (1.571 in.)

Intermediate Journal OD Wear Limit—Diameter........ 39.875 mm (1.570 in.)



TCAL26205 —UN—15JUN12

E—End Journals **F—Intermediate Journals**

Continued on next page RB14256,0000869 -19-24APR14-4/12

IMPORTANT: Camshaft bearing journals must be measured and found to be within specifications before camshaft bearings can be determined serviceable or unserviceable.

4. Measure camshaft bearing (G) diameter at gear housing end. If bearing diameter exceeds wear limit, replace bearing using a driver set.

Specification

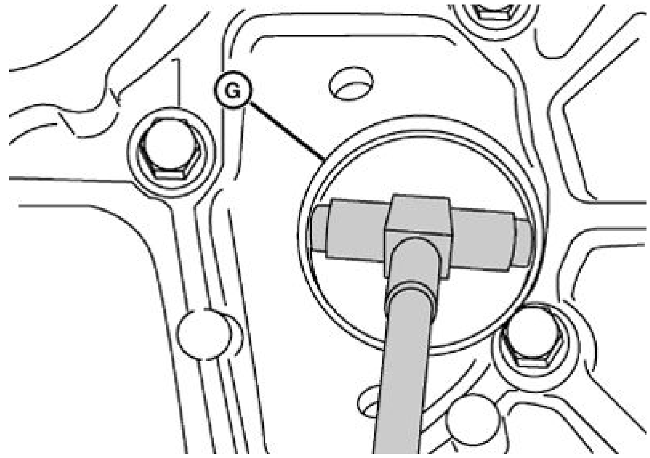
Gear Housing End
Bearing Wear Limit—ID... 40.150 mm
(1.581 in.)

5. Subtract camshaft journal outside diameter from gear housing end bearing inside diameter to determine clearance. If clearance exceeds specifications, replace bearing.

Specification

Bearing-to-Camshaft
Gear Housing End
Journal Clearance (Wear
Limit)—Clearance.. 0.245 mm
(0.010 in.)

Bearing-to-Camshaft
Intermediate Journals
Clearance (Wear
Limit)—Clearance.. 0.225 mm
(0.009 in.)



TCAL26206 —UN—15JUN12

G—Camshaft Bearing

Bearing-to-Camshaft
Flywheel End Journal
Clearance (Wear
Limit)—Clearance.. 0.195 mm
(0.008 in.)

6. Measure intermediate and flywheel end camshaft bearing diameter using the following steps.

Continued on next page

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7. Remove rear plug (H) using a long wooden dowel. Insert wooden dowel through gear housing side.

8. Measure flywheel end and intermediate bearing inside diameters with telescoping gauge and micrometer.

9. Subtract camshaft journal outside diameter from intermediate clearance. If clearance exceeds specification, replace engine block.

Specification

Bearing-to-Camshaft Intermediate Journals Clearance (Wear Limit)—Clearance.. 0.225 mm (0.009 in.)

10. Subtract camshaft journal outside diameter from flywheel end bearing inside diameter to determine clearance. If clearance exceeds specification, replace engine block.

Specification

Bearing-to-Camshaft Flywheel End Journal Clearance (Wear Limit)—Clearance.. 0.195 mm (0.008 in.)

11. Apply TY16021 John Deere High-Flex Form-in-Place Gasket, or equivalent, on outer edge of plug. Install plug until it bottoms in bore.

12. Install flywheel. (See Remove and Install Clutch and Flywheel—3TNV76.)

Camshaft Installation

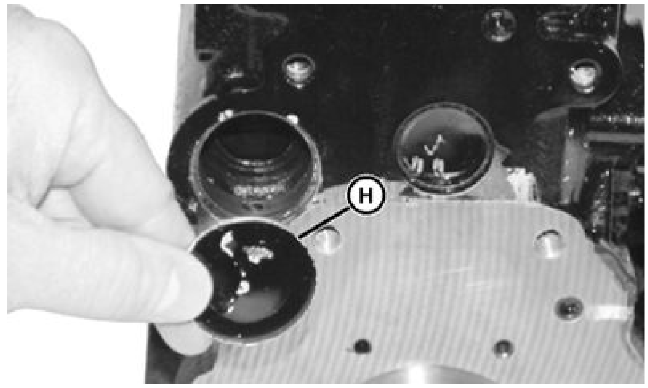
IMPORTANT: Do not allow camshaft lobes to hit bearing surfaces while installing camshaft. Machined surfaces can be damaged.

NOTE: Apply clean engine oil on all parts during installation.

The fuel injection drive gear, camshaft gear, and crankshaft gear all must be correctly timed to the idler gear. All three timing marks must line up at the same time. Due to the difference in gear sizes, it may take several revolutions to align all timing marks.

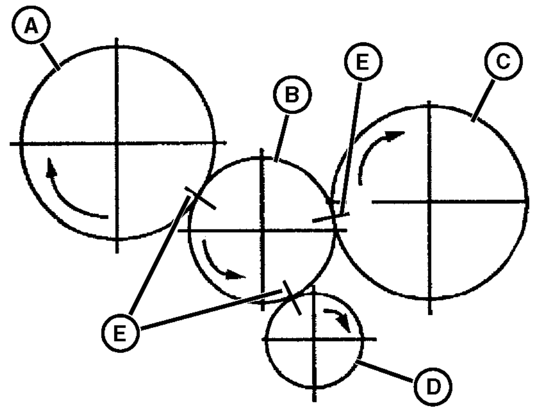
1. Rotate the crankshaft to align the timing marks.

2. Install the camshaft with thrust plate using two cap screws. Tighten cap screws.



TCAL26207 —UN—15JUN12

H—Rear Plug



TCAL26208 —UN—15JUN12

Arrows indicate direction of rotation (viewed from gear case).

A—Fuel Injection Drive Gear
B—Idler Gear
C—Camshaft Gear
D—Crankshaft Gear
E—Timing Marks

3. Install timing gear cover. (See Remove and Install Timing Gear Cover—3TNV76.)

4. If cam followers were removed, replace into same holes as removed.

5. Install push rods and rocker arm assembly. (See Remove and Install Rocker Arm Assembly—3TNV76.)

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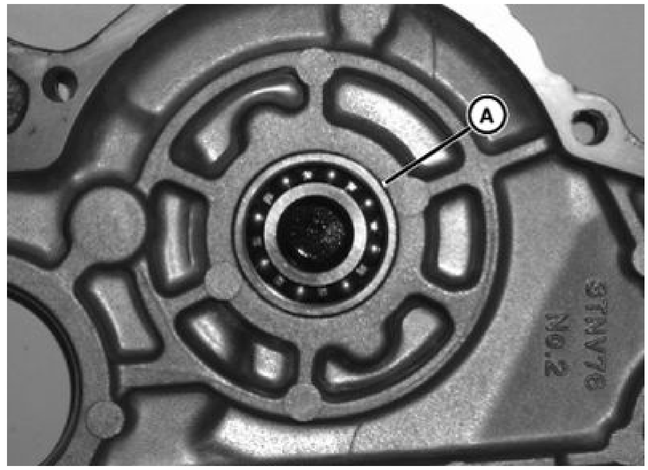
Pilot Bearing

1. Locate camshaft pilot bearing (A).

A—Camshaft Pilot Bearing

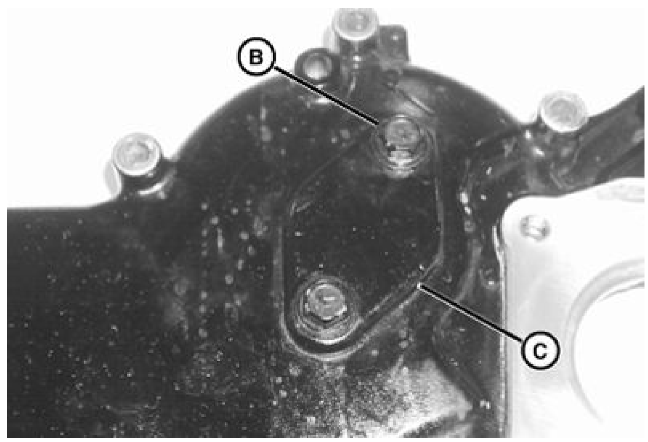


TCAL26209 —UN—15JUN12

RB14256,0000869 -19-24APR14-7/12

2. Remove two cap screws (B).
3. Remove pilot bearing cover (C).
4. Remove bearing using a bearing/bearing driver set.
5. Inspect bearings for wear or damage, replace as necessary
6. Installation is done in the reverse order of removal.

B—Two Cap Screws **C—Pilot Bearing Cover**



TCAL26210 —UN—15JUN12

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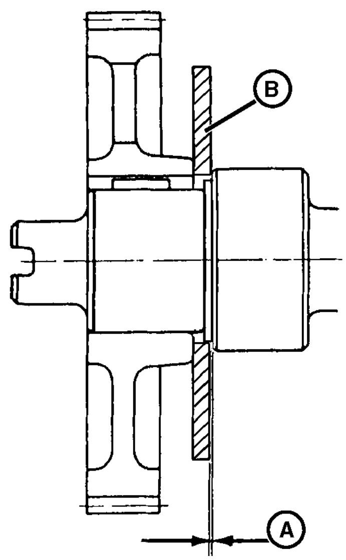
Camshaft End Play Check

NOTE: Follow this procedure if camshaft is installed in cylinder block. If camshaft is removed from cylinder block, check end play (A) using a feeler gauge between camshaft thrust plate (B) and front side of first camshaft bearing journal.

1. Remove timing gear cover. (See Remove and Install Timing Gear Cover—3TNV76.)
2. Remove idler gear. (See Remove and Install Idler Gear—3TNV76.)

A—End Play **B—Camshaft Thrust Plate**



TCAL26211 —UN—15JUN12

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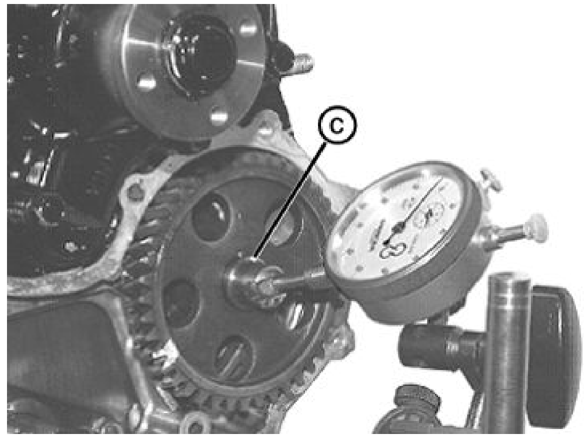
3. Fasten dial indicator base to cylinder block and position indicator tip on end of camshaft (C).
4. Push camshaft toward the rear as far as possible.
5. Set the dial indicator to zero.
6. Pull camshaft forward as far as possible.
7. If camshaft end play exceeds specification, remove camshaft and inspect thrust plate, camshaft, and camshaft gear for wear. Replace parts as needed.

Specification

Camshaft (Wear Limit)—End Play........ 0.25 mm (0.010 in.)



TCAL26212 —UN—15JUN12

C—End Of Camshaft

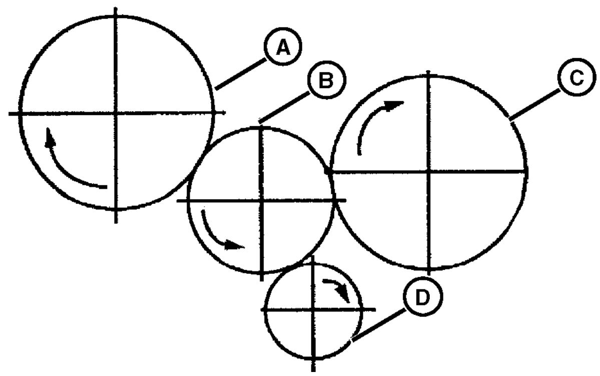
RB14256,0000869 -19-24APR14-10/12

Timing Gear Backlash Check

1. Remove timing gear cover. (See Remove and Install Timing Gear Cover—3TNV76.)
2. Place dial indicator magnetic base on cylinder block with tip of indicator on tooth of gear being measured.
3. Holding opposite gear stationary, move measured gear back and forth while measuring backlash between meshing gears.
4. If backlash exceeds specifications, replace worn gears as a complete set: idler gear, camshaft gear, crankshaft gear, fuel injection drive gear, and aux. hydraulic drive gear.

Specification

Timing Gear Clearance (Wear Limit)—Backlash........ 0.14 mm (0.0055 in.)



TCAL26213 —UN—15JUN12

Arrows indicate direction of rotation (viewed from gear case).

A—Fuel Injection Drive Gear
B—Idler Gear
C—Camshaft Gear
D—Crankshaft Gear

Camshaft Gear Removal

IMPORTANT: Camshaft gear is a shrink fit. Do not remove gear unless camshaft or gear are out of specification or damaged.

CAUTION: Do not heat oil over 182°C (360°F). Oil fumes or oil can ignite above 193°C (380°F). Use a thermometer. Do not allow a flame or heating element to come in direct contact with the oil. Heat the oil in a well-ventilated area. Plan a safe handling procedure to avoid burns.

1. Heat gear to approximately 150°C (300°F).
2. Remove gear from camshaft using a knife-edge puller and an arbor press. Place flat side of puller against camshaft gear.
3. Inspect gear for chipped or broken teeth. Replace if necessary.

Camshaft Gear Installation

CAUTION: Do not heat oil over 182°C (360°F). Oil fumes or oil can ignite above 193°C (380°F). Use a thermometer. Do not allow a flame or heating element to come in direct contact with the oil. Heat the oil in a well-ventilated area. Plan a safe handling procedure to avoid burns.

1. Heat gear to approximately 150°C (300°F).

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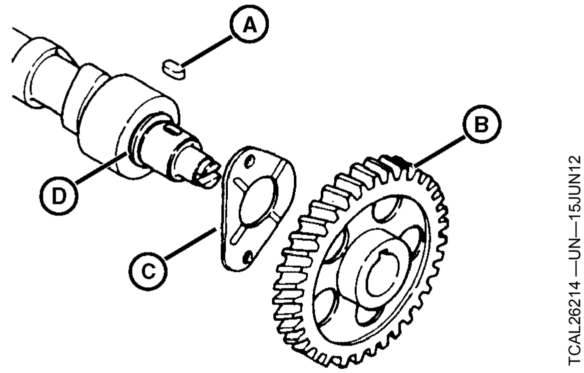
RB14256,0000869 -19-24APR14-11/12

2. Install key (A) into slot of camshaft.
3. Install thrust plate (C) onto camshaft, centering onto stepped shoulder (D). (Thrust plate has no “front” or “rear” side.)

IMPORTANT: Be sure thrust plate is not trapped between camshaft gear and stepped shoulder while gear is being pressed on.

4. Install heated camshaft gear (B) with longer hub of camshaft gear facing camshaft. Align slot in gear with key in shaft. Press camshaft into gear until hub of gear is tight against camshaft shoulder. Thrust plate must spin freely on camshaft.



A—Key
B—Camshaft Gear
C—Thrust Plate
D—Stepped Shoulder

RB14256,0000869 -19-24APR14-12/12

Remove, Inspect, and Install Camshaft Follower—3TNV76

Removal

1. Remove cylinder head. (See Remove and Install Cylinder Head—3TNV76.)

IMPORTANT: Cam followers must be installed in the same bores from which they were removed. Put a mark on each cam follower and cylinder block bore to aid in installation.

Always replace camshaft when replacing cam followers. Always replace cam followers when installing new camshaft. The components wear as a set and replacing only one will accelerate the wear of the other.

2. Remove cam followers from cylinder block with magnetic pick-up tool.
3. Inspect all parts for wear or damage.

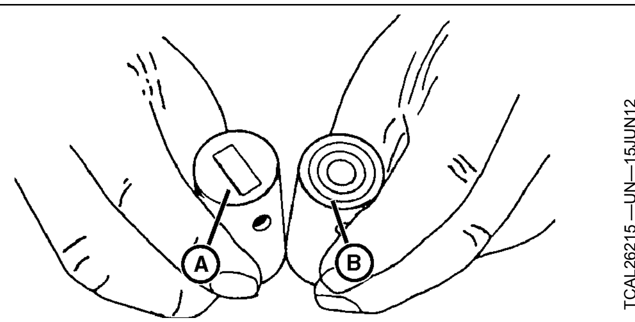
Installation

Installation is done in the reverse order of removal.

- Apply clean engine oil on all parts during installation.
- Install cam followers after camshaft is installed. Install followers with the flat contact surface toward the camshaft.

Inspection

1. Inspect cam follower contact surface for abnormal wear (A). Normal wear (B) has light circular lines and flat surface.



A—Abnormal Wear
B—Normal Wear

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RB14256,000086A -19-24APR14-1/2

2. Measure cam follower diameter. If outside diameter is less than wear limit, replace cam follower.

Specification

Cam Follower OD Wear Limit—Diameter........ 20.91 mm (0.823 in.)

3. Use a straightedge and place it on the contact surface perpendicular to the wear mark across cam follower. Replace if surface appears to “valley” on wear mark.
4. Measure cam follower bore diameter in cylinder block. If cam follower bore diameter exceeds wear limit, replace cylinder block.

Specification

Cam Follower Bore ID Wear Limit—ID........ 21.04 mm (0.828 in.)

5. If follower-to-bore oil clearance (bore ID minus follower OD) exceeds specification, replace cam follower, cylinder block, or both.

TCAL26216 —UN—15JUN12

Specification

Follower-to-Bore Oil Clearance Wear Limit—Clearance........ 0.13 mm (0.005 in.)

RB14256,000086A -19-24APR14-2/2

Remove and Install Idler Gear—3TNV76

Removal

1. Remove timing gear cover. (See Remove and Install Timing Gear Cover—3TNV76.)
2. Check backlash of timing gears.

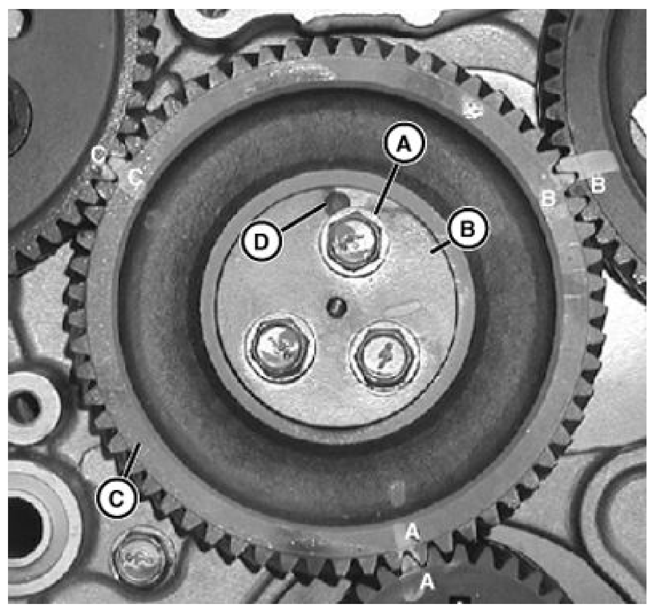
NOTE: All three timing marks must line up at the same time. Due to the difference in gear sizes, it may take several revolutions to align timing marks.

3. Rotate crankshaft and align timing marks.
4. Remove three cap screws (A), idler gear shaft (B), and idler gear (C).
5. Inspect all parts for wear or damage.

Installation

Installation is done in the reverse order of removal.

- Install idler gear shaft with dimple (D) at top.
- Ensure that all timing marks align.
- Tighten idler gear shaft cap screws.



TCAL26217 —UN—15JUN12

A—Cap Screws
B—Idler Gear Shaft
C—Idler Gear
D—Idler Gear Shaft Dimple

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RB14256,000086B -19-24APR14-1/3

Inspection/Replacement

1. Inspect gear for chipped or broken teeth. Replace if necessary.
2. Measure idler gear shaft diameter. If shaft diameter is less than wear limit, replace idler gear shaft.

Specification

Idler Gear Shaft OD Wear Limit—Diameter....... 36.90 mm (1.453 in.)

TCAL26218 —UN—15JUN12

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3. Measure idler gear bushing diameter. If bushing diameter exceeds wear limit, replace bushing using a driver set.

Specification

Idler Gear Bushing Wear Limit—ID....... 37.07 mm (1.4596 in.)

   a. Align oil holes in bushing and idler gear.

   b. Install bushing flush with surface of idler gear.

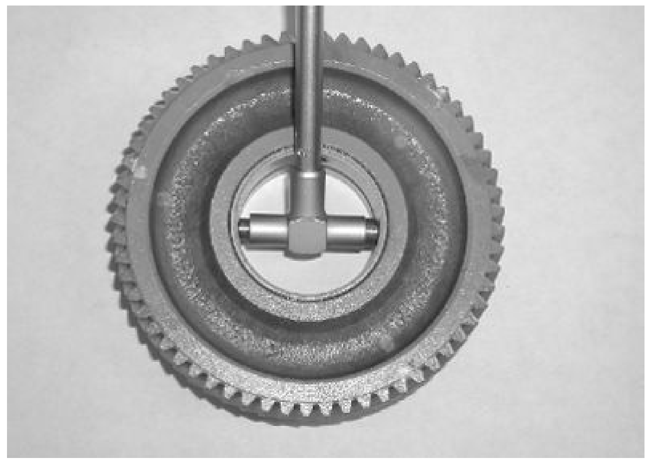
4. If bushing oil clearance (bushing ID minus shaft OD) exceeds specification, replace bushing, shaft, or both.

Specification

Oil Clearance Wear Limit—Clearance....... 0.175 mm (0.007 in.)

Specifications—Specification

Idler Gear Shaft Standard OD—Clearance....... 36.95—36.975 mm (1.455—1.456 in.)



TCAL26219 —UN—15JUN12

Idler Gear Bushing Standard ID—Clearance....... 37.00—37.025 mm (1.457—1.458 in.)

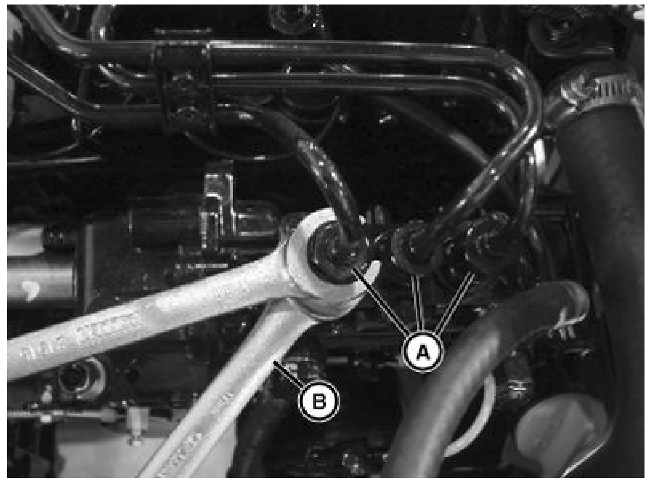
Oil Clearance—Clearance....... 0.025—0.075 mm (0.001—0.003 in.)

RB14256,000086B -19-24APR14-3/3

Remove and Install Timing Gear Housing—3TNV76

Removal

Number	Name	Use
PM38657 (U.S.)/PM38628(Canada) (U.S.)	John Deere High-Flex Form-in-Place Gasket	Applied to timing gear housing before installation.



TCAL26220 —UN—15JUN12

1. Remove engine. (See Remove and Install Engine—3TNV76.)
2. Remove timing gear cover. (See Remove and Install Timing Gear Cover—3TNV76.)

NOTE: Timing gear housing can be removed with fuel injection pump attached. Do not remove fuel injection pump from timing gear housing unless pump needs repair. If repair of fuel injection pump is required, see Remove and Install Fuel Injection Pump—3TNV76.

3. Loosen fuel line connectors (A) at injection pump to release pressure in the fuel system. When loosening connectors, use a backup wrench (B) to prevent delivery valves from turning.

A—Fuel Line Connectors **B—Backup Wrench**

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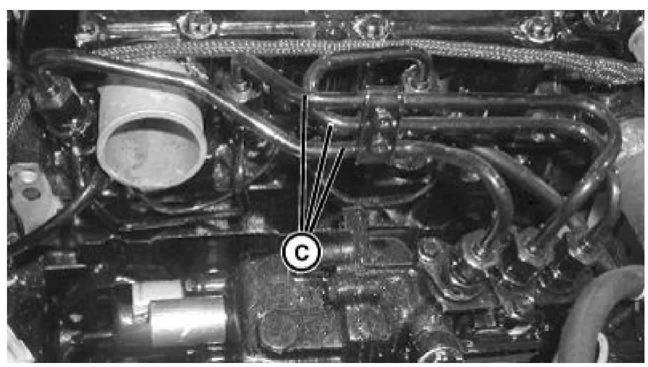


TCAL26221 —UN—15JUN12

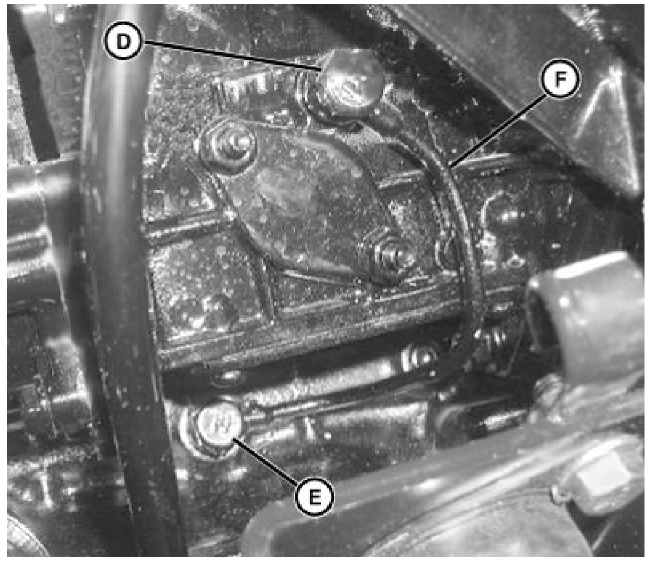
4. Remove fuel line nuts at injector nozzles and injection pump. When loosening line nuts, use a backup wrench to prevent fuel return line nuts from turning. Remove injector lines (C).

C—Injector Lines

Continued on next page RB14256,000086C -19-24APR14-2/4

NOTE: Oil supply line has a bronze washer on each side, do not lose washer when removing fittings.

5. Remove oil fitting (D) from injection pump.
6. Remove oil fitting (E) from side of engine.
7. Remove oil supply line (F).
8. Remove camshaft.
9. Remove idler gear. (See Remove and Install Idler Gear—3TNV76.)
10. Remove oil pan and crankcase extension. (See Oil Pan, Crankcase Extension and Pickup Tube—3TNV76.)



TCAL26222 —UN—15JUN12

D—Oil Fitting
E—Oil Fitting
F—Oil Supply Line

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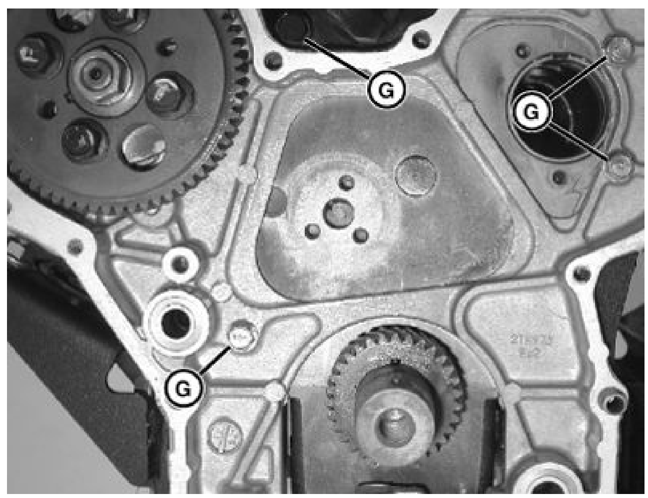
11. Remove timing gear housing mounting cap screws (G) and remove housing from cylinder block. Discard O-rings between housing and engine block.
12. If replacing timing housing, remove fuel injection pump. (See Remove and Install Fuel Injection Pump—3TNV76.)
13. Clean all old gasket material from timing gear cover housing and engine block. Discard O-rings between housing and engine block.

Installation

Installation is done in the reverse order of removal.

- Install alignment dowels in timing gear housing.
- Replace O-rings between housing and engine block.
- Apply TY16021 John Deere High-Flex Form-in-Place Gasket to timing gear housing when installing to cylinder block.
- Tighten mounting cap screws.



TCAL26223 —UN—15JUN12

G—Cap Screws

RB14256,000086C -19-24APR14-4/4

Remove and Install Piston and Connecting Rod—3TNV76

Removal

NOTE: The engine must be removed from the machine to perform this procedure.

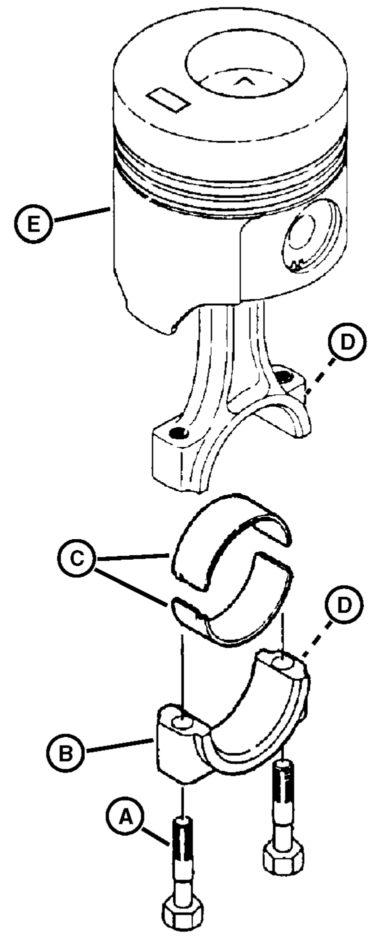
1. Remove the oil pan, crankcase extension and oil pickup tube. (See Oil Pan, Crankcase Extension and Pickup Tube—3TNV76.)
2. Remove timing gear housing. (See Remove and Install Timing Gear Housing—3TNV76.)
3. Remove clutch and flywheel. (See Remove and Install Clutch and Flywheel—3TNV76.)
4. Remove rear block plate.
5. Remove the cylinder head. (See Remove and Install Cylinder Head—3TNV76.)
6. Check the cylinder bore for ridges. These ridges can cause damage to piston if ridge is not removed. If necessary, remove any ridge from top of cylinder bore using a ridge reamer.
7. Measure the connecting rod side play. (See Check Connecting Rod Side Play.)
8. Measure the crankshaft end play. (See Check Crankshaft End Play.)
9. Measure the connecting rod bearing clearance. (See Check Connecting Rod Bearing Clearance.)

IMPORTANT: Keep the connecting rods and rod caps together. Rods and caps are a matched set. Note the stamped numbers on each part.

10. Remove the rod cap screws (A), connecting rod cap (B), and bearing inserts (C).

IMPORTANT: The pistons and cylinders are matched. Pistons must be installed in the cylinders from which they are removed.

11. Note the connecting rod stamped number (D) in relation to the cylinders. Start at the flywheel end with cylinder number one, then two, etc.



TCAL26224 —UN—15JUN12

A—Cap Screws
B—Connecting Rod Cap
C—Bearing Inserts
D—Stamped Number
E—Piston

12. Push the piston (E) and connecting rod out of the cylinder bore using a wooden dowel.
13. Disassemble and inspect all parts for wear or damage.
14. Inspect cylinder bore. (See Cylinder Bore—3TNV76.)

Continued on next page

RB14256,000086D -19-24APR14-1/14

Installation

1. Apply clean engine oil to all parts during installation.
2. Always replace the connecting rod cap screws. Do not reuse cap screws.
3. Assemble the piston and connecting rod.

IMPORTANT: Pistons must be installed in the cylinders from which they were removed and in the same direction. Be careful not to damage the crankshaft rod journals while installing pistons.

4. Install the piston and connecting rod into the cylinder from which it was removed. The stamped number (D) on the connecting rod and the piston recess (A) on top of piston should point toward the fuel injection pump.

IMPORTANT: Do not touch bearing insert surfaces. Oil and acid from your finger will corrode the bearing surface.

5. Install the bearing inserts to the connecting rod and rod cap, aligning tangs (F) with grooves (E).

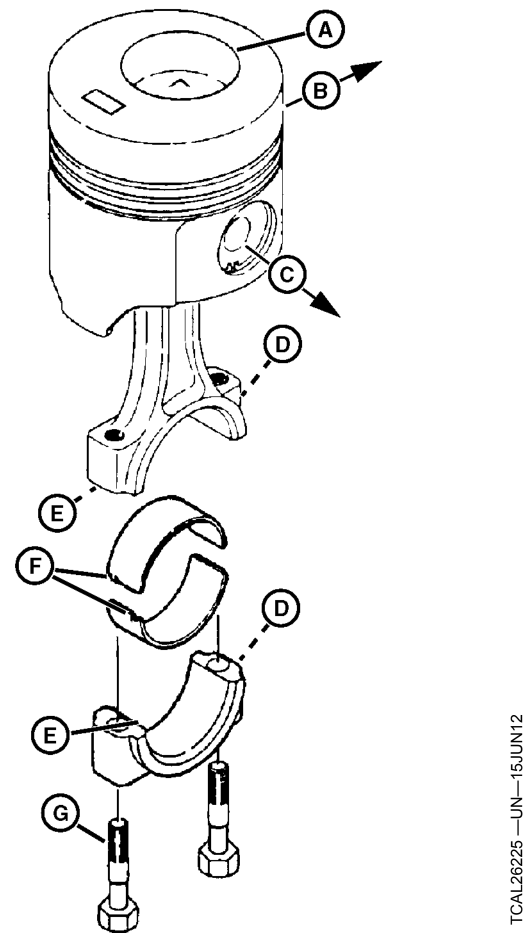
IMPORTANT: Connecting rod caps must be installed on the same connecting rods they were removed from.

6. Match the connecting rods to caps using stamped numbers (D). Install the rod caps.
7. Dip the entire connecting rod cap screws (G) in clean engine oil. Install new cap screws and tighten to specification.

Specification

Connecting Rod Cap
Screw Torque—Torque...22.6—27.5 N·m
(17—20 lb.-ft.)

8. If a new piston and connecting rod were installed, stamp a number corresponding to the cylinder number on the connecting rod and rod cap.
9. Install the cylinder head. (See Remove and Install Cylinder Head—3TNV76.)
10. Install timing gear housing. (See Remove and Install Timing Gear Housing—3TNV76.)



A—Piston Recess
B—Fuel Injection Pump Side
C—Flywheel Side
D—Stamped Number
E—Groove
F—Tang
G—Cap Screw

11. Install rear block plate.
12. Install clutch and flywheel. (See Remove and Install Clutch and Flywheel—3TNV76.)
13. Install the oil pan, crankcase extension and oil pickup tube. (See Oil Pan, Crankcase Extension and Pickup Tube—3TNV76.)

Continued on next page

RB14256,000086D -19-24APR14-2/14

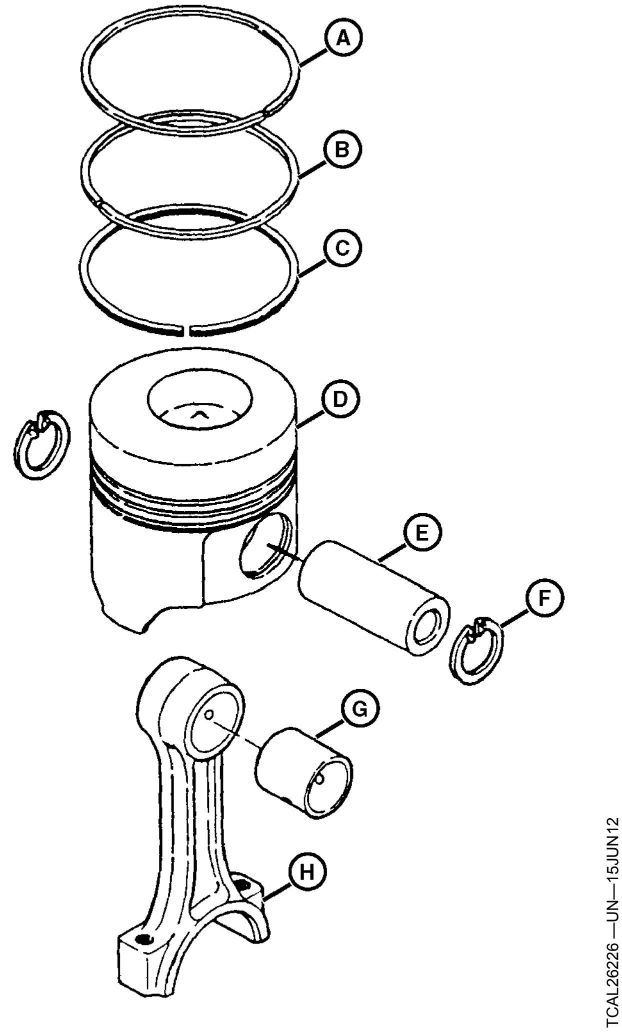
Disassembly

IMPORTANT: Pistons must be installed on the same connecting rod they were removed from.

1. Put a mark on each piston and connecting rod to aid in assembly.
2. Remove piston rings (A-C), starting with the first compression ring, by gently spreading them open just enough to clear the outside diameter of the piston. This can be done by hand or with a ring expander.
3. Remove piston pin retaining rings (F) and piston pin (E). Excessive pressure should not be necessary to remove piston pin.

NOTE: The piston pin bushing (G) is a press fit in the connecting rod. Remove the bushing only if replacement is necessary.

4. Inspect all parts for wear or damage. Replace as necessary.



A—Top Piston Ring
B—Middle Piston Ring
C—Oil Control Ring with Expander
D—Piston
E—Piston Pin
F—Retaining Ring
G—Piston Pin Bushing
H—Connecting Rod

Continued on next page

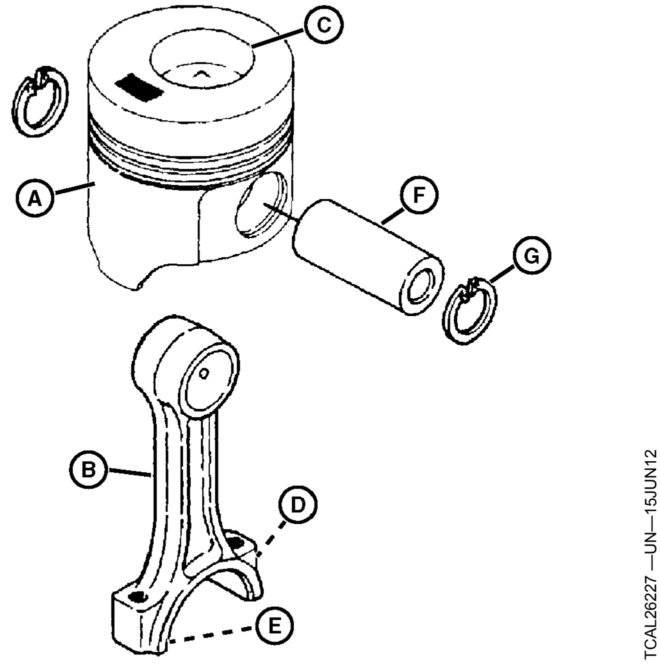
RB14256,000086D -19-24APR14-3/14

Assembly

1. Apply clean engine oil to all parts during assembly.
2. Install piston pin bushing in connecting rod with oil holes aligned, if removed.

IMPORTANT: The pistons must be installed on the same connecting rod they were removed from.

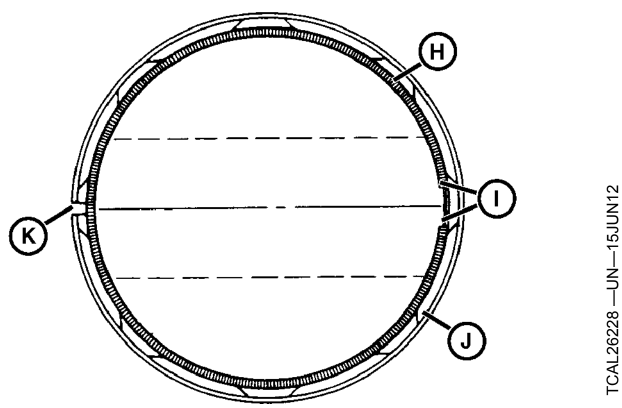
3. Assemble the piston (A) to the connecting rod (B) with piston recess (C) on the same side as the connecting rod stamped number (D). If a new connecting rod is used, assemble the piston to the connecting rod with piston recess opposite the connecting rod bearing insert groove (E).
4. Install piston pin (F) and retaining rings (G).



A—Piston
B—Connecting Rod
C—Piston Recess
D—Stamped Number
E—Bearing Insert Groove
F—Piston Pin
G—Retaining Rings

RB14256,000086D -19-24APR14-4/14

5. Install an oil ring expander (H) in the bottom ring groove of the piston, with the oil ring expander ends (I) above either end of the piston pin.
6. Install oil ring (J) over the expander with the oil ring gap (K) opposite (180°) the expander ends.



H—Oil Ring Expander
I— Oil Ring Expander Ends
J— Oil Ring
K—Oil Ring Gap

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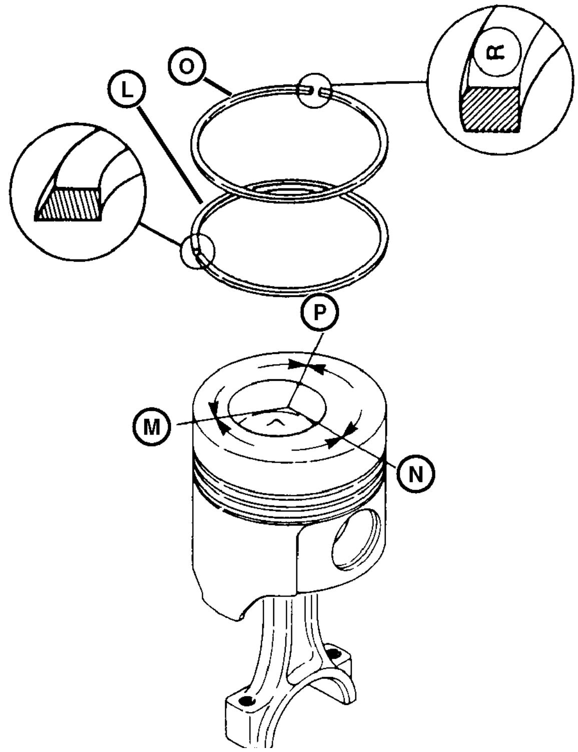
RB14256,000086D -19-24APR14-5/14

7. Install the middle piston ring (L), with the manufacturer's mark (near the ring gap) toward the top of the piston, in the middle groove. Turn the ring until the middle piston ring gap (M) is 120° away from the oil ring gap (N).
8. Install the top piston ring (O), with the manufacturer's mark (near the ring gap) toward the top of the piston, in the top groove. Turn the ring until the top piston ring gap (P) is 120° away from the middle ring gap (M).

Inspection/Replacement

1. Inspect all parts for wear or damage. Replace as necessary. (See "Connecting Rod Bearing," "Piston Ring Groove," "Piston Ring End Gap," "Piston Pin Bore," "Piston Pin Bushing," and "Piston Diameter" procedures below.)
2. Measure the crankshaft connecting rod journal diameter.



TCAL26229 —UN—15JUN12

L—Middle Piston Ring
M—Middle Piston Ring Gap
N—Oil Ring Gap
O—Top Piston Ring
P—Top Piston Ring Gap

RB14256,000086D -19-24APR14-6/14

Connecting Rod Bearing

1. Install the connecting rod cap and bearing inserts on the connecting rod. Install the old connecting rod cap screws and tighten to specification.

Specification

Connecting Rod Cap
Screw Torque—Torque.. 22.6—27.5 N·m
(17—20 lb.-ft.)

2. Measure the connecting rod bearing diameter. Replace the bearing inserts if bearing diameter is not within specification.

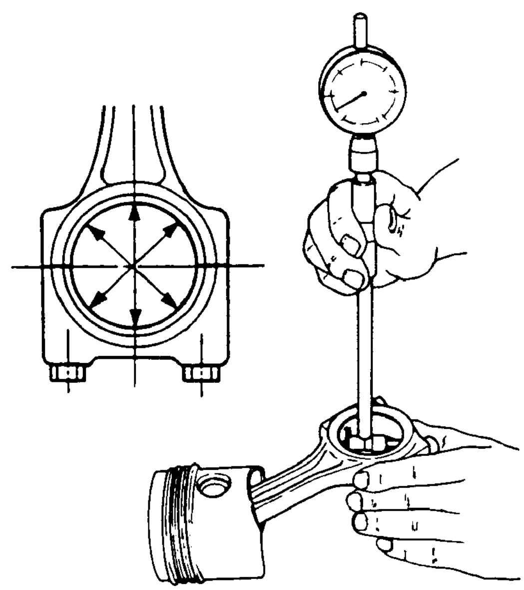
Specification

Connecting Rod Bearing
—ID..41.982—42.002 mm
(1.653—1.654 in.)

3. Measure the oil clearance between the bearing inserts and the crankshaft, and verify that the clearance is within specification. If the bearing oil clearance exceeds the wear limit, grind the crankshaft connecting rod journals and install undersized bearing inserts, or replace the bearing inserts and the crankshaft.

Specification

Connecting Rod Bearing
Oil Clearance Wear
Limit—Clearance...0.11 mm
(0.004 in.)


TCAL26230 —UN—15JUN12

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RB14256,000086D -19-24APR14-7/14

Piston Ring Groove

1. Using a micrometer, measure the thickness of each piston ring. Replace piston rings if rings do not meet specification.

Specification

Top Piston Ring Thickness Wear Limit—Thickness.. 1.45 mm (0.057 in.)

Middle Piston Ring Thickness Wear Limit—Thickness.. 1.41 mm (0.0555 in.)

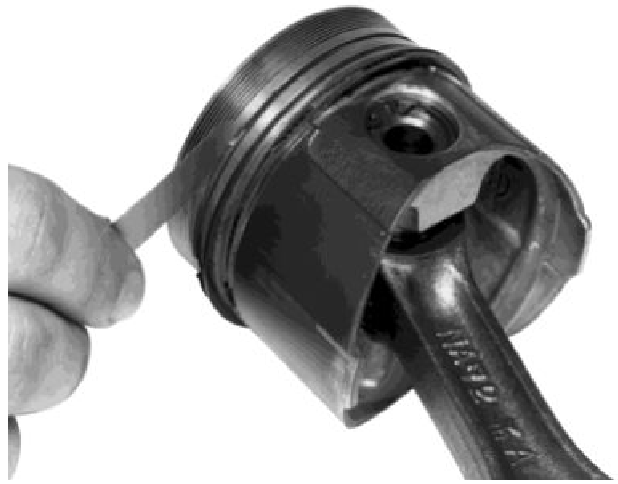
Oil Control Ring Thickness Wear Limit—Thickness.. 2.95 mm (0.116 in.)

NOTE: Piston ring grove side clearance must be checked using new rings or known good rings meeting thickness specifications.

2. With the rings installed on the piston, measure the piston ring groove side clearance. Measure at several places around each piston.
3. Replace the piston if the clearances exceed specification.

Specification

Top Piston Ring Groove Side Clearance—Clearance...0.06—0.10 mm (0.002—0.004 in.)



TCAL26231 —UN—15JUN12

Middle Piston Ring Groove Side Clearance—Clearance...0.013—0.165 mm (.0005—0.0065 in.)

Oil Control Ring Groove Side Clearance—Clearance...0.020—0.060 mm (0.0008—0.0024 in.)

Continued on next page

RB14256,000086D -19-24APR14-8/14

Piston Ring End Gap

NOTE: Piston ring end gap must be checked using a known good cylinder bore meeting specifications. (See Cylinder Bore—3TNV76.)

1. Push ring into cylinder bore, using a piston, until ring installed depth (B) is approximately 30 mm (1.18 in.) from bottom of cylinder bore.
2. Measure piston ring end gap (A). If ring end gap exceeds wear limit, replace ring.

Specification

Top Piston Ring Standard
End Gap—Gap....0.15—0.30 mm
(0.006—0.012 in.)

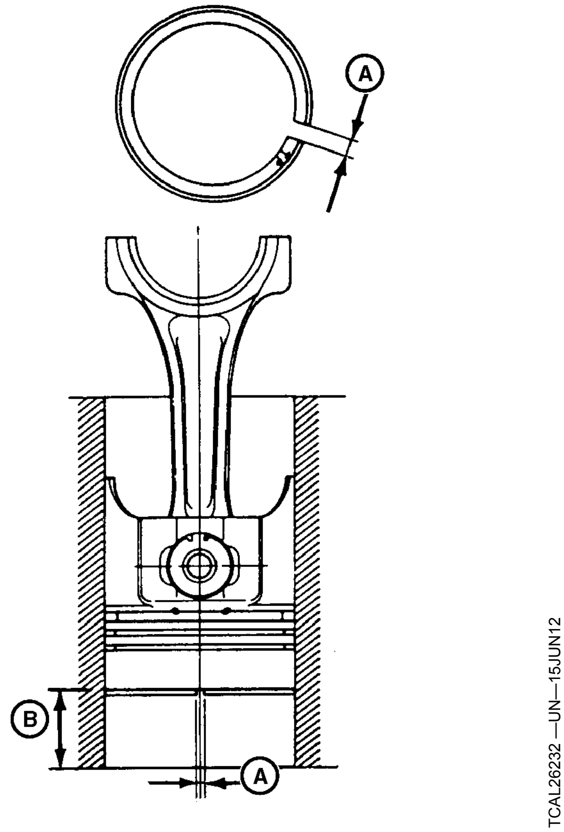
Top Piston Ring End Gap
Wear Limit—Gap.... 0.39 mm
(0.015 in.)

Middle Piston Ring
Standard End
Gap—Gap....0.18—0.33 mm
(0.007—0.013 in.)

Middle Piston Ring End
Gap Wear Limit—Gap.... 0.42 mm
(0.0165 in.)

Oil Control Ring Standard
End Gap—Gap....0.20—0.45 mm
(0.008—0.018 in.)

Oil Control Ring End Gap
Wear Limit—Gap.... 0.54 mm
(0.021 in.)



A—Piston Ring End Gap **B—Depth**

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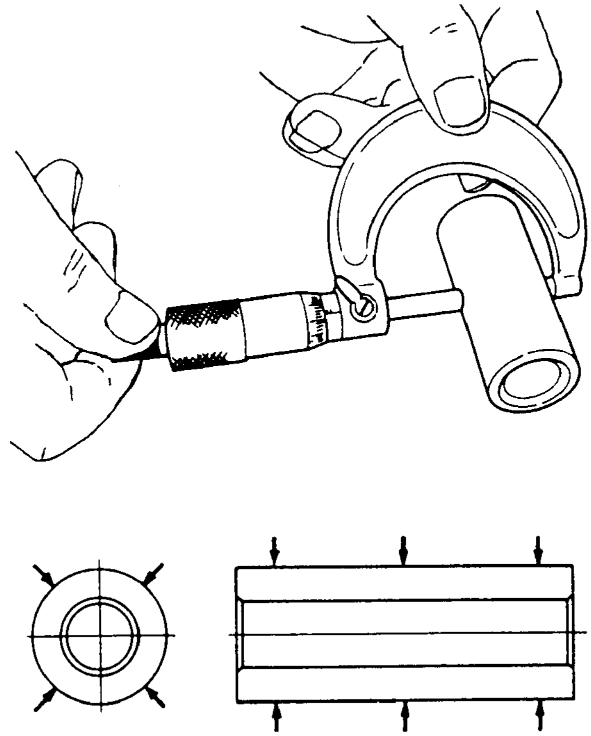
RB14256,000086D -19-24APR14-9/14

Piston Pin

Measure the piston pin diameter at six places. Replace any pin that is not within specification.

Specification

Piston Pin OD Wear
Limit—OD.. 21.965 mm
(0.865 in.)



TCAL26233 —UN—15JUN12

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Piston Pin Bore

1. Measure the pin bore diameter in the piston. If the piston pin bore exceeds the wear limit, replace the piston.

Specification

Bore ID Wear Limit—ID.. 22.04 mm
(0.868 in.)

2. If the piston pin-to-piston oil clearance (bore ID minus pin OD) exceeds the wear limit, replace the piston, piston pin, or both.

Specification

Pin-to-Piston Oil Wear
Limit—Clearance.. 0.105 mm
(0.004 in.)

TCAL26234 —UN—15JUN12

Continued on next page

RB14256,000086D -19-24APR14-11/14

Piston Pin Bushing

NOTE: The piston pin bushing is a press fit. Replace the bushing using a driver set. When installing the bushing, make sure to align the oil hole in the bushing with the hole in the connecting rod.

1. Measure the piston pin bushing diameter in the connecting rod. If the bushing diameter exceeds the wear limit, replace bushing.

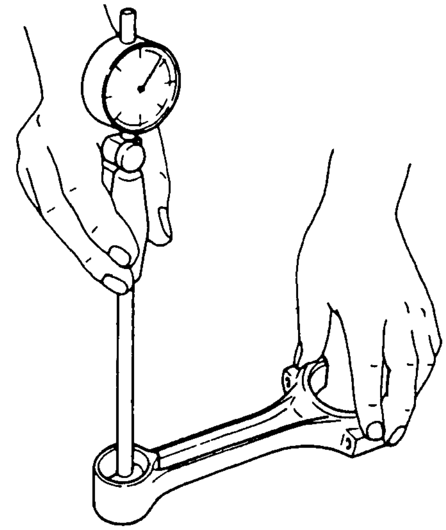
Specification

Bushing ID Wear
Limit—ID.. 22.07 mm
(0.869 in.)

2. If piston pin-to-bushing oil clearance (bushing ID minus pin OD) exceeds specification, replace the bushing or the piston pin.

Specification

Pin-to-Bushing
Clearance Wear
Limit—Clearance.. 0.105 mm
(0.004 in.)



TCAL26235 —UN—15JUN12

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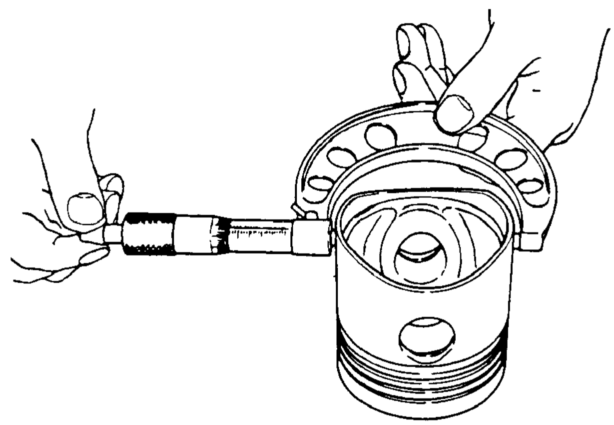
Piston Diameter

NOTE: If the engine has had a previous major overhaul, oversize pistons and rings may have been installed. Pistons and rings are available in 0.25 mm (0.010 in.) oversize.



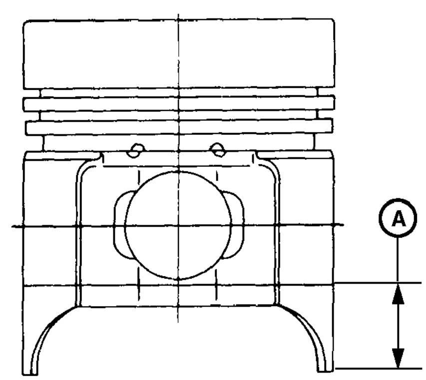
TCAL26236 —UN—15JUN12

RB14256,000086D -19-24APR14-13/14

Measure the piston diameter perpendicular to the piston pin bore at distance (A). If the piston diameter is less than the wear limit, install a new piston.

Specification

Diameter Measuring
Point Distance
(A)—Distance...22—25 mm
(0.866—0.984 in.)
Standard Size Piston OD
Wear Limit—OD... 75.910 mm
(2.989 in.)
Oversize Piston OD Wear
Limit—OD... 76.160 mm
(2.999 in.)



TCAL26237 —UN—15JUN12

RB14256,000086D -19-24APR14-14/14

Crankshaft and Main Bearings—3TNV76

Removal

1. Check crankshaft end play. (See Check Crankshaft End Play.)
2. Remove oil pan, crankcase extension and pickup tube. (See Oil Pan, Crankcase Extension and Pickup Tube—3TNV76.)
3. Remove flywheel. (See Remove and Install Clutch and Flywheel—3TNV76.)
4. Remove timing gear cover, timing gears, and timing gear housing of engine. (See Remove and Install Timing Gear Cover—3TNV76.)
5. Check crankshaft bearing clearance.

Specification

Main Bearing Standard Oil—Clearance....0.020—0.050 mm (0.001—0.002 in.)

Main Bearing Oil Wear Limit—Clearance....0.120 mm (0.005 in.)

IMPORTANT: Connecting rod end caps must be installed on the same connecting rods from which they were removed. Note stamped numbers on caps and rods.

6. Remove connecting rod cap screws and end caps. Push pistons and connecting rods away from crankshaft.

IMPORTANT: Main bearing caps must be installed on the same main bearings from which they were removed.

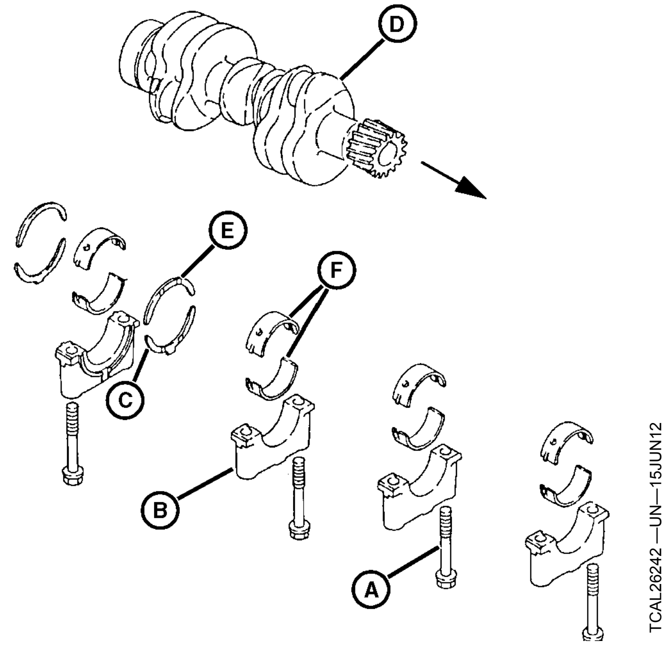
7. Remove main bearing cap screws (A), caps (B), and cap thrust bearings (C).
8. Remove crankshaft (D).
9. Remove block thrust bearings (E) and main bearing inserts (F).
10. Inspect all parts for wear or damage.

Installation

1. Apply clean engine oil on all parts during installation.

IMPORTANT: Do not touch bearing insert surfaces. Oil and acid from your finger will corrode the bearing surfaces.

2. Install bearing inserts drilled with oil passage in cylinder block bearing bores, aligning tangs with slots in bores.
3. Install block thrust bearings with oil grooves facing away from engine block.



Arrow Points to Front of Engine.

A—Cap Screws
B—Caps
C—Cap Thrust Bearings
D—Crankshaft
E—Block Thrust Bearings
F—Main Bearing Inserts

NOTE: Main bearing caps have raised arrows. The center two are stamped with numbers. The main bearing cap at the gear train end and the thrust main bearing (flywheel end) do not have a number. Both correspond to their location on the engine block. Install bearing caps beginning with number 1, then 2, then thrust main bearing, and then gear train end. Install all bearing caps with the arrow pointing toward the flywheel end.

4. Install crankshaft.
5. Install smooth bearing inserts in main bearing caps, aligning tangs with slots in caps.
6. Install cap thrust bearings with oil grooves facing away from cap.
7. Install main bearing caps in their original locations with arrows pointing toward flywheel side of engine.

IMPORTANT: Do not use high-speed power tools or air wrenches to tighten main bearing cap screws.

8. Dip entire main bearing cap screws in clean engine oil. Install cap screws and tighten. Do not tighten to specification at this time.
9. Using a soft-faced hammer, tap the front end of the crankshaft and then the rear end of the crankshaft to align the thrust bearings.

Continued on next page

RB14256,0000871 -19-10JUN14-1/6

10. Tighten main bearing cap screws to specification. When tightening, start at center main bearing cap and work your way out, alternating to the ends. Turn crankshaft by hand. If it does not turn easily, disassemble the parts and find the cause.

Specification

Main Bearing Cap Screw Torque—Torque	76—82 N·m (56—60 lb.-ft.)

IMPORTANT: The connecting rod caps must be installed on the same connecting rods from which they were removed. Never reuse connecting rod cap screws. Replace with new.

11. Match the connecting rod caps to the rods using stamped numbers. Install the caps to the rods.
12. Dip entire connecting rod cap screws in clean engine oil. Install new cap screws to the rods, and tighten to specification.

Specification

Connecting Rod Cap Screw Torque—Torque	23—28 N·m (204—248 lb.-in.)

13. Install the flywheel. (See Remove and Install Clutch and Flywheel—3TNV76.)
14. Install the timing gear housing, timing gears and timing gear cover. (See Remove and Install Timing Gear Housing—3TNV76.)
15. Install the front oil seal. (See Crankshaft Front Oil Seal—3TNV76.)
16. Install the pickup tube, crankcase extension and oil pan. (See Oil Pan, Crankcase Extension and Pickup Tube—3TNV76.)

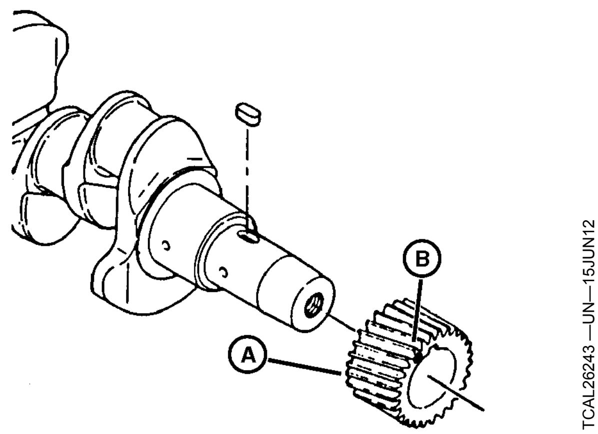
RB14256,0000871 -19-10JUN14-2/6

Inspection/Replacement

1. Inspect crankshaft gear for chipped or broken teeth. If replacement is necessary, remove gear from crankshaft using a knife-edge puller and a press.

CAUTION: Do not heat oil over 182°C (360°F). Oil fumes or oil can ignite above 193°C (380°F). Use a thermometer. Do not allow a flame or heating element to come in direct contact with the oil. Heat the oil in a well-ventilated area. Plan a safe handling procedure to avoid burns.

2. Heat gear to approximately 150°C (300°F). Install gear (A) with timing mark (B) toward press table.
3. Align slot in gear with key in shaft. Press crankshaft into gear until gear is tight against crankshaft shoulder.



A—Gear
B—Timing Mark

Continued on next page

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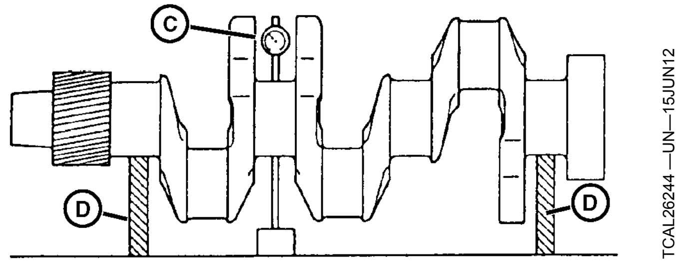
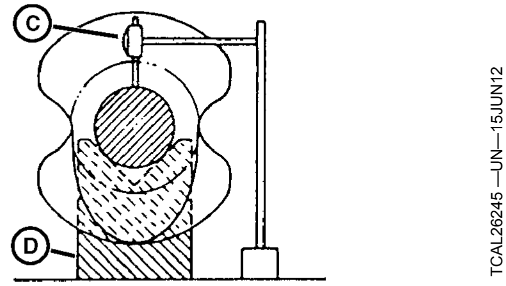
4. Inspect crankshaft for bend using V-blocks (D) and a dial indicator (C). Turn crankshaft slowly and read variation on indicator. If variation is greater than specification, replace crankshaft.

Specification

Crankshaft Bend (Maximum)—Axial Runout (Wobble).. 0.02 mm (0.001 in.)





C—Dial Indicator **D—V-Blocks**

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NOTE: If engine has had a previous major overhaul, journals may have been ground and undersize bearing inserts installed.

5. Measure crankshaft connecting rod journals (F) and main bearing journal (E) diameters. Measure several places around each journal.

6. If journal diameter is less than wear limit, replace crankshaft or have journals ground undersize by a qualified machine shop.

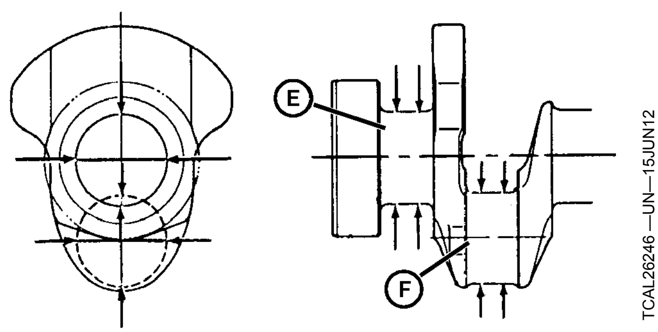
Specification

Crankshaft Connecting Rod Journal Standard OD—Diameter..41.95—41.96 mm (1.6517—1.652 in.)

Crankshaft Main Bearing Journal Standard OD—Diameter..46.95—46.96 mm (1.848—1.849 in.)

Crankshaft Connecting Rod Journal OD Wear Limit—Diameter.. 41.90 mm (1.650 in.)

Crankshaft Main Bearing Journal OD Wear Limit—Diameter.. 46.90 mm (1.847 in.)



E—Main Bearing Journal **F—Connecting Rod Journals**

7. If journals are ground, undersize bearing inserts must be installed. Bearing inserts are available in 0.25 mm (0.010 in.) undersize.

8. Install bearing inserts and main bearing cap on main bearing. Tighten main bearing cap screws to specification.

Specification

Main Bearing Cap Screw Torque—Torque..76—82 N·m (56—60 lb.-ft.)

Continued on next page

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9. Measure main bearing diameter.
10. Subtract the crankshaft main bearing journal outer diameter from the main bearing inner diameter to obtain the main bearing oil clearance.

Specification

Main Bearing Standard Oil—Clearance .... 0.020-0.050 mm (0.001-0.002 in.)
Main Bearing Oil Wear Limit—Clearance .... 0.120 mm (0.005 in.)

- If crankshaft is within specification but main bearing oil clearance exceeds the wear limit, replace the bearing inserts.

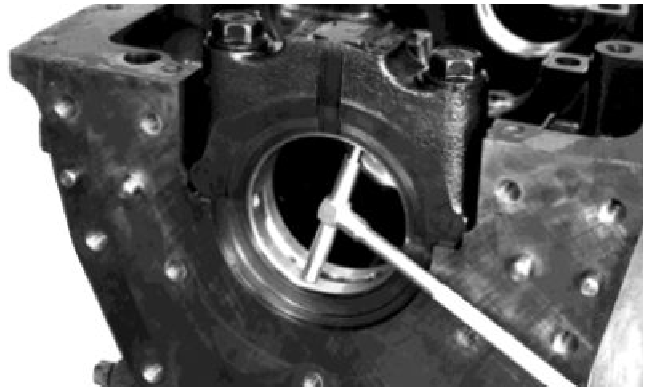
Specification

Main Bearing Oil Limit—Clearance .... 0.120 mm (0.005 in.)

- If crankshaft is not within specification, have crankshaft journals ground undersize by a qualified machine shop and install undersize bearing inserts.

Specification

Crankshaft Main Bearing Journal Standard OD—Diameter .... 46.95—46.96 mm (1.848—1.849 in.)



TCAL26247 —UN—15JUN12

Crankshaft Main Bearing Journal OD Wear Limit—Diameter .... 46.90 mm (1.847 in.)

- If crankshaft is worn past the wear limit, replace the crankshaft.

11. Clean and inspect oil passages in main bearing journals, connecting rod journals, and main bearing bores in cylinder block.
12. Inspect crankshaft for cracks or damage. Replace if necessary.

RB14256,0000871 -19-10JUN14-6/6

Crankshaft Main Bearing Clearance Check—3TNV76

NOTE: The engine must be removed to perform this test.

1. Remove the oil pan, oil pick-up, crankcase extension, and balancer assembly.

IMPORTANT: Main bearing caps must be installed to the same location and in the same direction to prevent crankshaft and main bearing damage.

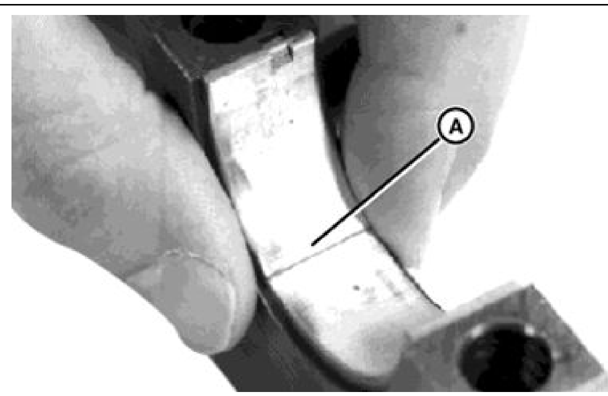
2. Remove the main bearing cap.
3. Wipe oil from the bearing insert and the crankshaft journal.

IMPORTANT: Rotating the crankshaft will cause PLASTIGAGE™ to smear, resulting in a false reading. Do not allow crankshaft to rotate after installing bearing cap.

4. Put a piece of Plastigage® (A), or equivalent, along the full width of the bearing insert approximately 6 mm (0.25 in.) off center.

NOTE: Lightly lubricate bolts with engine oil before installing.

Plastigage is a trademark of Perfect Circle Corporation



TCAL26248 —UN—15JUN12

A—Plastigage®

5. Install main bearing cap and bolts. Tighten bolts to specification.

Specification

Main Bearing Cap Screw —Torque .... 76—82 N·m (56—60 lb.-ft.)

6. Remove bolts and main bearing cap.

Continued on next page

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NOTE: The flattened Plastigage® will be found on either the bearing insert or crankshaft journal.

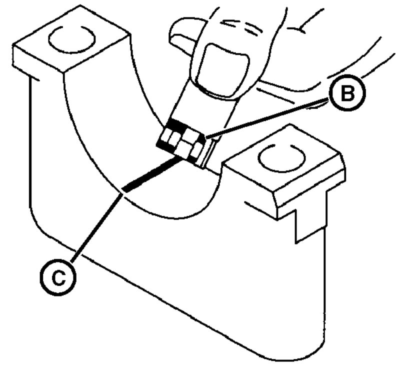
7. Use the graduation marks on the envelope (B) to compare the width of the flattened Plastigage® (C) at its widest point. The number within the graduation marks indicates the bearing clearance in inches or millimeters depending on which side of the envelope is used.

8. If clearance exceeds specification, replace main bearing.

Specification

Main Bearing Oil Clearance Wear Limit—Clearance .... 0.120 mm (0.005 in.)

9. Remove Plastigage®.



TCAL26249 —UN—15JUN12

B—Graduation Marks On The Envelope **C—Flattened Plastigage®**

RB14256,0000872 -19-24APR14-2/2

Cylinder Bore—3TNV76

Inspection

NOTE: If engine has had a previous major overhaul, the cylinders may have been bored oversize. Pistons and rings are available in 0.25 mm (0.010 in.) oversize.

1. Measure cylinder bore diameter at three positions: top (A), middle (B), and bottom (C). At these three positions, measure in both directions: along crankshaft centerline (D) and direction of crankshaft rotation (E).
2. If cylinder bore inner diameter exceeds wear limit, have cylinder rebored.

Specification

Standard Size Cylinder
Bore Standard ID—ID....................76.01—76.02 mm
(2.9925—2.9929 in.)
Standard Size Cylinder
Bore ID Wear Limit—ID.................... 76.20 mm
(3.000 in.)
Cylinder Roundness
Wear Limit—Roundness.................... 0.03 mm
(0.001 in.)
Cylinder Taper Wear
Limit—Taper.................... 0.03 mm
(0.001 in.)

3. If cylinder is rebored, oversize pistons and rings must be installed.
4. If cylinder bore exceeds oversize bore inner diameter, replace the cylinder block.

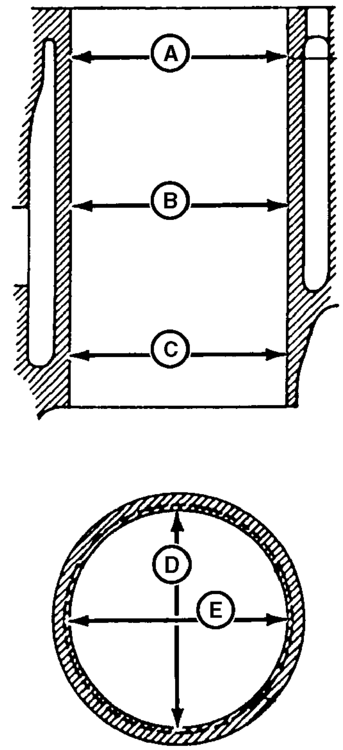
Specification

Oversize Cylinder Bore
Standard ID—ID....................76.26—76.27 mm
(3.0025—3.0029 in.)
Oversize Cylinder Bore
ID Wear Limit—ID.................... 76.45 mm
(3.010 in.)

5. If clearance (cylinder bore ID minus piston OD) exceeds specification, replace cylinder block, piston, or both, or rebore cylinder and install oversize pistons and rings.

Specification

Piston-to-Cylinder
Bore—Clearance....................0.03—0.05 mm
(0.001—0.002 in.)



TCAL26250 —UN—15JUN12

A—Top
B—Middle
C—Bottom
D—Crankshaft Centerline
E—Crankshaft Rotation

6. Slightly uneven wear, flaws, or minor damage may be corrected by deglazing.

Deglazing

IMPORTANT: If cylinder bores are to be deglazed with crankshaft installed in engine, put clean shop towels over crankshaft to protect journal and bearing surfaces from any abrasives.

1. Deglaze cylinder bores using a flex hone with 300-grit stone.

Continued on next page

RB14256,0000873 -19-24APR14-1/3

2. Use flex hone as instructed by manufacturer to obtain a 30-40° crosshatch pattern as shown.

IMPORTANT: Do not use gasoline, kerosene, or commercial solvents to clean cylinder bores. Solvents will not remove all abrasives from cylinder walls.

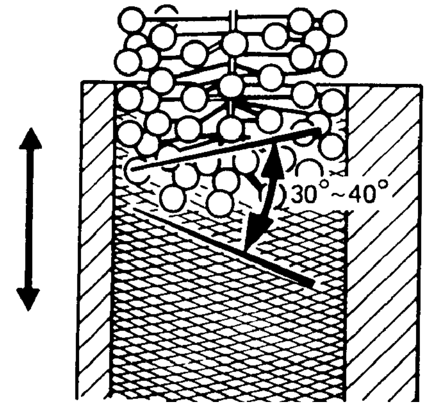
3. Remove excess abrasive residue from cylinder walls using a clean dry rag. Clean cylinder walls using clean white rags and warm soapy water. Continue to clean cylinder until white rags show no discoloration.

Reboring

NOTE: The cylinder block can be rebored to use oversize pistons and rings. Pistons and rings are available in 0.25 mm (0.010 in.) oversize.

1. Align center of bore to drill press center.

IMPORTANT: Follow hone manufacturer's recommendations for stone grit and rpm. Check stone for wear or damage.



TCAL26251 —UN—15JUN12

2. Adjust rigid hone so lower end is even with lower end of cylinder bore.
3. Adjust rigid hone stones until they contact narrowest point of cylinder.
4. Coat cylinder with honing oil. Rigid hone should turn by hand. Adjust if too tight.

RB14256,0000873 -19-24APR14-2/3

5. Run drill press at hone manufacturer's recommended rpm. Move rigid hone up and down in order to obtain a 30-40° crosshatch pattern.

NOTE: Measure bore when cylinder is cool.

6. Stop press and check cylinder diameter.

NOTE: Finish should not be smooth. It should have a 30-40° crosshatch pattern.

7. Remove rigid hone when cylinder is within 0.03 mm (0.001 in.) of desired size.

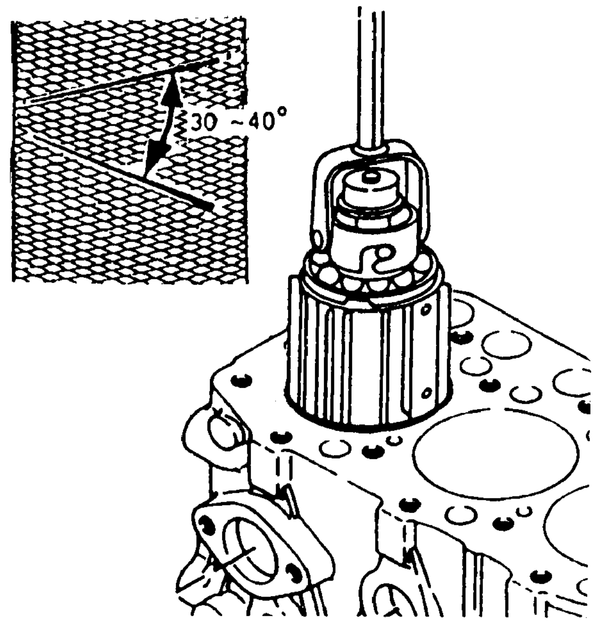
Specification

Oversize Cylinder Bore Standard ID—ID	76.26—76.27 mm (3.0025—3.0029 in.)

8. Use a flex hone with 300-grit stone, at manufacturer's recommended rpm, for honing to final size.
9. Check bore for size, taper, and out-of-round.

Specification

Oversize Cylinder Bore Standard ID—ID	76.26—76.27 mm (3.0025—3.0029 in.)
Cylinder Standard Roundness—Roundness	0.00—0.01 mm (0.0000—0.0004 in.)
Cylinder Standard Taper—Taper	0.00—0.01 mm (0.0000—0.0004 in.)



TCAL26252 —UN—15JUN12

IMPORTANT: Do not use solvents to clean cylinder bore. Solvents will not remove all metal particles and abrasives produced during honing.

10. Clean cylinder thoroughly using warm soapy water until clean white rags show no discoloration.

RB14256,0000873 -19-24APR14-3/3

Remove and Install Fuel Filter and Water Separator Assembly—3TNV76

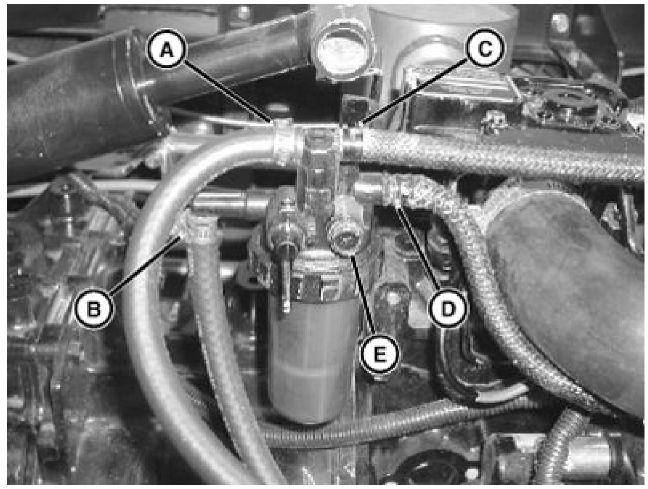
Removal

NOTE: Label hoses to avoid confusion during assembly.

1. Disconnect leak-off hose (A).
2. Disconnect fuel pump-to-fuel filter hose (B).
3. Disconnect fuel return-to-tank hose (C).
4. Disconnect fuel filter-to-injection pump hose (D).
5. Remove mounting cap screw (E).
6. Remove fuel filter/water separator assembly.

Installation

Installation is done in reverse order of removal.



TCAL26253 —UN—15JUN12

A—Leak-Off Hose
B—Fuel Pump-To-Fuel Filter Hose
C—Fuel Return-To-Tank Hose
D—Fuel Filter-To-Injection Pump Hose
E—Mounting Cap Screw

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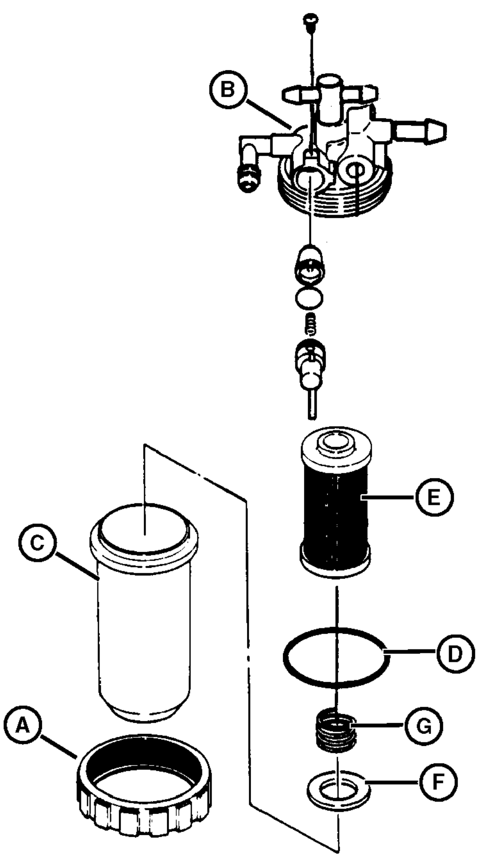
Assemble Fuel Filter and Water Separator—3TNV76

1. Remove the retaining ring (A) from the mounting base (B) while holding on to the filter cover (C).
2. Remove the filter cover from the mounting base.
3. Remove and replace O-ring (D) and filter element (E).
4. Be sure the ring (F) and spring (G) are in the filter cover.

IMPORTANT: Tighten retaining nut only enough to keep the filter assembly from leaking. Overtightening the nut may damage the filter cover or retaining ring.

5. Place the filter element on mounting base.
6. Install the filter cover and retaining ring.

A—Retaining Ring
B—Mounting Base
C—Filter Cover
D—O-Ring
E—Filter Element
F—Ring
G—Spring



TCAL26254 —UN—15JUN12

RB14256,0000875 -19-24APR14-1/1

Remove, Inspect, and Install Fuel Injection Nozzle—3TNV76

Special or Required Tools

- JDF13 Nozzle Cleaning Kit

Removal

CAUTION: Escaping fluid under high pressure can penetrate the skin and cause serious injury. Avoid the hazard by relieving pressure before connecting hydraulic or other lines. Tighten all connections before applying pressure.

- **Search for leaks with a piece of cardboard. Protect hands and body from high pressure fluids.**
- **If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available from Deere & Company Medical Department in Moline, Illinois, U.S.A. In the United States and Canada only, this information may be obtained by calling 1-800-822-8262.**

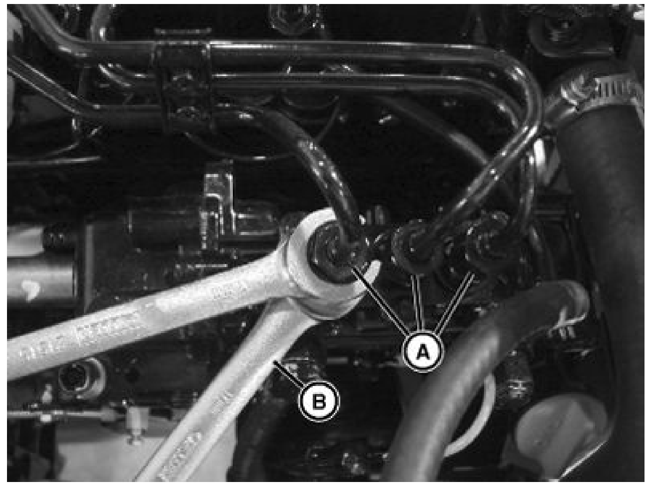
IMPORTANT: Never steam clean or pour cold water on injection pump while the pump is running, or engine is warm. Doing so can damage the pump.

When removing injection lines, Do not turn pump delivery valve fittings or leak-off fitting nuts. Turning fittings may damage parts internally. Always use a backup wrench when removing lines.

1. Clean the injection pump lines and area around the pump using a parts cleaning solvent or steam cleaner (cold engine).

NOTE: Nozzles are matched to the cylinders. If removing more than one nozzle, tag each nozzle, according to the cylinder from which it was removed.

2. Loosen fuel line connectors (A) at injection pump to release pressure in the fuel system. When loosening connectors, use a backup wrench (B) to prevent delivery valves from turning.



TCAL26255 —UN—15JUN12

A—Fuel Line Connectors **B—Backup Wrench**

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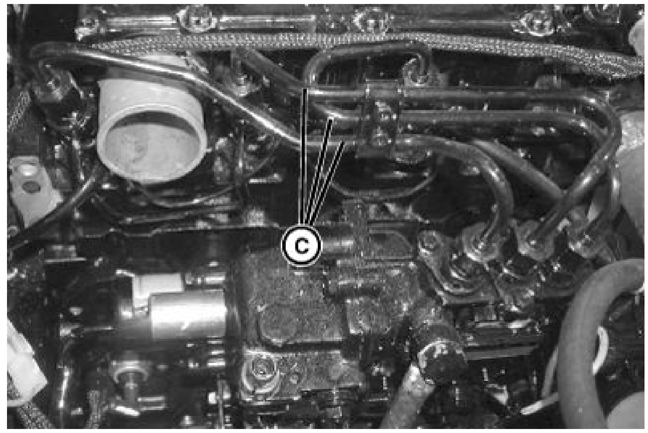
3. Remove fuel line nuts at injector nozzles and remove injection lines (C). When loosening line nuts, use a backup wrench to prevent fuel return line nuts from turning.

C—Remove Injection Lines



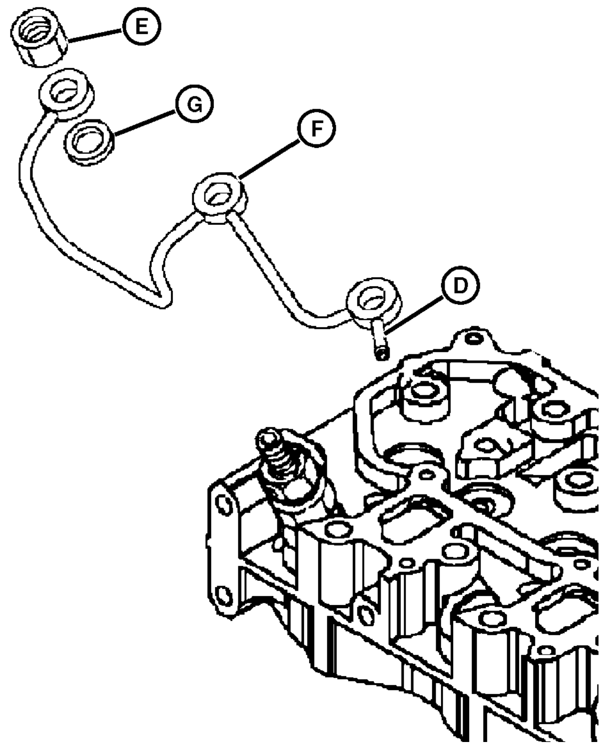
TCAL26256 —UN—15JUN12

RB14256,0000876 -19-24APR14-2/7

IMPORTANT: Leak-off lines are a one-piece assembly connected to all three fuel injectors. Use care not to bend or twist the leak-off lines when removing.

4. Disconnect leak-off return hose from end of leak-off line assembly (D).
5. Remove nut (E) from each injector.
6. Remove leak-off line assembly (F).
7. Remove bronze washers (G).

D—End Of Leak-Off Line Assembly
E—Nut
F—Leak-Off Line Assembly
G—Bronze Washers



TCAL26257 —UN—15JUN12

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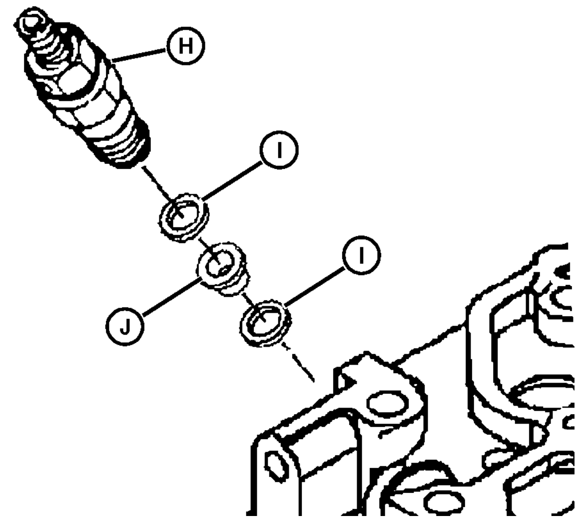
RB14256,0000876 -19-24APR14-3/7

8. Remove injection nozzle (H).
9. Remove washers (I) and heat protector (J).
10. Test injection nozzles. (See Test Fuel Injection Nozzle.)



H—Injection Nozzle
I— Washers
J— Heat Protector

Installation

Installation is done in the reverse order of removal.

- Replace all heat protectors and washers.
- Tighten injection nozzle to specification.

Specification

Injection Nozzle
Torque—Torque..49—59 N·m
(36—43 lb.-ft.)

- Tighten leak-off fitting nut to specification.

Specification

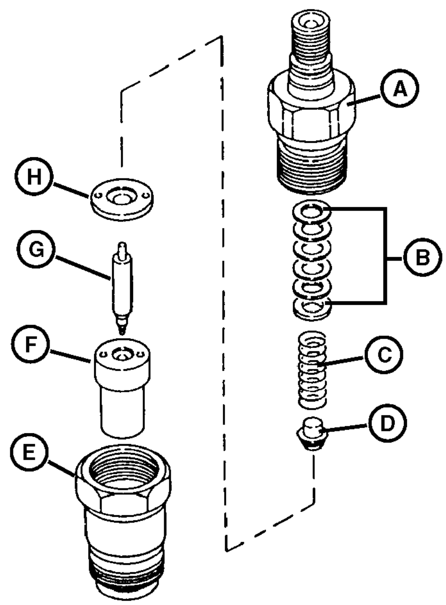
Leak-Off Fitting Nut
Torque—Torque..24—33 N·m
(18—24 lb.-ft.)

Repair

IMPORTANT: If injection nozzles are disassembled to be cleaned, the same number and thickness of shims must be installed.

NOTE: If servicing more than one nozzle, keep parts for each nozzle separate from one another.

- Clean and inspect nozzle assembly.
- After assembly is complete, test injection nozzle. (See Test Fuel Injection Nozzle.)



A—Injector Body
B—Shims (as required)
C—Spring
D—Spring Seat
E—Nozzle Fitting
F—Nozzle Body
G—Nozzle Valve
H—Separator Plate

Continued on next page

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Injection Nozzle Cross Section

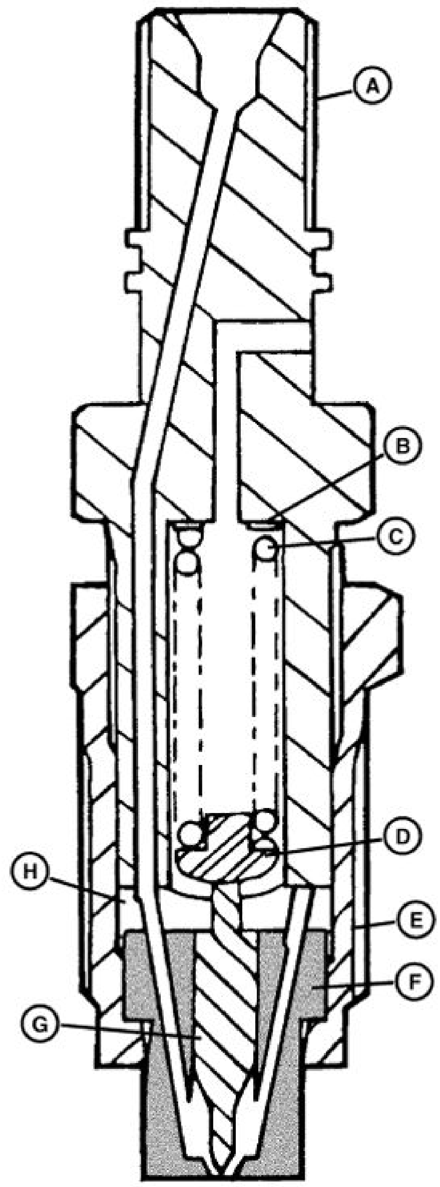
Cleaning and Inspection

NOTE: To clean nozzles properly, JDF13 Nozzle Cleaning Kit is recommended. The Cleaning Kit is available through the John Deere SERVICEGARD™ Catalog.

1. Remove anti-corrosive grease from new or reconditioned nozzles by washing them thoroughly in diesel fuel.

IMPORTANT: Never use a steel brush to clean nozzles as this will distort the spray hole.

2. Remove carbon from used nozzles, and clean by washing in diesel fuel. If parts are coated with hardened carbon or lacquer, it may be necessary to use a brass wire brush (supplied in JDF13 Nozzle Cleaning Kit).
3. After removing carbon or lacquer from the exterior of nozzle, inspect sealing surfaces between separator plate and nozzle body for nicks or scratches.



TCAL26260 —UN—15JUN12

A—Injector Body
B—Shims (as required)
C—Spring
D—Spring Seat
E—Nozzle Fitting
F—Nozzle Body
G—Nozzle Valve
H—Separator Plate

Continued on next page

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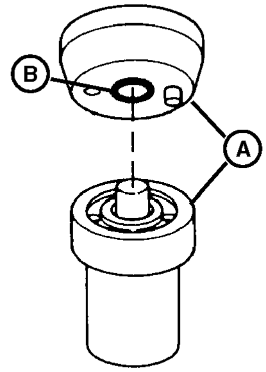
4. Inspect condition of separator plate and nozzle body. Contact area of separator plate (A) (both parts) must not be scored or pitted. Use an inspection magnifier (No. 16487 or equivalent) to aid in making the inspection.
5. Check nozzle contact surface (B) on separator plate for wear. If contact surface is more than the specified measurement, replace nozzle assembly.

Specification

Separator Plate Contact
Surface—Thickness.. 0.10 mm
(0.004 in.)



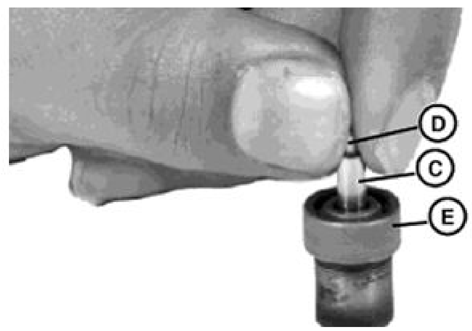
A—Contact Area Of Separator Plate **B—Nozzle Contact Surface**

RB14256,0000876 -19-24APR14-6/7

6. Inspect the piston (C) (large) part of nozzle valve to see that it is not scratched or scored and that lower (tip) end of valve is not broken. If any of these conditions are present, replace the nozzle assembly.
7. Further inspect the nozzle assembly by performing a slide test.
   - Dip the nozzle valve (D) in clean diesel fuel. Insert valve in nozzle body (E).
   - Hold nozzle vertical, and pull valve out about 1/3 of its engaged length.
   - Release valve. Valve should slide down to its seat by its own weight.
8. Replace nozzle assembly if the valve does not slide freely to its seat.

Specifications—Specification

Nozzle Fitting
Torque—Thickness..29—49 N·m
(21—36 lb.-ft.)



C—Piston
D—Nozzle Valve
E—Nozzle Body

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Remove and Install Fuel Injection Pump—3TNV76

Removal

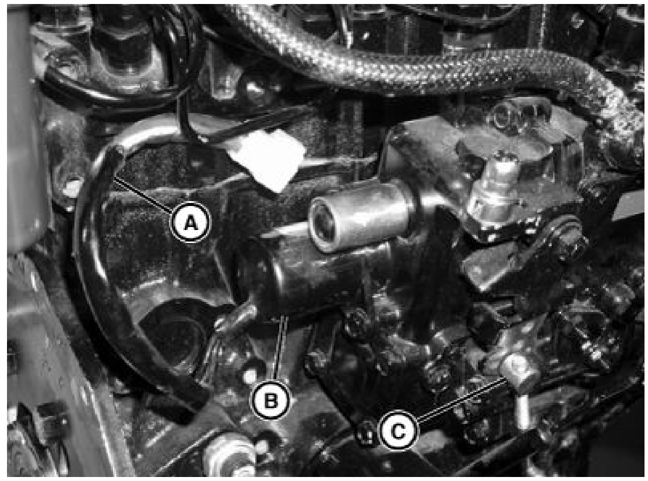
CAUTION: Escaping fluid under high pressure can penetrate the skin and cause serious injury. Avoid the hazard by relieving pressure before connecting hydraulic or other lines. Tighten all connections before applying pressure.

- **Search for leaks with a piece of cardboard. Protect hands and body from high pressure fluids.**
- **If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available from Deere & Company Medical Department in Moline, Illinois, U.S.A. In the United States and Canada only, this information may be obtained by calling 1-800-822-8262.**

CAUTION: Do not attempt to remove the CARB/EPA Certified Emissions fuel injection pump unless you are a factory trained technician with authorization to service CARB/EPA Certified Emissions engines.

IMPORTANT: Never steam clean or pour cold water on injection pump while pump is running or warm. Doing so can damage the pump.

1. Park machine on level surface with park brake locked and key switch off.
2. Turn the fuel shutoff valve on the fuel filter/water separator to the closed position.
3. Clean the injection pump lines and area around the pump using a parts cleaning solvent or steam cleaner (cold engine).
4. Remove tie straps as needed.
5. Disconnect the electrical lead (A) to the fuel shutoff solenoid (B).
6. Remove throttle linkage (C).



TCAL26263 —UN—15JUN12

Electrical lead and throttle linkage are shown disconnected.

A—Electrical Lead
B—Fuel Shutoff Solenoid
C—Throttle Linkage

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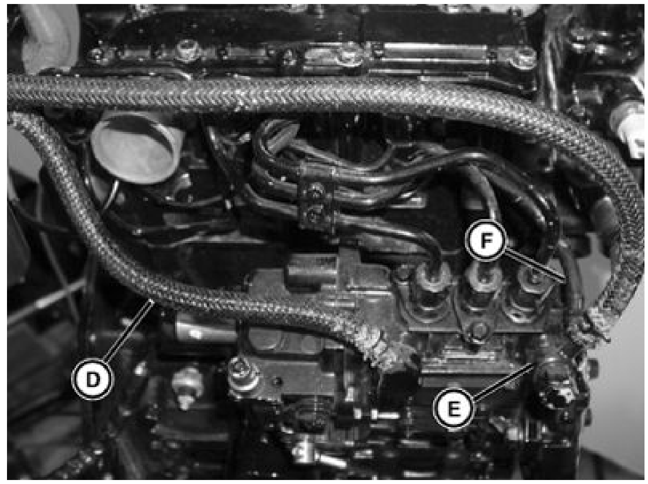
7. Disconnect and plug injection pump supply line (D).
8. Disconnect and plug injection pump-to-fuel filter return line (E).
9. Disconnect and plug fuel injector-to-injection pump return line (F).

D—Injection Pump Supply Line
E—Injection Pump-To-Fuel Filter Return Line
F—Fuel Injector-To-Injection Pump Return Line



TCAL26264 —UN—15JUN12

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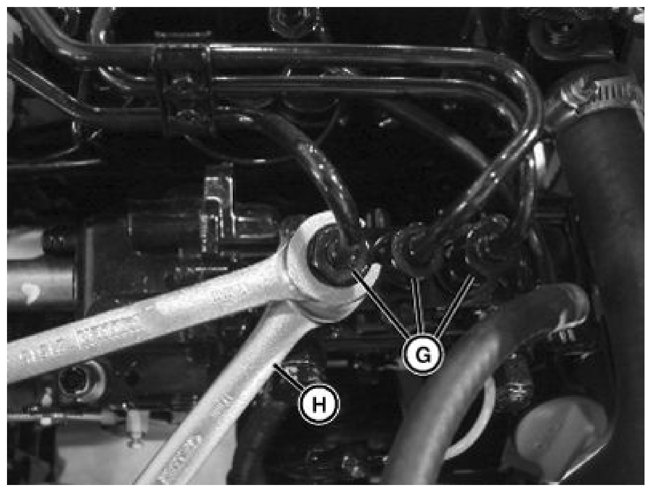
10. Loosen fuel line connectors (G) at injection pump to release pressure in the fuel system. When loosening connectors, use a backup wrench (H) to prevent delivery valves from turning.

G—Fuel Line Connectors
H—Backup Wrench



TCAL26265 —UN—15JUN12

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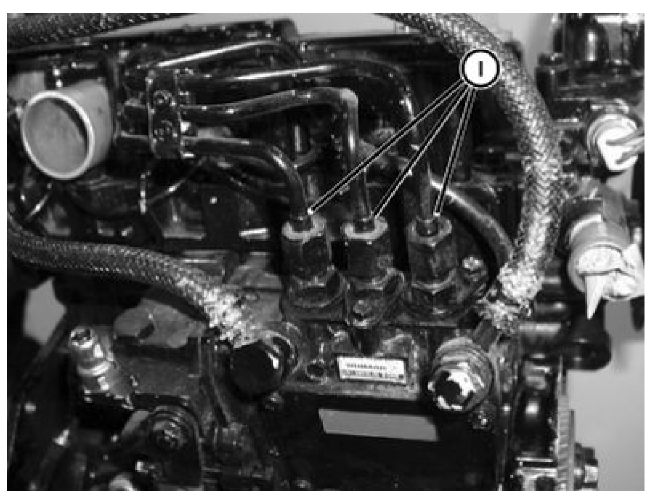
11. Remove fuel line nuts at injector nozzles and injection pump. When loosening line nuts, use a backup wrench to prevent fuel return line nuts from turning. Remove injection lines (I).

I— Injection Lines



TCAL26266 —UN—15JUN12

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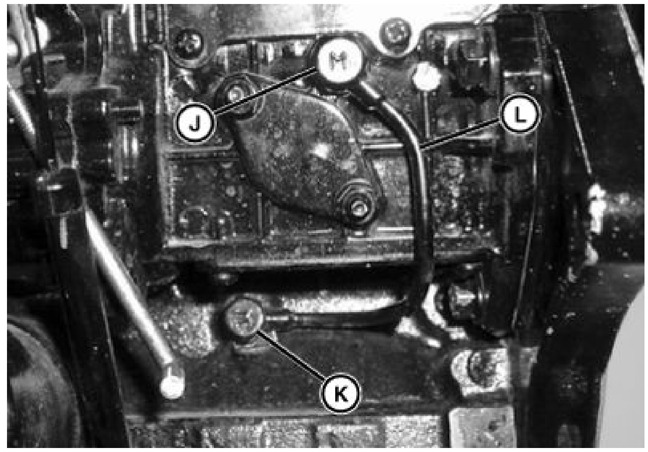
NOTE: Oil supply line has a bronze washer on each side. Do not lose washer when removing fittings.

12. Remove oil fitting (J) from injection pump.
13. Remove oil fitting (K) from side of engine.
14. Remove oil supply line (L).

J—Oil Fitting From Injection Pump
K—Oil Fitting From Side Of Engine
L—Oil Supply Line

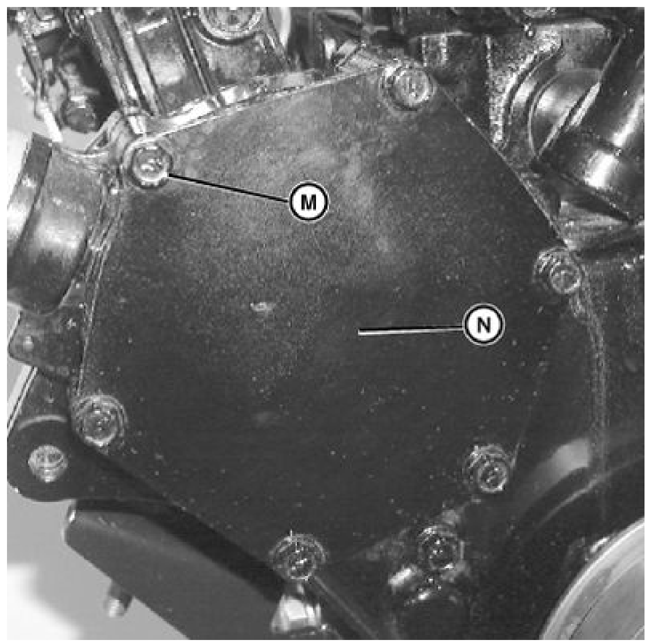


TCAL26267 —UN—15JUN12

RB14256,0000877 -19-19JUN14-5/10

15. Remove six cap screws (M) and injection pump drive cover (N).

M—Six Cap Screws
N—Injection Pump Drive Cover



TCAL26268 —UN—15JUN12

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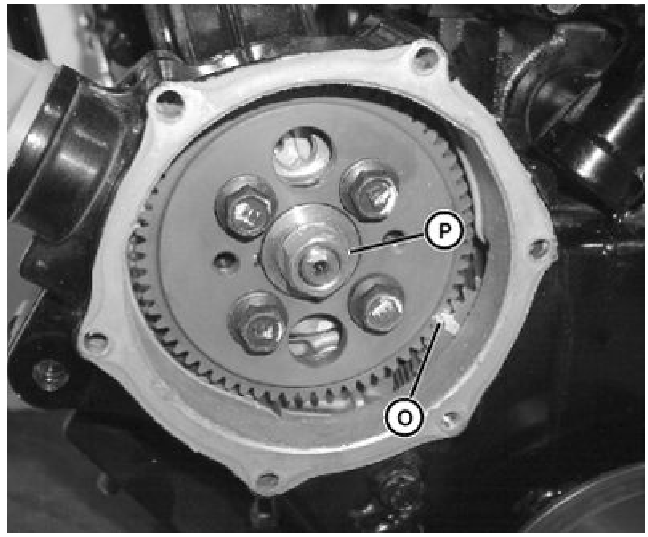
RB14256,0000877 -19-19JUN14-6/10

IMPORTANT: Do not loosen or remove the four cap screws that hold the drive gear to the drive hub. Injection pump timing will be changed.

Do not rotate engine after marking timing gears.

16. Place alignment marks on gears (O) at the point that the gears mesh.
17. Without turning gears, remove drive gear retaining nut and lock washer (P).
18. Reinstall retaining nut, without lock washer, until nut is flush with end of drive shaft.

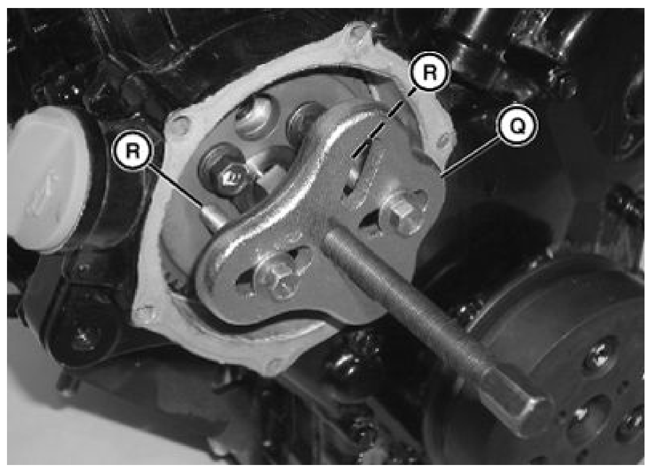


TCAL26269 —UN—15JUN12

O—Alignment Marks On Gears
P—Retaining Nut And Lock Washer

RB14256,0000877 -19-19JUN14-7/10

19. Attach an appropriate puller (Q) to the drive gear using the two threaded holes (R) in drive gear.
20. Pull drive gear until it “pops” loose from tapered drive shaft.
21. Remove puller and retaining nut. Ensure drive gear is loose on drive shaft, but do not remove drive gear from gear case.



TCAL26270 —UN—15JUN12

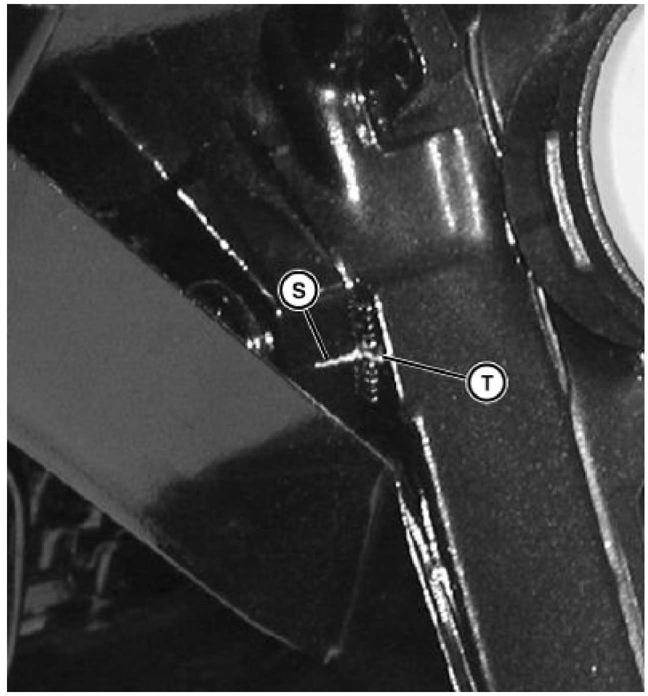
Q—Puller
R—Two Threaded Holes

Continued on next page

RB14256,0000877 -19-19JUN14-8/10

IMPORTANT: Injection pump must be reinstalled with timing marks aligned exactly as it was removed.

22. Note exact location of injection pump timing mark (S) in relation to gear case timing scale (T).

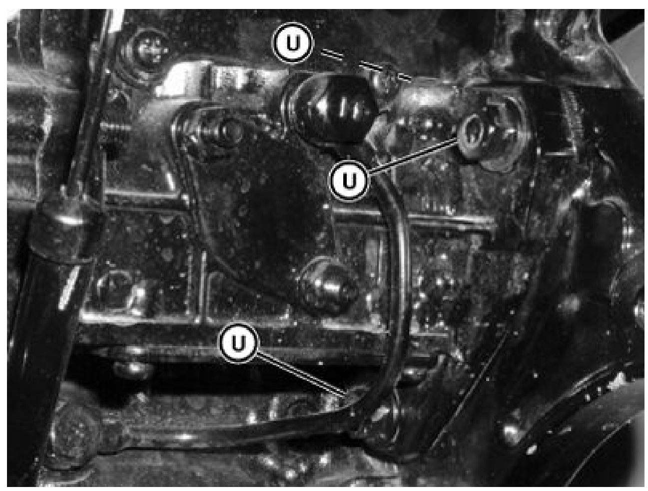


TCAL26271 —UN—15JUN12

S—Injection Pump Timing Mark T—Gear Case Timing Scale

RB14256,0000877 -19-19JUN14-9/10

23. Remove three injection pump mounting nuts (U) and remove injection pump.



TCAL26272 —UN—15JUN12

U—Three Injection Pump Mounting Nuts

Installation

CAUTION: Do not attempt to adjust the CARB/EPA Certified Emissions fuel injection pump unless you are a factory trained technician with authorization to service CARB/EPA Certified Emissions engines.

1. Install fuel injection pump. Installation is done in the reverse order of removal.

   a. Tighten injection pump mounting nuts to specification.

Specification

Injection Pump Mounting Nut Torque—Torque....23—28 N·m (17—21 lb.-ft.)

   b. Tighten drive gear nut to specification.

Specification

Injection Pump Drive Gear Nut Torque—Torque....59—69 N·m (44—51 lb.-ft.)

   c. Tighten high-pressure fuel line nuts to specification.

Specification

High-Pressure Line Nut Torque—Torque....29—34 N·m (22—25 lb.-ft.)

2. If new injection pump is being installed, check and adjust injection pump timing. (See Injection Pump Static Timing.)

3. Bleed fuel system. (See Bleed Fuel System.)

RB14256,0000877 -19-19JUN14-10/10

Remove and Install Fuel Shutoff Solenoid—3TNV76

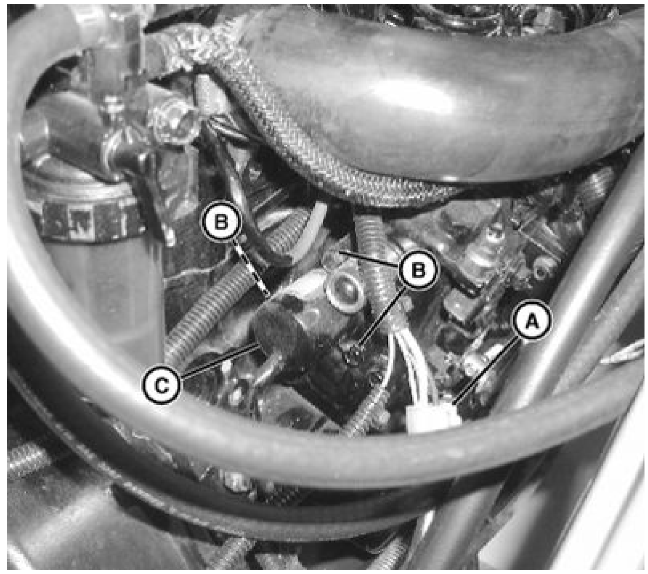
Removal

1. Park machine on level surface, park brake locked, key switch in off position.
2. Clean around the fuel shutoff solenoid using a parts cleaning solvent or steam cleaner.
3. Disconnect the electrical lead (A) to the fuel shutoff solenoid.
4. Remove three mounting cap screws (B) and remove fuel shutoff solenoid (C).
5. Test fuel solenoid. (See Fuel Shutoff Solenoid Test—Diesel Engine.)

Installation

NOTE: Replace O-ring on solenoid before installing. Used O-rings will leak.

Install fuel shutoff solenoid. Installation is done in the reverse order of removal.



TCAL26273 —UN—15JUN12

A—Electrical Lead
B—Mounting Cap Screws
C—Fuel Shutoff Solenoid

RB14256,0000878 -19-24APR14-1/1

Remove and Install Fuel Pump—3TNV76

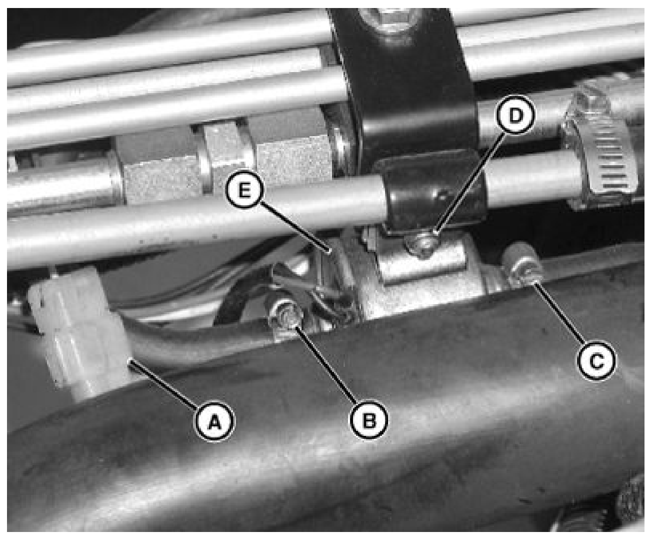
Removal

1. Park machine safely. See the “Safety Section”.
2. Disconnect negative (-) battery cable.
3. Disconnect connector (A) to fuel pump.
4. Disconnect supply hose from fuel tank (B).
5. Disconnect fuel pump-to-fuel filter hose (C).
6. Remove locknut (D) and bolt.
7. Remove fuel pump (E).

Installation

Installation is done in the reverse order of removal.

- Bleed air from fuel system. (See Bleed Fuel System.)



TCAL26274 —UN—15JUN12

A—Connector
B—Supply Hose From Fuel Tank
C—Fuel Pump-To-Fuel Filter Hose
D—Locknut
E—Fuel Pump

RB14256,0000879 -19-24APR14-1/1

Remove and Install Alternator—3TNV76

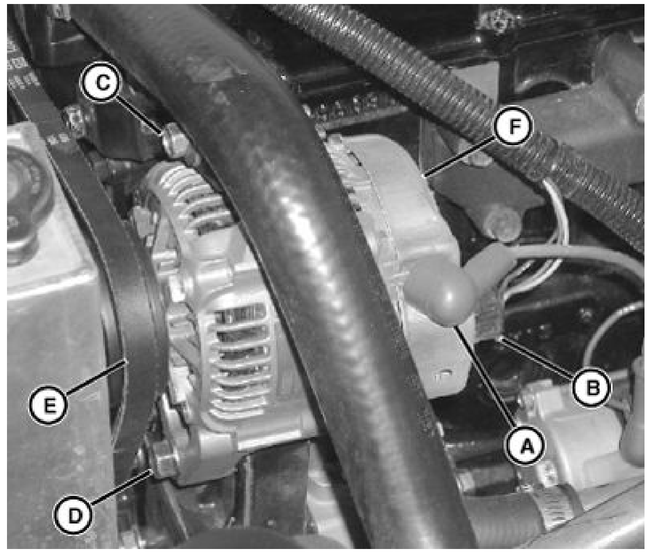
Removal

1. Park machine safely. See the “Safety Section”.
2. Raise attachment to service position. Install lift cylinder safety support.
3. Disconnect negative (-) battery cable.
4. Disconnect red wire (A) from alternator.
5. Disconnect harness connector (B).
6. Loosen top cap screw (C) and mounting bracket cap screw (D) and push alternator toward engine to loosen belt.
7. Remove drive belt (E) from alternator pulley.
8. Remove top cap screw and mounting bracket cap screw.
9. Remove alternator (F).

Installation

Installation is done in the reverse order of removal.

- Adjust belt tension. (See Adjust Alternator—Fan and Coolant Pump Drive Belts.)



TCAL26275 —UN—15JUN12

A—Red Wire
B—Harness Connector
C—Top Cap Screw
D—Mounting Bracket Cap Screw
E—Drive Belt
F—Alternator

RB14256,000087A -19-24APR14-1/1

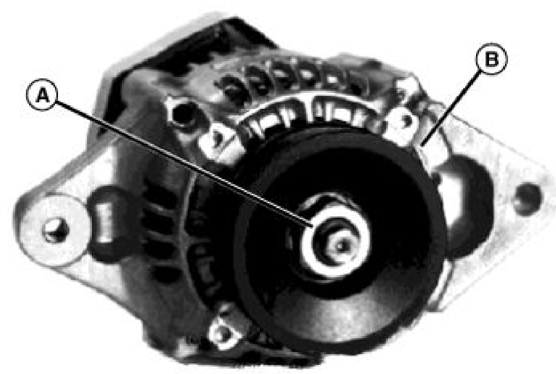
Inspect and Repair Alternator—3TNV76

Disassembly

NOTE: Clamp pulley in soft-jawed vise and use air impact wrench to remove pulley nut.

1. Remove pulley nut (A).
2. Use puller to remove pulley (B).

A—Pulley Nut **B—Pulley**



TCAL26276 —UN—15JUN12

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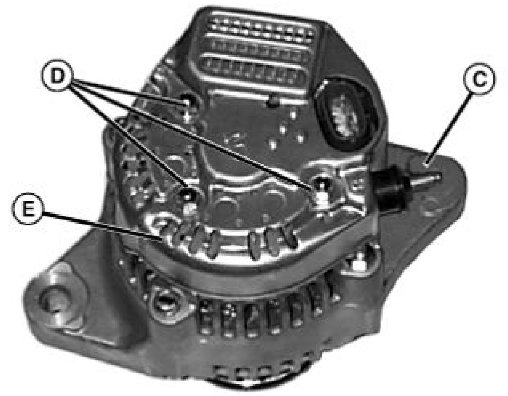
RB14256,000087B -19-24APR14-1/10

3. Remove nut, washer, and insulator from battery terminal post (C).
4. Remove three screws (D) securing cover to body. Remove cover (E).

C—Battery Terminal Post
D—Three Screws
E—Cover



TCAL26277 —UN—15JUN12

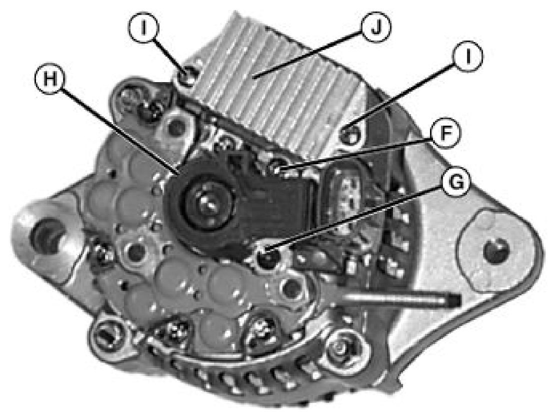
RB14256,000087B -19-24APR14-2/10

5. Remove the short screw (F) and the long screw (G) securing brush holder and cover (H) to body. Remove brush holder and cover.

NOTE: Remember location of short screw on regulator tab.

6. Remove the two screws (I) securing regulator to body. Remove regulator (J).

F—Short Screw
G—Long Screw
H—Brush Holder And Cover
I— Two Screws
J—Regulator

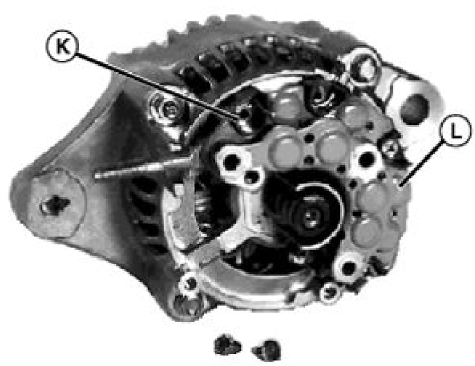


TCAL26278 —UN—15JUN12

RB14256,000087B -19-24APR14-3/10

7. Remove screw and straighten wire leads (K).
8. Remove rectifier (L).

K—Wire Leads
L—Rectifier



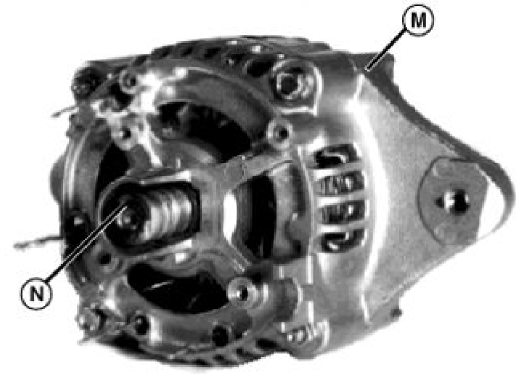
TCAL26279 —UN—15JUN12

Continued on next page

RB14256,000087B -19-24APR14-4/10

9. Remove rear case assembly (M).
10. Press rotor shaft (N) from rear case.

M—Rear Case Assembly **N—Rotor Shaft**

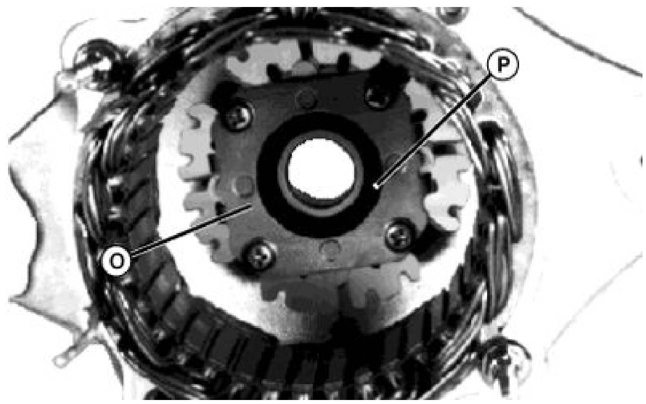


TCAL26280 —UN—15JUN12

RB14256,000087B -19-24APR14-5/10

11. Remove retainer plate (O).
12. Press bearing (P) from case.

O—Retainer Plate **P—Bearing**



TCAL26281 —UN—15JUN12

RB14256,000087B -19-24APR14-6/10

Inspection

1. Inspect bearing (Q) for smooth rotation. Replace if necessary.
2. Inspect slip rings (R) for dirt or rough spots. If necessary, use No. 00 sandpaper or 400-grit silicon carbide paper to polish rings.
3. Measure outer diameter of slip rings. Replace rotor if not within specification.

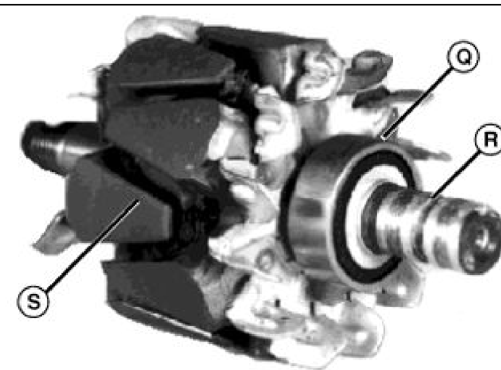
Specification

Rotor Slip Ring
(Min)—Diameter.. 14 mm
(0.55 in.)

4. Check continuity between slip rings using ohmmeter or continuity tester. Replace rotor assembly if there is no continuity.
5. Check continuity between slip rings and rotor core (S). Replace rotor assembly if there is continuity.

NOTE: Use an ohmmeter that is sensitive to 0-1 ohm.

6. Inspect stator for defective insulation, discoloration, or burned odor.



TCAL26282 —UN—15JUN12

Q—Bearing
R—Slip Rings
S—Rotor Core

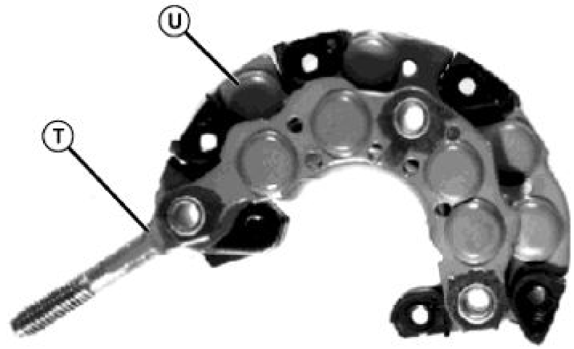
7. Check for continuity between each stator lead and body. Replace stator if there is continuity.

Continued on next page RB14256,000087B -19-24APR14-7/10

NOTE: Set ohmmeter to the k-ohm range.

8. Check continuity between main lead (T) and each diode lead (U). Reverse ohmmeter leads and recheck. There is continuity in one direction, but not the other. Replace diodes or rectifier plate if bad.

T—Main Lead **U—Diode Lead**



TCAL26283 —UN—15JUN12

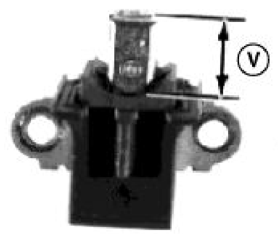
RB14256,000087B -19-24APR14-8/10

9. Measure length of brush (V) protruding from holder. Dimensions need to be within specifications. Replace brushes if worn below minimum.

Specification

Exposed Brush Length (Min)—Height	4.50 mm (0.17 in.)
Exposed Brush Length (Max)—Height	10.50 mm (0.41 in.)

V—Brush



TCAL26284 —UN—15JUN12

RB14256,000087B -19-24APR14-9/10

10. Check continuity between brush and terminal (W). Check continuity between brush and terminal (X). There should be continuity only at these points.

Assembly

Assembly is done in the reverse order of disassembly.

NOTE: Check that rotor fan does not contact case and that rotor assembly turns smoothly in bearing.

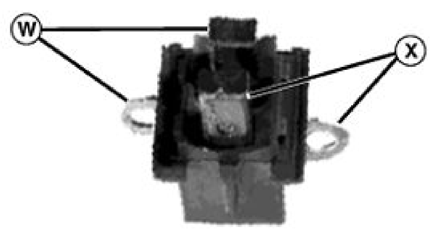
IMPORTANT: Check that short screw (F) is installed in regulator tab. Longer screw (G) will contact frame and will cause damage to the charging system.

Clamp pulley in soft-jawed vise. Install pulley nut. Tighten to specification.

Specification

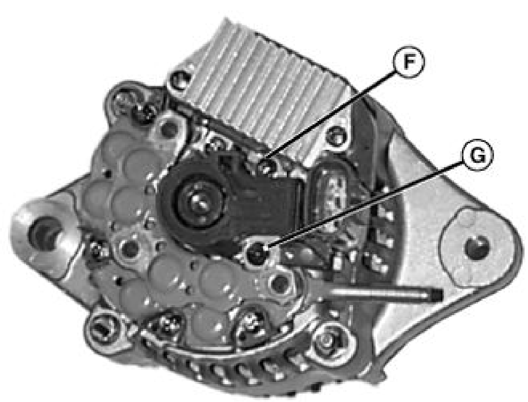
Pulley Nut—Torque	69 N·m (51 lb.-ft.)

F—Short Screw **G—Longer Screw**



TCAL26285 —UN—15JUN12

W—terminal **X—terminal**



TCAL26286 —UN—15JUN12

RB14256,000087B -19-24APR14-10/10

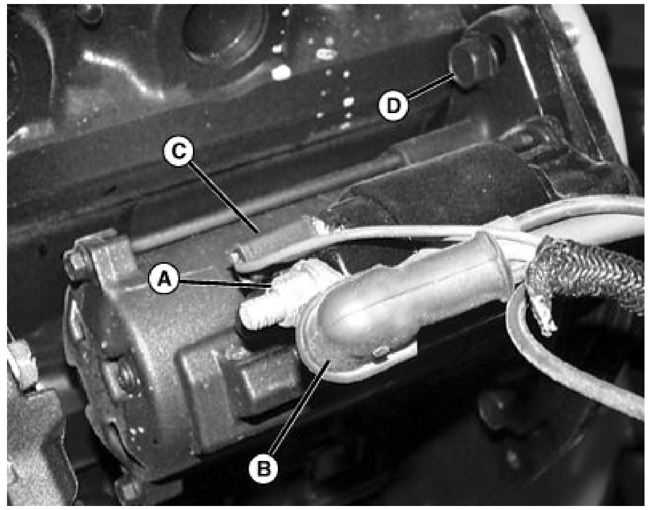
Remove and Install Starting Motor—3TNV76

Removal

1. Park vehicle on a hard, level surface. Lock park brake.

NOTE: Disconnect negative (-) battery cable first.

2. Disconnect negative (-) battery cable at the battery.
3. Remove nut (A) from starting motor solenoid battery terminal.
4. Remove positive (+) battery cable and wires (B) from solenoid terminal.
5. Disconnect purple wire (C) from solenoid signal terminal.
6. Remove two cap screws (D) and starter.



TCAL26287 —UN—15JUN12

Gas Shown, Diesel Similar

A—Nut
B—Battery Cable And Wires
C—Purple Wire
D—Two Cap Screws

Installation

Installation is done in the reverse order of removal.

NOTE: Connect negative (-) battery cable last.

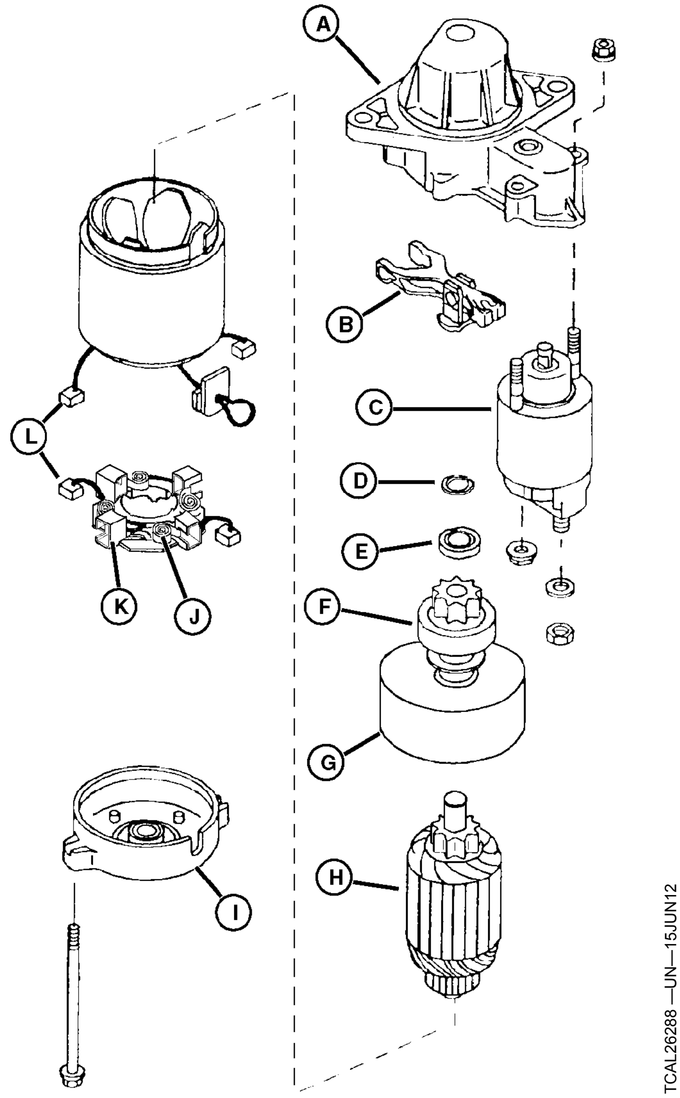
- Tighten cap screws to specifications.

Specification	
Starting Motor Cap Screw—Torque	24 N·m (216 lb.-in.)

- Clean all battery cable connections before installing cable.

RB14256,000087C -19-24APR14-1/1

Inspect and Repair Starting Motor—3TNV76



A—Front Cover
B—Shift Lever
C—Solenoid
D—Retaining Clip
E—Pinion Stopper
F—Pinion
G—Planetary Gear Assembly
H—Armature
I— End Cover
J— Brush Spring
K—Brush Holder
L—Brush

Analyze Condition

The starter overheats because of:

- Long cranking
- Armature binding

The starter operates poorly because of:

- Armature binding
- Dirty or damaged starter drive.
- Badly worn brushes or weak brush springs
- Excessive voltage drop in cranking system
- Battery or wiring defective
- Shorts, opens, or grounds in armature

NOTE: Starter repair is limited to brushes, end caps, and starter drive. Fields in starter are permanent magnets and are not serviceable. If housing or armature is damaged, replace starter.

Disassembly

1. Mark body and covers for correct alignment during reassembly.
2. Remove the two nuts securing the solenoid to the front cover.
3. Tip the terminal end of the solenoid in toward the starter housing while pulling the solenoid away from the front cover.
4. Remove the two screws from the end cover.
5. Remove the through bolts securing the starting motor body together.
6. Carefully pull the sections apart.
7. Inspect parts for wear or damage.
8. Test solenoid, starter armature, and brushes. (See Starting Motor Solenoid Test.)

Assembly

Assembly is done in the reverse order of disassembly.

Apply a thin coat of multipurpose grease to:

- Sliding surfaces of armature and solenoid shift lever.
- Armature shaft spline.
- Points where shaft contacts cover.

Continued on next page

RB14256,000087D -19-19JUN14-1/6

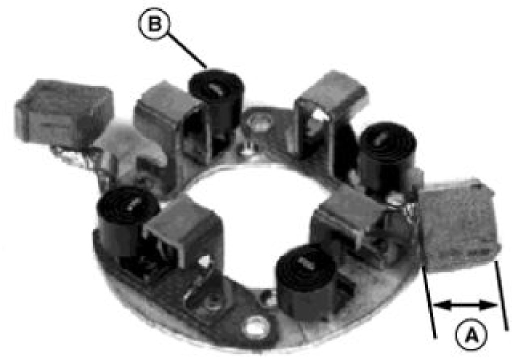
Inspection and Test

1. Measure field coil brush lengths (A). If any one brush length is less than minimum specification, replace all four brushes.

Specification

Field Coil Brush Length
Minimum—Length.. 10.50 mm
(0.413 in.)

2. Inspect brush springs (B) for wear or damage. Replace if necessary.

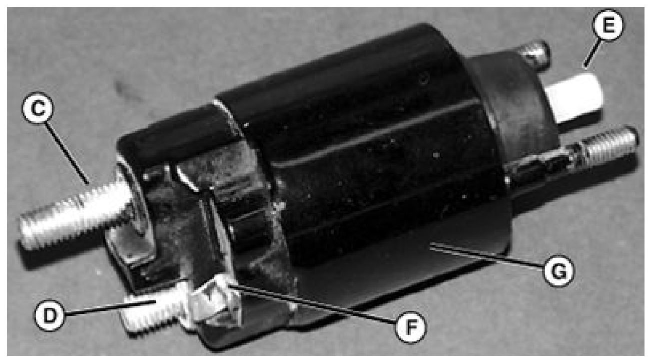


TCAL26289 —UN—15JUN12

A—Field Coil Brush Lengths **B—Brush Springs**

RB14256,000087D -19-19JUN14-2/6

3. Test solenoid terminals (C and D) for continuity. There should be no continuity.
4. Depress switch plunger (E). There should be continuity when plunger is fully depressed.
5. Test for open circuits between terminal (D) and tang (F). There should be continuity.
6. Test for open circuits between tang (F) and body (G). There should be continuity.
7. If solenoid fails any test, it is defective and must be replaced.

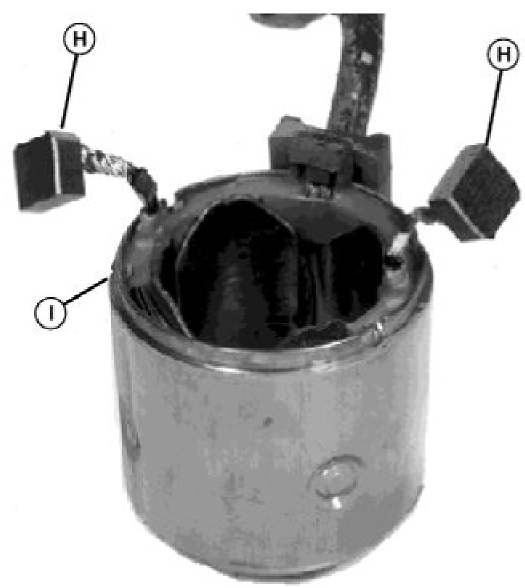


TCAL26290 —UN—15JUN12

C—Solenoid Terminal
D—Solenoid Terminal
E—Switch Plunger
F—Tang
G—Body

RB14256,000087D -19-19JUN14-3/6

8. Test for grounded field winding:
   - Touch one probe of tester to field coil brush (H) and other probe to field coil housing (I).
   - Be sure the brush lead is not touching the frame. If there is continuity, the coil is grounded and the field coil housing assembly must be replaced.
9. Test for open field coil:
   - Touch one probe of tester to each field coil brush (H).
   - If there is no continuity, the field coil is open and the field coil housing assembly must be replaced.



TCAL26291 —UN—15JUN12

H—Field Coil Brush **I— Field Coil Housing**

Continued on next page

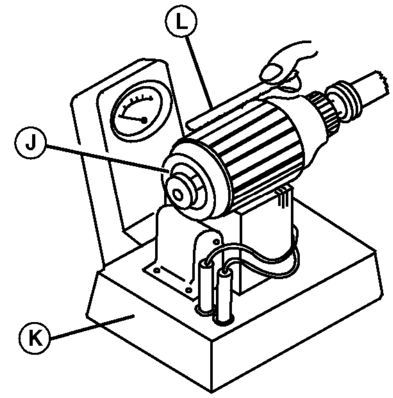
RB14256,000087D -19-19JUN14-4/6

IMPORTANT: DO NOT clean armature with solvent. Solvent can damage insulation on windings. Use only mineral spirits and a brush.

10. Locate short circuits by rotating armature (J) on a growler (K) while holding a hacksaw blade or steel strip (L) on armature. The hacksaw blade will vibrate in area of short circuit.

NOTE: Shorts between bars are sometimes caused by dirt or copper between bars. Inspect for this condition.

11. If test indicates short-circuited windings, clean the commutator of dust and filings. Check armature again. If test still indicates short circuit, replace armature.



TCAL26292 —UN—15JUN12

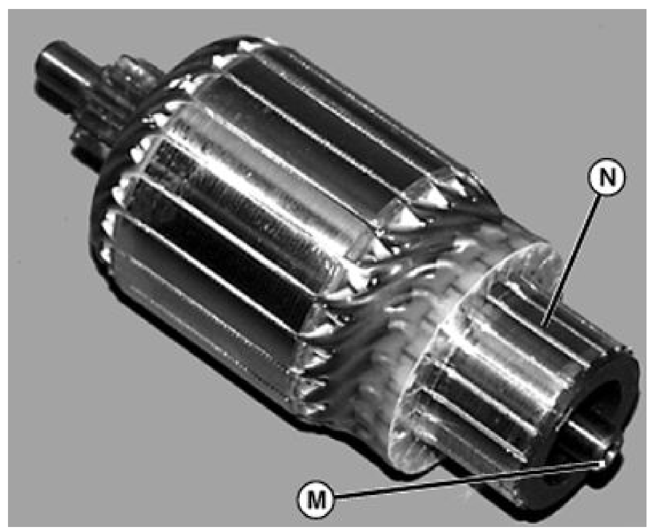
J— Armature
K—Growler
L—Hacksaw Blade Or Steel Strip

RB14256,000087D -19-19JUN14-5/6

12. Test for grounded windings using an ohmmeter. Touch one probe to the armature shaft (M) and the other probe on each commutator bar (N). Armature windings are connected in parallel, so each commutator bar needs to be checked. If test shows continuity, a winding is grounded and the armature must be replaced.

13. Test for open-circuited windings using an ohmmeter. Touch one probe on a commutator bar (N) and the other probe on each remaining commutator bar. Armature windings are connected in parallel, so each commutator bar needs to be checked. If test shows no continuity, there is an open circuit and the armature must be replaced.

M—Armature Shaft
N—Commutator Bar



TCAL26293 —UN—15JUN12

RB14256,000087D -19-19JUN14-6/6

Specifications

Item	Measurement	Specification
Engine Mounting		
Engine-to-Subframe Mounting Cap Screw	Torque	75 N·m (55 lb.-ft.)
Camshaft		
Camshaft	Bend	0.00—0.02 mm (0.00—0.0008 in.)
Camshaft (Wear Limit)	Bend	0.05 mm (0.002 in.)
Camshaft Lobe	Height	34.535—34.665 mm (1.3596—1.3647 in.)
Camshaft Lobe (Wear Limit)	Height	34.29 mm (1.35 in.)
Camshaft Thrust Plate Cap Screw	Torque	11 N·m (96 lb.-in.)
Camshaft	End Play	0.05—0.15 mm (0.002—0.006 in.)
Camshaft (Wear Limit)	End Play	0.25 mm (0.0098 in.)
Camshaft Followers	OD	20.94—20.96 mm (0.824—0.825 in.)
Camshaft Followers (Wear Limit)	OD	20.91 mm (0.823 in.)
Camshaft Follower Bore	ID	21.00—21.02 mm (0.827—0.828 in.)
Camshaft Follower Bore (Wear Limit)	ID	21.04 mm (0.828 in.)
Follower to Bore	Oil Clearance	0.040—0.082 mm (0.0016—0.0032 in.)
Follower to Bore (Wear Limit)	Oil Clearance	0.134 mm (0.0053 in.)
Camshaft Flywheel End Bore		
Camshaft Flywheel-End Bore	ID	40—40.025 mm (1.5748—1.5758 in.)
Camshaft Flywheel-End Bore (Wear Limit)	ID	40.10 mm (1.5787 in.)
Camshaft Flywheel-End Bore	Oil Clearance	0.040—0.085 mm (0.0016—0.0033 in.)
Camshaft Flywheel-End Bore (Wear Limit)	Oil Clearance	0.195 mm (0.0077 in.)
Camshaft Gear End		
Camshaft Bushing—Gear End	ID	40—40.025 mm (1.5748—1.5758 in.)
Camshaft Bushing—Gear End (Wear Limit)	ID	40.150 mm (1.5807 in.)

Continued on next page

BS62576,00017A2 -19-20JUN14-1/8

Item	Measurement	Specification
Camshaft Bushing—Gear End	Oil Clearance	0.040—0.085 mm (0.0016—0.0033 in.)
Camshaft Bushing—Gear End (Wear Limit)	Oil Clearance	0.245 mm (0.0096 in.)
Camshaft Intermediate Bore		
Camshaft Intermediate Bore	ID	40—40.025 mm (1.5748—1.5758 in.)
Camshaft Intermediate Bore (Wear Limit)	ID	40.10 mm (1.5787 in.)
Camshaft Intermediate Bore	Oil Clearance	0.065—0.115 mm (0.0026—0.0045 in.)
Camshaft Intermediate Bore (Wear Limit)	Oil Clearance	0.225 mm (0.0089 in.)
Camshaft Journals		
Intermediate Journal	OD	39.910—39.935 mm (1.571—1.572 in.)
Intermediate Journal (Wear Limit)	OD	39.875 mm (1.569 in.)
Gear Housing and Flywheel End Journals	OD	39.940—39.960 mm (1.572—1.573 in.)
Gear Housing and Flywheel End Journals (Wear Limit)	OD	39.905 mm (1.571 in.)
Clutch Cover		
Clutch Cover Cap Screw	Torque	23 N·m (200 lb.-in.)
Connecting Rod		
Connecting Rod Cap Screw	Torque	23—28 N·m (17—20 lb.-ft.)
Connecting Rod Bearings	ID	41.982—42.002 mm (1.653—1.654 in.)
Connecting Rod Bearings	Oil Clearance	0.020—0.050 mm (0.0008—0.0020 in.)
Connecting Rod Bearings (Wear Limit)	Oil Clearance	0.110 mm (0.0043 in.)
Connecting Rod	Side Play	0.20—0.40 mm (0.008—0.016 in.)
Connecting Rod-to-Crankshaft Journal	Oil Clearance	0.020—0.050 mm (0.0008—0.0020 in.)
Connecting Rod-to-Crankshaft Journal (Wear Limit)	Oil Clearance	0.110 mm (0.0043 in.)
Cooling		
Cooling System	Capacity (Approximate)	6.6 L (7 qt.)
Crankshaft and Main Bearings		
Crankshaft Connecting Rod Journal	OD	41.952—41.962 mm (1.8485—1.8488 in.)

Continued on next page

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Item	Measurement	Specification
Crankshaft Connecting Rod Journal (Wear Limit)	OD	41.902 mm (1.650 in.)
Crankshaft Main Bearing Journal	OD	46.952—46.962 mm (1.848—1.8489 in.)
Crankshaft Main Bearing Journal (Wear Limit)	OD	46.902 mm (1.8465 in.)
Main Bearing	Oil Clearance	0.020—0.050 mm (0.001—0.002 in.)
Main Bearing (Wear Limit)	Oil Clearance	0.12 mm (0.005 in.)
Main Bearing Cap Screw	Torque	76—82 N·m (56—60 lb.-ft.)
Crankshaft Sheave Cap Screw	Torque	88 N·m (65 lb.-ft.)
Main Bearing Cap Screw	Torque	76—82 N·m (58—60 lb.-ft.)
Crankshaft	Bend (Maximum)	0.02 mm (0.0008 in.)
Main Bearing-to-Crankshaft Journal	Oil Clearance	0.020—0.050 mm (0.001—0.002 in.)
Main Bearing (Wear Limit)	Oil Clearance	0.120 mm (0.005 in.)
Crankshaft	End Play	0.133—0.228 mm (0.0052—0.0090 in.)
Crankshaft (Wear Limit)	End Play (Wear Limit)	0.28 mm (0.0110 in.)
Cylinder Bore Diameter		
Standard Cylinder Bore	ID	80.00—80.02 mm (3.150—3.151 in.)
Standard Cylinder Bore (Wear Limit)	ID	80.20 mm (3.158 in.)
Oversize Cylinder Bore	ID	80.25—80.28 mm (3.159—3.161 in.)
Oversize Cylinder Bore (Wear Limit)	ID	80.45 mm (3.167 in.)
Cylinder Bore Roundness		
Piston-to-Cylinder Bore	Clearance	0.040—0.060 mm (0.001—0.002 in.)
Cylinder	Roundness	0.00—0.01 mm (0.0000—0.0004 in.)
Cylinder (Wear Limit)	Roundness	0.03 mm (0.001 in.)
Cylinder	Taper	0.00—0.01 mm (0.0000—0.0004 in.)
Cylinder (Wear Limit)	Taper	0.03 mm (0.001 in.)

Continued on next page

BS62576,00017A2 -19-20JUN14-3/8

Item	Measurement	Specification
Cylinder Head Cap Screws		
Initial Pass	Torque	30—32 N·m (22—24 lb.-ft.)
Final Pass	Torque	59—64 N·m (43—47 lb.-ft.)
Cylinder Head		
Cylinder Head	Out-of-Flat	0.05 mm (0.002 in.)
Cylinder Head	Out-of-Flat (Wear Limit)	0.15 mm (0.006 in.)
Cylinder Head	Maximum Allowable Removed Material	0.20 mm (0.008 in.)
Exhaust		
Muffler Flange Nut Torque	Torque	25 N·m (221 lb.-in.)
Exhaust Manifold Mounting Cap Screw	Torque	28 N·m (20 lb.-ft.)
Fuel Control and Governor Linkage		
Governor Shaft	OD (Wear Limit)	8.01 mm (0.315 in.)
Governor Shaft Bore	Clearance	0.09 mm (0.003 in.)
Governor Shaft Bore	ID (Wear Limit)	8.50 mm (0.33 in.)
Sleeve Bore	ID (Wear Limit)	9.00 mm (0.354 in.)
Injection Pump Camshaft	OD (Wear Limit)	7.90 mm (0.311 in.)
Injection Pump Camshaft	Clearance	0.15 mm (0.006 in.)
Injector Pump Mounting Nuts	Torque	22.5—28.4 N·m (17—21 lb.-ft.)
Fuel Injection Pump Drive Gear Nut	Torque	58—68 N·m (43—50 lb.-ft.)
Fuel Injection Gear Cover Cap Screws	Torque	11 N·m (97 lb.-in.)
Fuel Injection Line Nuts	Torque	29.4—34.4 N·m (22—25 lb.-ft.)
Fuel Injectors		
Injection Nozzle Body	Torque	50 N·m (37 lb.-ft.)
Leak-Off Fitting	Torque	40 N·m (30 lb.-ft.)
Separator Plate	Contact Surface	0.10 mm (0.0039 in.)

Continued on next page

BS62576,00017A2 -19-20JUN14-4/8

Item	Measurement	Specification
Flywheel		
Flywheel Mounting Cap Screw	Torque	80—86 N·m (59—64 lb.-ft.)
Idler Gear		
Idler Gear Shaft	OD	36.950—36.975 mm (1.4547—1.4557 in.)
Idler Gear Shaft (Wear Limit)	OD	36.90 mm (1.4528 in.)
Idler Gear Bushing	ID	37.0—37.025 mm (1.4567—1.4577 in.)
Idler Gear Bushing (Wear Limit)	ID	37.075 mm (1.4596 in.)
Idler Gear Bushing-to-Shaft	Oil Clearance	0.025—0.075 mm (0.0010—0.0030 in.)
Idler Gear Bushing-to-Shaft (Wear Limit)	Oil Clearance	0.175 mm (0.0069 in.)
Timing Components		
Timing Gear	Backlash	0.06—0.12 mm (0.0024—0.0047 in.)
Timing Gear (Wear Limit)	Backlash	0.14 mm (0.0055 in.)
Timing Gear Cover Mounting Cap Screw	Torque	9 N·m (78 lb.-in.)
Timing Gear Housing Mounting Cap Screw	Torque	11 N·m (96 lb.-in.)
Oil Pump		
Oil Pump Rotor Side Clearance	Clearance	0.12—0.21 mm (0.0047—0.0083 in.)
Oil Pump Rotor Side Clearance (Wear Limit)	Clearance	0.30 mm (0.0118 in.)
Oil Pump Rotor Inner-to-Outer (Limit)	Clearance	0.16 mm (0.006 in.)
Oil Pump Outer Rotor-to-Timing Cover	Clearance	0.02—0.07 mm (0.0008—0.0028 in.)
Oil Pump Outer Rotor-to-Timing Cover (Wear Limit)	Clearance	0.12 mm (0.0047 in.)
Push Rod		
Push Rod	Bend (limit)	0.03 mm (0.001 in.)
Piston Ring Groove		
Top Piston Ring Groove	Side Clearance	0.080—0.120 mm (0.0031—0.0047 in.)
Middle Piston Ring Groove	Side Clearance	0.050—0.090 mm (0.0020—0.0035 in.)
Middle Piston Ring Groove (Wear Limit)	Side Clearance	0.285 mm (0.0112 in.)

Continued on next page

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Item	Measurement	Specification
Oil Control Ring Groove	Side Clearance	0.020—0.055 mm (0.0008—0.0022 in.)
Oil Control Ring Groove (Wear Limit)	Side Clearance	0.180 mm (0.0071 in.)
Piston Ring End Gap		
Top Piston Ring	End Gap	0.15—0.30 mm (0.0059—0.0118 in.)
Top Piston Ring (Wear Limit)	End Gap	0.39 mm (0.015 in.)
Middle Piston Ring	End Gap	0.18—0.33 mm (0.0071—0.0130 in.)
Middle Piston Ring (Wear Limit)	End Gap	0.42 mm (0.0165 in.)
Oil Control Ring	End Gap	0.20—0.45 mm (0.0079—0.0177 in.)
Oil Control Ring (Wear Limit)	End Gap	0.54 mm (0.0213 in.)
Piston Pin		
Piston Pin	OD	21.995—22.00 mm (0.8659—0.866 in.)
Piston Pin (Wear Limit)	OD	21.965 mm (0.8648 in.)
Piston Pin Bore		
Piston Pin Bore	ID	22.0—22.009 mm (0.8661—0.8665 in.)
Piston Pin Bore (Wear Limit)	ID	22.0039 mm (0.8677 in.)
Piston Pin Bushings		
Piston Pin Bushing	ID	22.025—22.038 mm (0.8671—0.8676 in.)
Piston Pin Bushing (Wear Limit)	ID	22.068 mm (0.8688 in.)
Piston Pin Bushings		
Piston Pin Bushing	Oil Clearance	0.025—0.043 mm (0.001—0.0017 in.)
Piston Pin-to-Rod Bore (Wear Limit)	Oil Clearance	0.105 mm (0.0041 in.)
Pistons		
Standard Size Piston	OD	79.962—79.972 mm (3.148—3.1485 in.)
Standard Size Piston (Wear Limit)	OD	79.91 mm (3.146 in.)
Rocker Arm		
Rocker Arm Cover-to-Cylinder Head Cap Screws	Torque	11 N·m (97 lb.-in.)

Continued on next page

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Item	Measurement	Specification
Rocker Arm Support Bolts	Torque	26 N·m (19 lb.-ft.)
Rocker Arm Shaft	OD	11.966—11.984 mm (0.471—0.472 in.)
Rocker Arm Shaft (Wear Limit)	OD	11.95 mm (0.47 in.)
Rocker Arm and Shaft Support	ID	12.00—12.02 mm (0.472—0.473 in.)
Rocker Arm and Shaft Support	ID (Wear Limit)	12.07 mm (0.475 in.)
Rocker Arm/Support-to-Shaft	Clearance	0.016—0.054 mm (0.006—0.002 in.)
Rocker Arm/Support-to-Shaft	Clearance (Wear Limit)	0.13 mm (0.005 in.)
Valves		
Valve Face Angle	Angle	30° for Intake Seat, 45° for Exhaust Seat
Valve Margin (Wear Limit)	Width	0.50 mm (0.020 in.)
Intake Valve Stem Standard	OD	5.960—5.975 mm (0.234—0.235 in.)
Exhaust Valve Stem Standard	OD	5.945—5.960 mm (0.234—0.2346 in.)
Intake and Exhaust Valve Stem (Wear Limit)	OD	5.90 mm (0.232 in.)
Intake Valve Standard	Recess	0.40—0.60 mm (0.016—0.024 in.)
Intake Valve (Wear Limit)	Recess	0.90 mm (0.035 in.)
Exhaust Valve Standard	Recess	0.40—0.60 mm (0.016—0.024 in.)
Exhaust Valve (Wear Limit)	Recess	0.8 mm (0.032 in.)
Intake Valve Guide-to-Valve Stem	Oil Clearance	0.025—0.052 mm (0.001—0.002 in.)
Exhaust Valve Guide-to-Valve Stem	Oil Clearance	0.040—0.067 mm (0.0016—0.0026 in.)
Intake Valve Guide-to-Valve Stem (Wear Limit)	Oil Clearance	0.15 mm (0.006 in.)
Exhaust Valve Guide-to-Valve Stem (Wear Limit)	Oil Clearance	0.17 mm (0.007 in.)
Valve Grinding		
Intake Valve Face	Width	0.99—1.29 mm (0.039—0.051 in.)
Exhaust Valve Face	Width	0.95—1.25 mm (0.037—0.049 in.)

Continued on next page

BS62576,00017A2 -19-20JUN14-7/8

Item	Measurement	Specification
Intake Valve Face Angle	Angle	30°
Exhaust Valve Face Angle	Angle	45°
Valve Guide		
Valve Guide Standard	ID	6.0—6.01 mm (0.236—0.237 in.)
Valve Guide (Wear Limit)	ID	6.08 mm (0.239 in.)
Valve Guide	Installation height above valve seat	9.8—10.0 mm (0.386—0.394 in.)
Valve Seat		
Intake Valve Seat	Width	1.44 mm (0.057 in.)
Intake Valve Seat (Wear Limit)	Width	1.98 mm (0.078 in.)
Exhaust Valve Seat	Width	1.77 mm (0.07 in.)
Exhaust Valve Seat (Wear Limit)	Width	2.27 mm (0.089 in.)
Valve Spring		
Valve Spring	Free Length	37.8 mm (1.488 in.)
Valve Spring	Inclination (Maximum)	1.3 mm (0.051 in.)

BS62576,00017A2 -19-20JUN14-8/8

Remove and Install Alternator Drive Belt—3TNV80F

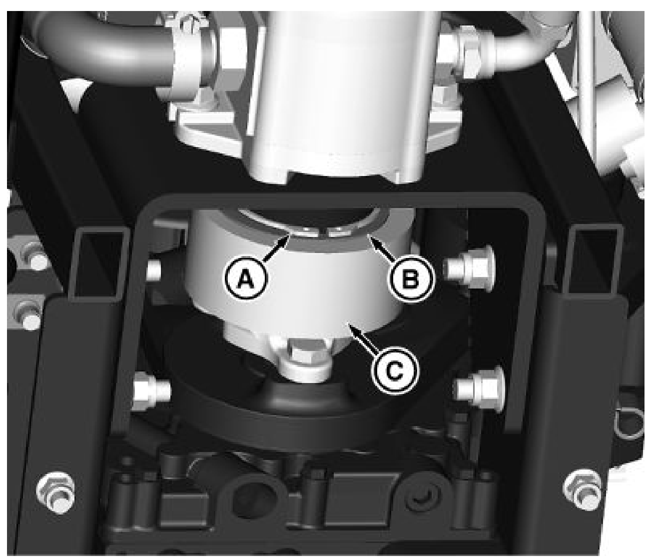
Removal

CAUTION: Entanglement in a belt or sheave can cause serious injury. Stop engine and wait for all moving parts to stop.

1. Park machine with the park brake locked, transmission in neutral and engine off.
2. Raise attachment to service position. Install lift cylinder safety support.

NOTE: The removal of the skid plate may ease access to hydraulic coupler.

3. Remove snap ring (A).
4. Slide washer (B) forward.
5. Slide coupler (C) forward.



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A—Snap Ring
B—Washer
C—Coupler

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BS62576,00017D9 -19-08MAY14-1/2

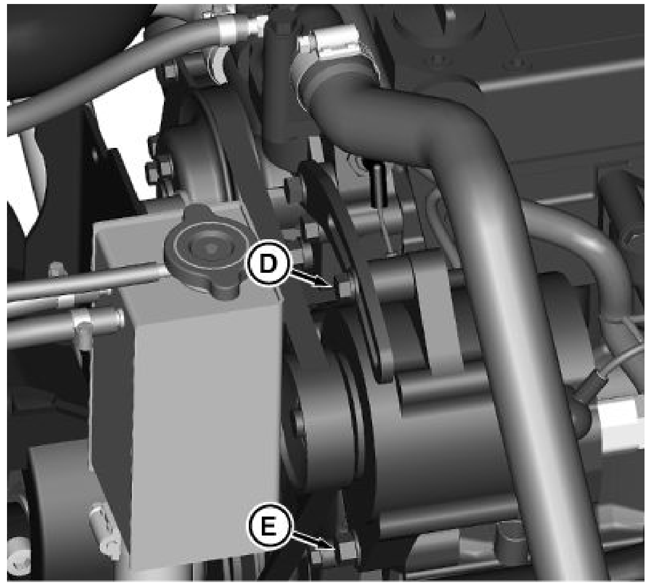
6. Loosen alternator adjustment cap screw (D) and alternator mounting cap screw (E).
7. Apply inward pressure to the alternator housing.
8. Remove worn belt from both the alternator and engine sheaves.

Installation

1. Install and route new belt around sheaves.
2. Apply outward pressure to the alternator housing.
3. Tighten adjustment cap screw and then the mounting cap screw.
4. Check belt tension:
   - Apply thumb pressure to the belt approximately halfway between the sheaves. Belt should deflect inward approximately 10 mm (3/8 in.).
5. Install and tighten hardware as required.
6. Slide coupler and washer rearward.
7. Replace coupler snap ring.

NOTE: Install skid plate if removed for access.

8. Remove lift cylinder safety support.



D—Adjustment Cap Screw **E—Mounting Cap Screw**

9. Lower attachment and return vehicle to service.

BS62576,00017D9 -19-08MAY14-2/2

Remove and Install Air Filter Restriction Indicator—3TNV80F

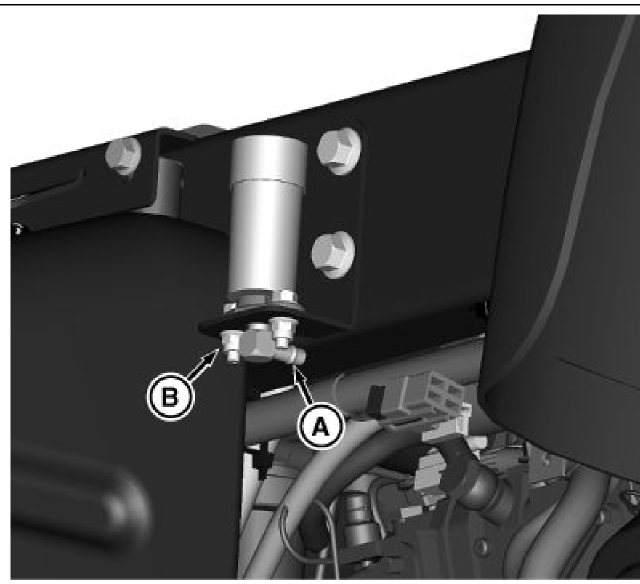
Removal

1. Park unit with park brake locked, transmission in neutral, and engine off.
2. Raise attachment to service position. Install lift cylinder safety support.
3. Remove hose from fitting (A).
4. Remove bolts and nuts (B) securing air filter restrictor to bracket.
5. Inspect housing for cracks or other damage. Replace as needed.

Installation

Installation is done in reverse order of removal.

- Install air restriction indicator onto mounting bracket.
- Connect hose to fitting.



A—Fitting **B—Nut**

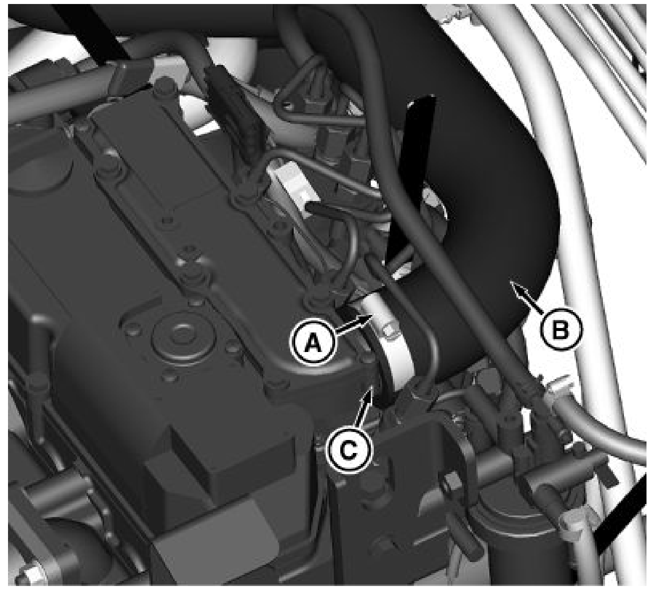
BS62576,00017DB -19-08MAY14-1/1

Remove and Install Air Cleaner Assembly—3TNV80F

Removal

1. Park unit with park brake locked, transmission in neutral, and engine off.
2. Raise attachment to service position. Install lift cylinder safety support.
3. Loosen hose clamp (A).
4. Remove hose (B) from intake manifold (C).

A—Hose Clamp
B—Hose
C—Intake Manifold

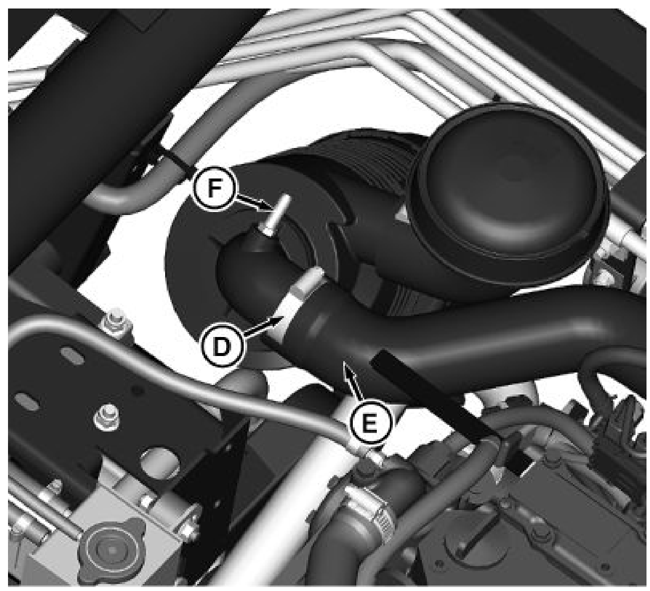


TCT011055 —UN—08MAY14

BS62576,00017DC -19-08MAY14-1/3

5. Loosen hose clamp (D).
6. Remove hose from air cleaner assembly (E).
7. Remove air filter restricted indicator from fitting (F).

D—Hose Clamp
E—Air Cleaner Assembly
F—Fitting



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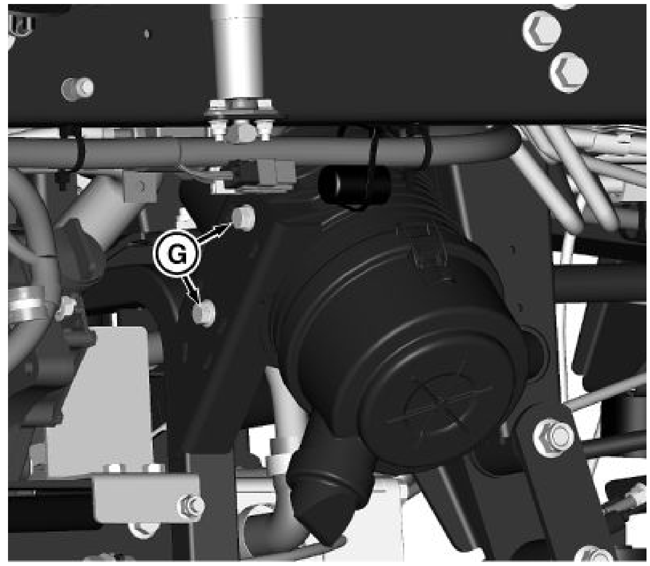
8. Remove flange head cap screws and nuts (G).
9. Remove air cleaner assembly.
10. Inspect all parts for wear or damage. Replace as needed.
11. Inspect hose for cracking or damage. Replace as needed.

Installation

Installation is done in reverse order of removal.



G—Flange Head Cap Screws and Nuts

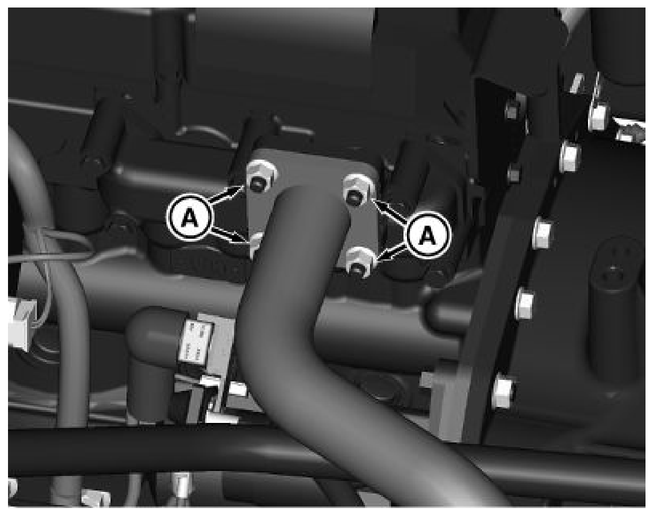
BS62576,00017DC -19-08MAY14-3/3

Remove and Install Muffler—3TNV80F

Removal

CAUTION: To prevent possible burns, allow engine to cool before removing muffler.

1. Park unit with park brake locked, transmission in neutral, and engine off.
2. Raise attachment to service position. Install lift cylinder safety support.
3. Allow muffler to cool, or wear protective gloves before working on muffler. Access muffler.
4. Remove tailpipe hanger clamp near rear axle and clamp from muffler outlet. Remove tailpipe.
5. Remove four nuts (A) holding muffler to exhaust manifold.



A—Four Nuts

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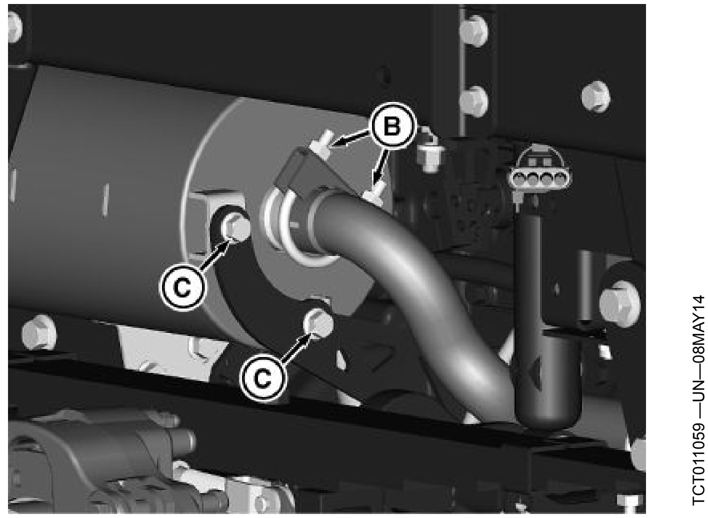
6. Remove exhaust clamp nuts (B), remove clamp.
7. Remove cap screws (C) from lower muffler support and remove muffler from engine.

Installation

Installation is done in reverse order of removal.

- Clean sealing surfaces of muffler flange and exhaust manifold.
- Install new gasket on exhaust manifold.
- Securely tighten muffler-to-manifold nuts.



B—Nuts **C—Cap Screws**

BS62576,00017DD -19-08MAY14-2/2

Remove and Install Engine—3TNV80F

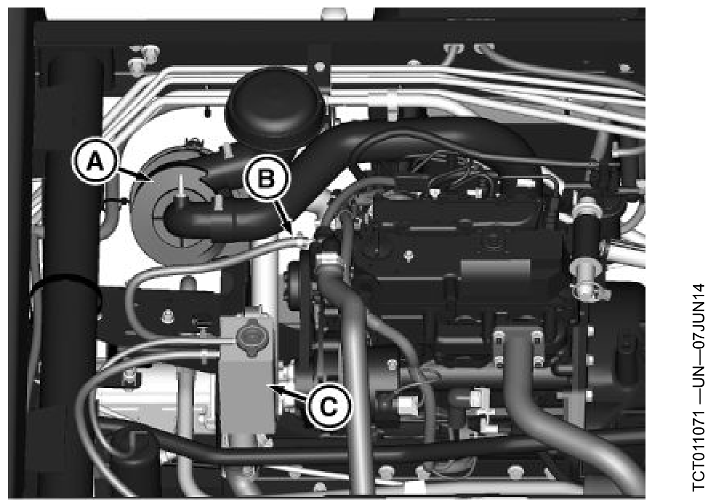
Special or Required Tools

- JT01748 Lifting Brackets (2 used)

Removal

CAUTION: USE CAUTION AROUND MOVING PARTS. STOP engine. Remove ignition key. Wait for all moving parts to STOP.

1. Park vehicle on a hard, level surface. Lock park brake.
2. Stop engine. Cycle hydraulic valves to release any hydraulic pressure.
3. Disconnect negative (-) cable from the battery.
4. Remove cargo box or any attachments that may be limiting engine access.
5. Remove air filter assembly (A). (See Remove and Install Air Cleaner Assembly—3TNV80F.)
6. Drain coolant from radiator. Remove upper radiator hose from thermostat housing and lower radiator hose assembly.



A—Air Filter Assembly
B—Hose
C—Pressure Tank

7. Disconnect hose (B) from thermostat housing and remove pressure tank (C).

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8. Secure hydraulic cylinder away from work area.
9. Remove muffler. (See Remove and Install Muffler—3TNV80F.)

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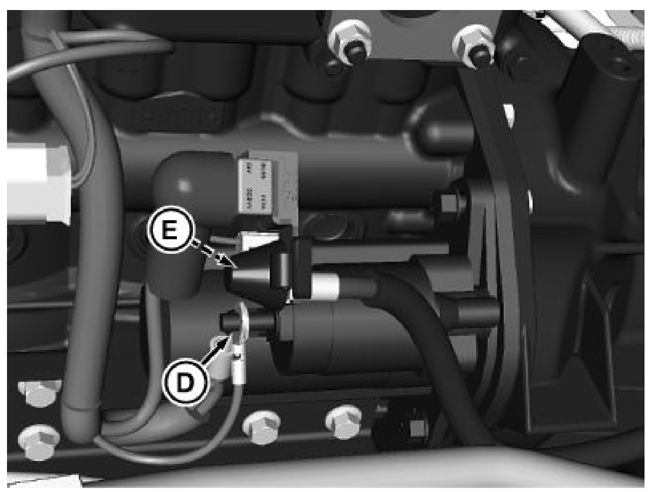
10. Disconnect positive (+) battery cable (D) and exciter wires (E) from starting motor solenoid.
11. Disconnect positive wire and plug from alternator.
12. Disconnect the ground wire, neutral switch and speed sensor from the transaxle.
13. Disconnect glow plugs, coolant temperature sensor, fan/over-temperature switch, fuel shutoff solenoid and engine oil pressure switch from the engine.
14. Move harness out from the work area to prevent damage and to ease engine removal.
15. Disconnect line from bottom of the steering pump. Install caps and plugs.
16. Disconnect suction tube from top of the steering pump.



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D—Battery Cable **E—Sensing Wires**

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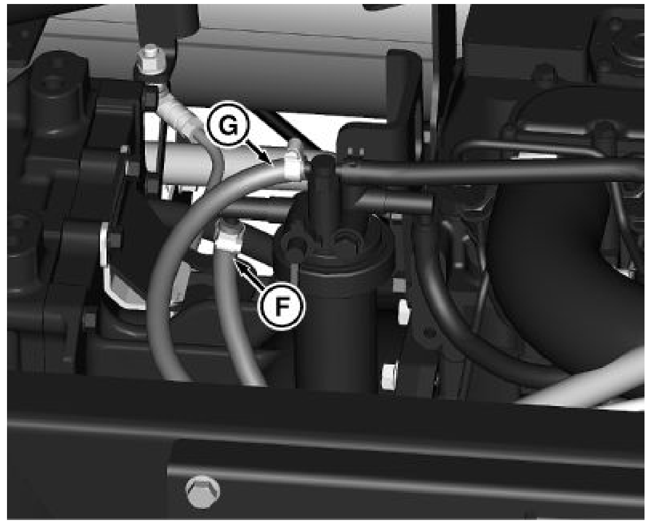
17. Turn the fuel shutoff valve on the fuel filter/water separator to the closed position.
18. Disconnect fuel supply (F) and return (G) hoses from the fuel filter/water separator. Label hoses to avoid confusion during assembly. Plug each end of hose.
19. Disconnect throttle linkage.
20. Remove skid plate from engine subframe.
21. Support front of transaxle and support engine with hoist while removing cap screws from bell housing.

NOTE: It is not necessary to remove starter from backplate.

22. Remove nuts from starter mounting cap screws.



TCT011073 —UN—07JUN14

F—Fuel Supply **G—Return**

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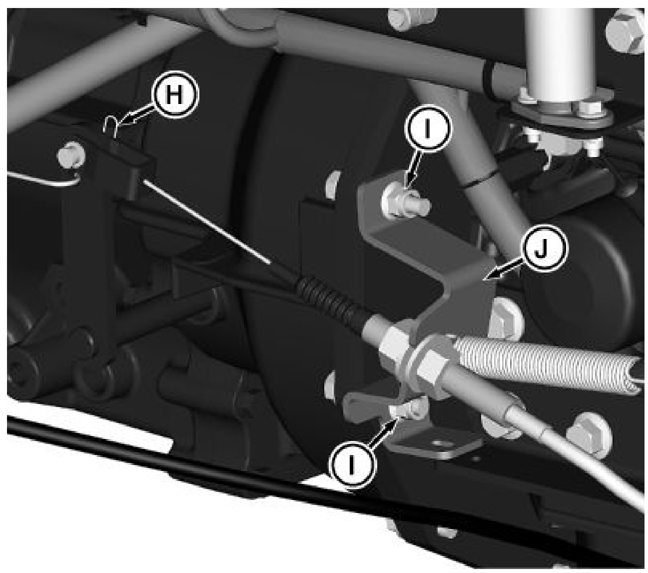
23. Remove pin (H) from clutch lever. Remove cap screws (I) and clutch cable bracket (J).



TCT011074 —UN—07JUN14

H—Pin
I— Cap Screws
J— Clutch Cable Bracket

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24. Remove nuts (K) from the subframe isolator.
25. Remove subframe from engine.
26. Slide engine forward and raise from machine.

Installation

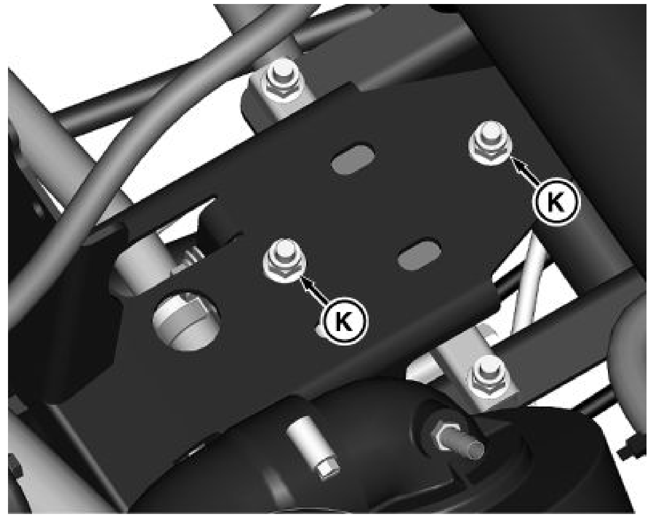
Installation is the reverse of removal.

1. Tighten subframe to engine mounting cap screws to specification.

Specification

Engine-to-Subframe Mounting Cap Screw—Torque .... 75 N·m (55 lb.-ft.)

2. Attach throttle and clutch linkage.
3. Attach fuel lines to fuel filter/water separator.
4. Connect all engine wiring harness connectors.
5. Connect remaining engine harness connectors and ground wire to transaxle.
6. Attach battery positive (+) cable and solenoid exciter wires to starting motor solenoid.
7. Clean muffler flange and exhaust manifold surfaces of any old gasket material. Install a new muffler gasket.
8. Install muffler flange nuts and tighten to specification.



TCT011075 —UN—07JUN14

K—Nuts

Specification

Muffler Flange Nut Torque—Torque .... 25 N·m (221 lb.-in.)

9. Service engine oil, coolant and hydraulic tank to proper levels. Use fluids of correct specifications.
10. Attach negative (-) cable to battery.

BS62576,00017DA -19-07JUN14-6/6

Remove and Install Rocker Arm Cover—3TNV80F

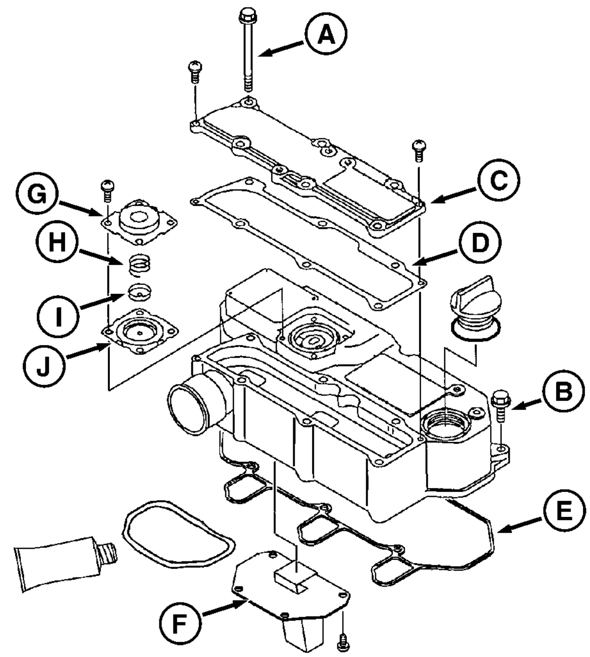
1. Park machine safely. See the “Safety Section”.
2. Loosen hose clamps from air cleaner hose and remove air cleaner.
3. Remove cap screws (A and B).
4. Remove rocker cover.
5. Remove intake cover (C) and clean off mating surfaces and replace gasket (D).
6. Remove and disassemble breather baffle (F) and clean or replace mesh media.
7. Remove diaphragm cover (G), spring (H), center plate (I), and diaphragm (J).
8. Inspect diaphragm, spring, and center plate for wear or damage. Diaphragm must not have any cracks or tears and must not leak. Replace parts showing any wear.

Installation

- Clean all parts.
- Reassemble rocker arm cover using new gaskets.
- Use John Deere Form in Place Gasket between breather baffle and rocker cover.
- Tighten rocker cover cap screws to specification.

Specification

Rocker Arm
Cover-to-Cylinder Head
Cap Screws—Torque..11 N·m
(97 lb.-in.)



A—Cap Screw, Long (6 used)
B—Cap Screw, Short (3 used)
C—Intake Cover
D—Gasket
E—Gasket
F—Breather Baffle
G—Diaphragm Cover
H—Spring
I— Center Plate
J—Diaphragm

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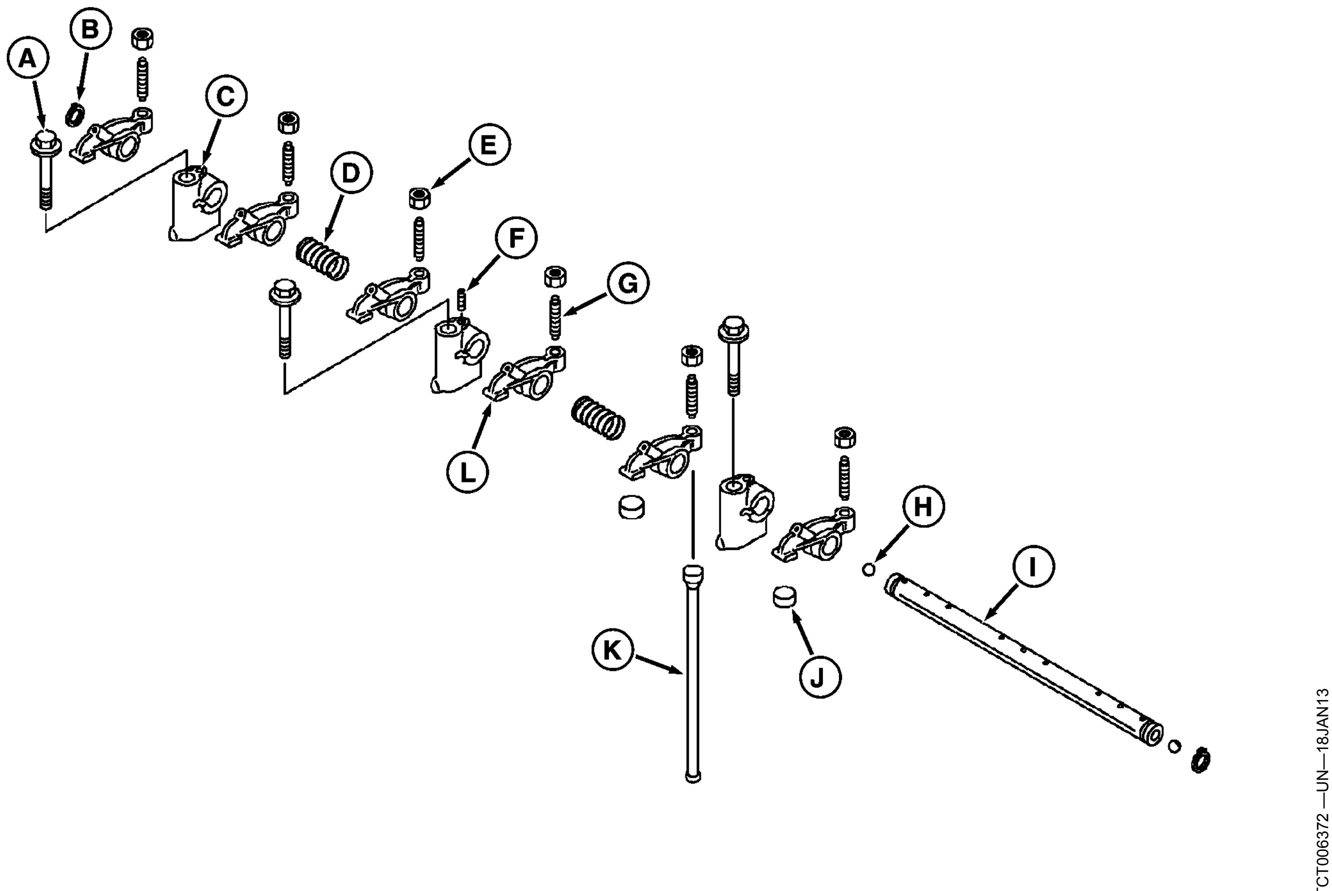
Remove and Install Rocker Arm Assembly—3TNV80F

Removal

1. Remove the rocker arm cover. (See Remove and Install Rocker Arm Cover—3TNV80F.)



A—Bolt (3 Used)
B—Retaining Ring (2 Used)
C—Shaft Support (3 Used)
D—Spring (3 Used)
E—Nut (6 Used)
F—Set Screw
G—Adjuster Screw (6 Used)
H—Ball (2 Used)
I— Rocker Arm Shaft
J—Valve Cap (6 Used)
K—Push Rod (6 Used)
L—Rocker Arm (6 Used)

2. Remove the rocker arm support bolts (A).
3. Lift the rocker arm assembly from the cylinder head and set the assembly on a bench.

NOTE: If the rocker arm shaft assembly is disassembled, replace components in same location on the rocker arm shaft they were removed from.

4. Note the positions of the rocker arm assembly components. Slide the components off the rocker arm shaft.
5. Remove set screw from center support. Remove rocker shaft from center support.
6. Lift the push rods from the cylinder head and note the order of removal for reassembly.
7. Inspect the rocker arm components and push rods. (See Inspect Rocker Arm Assembly and Push Rods—3TNV80F.)

Installation

1. Install the push rods in their original locations in the cylinder head, with the ball shaped end down in head.
2. Lubricate all parts with clean oil during assembly.
3. Assemble the rocker arm assembly components in the reverse order of removal.
4. Place the rocker arm assembly on the cylinder head.
   a. Align the rocker arms with the valves and push rods.

Continued on next page

BS62576,0001793 -19-24APR14-1/2

b. Align the rocker arm supports with the corresponding holes in the head.

5. Install the rocker arm support bolts. Tighten the bolts to specification.

Specification

Rocker Arm Support Bolts—Torque..26 N·m (19 lb.-ft.)

6. Adjust the valve clearance. (See Adjust Valve Clearance.)

7. Install rocker arm cover. (See Remove and Install Rocker Arm Cover—3TNV80F.)

BS62576,0001793 -19-24APR14-2/2

Inspect Rocker Arm Assembly and Push Rods—3TNV80F

Rocker Arm Inspection

1. Measure outer diameter of rocker arm shaft. Replace rocker arm shaft if measurement is less than wear limit.

Specification

Rocker Arm Shaft—OD.. 11.966—11.984 mm (0.471—0.472 in.)

Rocker Arm Shaft (Wear Limit)—OD..11.95 mm (0.47 in.)

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2. Measure inside diameter of rocker arms and rocker shaft supports. Replace rocker arms or supports if inner diameter is more than wear limit.

Specification

Rocker Arm and Shaft Support—ID..12.00—12.02 mm (0.472—0.473 in.)

Rocker Arm and Shaft Support—ID (Wear Limit).. 12.07 mm (0.475 in.)

3. If shaft and support/arm clearance (support/arm ID minus shaft OD) exceeds wear limit, replace all parts.

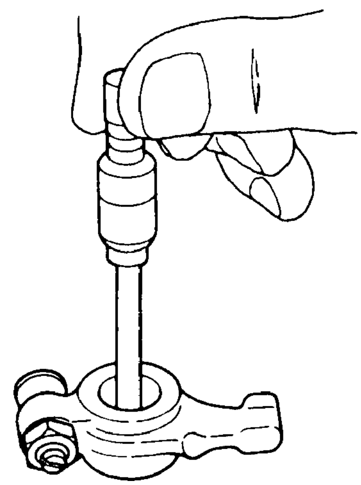
Specification

Rocker Arm/Support-to-Shaft—Clearance..0.016—0.054 mm (0.006—0.002 in.)

Rocker Arm/Support-to-Shaft—Clearance (Wear Limit).. 0.13 mm (0.005 in.)

Push Rod Inspection

1. Lay push rod on flat surface and roll while checking for a gap under center of rod. Use feeler gage to check dimension.



TCAL28380 —UN—28JUN12

Specification

Push Rod—Bend (limit).. 0.03 mm (0.001 in.)

2. Check the surface of the adjusting screw that contacts the push rod for wear. Replace push rod or adjusting screw if worn.

3. Check the rocker arm-to-valve stem cap contact surface for wear. Replace rocker arm if worn.

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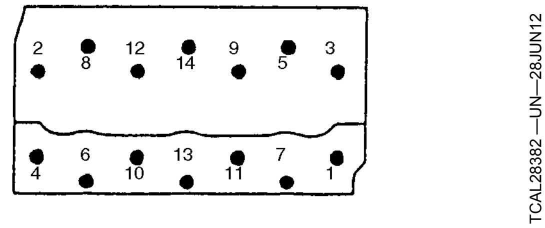
Remove and Install Cylinder Head and Valves—3TNV80F



Top of Drawing Is Exhaust Manifold Side, Bottom Is Intake Manifold Side

Special or Required Tools

- Hoist
- JT01748 Lifting Bracket (2 used)

Removal

1. Park machine on level surface with park brake locked and engine off.
2. Disconnect negative (—) battery cable from battery.
3. Shut off fuel valve on fuel filter.
4. Allow engine to cool, and cooling system pressure to return to zero. Drain coolant from drain valves located on left side of engine and radiator.
5. Remove pipe from exhaust manifold. (See Remove and Install Exhaust Manifold—3TNV80F.)
6. Remove upper and lower radiator hoses from water pump.
7. Disconnect wiring from coolant temperature sensor.
8. Remove upper alternator bracket and belt from water pump.
9. Remove water pump. (See Remove and Install Water Pump—3TNV80F.)
10. Remove high-pressure fuel lines and fuel leak-off line running from fuel injection pump to nozzles.
11. Disconnect glow plug wiring harness from engine harness.
12. Remove rocker arm cover. (See Remove and Install Rocker Arm Cover—3TNV80F.)
13. Remove rocker arm assembly, push rods, and valve caps from cylinder head. (See Remove and Install Rocker Arm Assembly—3TNV80F.)
14. Remove cylinder head cap screws in the order shown.
15. Using lift brackets and hoist, pull head straight up from block.
16. Remove exhaust and intake manifolds. (See Remove and Install Exhaust Manifold—3TNV80F and Remove and Install Intake Manifold—3TNV80F.)
17. Disassemble and inspect cylinder head and valves. (See Disassemble and Assemble Cylinder Head and Valves—3TNV80F and Inspect Cylinder Head and Valves—3TNV80F.)

Continued on next page

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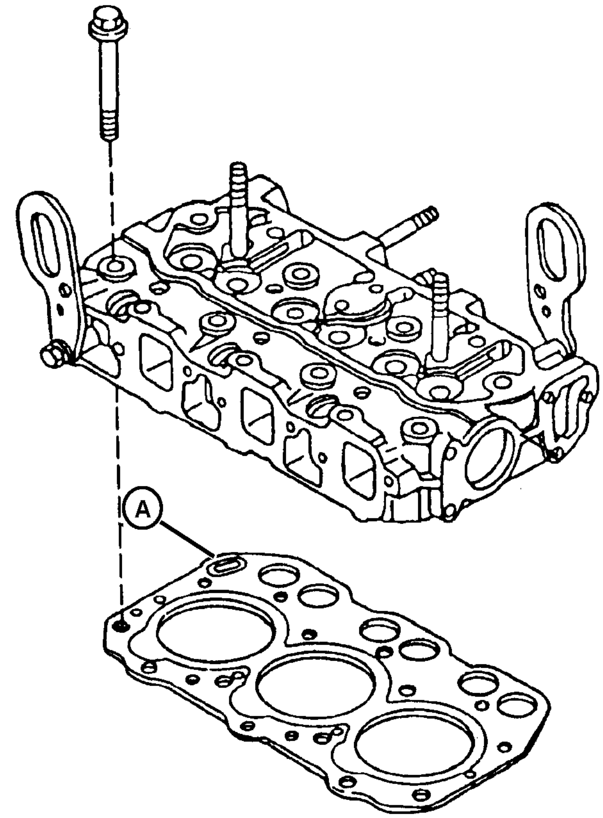
Installation

1. Clean all threads in top of cylinder block with a flat bottom tap, and blow debris from hole.
2. Clean top of cylinder block and check for flatness.

IMPORTANT: Oil passage in gasket must be located over oil passage (A) in cylinder block.

If cylinder head was resurfaced, check piston-to-cylinder head clearance.

3. Place a new cylinder head gasket on cylinder block with locating pins on front and rear of block inside holes in gasket. Line up oil passage (A) on left rear of block with oil passage in gasket. If cylinder head was resurfaced, check piston-to-cylinder head clearance.
4. Clean threads of cylinder head cap screws and dip in clean oil before installing. Install all cap screws finger tight before tightening with wrench.



TCAL28383 —UN—28JUN12

A—Oil Passage

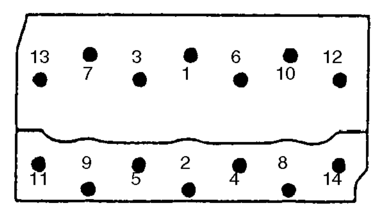
BS62576,0001795 -19-24APR14-2/3

5. Tighten cylinder head cap screws to specification in sequence shown, in three steps.

Cylinder Head Cap Screws—Specification

Initial Pass—Torque	30—32 N·m (22—24 lb.-ft.)
Final Pass—Torque	59—64 N·m (43—47 lb.-ft.)

6. Install rocker arm assembly, push rods, and valve caps. (See Remove and Install Rocker Arm Assembly—3TNV80F.)
7. Install rocker arm cover. (See Remove and Install Rocker Arm Cover—3TNV80F.)
8. Connect fuel lines, radiator hoses, and wires.
9. Install water pump. (See Remove and Install Water Pump—3TNV80F.)
10. Install exhaust pipe to manifold. (See Remove and Install Exhaust Manifold—3TNV80F.)



TCAL28384 —UN—28JUN12

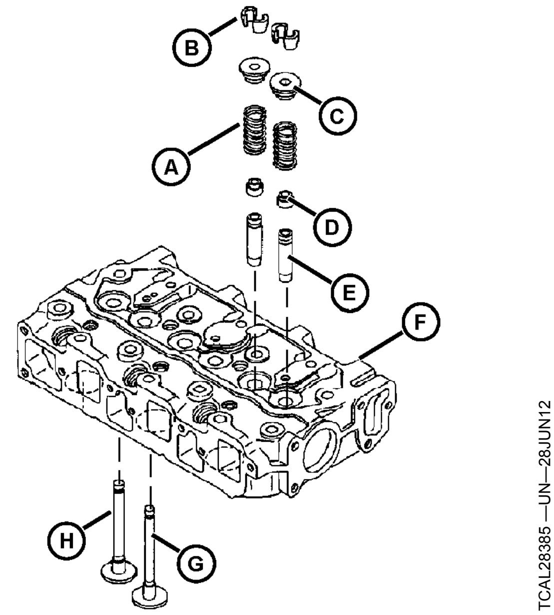
Top of Drawing Is Exhaust Manifold Side, Bottom Is Intake Manifold Side

11. Install upper alternator bracket and belt.

IMPORTANT: Cylinder head mounting cap screws must be checked for proper torque after 50 hours of engine operation.

BS62576,0001795 -19-24APR14-3/3

Disassemble and Assemble Cylinder Head and Valves—3TNV80F



A—Valve Springs
B—Valve Collets
C—Valve Spring Retainer
D—Stem Seal
E—Intake and Exhaust Valve Guides
F—Head
G—Valve
H—Valve

Special or Required Tools

- JDE138 Valve Spring Compressor

NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

Disassembly

1. Check valve recession before disassembly. (See Inspect Cylinder Head and Valves—3TNV80F.)
2. Compress valve springs (A) using JDE138 Valve Spring Compressor.

NOTE: It can be necessary to tap on valve spring retainer (C) while initially operating compressor to break retainer free from valve stem.

3. Remove valve collets (B) from retainer.
4. Slowly release compressor and valve spring.

IMPORTANT: Do not reuse stem seals (D) if removed. Used seals will leak.

5. Remove valve spring, stem seal (D), and valve (G or H) from Intake and exhaust valve guides (F).

NOTE: Valve seats are not replaceable.

6. Intake and exhaust valve guides (E) are press fit. Remove guides only if replacement is necessary.
7. Inspect all parts for wear or damage. Clean all carbon deposits and measure all parts for proper clearances.

Assembly

1. Apply clean engine oil on intake and exhaust valve stems during assembly.
2. Install springs with smaller pitch end or paint mark toward cylinder head.
3. Use valve spring compressor to compress spring and retainer, and install collet as removed.
4. After valve has been assembled, tap on top of valve stem with a plastic hammer to seat retainer.
5. Repeat for remaining valves.
6. Measure valve recession if new valves were installed. (See Inspect Cylinder Head and Valves—3TNV80F.)

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Inspect Cylinder Head and Valves—3TNV80F

Special or Required Tools

- JDG504 Valve Guide Driver
- 7 mm Valve Guide Reamer

NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

IMPORTANT: Avoid Damage! Before inspection, thoroughly clean all components of carbon or dirt.

Cylinder Head

1. Measure cylinder head flatness. Place a straightedge (I) along each of the four sides and each diagonal. Measure clearance between straightedge and gasket surface with a feeler gauge (J).

Specification

Cylinder Head—Out-of-Flat.......... 0.05 mm (0.002 in.)

2. If distortion exceeds the wear limit, resurface or replace cylinder head. Remove only enough metal to make cylinder head flat, but do not remove more than maximum amount specified.

Specification

Cylinder Head—Out-of-Flat (Wear Limit).......... 0.15 mm (0.006 in.)

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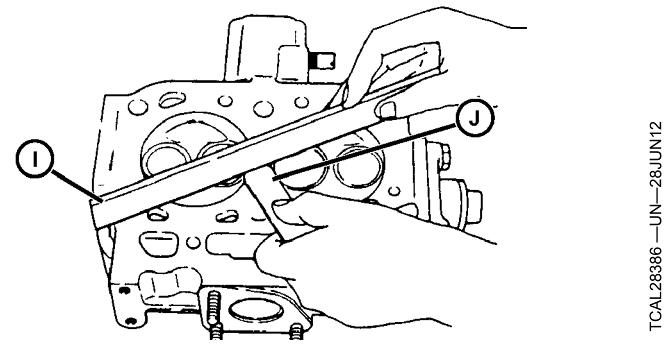

I— Straightedge **J— Feeler Gauge**

Cylinder Head—Maximum Allowable Removed Material.......... 0.20 mm (0.008 in.)

3. Inspect for cracks or other damage.
4. Inspect condition of valve seats and measure valve seat width. (See Valve Seat Width procedure.)
5. If cylinder head was resurfaced, measure valve recession. (See Valve Recession Measurement procedure.)

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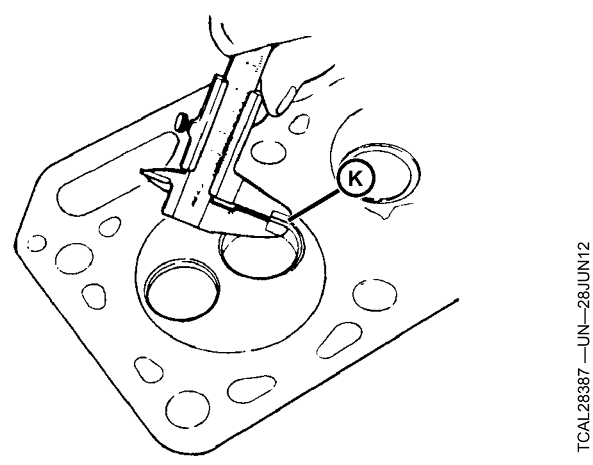
Valve Seat Width

1. Measure valve seat width (K) for intake and exhaust valves and compare to specification.

Specification

Intake Valve Seat—Width.......... 1.44 mm (0.057 in.)
Intake Valve Seat (Wear Limit)—Width.......... 1.98 mm (0.078 in.)
Exhaust Valve Seat—Width.......... 1.77 mm (0.07 in.)
Exhaust Valve Seat (Wear Limit)—Width.......... 2.27 mm (0.089 in.)

2. If necessary, grind valve seats to meet specification.



K—Valve Seat Width

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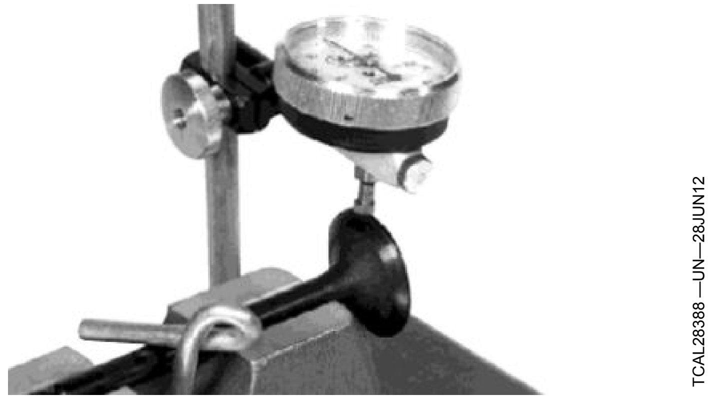
Intake and Exhaust Valves

1. Check valve for out-of-round, bent, or warped condition using a valve inspection center and dial indicator. Replace valve if necessary.



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2.

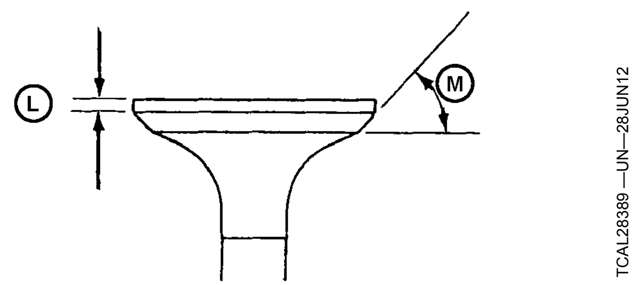
Specification

Valve Face Angle—Angle .... 30° for Intake Seat, 45° for Exhaust Seat

Specification

Valve Margin (Wear Limit)—Width .... 0.50 mm (0.020 in.)

If valve faces are worn, burned, or pitted, grind valves to proper face angle (M). If valve face margin (L) is less than specification after grinding, replace valve.



L—Valve Margin **M—Proper Face Angle**

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3. Measure valve stem diameter at the two locations (N and O) shown above. Replace valve if measurement exceeds wear limit specification.

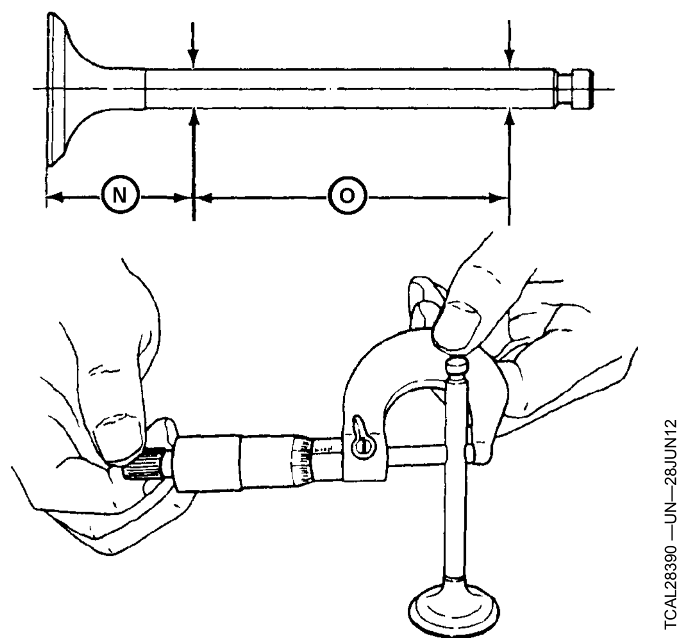
Specification

Intake Valve Stem Standard—OD .... 5.960—5.975 mm (0.234—0.235 in.)

Exhaust Valve Stem Standard—OD .... 5.945—5.960 mm (0.234—0.2346 in.)

Intake and Exhaust Valve Stem (Wear Limit)—OD .... 5.90 mm (0.232 in.)

N—20 mm (0.787 in.) **O—40 mm (1.575 in.)**



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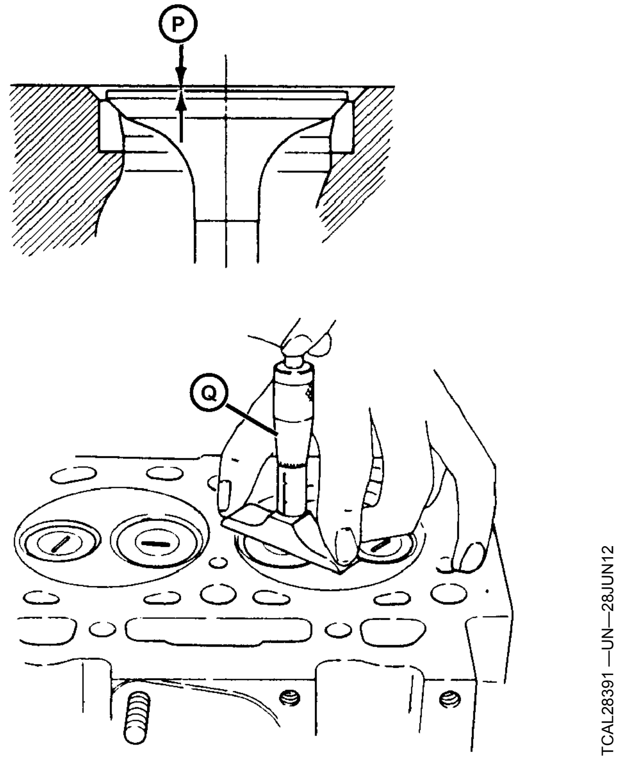
Valve Recession Measurement

Measure valve recession (P) using a depth gauge (Q). Replace valve or cylinder head if measurement exceeds wear limit specification.



Specification

Intake Valve
Standard—Recess....0.40—0.60 mm (0.016—0.024 in.)

Intake Valve (Wear Limit)—Recess.... 0.90 mm (0.035 in.)

Exhaust Valve
Standard—Recess....0.40—0.60 mm (0.016—0.024 in.)

Exhaust Valve (Wear Limit)—Recess.... 0.8 mm (0.032 in.)

P—Valve Recession **Q—Depth Gauge**

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BS62576,0001797 -19-24APR14-6/9

Valve Guide Measurement

1. Clean valve guides using a valve guide brush.
2. Measure valve guide inside diameter using a ball or telescoping snap gage.
   - If valve guide inside diameter exceeds wear limit specification, replace guide.

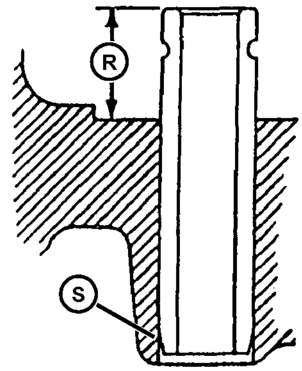
Specification

Valve Guide Standard—ID.................6.0—6.01 mm (0.236—0.237 in.)
Valve Guide (Wear Limit)—ID.................6.08 mm (0.239 in.)

   - If valve guide inside diameter is less than wear limit specification, determine guide-to-stem oil clearance (valve guide diameter minus valve stem diameter).

Specification

Intake Valve Guide-to-Valve Stem—Oil Clearance.................0.025—0.052 mm (0.001—0.002 in.)
Exhaust Valve Guide-to-Valve Stem—Oil Clearance.................0.040—0.067 mm (0.0016—0.0026 in.)
Intake Valve Guide-to-Valve Stem (Wear Limit)—Oil Clearance.................0.15 mm (0.006 in.)
Exhaust Valve Guide-to-Valve Stem (Wear Limit)—Oil Clearance.................0.17 mm (0.007 in.)



TCAL28392 —UN—28JUN12

R—Installation Height **S—Tapered End**

   - If clearance exceeds wear limit specification, replace valve guides.

3. Install valve guides with tapered end (S) down using JDE504 Valve Guide Driver. Push valve guides down until tops of valve guides are projecting at the specified height (R) from the valve spring seat in the cylinder head.

Specification

Valve Guide—Installation height above valve seat.................9.8—10.0 mm (0.386—0.394 in.)

4. Ream inside diameter of valve guides using a 6 mm valve guide reamer.

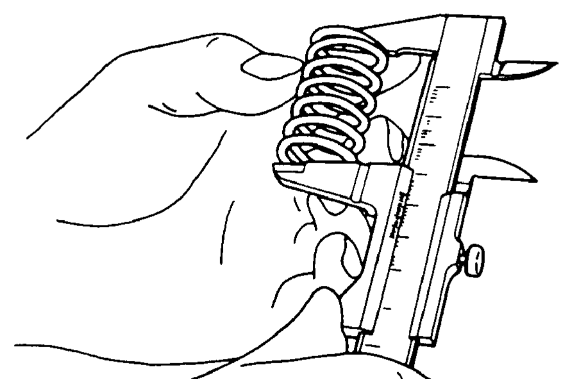
BS62576,0001797 -19-24APR14-7/9

Valve Springs

1. Measure spring free length. Replace spring if measurement exceeds specification.

Specification

Valve Spring—Free Length.................37.8 mm (1.488 in.)



TCAL28393 —UN—28JUN12

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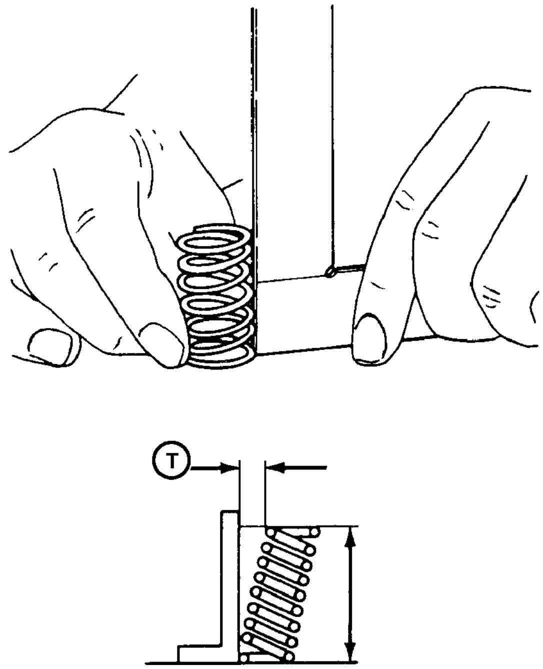
BS62576,0001797 -19-24APR14-8/9

2. Measure spring inclination (T). Replace spring if measurement exceeds specification.

Specification

Valve Spring—Inclination
(Maximum).. 1.3 mm
(0.051 in.)

T—Valve Spring Inclination



TCAL28394 —UN—28JUN12

BS62576,0001797 -19-24APR14-9/9

Remove and Install Exhaust Manifold—3TNV80F

Removal

1. Remove muffler and gasket. (See Remove and Install Muffler—3TNV80F.)
2. Remove four cap screws (A) and two nuts (B).
3. Remove manifold and gasket. Check for cracks or warpage.
4. Clean all mating surfaces thoroughly.

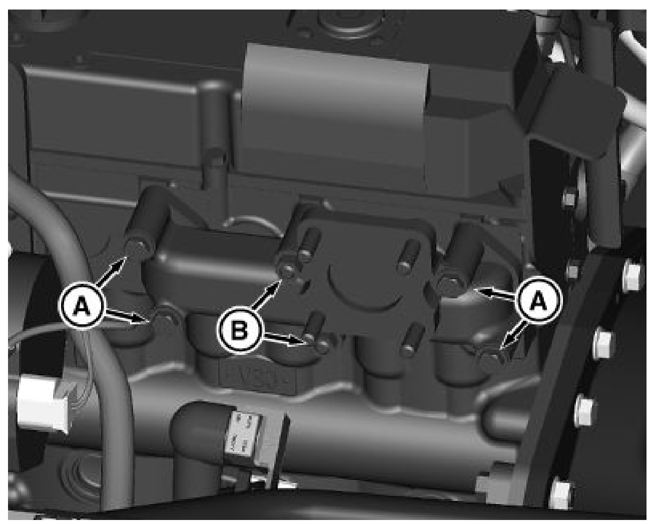
Installation

NOTE: Installation is done in the reverse order of removal.

1. Install new gasket between exhaust manifold, cylinder head, and exhaust pipe.
2. Tighten mounting cap screws to specification.

Specification

Exhaust Manifold
Mounting Cap
Screw—Torque..28 N·m
(20 lb.-ft.)



TCT011060 —UN—08MAY14

A— Nuts **B— Cap Screws**

BS62576,0001798 -19-08MAY14-1/1

Remove and Install Intake Manifold—3TNV80F

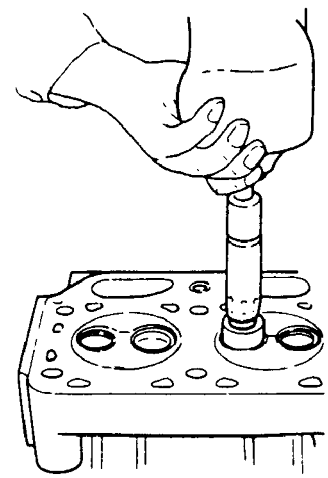
NOTE: The intake manifold is integral with the rocker arm cover. (See Remove and Install Rocker Arm Cover—3TNV80F.)

BS62576,0001799 -19-24APR14-1/1

Grind Valve Seats—3TNV80F

NOTE: Lightly grind valve seats for only a few seconds to avoid excessive valve seat width. If valve guide is to be replaced, always replace guide before grinding valve seat, as seat grinder pilot is centered by guide.

1. Grind intake valve seat using a 30°-seat grinder, and exhaust valve seat using a 45° seat grinder. Follow tool manufacturer's instructions.

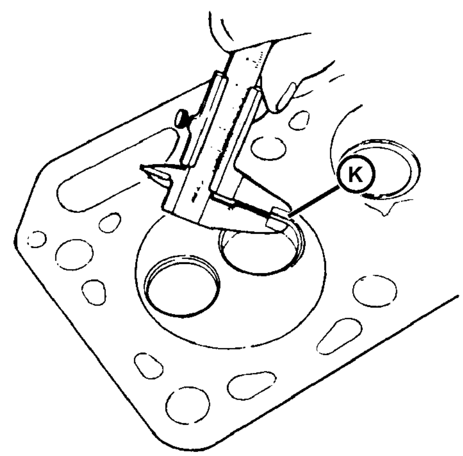


TCAL28395 —UN—28JUN12

BS62576,000179A -19-24APR14-1/3

2. Measure valve seat width (K) after grinding.

K—Valve Seat Width



TCAL28396 —UN—28JUN12

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BS62576,000179A -19-24APR14-2/3

3. If seat (U) is too wide after grinding, grind lower seat surface (V) using a 70° seat grinder until seat width is close to specifications.

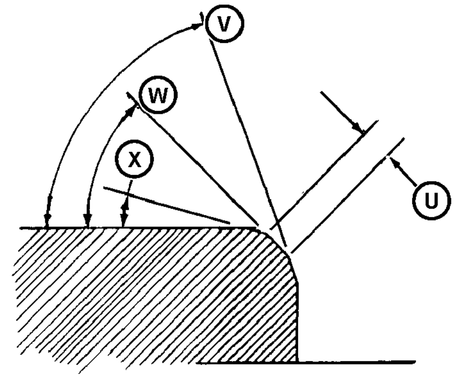
Valve Grinding—Specification

Intake Valve Face —Width	0.99—1.29 mm (0.039—0.051 in.)
Exhaust Valve Face —Width	0.95—1.25 mm (0.037—0.049 in.)
Intake Valve Face Angle—Angle	30°
Exhaust Valve Face Angle—Angle	45°

4. Grind upper seat surface (X) using a 15°-seat grinder until seat width is narrowed to specification.
5. Dimension (W) is 30° for intake and 45° for exhaust seat.

NOTE: If valve recession exceeds maximum specification, replace cylinder head.

6. If valve seats are ground, measure valve recession and check contact pattern between the seat and valve with bluing dye.



TCAL28397 —UN—28JUN12

U—Valve Seat Surface
V—Lower Seat Surface
W—Upper Seat Surface
X—30° for Intake Seat, 45° for Exhaust Seat

7. Lap valves. (See Lap Valves—3TNV80F.)

BS62576,000179A -19-24APR14-3/3

Lap Valves—3TNV80F

NOTE: Use a rubber-type lapping tool for valves without a lapping tool groove slit.

If seat does not make proper contact, lap the valve into the seat.

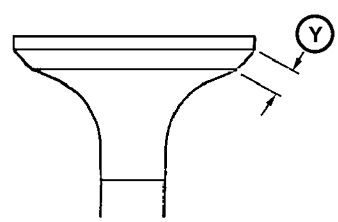
1. Apply small amount of fine lapping compound to face of valve.
2. Turn valve to lap valve to seat.

TCAL28398 —UN—28JUN12

BS62576,000179B -19-24APR14-1/2

3. Lift valve from seat every 8 to 10 strokes. Lap until a uniform ring appears around the surface (Y) of the valve face.
4. Wash all parts in solvent to remove lapping compound. Dry parts.
5. Check position of lap mark on valve face. Lap mark must be on or near center of valve face.

TCAL28399 —UN—28JUN12



Y—Valve Face Surface

BS62576,000179B -19-24APR14-2/2

Remove and Install Piston and Connecting Rod—3TNV80F

Special or Required Tools

- Ridge Reamer

Removal

NOTE: The engine must be removed from the machine to perform this procedure.

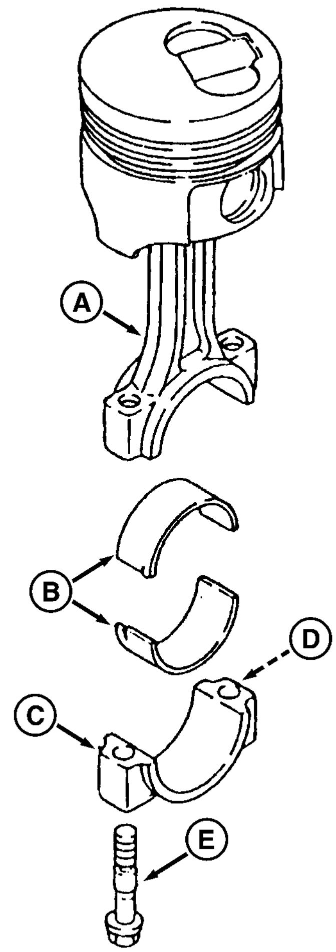
1. Remove the oil pan and oil pickup tube. (See Remove and Install Oil Pan and Strainer—3TNV80F.)
2. Remove the cylinder head. (See Remove and Install Cylinder Head and Valves—3TNV80F.)
3. Check the cylinder bore for ridges. These ridges can cause damage to piston if ridge is not removed. If necessary, remove any ridge from top of cylinder bore using a ridge reamer.
4. Measure the connecting rod side play. (See Check Connecting Rod Side Play—3TNV80F.)
5. Measure the crankshaft end play. (See Check Crankshaft End Play—3TNV80F.)
6. Measure the connecting rod bearing clearance. (See Check Connecting Rod Bearing Clearance—3TNV80F.)

IMPORTANT: Keep the connecting rods and rod caps together. Rods and caps are a matched set. Note the alignment marks on each part.

7. Remove the rod cap screws (E), connecting rod cap (C), and bearing inserts (B).

IMPORTANT: The pistons and cylinders are matched. Pistons must be installed in the cylinders from which they were removed.

8. Note the connecting rod alignment mark (D) in relation to the cylinders. Start at the flywheel end with cylinder number one, then two, etc.
9. Push the piston and connecting rod (A) out of the cylinder bore using a wooden dowel.



TCT004701 —UN—25SEP12

A—Piston and Connecting Rod
B—Bearing Inserts
C—Connecting Rod Cap
D—Connecting Rod Alignment Mark
E—Rod Cap Screws

10. Disassemble and inspect all parts for wear or damage. (See Disassemble and Assemble Piston and Connecting Rod—3TNV80F.)
11. Inspect cylinder bore. (See Inspect Cylinder Bore—3TNV80F.)

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BS62576,000179C -19-24APR14-1/2

Installation

1. Apply clean engine oil to all parts during installation.
2. Always replace the connecting rod cap screws. Do not reuse the bolts.
3. Assemble the piston and connecting rod. (See Disassemble and Assemble Piston and Connecting Rod—3TNV80F.)

IMPORTANT: Pistons must be installed in the cylinders from which they were removed and in the same direction. Be careful not to damage the crankshaft rod journals while installing pistons.

4. Install the piston and connecting rod into the cylinder from which it was removed. The alignment mark (D) on the connecting rod or the piston recess (A) on top of piston should point toward the fuel injection pump.

IMPORTANT: Do not touch bearing insert surfaces. Oil and acid from your finger will corrode the bearing surface.

5. Install the bearing inserts to the connecting rod and rod cap, aligning tangs (F) with grooves (E).

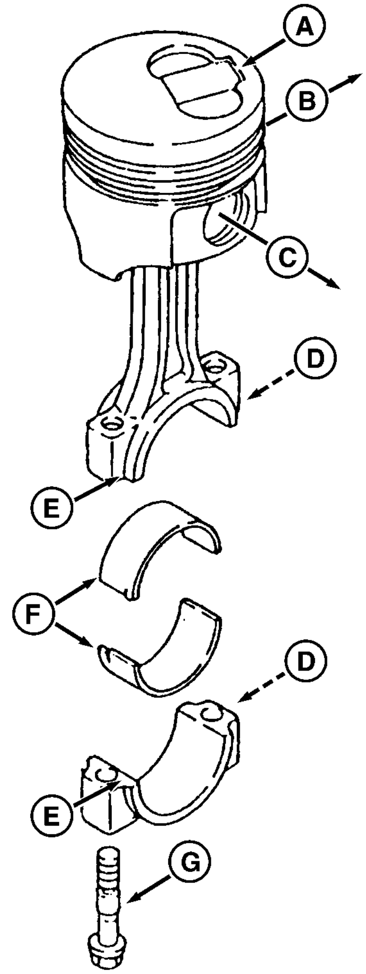
IMPORTANT: Connecting rod caps must be installed on the same connecting rods they were removed from.

6. Match the connecting rods to caps using alignment marks (D). Install the rod caps.
7. Dip the entire connecting rod cap screws (G) in clean engine oil. Install new cap screws and tighten to specification.

Specification

Connecting Rod Cap
Screw—Torque....................23—28 N·m
(17—20 lb.-ft.)

8. If a new piston and connecting rod were installed, stamp a number corresponding to the cylinder number on the connecting rod and rod cap.
9. Install the cylinder head. (See Remove and Install Cylinder Head and Valves—3TNV80F.)



A—Piston Recess
B—Fuel Injection Pump Side
C—Flywheel Side
D—Alignment Mark
E—Groove
F—Tang
G—Cap Screws

10. Install the oil pan and oil pickup tube. (See Remove and Install Oil Pan and Strainer—3TNV80F.)

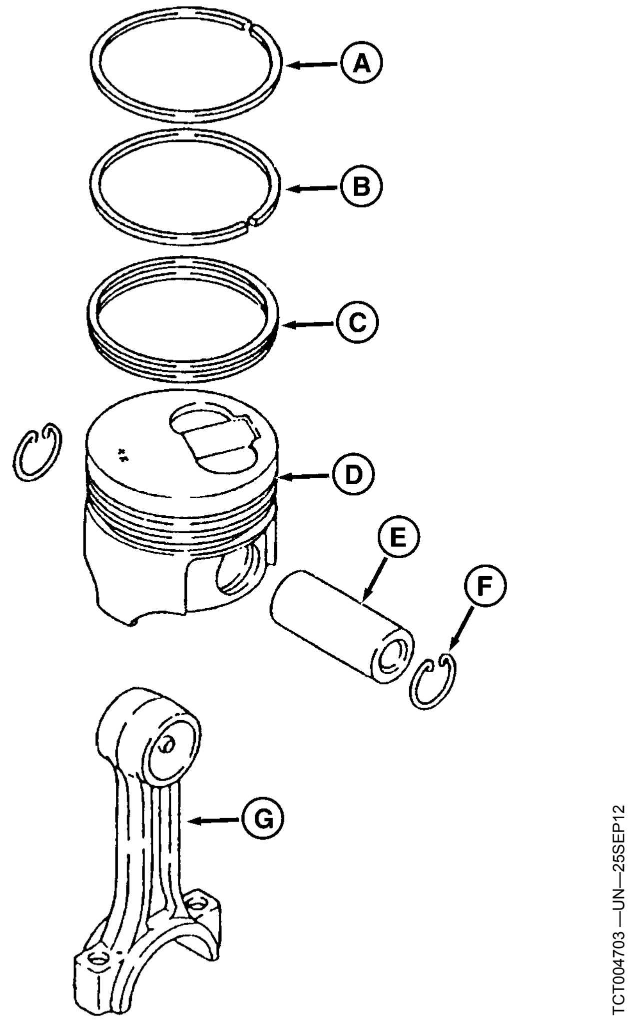
BS62576,000179C -19-24APR14-2/2

Disassemble and Assemble Piston and Connecting Rod—3TNV80F

Disassembly

IMPORTANT: Pistons must be installed on the same connecting rod they were removed from.

1. Put a mark on each piston and connecting rod to aid in assembly.
2. Inspect all parts for wear or damage. Replace as necessary.



A—Top Piston Ring
B—Middle Piston Ring
C—Oil Control Ring with Expander
D—Piston
E—Piston Pin
F—Snap Ring
G—Piston Pin Bushing
H—Connecting Rod

Continued on next page

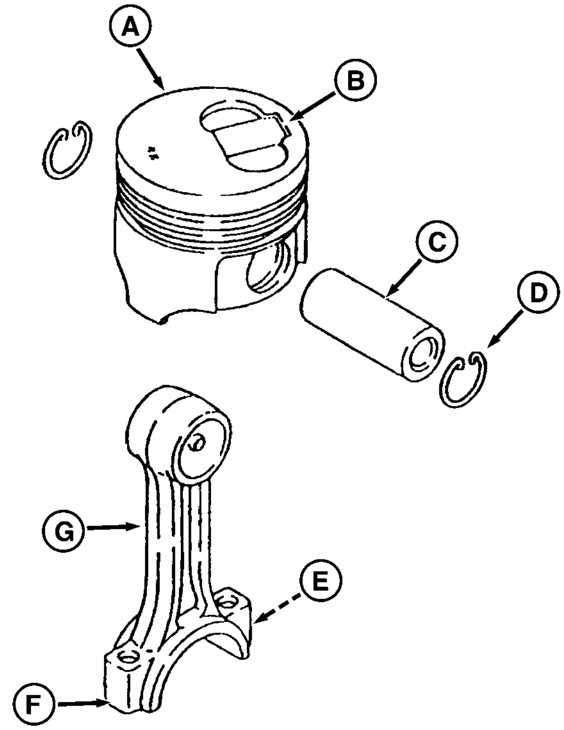
BS62576,000179D -19-24APR14-1/4

Assembly

1. Apply clean engine oil to all parts during assembly.

IMPORTANT: The pistons must be installed on the same connecting rod they were removed from.

2. Install piston pin bushing in connecting rod with oil holes aligned.
3. Assemble the piston (A) to the connecting rod (G) with piston recess (B) on the same side as the connecting rod stamped mark (E). If a new connecting rod is used, assemble the piston to the connecting rod with piston recess opposite the connecting rod bearing insert groove (F).
4. Install piston pin (C) and snap rings (D).

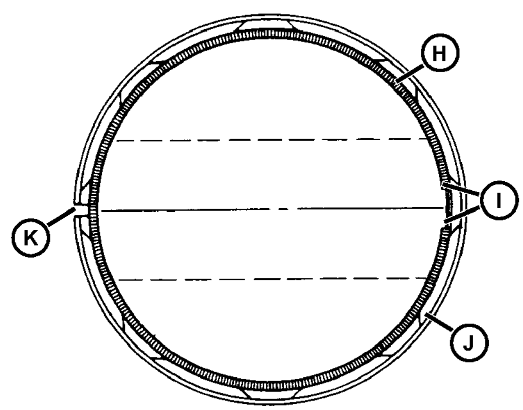


TCT004704 —UN—25SEP12

A—Piston
B—Piston Recess
C—Piston Pin
D—Snap Rings
E—Connecting Rod Stamped Mark
F—Connecting Rod Bearing Insert Groove
G—Connecting Rod

BS62576,000179D -19-24APR14-2/4

5. Install an oil ring expander (H) in the bottom ring groove of the piston, with the ends (I) above either end of the piston pin.
6. Install oil ring (J) over the expander with the ring gap (K) opposite (180°) the expander ends.



TCAL28406 —UN—28JUN12

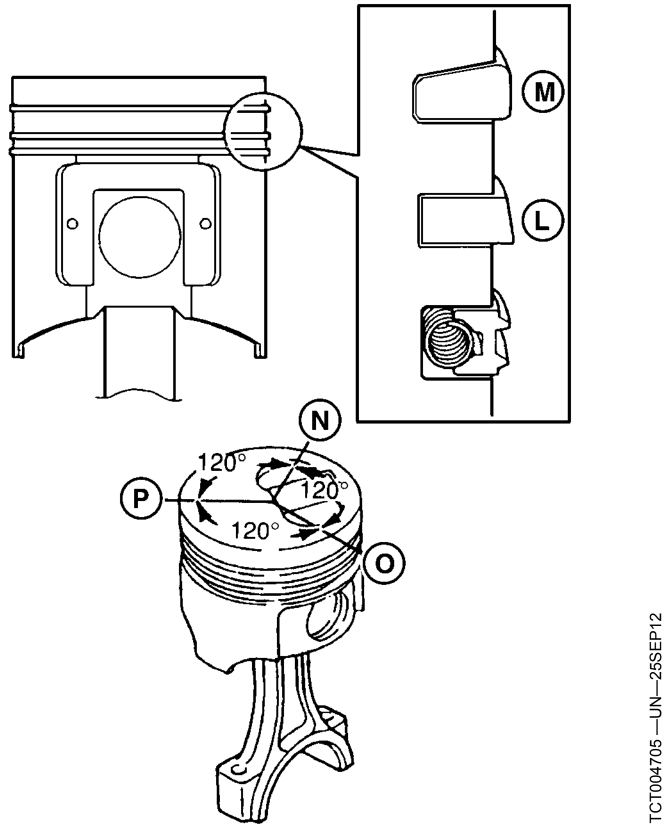
H—Oil Ring Expander
I— Ends
J— Oil Ring
K—Ring Gap

Continued on next page

BS62576,000179D -19-24APR14-3/4

7. Install the middle piston ring (L), with the small diameter of taper toward top of piston, in the middle groove. Turn the ring until the middle piston ring gap (P) is 120° away from the oil ring gap (O).

8. Install the top piston ring (chrome plated) (M), with the manufacturer's mark "R," "T," or "RN" (near the ring gap) toward the top of the piston, in the top groove. Turn the ring until the top piston ring gap (N) is 120° away from the second ring gap (P).



L—Middle Piston Ring
M—Top Piston Ring
N—Top Piston Ring Gap
O—Oil Ring Gap
P—Middle Piston Ring Gap

BS62576,000179D -19-24APR14-4/4

Inspect Piston and Connecting Rod—3TNV80F

Special or Required Tools

- Bushing, Bearing, and Seal Driver Set

Connecting Rod Bearing

1. Install the connecting rod cap and bearing inserts on the connecting rod. Install the old connecting rod cap screws and tighten to specification.

Specification

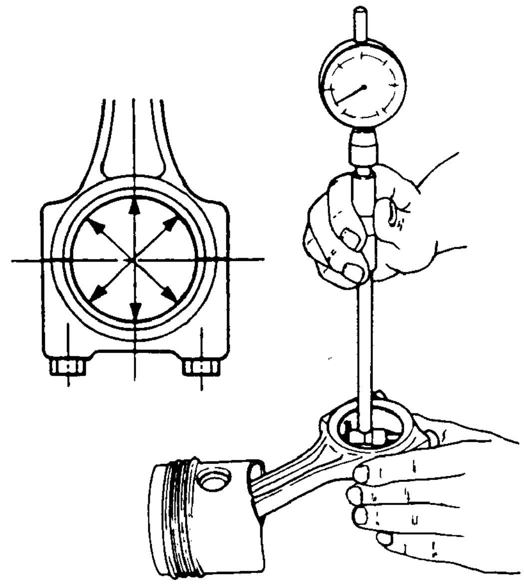
Connecting Rod Cap Screw—Torque....................23—28 N·m (17—20 lb.-ft.)

2. Measure the connecting rod bearing diameter. Replace the bearing inserts if bearing diameter is not within specification.

Specification

Connecting Rod Bearings—ID....................41.982—42.002 mm (1.653—1.654 in.)

3. Measure the oil clearance between the bearing inserts and the crankshaft, and verify that the clearance is within specification. If the bearing oil clearance exceeds the wear limit, grind the crankshaft connecting rod journals and install undersized bearing inserts, or replace the bearing inserts and the crankshaft.



TCAL28408 —UN—28JUN12

Specification

Connecting Rod Bearings—Oil Clearance....................0.020—0.050 mm (0.0008—0.0020 in.)

Connecting Rod Bearings (Wear Limit)—Oil Clearance....................0.110 mm (0.0043 in.)

BS62576,000179E -19-24APR14-1/7

Piston Ring Groove

1. With the rings installed on the piston, measure the piston ring groove side clearance. Measure at several places around each piston.
2. Replace the rings or the piston if the clearances exceed specification.

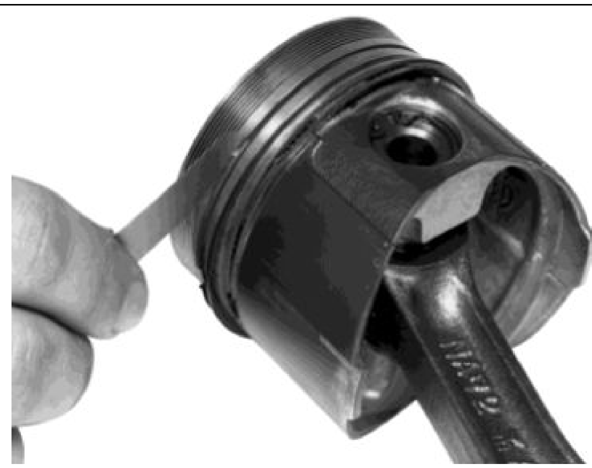
Piston Ring Groove—Specification

Top Piston Ring Groove—Side Clearance....................0.080—0.120 mm (0.0031—0.0047 in.)

Middle Piston Ring Groove—Side Clearance....................0.050—0.090 mm (0.0020—0.0035 in.)

Middle Piston Ring Groove (Wear Limit)—Side Clearance....................0.285 mm (0.0112 in.)

Oil Control Ring Groove—Side Clearance....................0.020—0.055 mm (0.0008—0.0022 in.)



TCAL28409 —UN—28JUN12

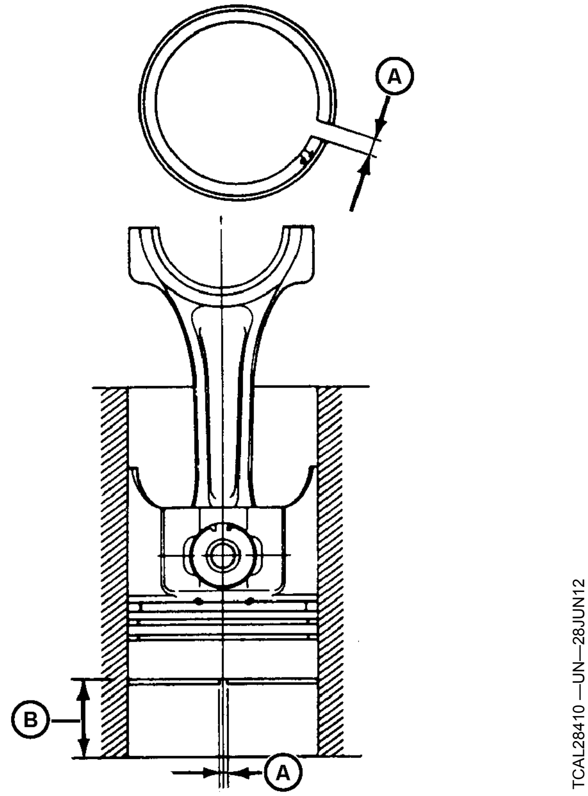
Oil Control Ring Groove (Wear Limit)—Side Clearance....................0.180 mm (0.0071 in.)

Continued on next page

BS62576,000179E -19-24APR14-2/7

Piston Ring End Gap

1. Push ring into cylinder bore, using a piston, until ring installed depth (B) is approximately 30 mm (1.18 in.) from bottom of cylinder bore.
2. Measure piston ring end gap (A). If ring end gap exceeds wear limit specifications, replace ring.



Piston Ring End Gap—Specification

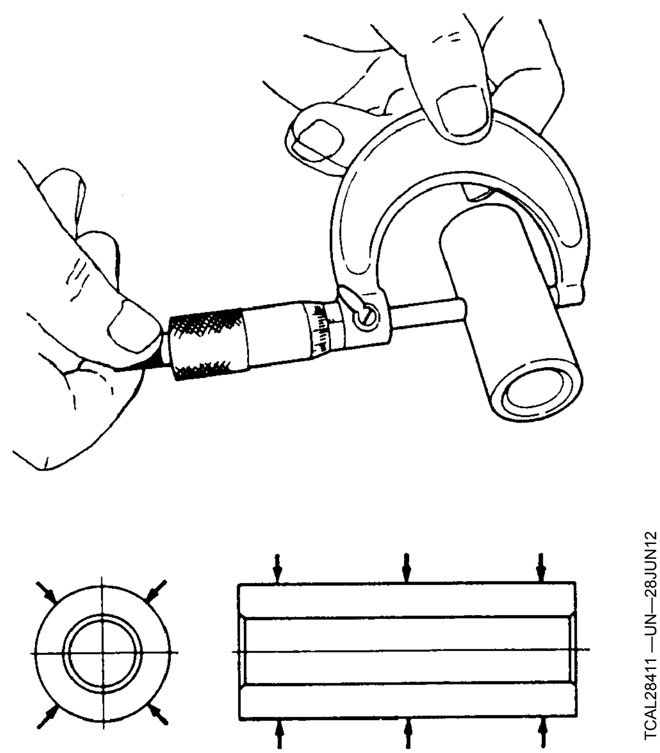
Top Piston Ring—End Gap....0.15—0.30 mm (0.0059—0.0118 in.)
Top Piston Ring (Wear Limit)—End Gap.... 0.39 mm (0.015 in.)
Middle Piston Ring—End Gap....0.18—0.33 mm (0.0071—0.0130 in.)
Middle Piston Ring (Wear Limit)—End Gap.... 0.42 mm (0.0165 in.)
Oil Control Ring—End Gap....0.20—0.45 mm (0.0079—0.0177 in.)
Oil Control Ring (Wear Limit)—End Gap.... 0.54 mm (0.0213 in.)

A—Piston Ring End Gap **B—30 mm (1.18 in.)**

BS62576,000179E -19-24APR14-3/7

Piston Pin

Measure the piston pin diameter at six places. Replace any pin that is not within specification.



Piston Pins—Specification

Piston Pin—OD....21.995—22.00 mm (0.8659—0.866 in.)
Piston Pin (Wear Limit)—OD.... 21.965 mm (0.8648 in.)

Continued on next page BS62576,000179E -19-24APR14-4/7

Piston Pin Bore

1. Measure the pin bore diameter in the piston. If the piston pin bore exceeds the wear limit, replace the piston.

2. If the piston pin-to-piston oil clearance (bore ID minus pin OD) exceeds the wear limit specifications, replace the piston, piston pin, or both.

Piston Pin Bores—Specification

Piston Pin Bore—ID..22.0—22.009 mm (0.8661—0.8665 in.)

Piston Pin Bore (Wear Limit)—ID.. 22.0039 mm (0.8677 in.)

TCAL28412 —UN—28JUN12

BS62576,000179E -19-24APR14-5/7

Piston Pin Bushing

NOTE: The piston pin bushing is a press fit. Replace the bushing using a driver set. When installing the bushing, make sure to align the oil hole in the bushing with the hole in the connecting rod.

1. Measure the piston pin bushing diameter in the connecting rod. If the bushing diameter exceeds the wear limit specifications, replace bushing.

Piston Pin Bushings—Specification

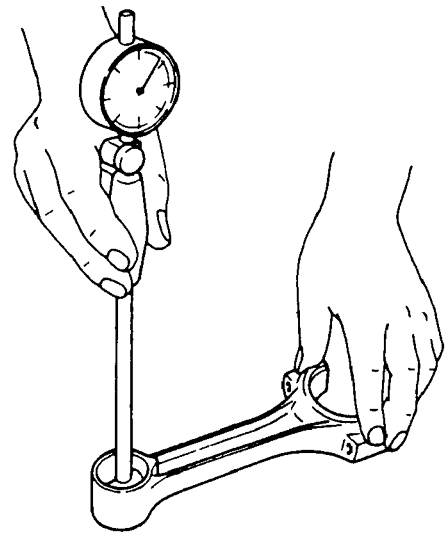
Piston Pin Bushing—ID...22.025—22.038 mm (0.8671—0.8676 in.)

Piston Pin Bushing (Wear Limit)—ID.. 22.068 mm (0.8688 in.)

2. If piston pin-to-rod bore oil clearance (bushing ID minus pin OD) exceeds specification, replace the bushing or the piston pin.

Piston Pin Bushings—Specification

Piston Pin Bushing—Oil Clearance..0.025—0.043 mm (0.001—0.0017 in.)



TCAL28413 —UN—28JUN12

Piston Pin-to-Rod Bore (Wear Limit)—Oil Clearance.. 0.105 mm (0.0041 in.)

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BS62576,000179E -19-24APR14-6/7

Piston Diameter

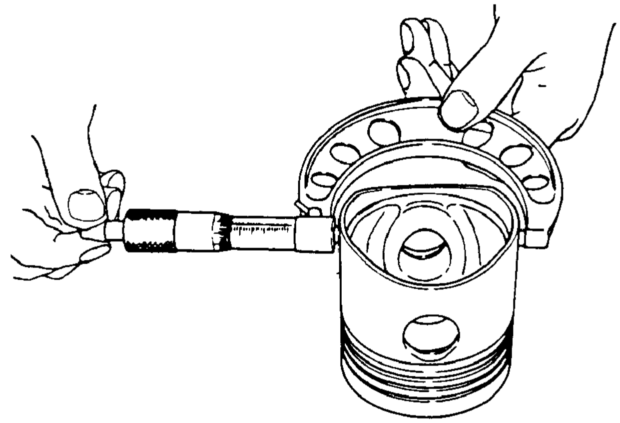
NOTE: If the engine has had a previous major overhaul, oversize pistons and rings may have been installed. Pistons and rings are available in 0.25 mm (0.010 in.) oversize.

Measure the piston diameter perpendicular to the piston pin bore at distance (A). If the piston diameter is less than the wear limit specifications, install a new piston.

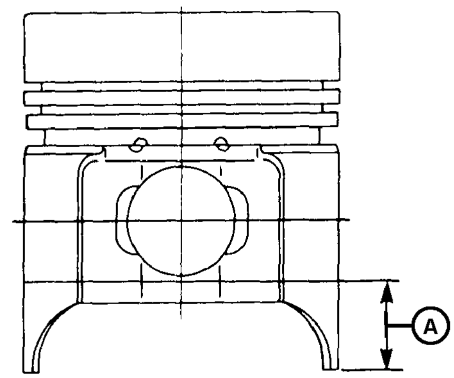
Pistons—Specification

Standard Size Piston—OD...79.962—79.972 mm (3.148—3.1485 in.)

Standard Size Piston (Wear Limit)—OD.. 79.91 mm (3.146 in.)



TCAL28414 —UN—28JUN12



TCAL28415 —UN—28JUN12

A—5 mm (0.197 in.)

BS62576,000179E -19-24APR14-7/7

Check Connecting Rod Side Play—3TNV80F

Procedure

1. Remove crankshaft from cylinder block. (See Remove and Install Crankshaft and Main Bearings—3TNV80F.)
2. Install connecting rod on crankshaft. Tighten connecting rod cap screws to specification.

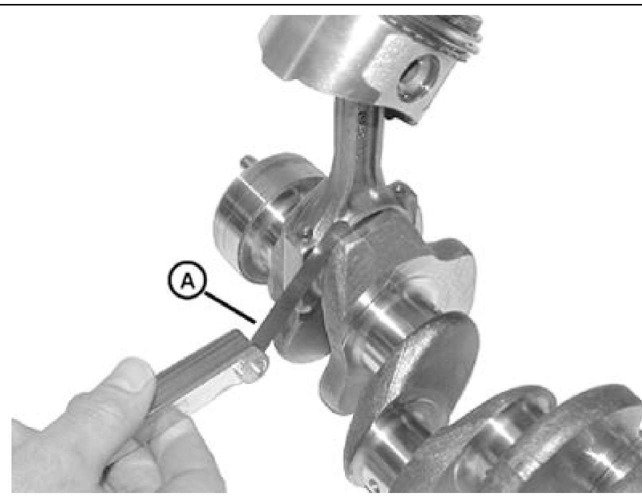
Specification

Connecting Rod Cap Screw—Torque...23—28 N·m (17—20 lb.-ft.)

3. Measure connecting rod side play using a feeler gage (A). Replace connecting rod and crankshaft, as necessary, if side play exceeds specification.

Specification

Connecting Rod—Side Play...0.20—0.40 mm (0.008—0.016 in.)



TCAL28416 —UN—28JUN12

A—Feeler Gage

BS62576,000179F -19-24APR14-1/1

Check Connecting Rod Bearing Clearance—3TNV80F

Reason

To measure oil clearance between connecting rod bearing and crankshaft journal.

Special or Required Tools

- Plastigage® Bearing Clearance Measurement Tool (or equivalent)

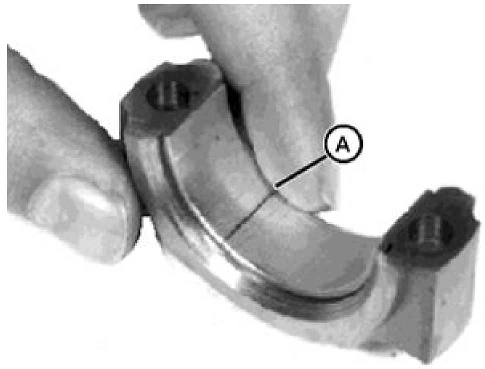
Procedure

IMPORTANT: Connecting rod caps must be installed on the same connecting rod and in the same direction to prevent crankshaft and connecting rod damage.

1. Remove connecting rod cap.
2. Wipe oil from bearing insert and crankshaft journal.
3. Put a piece of Plastigage® (A), or an equivalent, along the full width of the bearing insert, approximately 6 mm (0.250 in.) off center.
4. Turn crankshaft approximately 30° from bottom dead center.

IMPORTANT: Rotating the crankshaft will cause Plastigage® to smear, resulting in a false reading. Do not allow crankshaft to rotate after installing bearing cap.

Plastigage is a trademark of Perfect Circle Corporation



TCAL28417 —UN—28JUN12

A—Plastigage®

NOTE: Lightly lubricate bolts with engine oil before installing.

5. Install connecting rod end cap and original cap screws. Tighten cap screws to specification.

Specification

Connecting Rod Cap Screw—Torque.....23—28 N·m (17—20 lb.-ft.)

6. Remove cap screws and connecting rod cap.

BS62576,00017A0 -19-24APR14-1/2

NOTE: The flattened Plastigage® is found on either the bearing insert or the crankshaft journal.

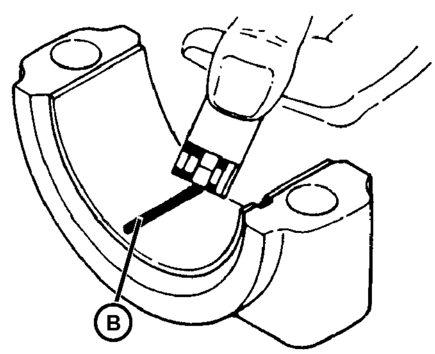
7. Use the graduation marks on the envelope to compare the width of the flattened Plastigage® (B) at its widest point.
8. Determine bearing clearance. The number within the graduation marks indicates the bearing clearance in inches or millimeters, depending on which side of the envelope is used.

Specification

Connecting Rod-to-Crankshaft Journal—Oil Clearance.....0.020—0.050 mm (0.0008—0.0020 in.)

Connecting Rod-to-Crankshaft Journal (Wear Limit)—Oil Clearance.....0.110 mm (0.0043 in.)

9. Remove Plastigage®.



TCAL28418 —UN—28JUN12

B—Flattened Plastigage®

Results

If clearance exceeds specification, replace bearing inserts.

BS62576,00017A0 -19-24APR14-2/2

Inspect Cylinder Bore—3TNV80F

Special or Required Tools

- Flex Hone (with 180-Grit Stone)
- Rigid Hone (with 300-Grit Stone)
- Drill Press

Cylinder Bore Diameter

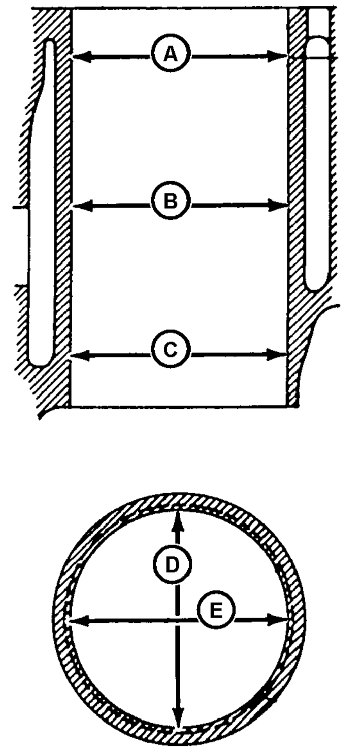
NOTE: If engine has had a previous major overhaul, the cylinders may have been bored oversize. Pistons and rings are available in 0.25 mm (0.010 in.) oversize.

NOTE: Slightly uneven wear, flaws, or minor damage can be corrected by deglazing.

1. Measure cylinder bore diameter at three positions: top (A), middle (B), and bottom (C). At these three positions, measure in both directions: along crankshaft centerline (D) and direction of crankshaft rotation (E).
2. If cylinder bore inner diameter exceeds wear limit, have cylinder rebored. (See Reboring within this Group.)
3. If cylinder is rebored, oversize pistons and rings must be installed.
4. If cylinder bore exceeds oversize bore inner diameter, replace the cylinder block.

Cylinder Bore Diameter—Specification

Standard Cylinder Bore—ID	80.00—80.02 mm (3.150—3.151 in.)
Standard Cylinder Bore (Wear Limit)—ID	80.20 mm (3.158 in.)
Oversize Cylinder Bore—ID	80.25—80.28 mm (3.159—3.161 in.)
Oversize Cylinder Bore (Wear Limit)—ID	80.45 mm (3.167 in.)



TCAL28419 —UN—28JUN12

A—Top
B—Middle
C—Bottom
D—Crankshaft Centerline
E—Direction of Crankshaft Rotation

5. If clearance (cylinder bore ID minus piston OD) exceeds specification, replace cylinder block, piston, or both, or rebore cylinder and install oversize pistons and rings.

Continued on next page

BS62576,00017A1 -19-24APR14-1/3

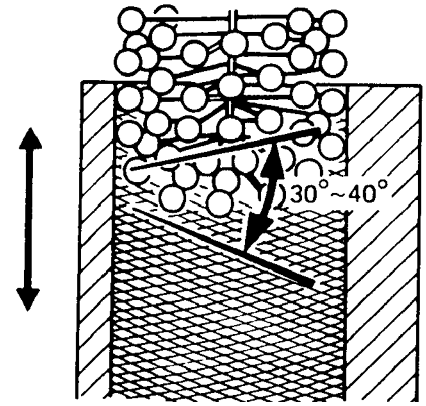
Deglazing

IMPORTANT: If cylinder bores are to be deglazed with crankshaft installed in engine, put clean shop towels over crankshaft to protect journal and bearing surfaces from any abrasives.

1. Deglaze cylinder bores using a flex hone with 180-grit stone.
2. Use flex hone as instructed by manufacturer to obtain a 30-40° crosshatch pattern as shown.

IMPORTANT: Do not use gasoline, kerosene, or commercial solvents to clean cylinder bores. Solvents will not remove all abrasives from cylinder walls.

3. Remove excess abrasive residue from cylinder walls using a clean dry rag. Clean cylinder walls using clean white rags and warm soapy water. Continue to clean cylinder until white rags show no discoloration.



TCAL28420 —UN—28JUN12

BS62576,00017A1 -19-24APR14-2/3

Reboring

NOTE: The cylinder block can be rebored to use oversize pistons and rings. Pistons and rings are available in 0.25 mm (0.010 in.) oversize.

1. Align center of bore to drill press center.

IMPORTANT: Check stone for wear or damage. Use a rigid hone with 300-grit stone.

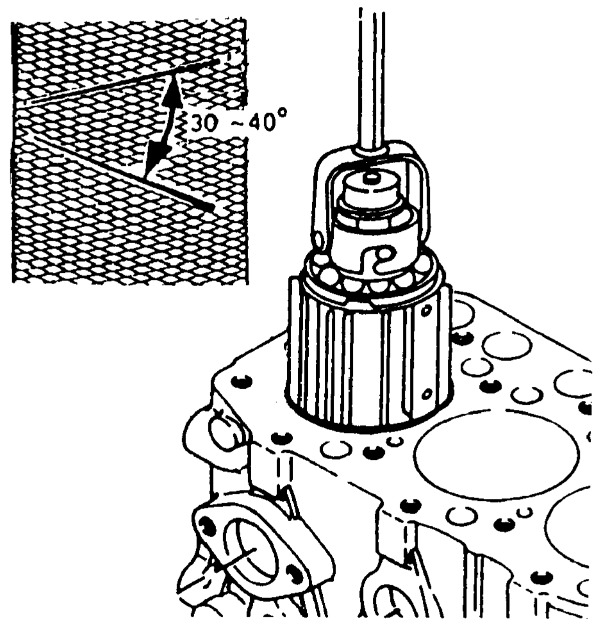
2. Adjust rigid hone so lower end is even with lower end of cylinder bore.
3. Adjust rigid hone stones until they contact narrowest point of cylinder.
4. Coat cylinder with honing oil. Rigid hone should turn by hand. Adjust if too tight.
5. Run drill press at about 250 rpm. Move rigid hone up and down in order to obtain a 30—40° crosshatch pattern.

NOTE: Measure bore when cylinder is cool.

6. Stop press and check cylinder diameter.

NOTE: Finish should not be smooth. It should have a 30-40° crosshatch pattern.

7. Remove rigid hone when cylinder is within 0.03 mm (0.001 in.) of desired size.
8. Use a flex hone with 180-grit stone for honing to final size.
9. Check the bore for taper and out-of-round. (See Inspect Cylinder Bore Taper and Out-of-Round—3TNV80F.)



TCAL28421 —UN—28JUN12

IMPORTANT: Do not use solvents to clean cylinder bore. Solvents will not remove all metal particles and abrasives produced during honing.

10. Clean cylinder thoroughly using warm soapy water until clean white rags show no discoloration.
11. Dry the cylinder and apply engine oil.

BS62576,00017A1 -19-24APR14-3/3

Inspect Cylinder Bore Taper and Out-of-Round—3TNV80F

1. Use a cylinder dial gauge and inside micrometer, or a telescope gauge and outside micrometer, to measure cylinder bore.
2. Measure the bore parallel to the crankshaft at the top end of the ring travel zone.
3. Measure the bore in the same position at the bottom end of the ring travel zone.
4. Measure the bore at right angles to the crankshaft at the top end of the ring travel zone.
5. Measure the bore in the same position at the bottom end of the ring travel zone.
6. Compare measurements from steps 2 and 4 to find the out-of-round wear at the top end of the bore.
7. Compare measurements from steps 3 and 5 to find the out-of-round wear at the bottom end of the bore.
8. Compare results of measurements from steps 2, 3, 4, and 5 to find out whether the bore has worn tapered.

Cylinder Bore Roundness—Specification

Piston-to-Cylinder
Bore—Clearance...0.040—0.060 mm
(0.001—0.002 in.)
Cylinder—Roundness...0.00—0.01 mm
(0.0000—0.0004 in.)
Cylinder (Wear
Limit)—Roundness.. 0.03 mm
(0.001 in.)
Cylinder—Taper...0.00—0.01 mm
(0.0000—0.0004 in.)
Cylinder (Wear
Limit)—Taper... 0.03 mm
(0.001 in.)

BS62576,00017A2 -19-24APR14-1/1

Replace Crankshaft Rear Oil Seal—3TNV80F

Special or Required Tools

- Hoist
- Lifting Bracket (2 used)
- Bushing, Bearing, and Seal Driver Set

Rear Oil Seal

IMPORTANT: Flywheel is heavy! Do not remove flywheel mounting cap screws unless flywheel is secure. Use a hoist and lifting brackets to lift flywheel from crankshaft.

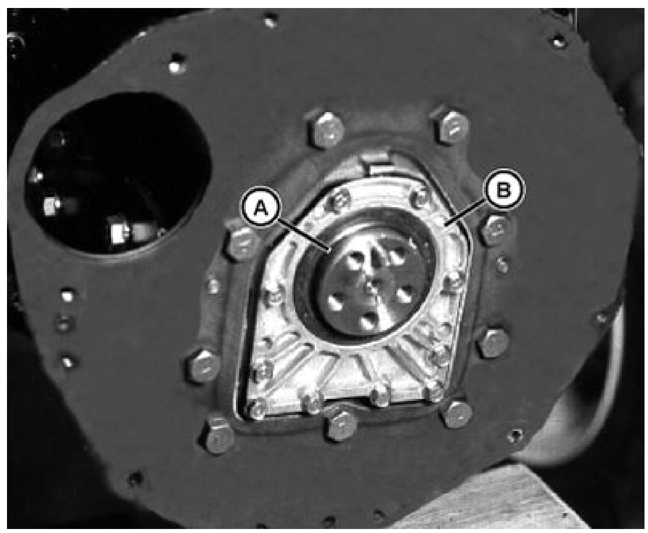
NOTE: Engine removal is not necessary to replace rear oil seal.

1. Remove flywheel. (See Remove and Install Clutch and Flywheel—3TNV80F.)

NOTE: It is not necessary to remove oil seal case (B) to remove oil seal (A).

2. Carefully pry oil seal (A) from oil seal case (B).

NOTE: Oil seal is normally installed flush with surface of oil seal case. If oil seal has worn a groove in crankshaft at oil seal contact point, seal can be installed 3 mm (0.120 in.) deeper into oil seal case.



TCAL28422 —UN—28JUN12

A—Oil Seal **B—Oil Seal Case**

3. Replace oil seal using a driver set. Install seal with lip toward cylinder block. Install seal flush with surface of oil seal case.

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BS62576,00017A3 -19-19JUN14-1/2

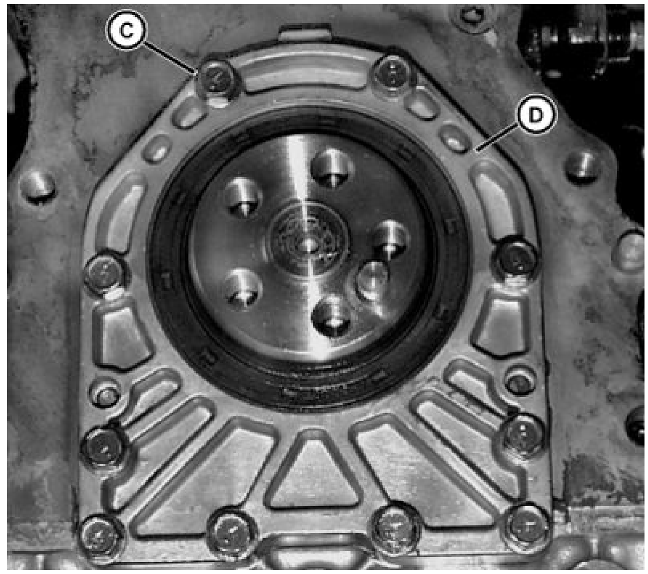
Rear Oil Seal Case

NOTE: It is not necessary to remove oil seal case to remove oil seal. It is not necessary to remove oil seal to remove oil seal case.

1. Remove oil seal case-to-cylinder block cap screws (C).
2. Pry oil seal case (D) from engine block.
3. Clean all old gasket material from oil seal case and engine block.
4. Apply PM37465 Ultra-Blue RTV Form-in-Place Gasket to seal case-to-engine block mating surfaces. Install seal case.
5. Install new oil seal after oil seal case is installed.
6. Install flywheel onto crankshaft, aligning crankshaft pin into flywheel mounting flange. Tighten mounting cap screws to specification.

Specification	
Flywheel Mounting Cap Screw—Torque	80—86 N·m (59—64 lb.-ft.)

7. Install flex plate with longer center hub facing out.
8. Install drive shaft.



TCAL28423 —UN—28JUN12

C—Oil Seal Case-to-Cylinder Block Cap Screws **D—Oil Seal Case**

BS62576,00017A3 -19-19JUN14-2/2

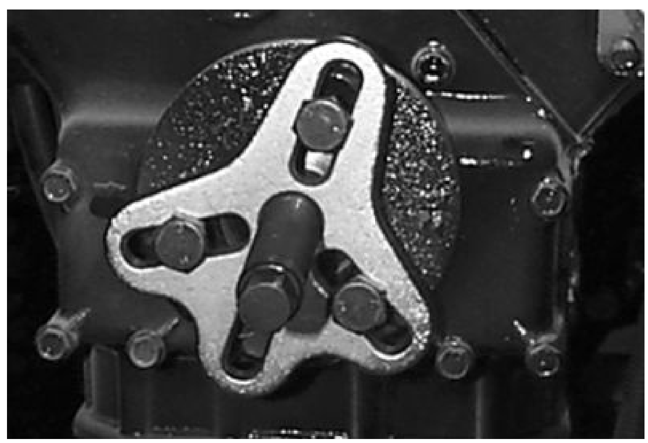
Replace Crankshaft Front Oil Seal—3TNV80F

Special or Required Tools

- Pulley Puller
- Bushing, Bearing, and Seal Driver Set

Procedure

1. Park machine with engine off and park brake on.
2. Remove alternator belt. (See <u>Remove and Install Alternator Drive Belt—3TNV80F</u>.)
3. Remove crankshaft sheave cap screw. Install puller to crankshaft sheave and remove sheave.



TCAL28424 —UN—28JUN12

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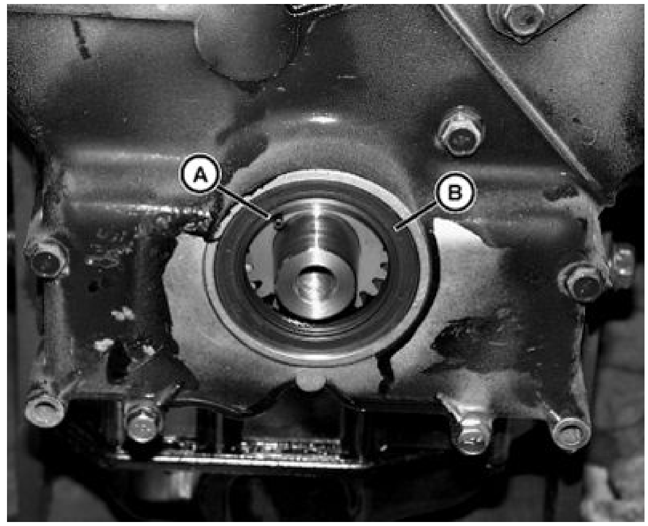
BS62576,00017A4 -19-24APR14-1/2

4. Carefully pry oil seal (B) from timing gear cover.
5. Install new oil seal using a bushing, bearing, and seal driver set. Install seal with lip toward engine. Install seal flush with surface of cover.
6. Coat lip of seal with clean engine oil.
7. Install crankshaft sheave on crankshaft, lining up pin (A) on crankshaft timing gear with hole in crankshaft sheave.
8. Install flat washer and cap screw. Tighten cap screw to specification.

Specification

Crankshaft Sheave Cap Screw—Torque............88 N·m (65 lb.-ft.)

9. Install alternator belt and adjust belt. (See Remove and Install Alternator Drive Belt—3TNV80F and Adjust Alternator—Fan and Coolant Pump Drive Belts.)



TCAL28425 —UN—28JUN12

A—Pin **B—Oil Seal**

BS62576,00017A4 -19-24APR14-2/2

Remove and Install Crankshaft and Main Bearings—3TNV80F

Special or Required Tools

- Knife-Edge Puller
- Press
- Dial Indicator
- V-Block (2 used)

Removal

1. Check crankshaft end play. (See Check Crankshaft End Play—3TNV80F.)
2. Remove flywheel. (See Remove and Install Clutch and Flywheel—3TNV80F.)
3. Remove rear oil seal case. (See Replace Crankshaft Rear Oil Seal—3TNV80F.)
4. Remove timing gear cover, timing gears, timing gear housing, and flywheel of engine.
5. Check crankshaft bearing clearance. (See Check Crankshaft Main Bearing Clearance—3TNV80F.)

IMPORTANT: Connecting rod end caps must be installed on the same connecting rods from which they were removed. Note alignment marks on caps and rods.

6. Remove connecting rod cap screws and end caps. Push pistons and connecting rods away from crankshaft.

IMPORTANT: Main bearing caps must be installed on the same main bearings from which they were removed.

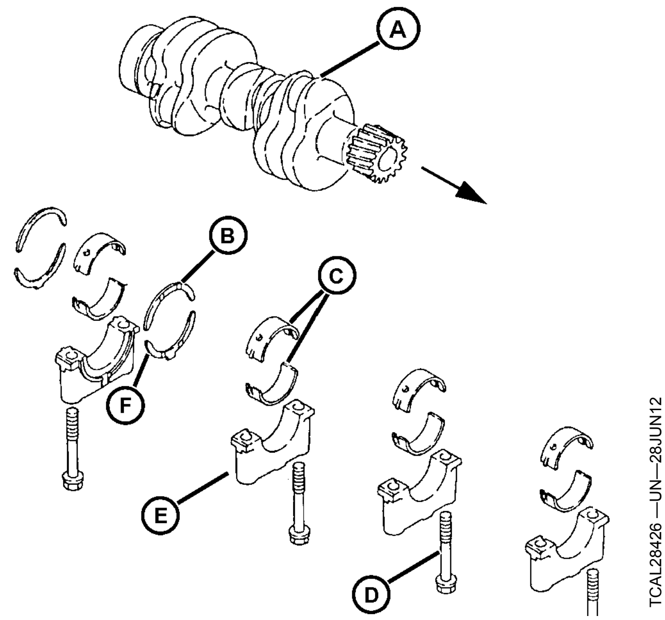
7. Remove main bearing cap screws (D), caps (E), and cap thrust bearings (F).
8. Remove crankshaft (A).
9. Remove block thrust bearings (B) and main bearing inserts (C).
10. Inspect all parts for wear or damage. (See Inspection/Replacement procedures within this Group.)

Installation

1. Apply clean engine oil on all parts during installation.

IMPORTANT: Do not touch bearing insert surfaces. Oil and acid from your finger will corrode the bearing surfaces.

2. Install bearing inserts drilled with oil passage in cylinder block bearing bores, aligning tangs with slots in bores.
3. Install block thrust bearings with oil grooves facing away from engine block.



Arrow Points to Front of Engine

A—Crankshaft
B—Block Thrust Bearings
C—Main Bearing Inserts
D—Main Bearing Cap Screws
E—Caps
F—Cap Thrust Bearings

NOTE: Main bearing caps have raised arrows that are stamped with numbers. Both correspond to their location on the engine block. The number “1” main bearing bore is at flywheel end. Install bearing caps beginning with number 1, then 2, etc. The main bearing cap at gear train end does not have a number. Also install bearing caps with the arrow toward the flywheel end.

4. Install crankshaft.
5. Install smooth bearing inserts in main bearing caps, aligning tangs with slots in caps.
6. Install cap thrust bearings with oil grooves facing away from cap, in the number “1” main bearing cap.
7. Install main bearing caps in their original locations with arrows pointing toward flywheel side of engine.

IMPORTANT: Do not use high-speed power tools or air wrenches to tighten main bearing cap screws.

8. Dip entire main bearing cap screws in clean engine oil. Install cap screws and tighten. Do not tighten to specification at this time.
9. Using a soft-faced hammer, tap the front end of the crankshaft and then the rear end of the crankshaft to align the thrust bearings.

Continued on next page

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10. Tighten main bearing cap screws to specification. When tightening, start at center main bearing cap and work your way out, alternating to the ends. Turn crankshaft by hand. If it does not turn easily, disassemble the parts and find the cause.

Specification

Main Bearing Cap Screw—Torque .... 76—82 N·m (58—60 lb.-ft.)

IMPORTANT: The connecting rod caps must be installed on the same connecting rods from which they were removed. Never reuse connecting rod cap screws. Replace with new.

11. Match the connecting rod caps to the rods using alignment marks. Install the caps to the rods.

12. Dip entire connecting rod cap screws in clean engine oil. Install new cap screws to the rods, and tighten to specification.

Specification

Connecting Rod Cap Screw—Torque .... 23—28 N·m (17—20 lb.-ft.)

13. Install the rear oil seal. (See Replace Crankshaft Rear Oil Seal—3TNV80F.)

14. Install the flywheel. (See Remove and Install Clutch and Flywheel—3TNV80F.)

15. Install the timing gear cover. (See Remove and Install Timing Gear Cover—3TNV80F.)

16. Install the front oil seal. (See Replace Crankshaft Front Oil Seal—3TNV80F.)

17. Install the oil pan. (See Remove and Install Oil Pan and Strainer—3TNV80F.)

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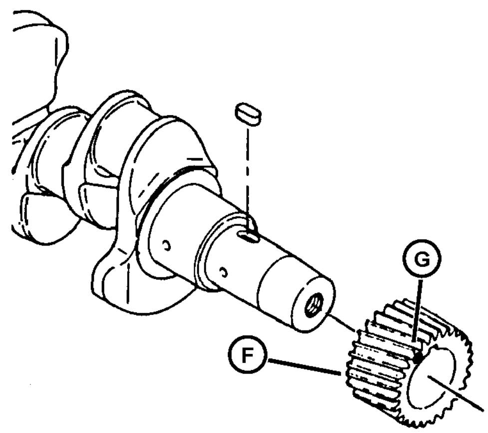
Inspect Crankshaft and Main Bearings—3TNV80F

1. Inspect crankshaft gear for chipped or broken teeth. If replacement is necessary, remove gear from crankshaft using a knife-edge puller and a press.

CAUTION: Do not heat oil over 182°C (360°F). Oil fumes or oil can ignite above 193°C (380°F). Use a thermometer. Do not allow a flame or heating element to come in direct contact with the oil. Heat the oil in a well-ventilated area. Plan a safe handling procedure to avoid burns.

2. Heat gear to approximately 150°C (300°F). Install gear (F) with timing mark (G) toward press table.

3. Align slot in gear with key in shaft. Press crankshaft into gear until gear is tight against crankshaft shoulder.



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F—Gear G—Timing Mark

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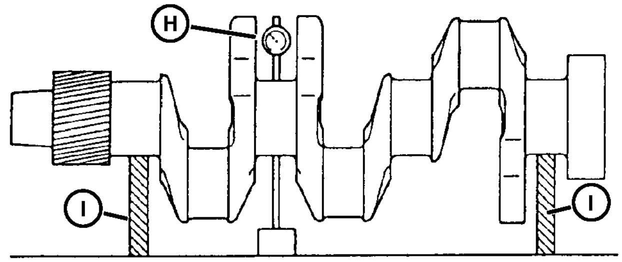
4. Inspect crankshaft for bend using V-blocks (I) and a dial indicator (H). Turn crankshaft slowly and read variation on indicator. If variation is greater than specification, replace crankshaft.

Specification

Crankshaft—Bend
(Maximum).. 0.02 mm
(0.0008 in.)

H—Dial Indicator **I— V-blocks**



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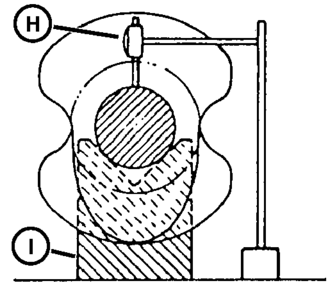


TCAL28429 —UN—28JUN12

BS62576,00017A6 -19-24APR14-2/4

NOTE: If engine has had a previous major overhaul, journals may have been ground and undersize bearing inserts installed.

5. Measure crankshaft connecting rod journals (K) and main bearing journal (J) diameters. Measure several places around each journal.

Crankshaft and Main Bearings—Specification

Crankshaft Connecting
Rod Journal—OD..41.952—41.962 mm
(1.8485—1.8488 in.)

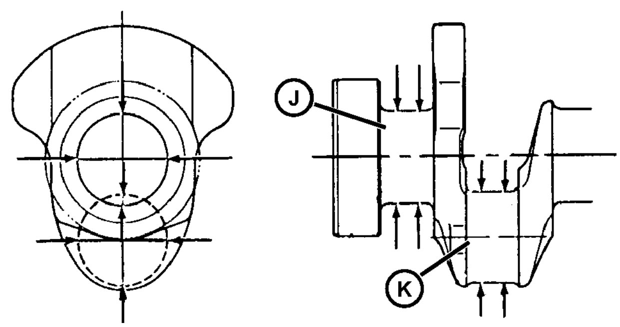
Crankshaft Connecting
Rod Journal (Wear
Limit)—OD... 41.902 mm
(1.650 in.)

Crankshaft Main Bearing
Journal—OD..46.952—46.962 mm
(1.848—1.8489 in.)

Crankshaft Main
Bearing Journal (Wear
Limit)—OD... 46.902 mm
(1.8465 in.)

6. If journal diameter is less than wear limit, replace crankshaft or have journals ground undersize by a qualified machine shop.

7. If journals are ground, undersize bearing inserts must be installed. Bearing inserts are available in 0.25 mm (0.010 in.) undersize.



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J— Main Bearing Journal **K—Connecting Rod Journals**

8. Install bearing inserts and main bearing cap on main bearing. Tighten main bearing cap screws to specification.

Specification

Main Bearing Cap
Screw—Torque... 76—82 N·m
(56—60 lb.-ft.)

Continued on next page

BS62576,00017A6 -19-24APR14-3/4

9. Measure main bearing diameter.

10. Subtract the crankshaft main bearing journal outer diameter from the main bearing inner diameter to obtain the main bearing oil clearance.

    - If crankshaft is within specification but main bearing oil clearance exceeds the wear limit, replace the bearing inserts.
    - If crankshaft is not within specification, have crankshaft journals ground undersize by a qualified machine shop and install undersize bearing inserts.
    - If crankshaft is worn past the wear limit, replace the crankshaft.

Crankshaft and Main Bearings—Specification

Main Bearing—Oil Clearance	0.020—0.050 mm (0.001—0.002 in.)
Main Bearing (Wear Limit)—Oil Clearance	0.12 mm (0.005 in.)

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11. Clean and inspect oil passages in main bearing journals, connecting rod journals, and main bearing bores in cylinder block.

12. Inspect crankshaft for cracks or damage. Replace if necessary.

BS62576,00017A6 -19-24APR14-4/4

Check Crankshaft Main Bearing Clearance—3TNV80F

Reason

To measure oil clearance between main bearing and crankshaft journal.

Special or Required Tools

- Plastigage®

Procedure

NOTE: The engine must be removed from the tractor to perform this test.

1. Remove the oil pan, oil pick-up, crankcase extension, and balancer assembly.

IMPORTANT: Main bearing caps must be installed to the same location and in the same direction to prevent crankshaft and main bearing damage.

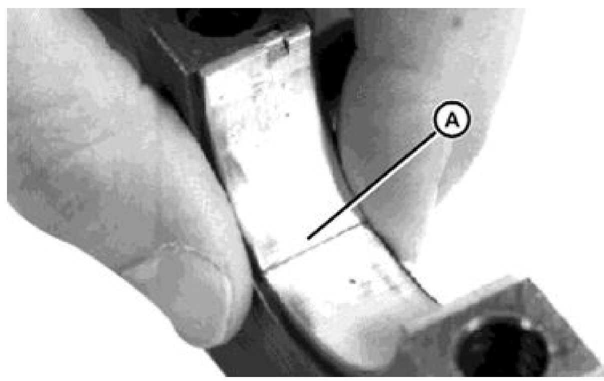
2. Remove the main bearing cap.

3. Wipe oil from the bearing insert and the crankshaft journal.

4. Put a piece of Plastigage® (A), or equivalent, along the full width of the bearing insert approximately 6 mm (0.25 in.) off center.

IMPORTANT: Rotating the crankshaft will cause Plastigage® to smear, resulting in a false reading. Do not allow crankshaft to rotate after installing bearing cap.

Plastigage is a trademark of Perfect Circle Corporation



TCAL28432 —UN—28JUN12

A—Plastigage® Placement

NOTE: Lightly lubricate bolts with engine oil before installing.

5. Install main bearing cap and bolts. Tighten bolts to specification.

Specification

Main Bearing Cap Screw—Torque	76—82 N·m (56—60 lb.-ft.)

6. Remove bolts and main bearing cap.

Continued on next page

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NOTE: The flattened Plastigage® will be found on either the bearing insert or crankshaft journal.

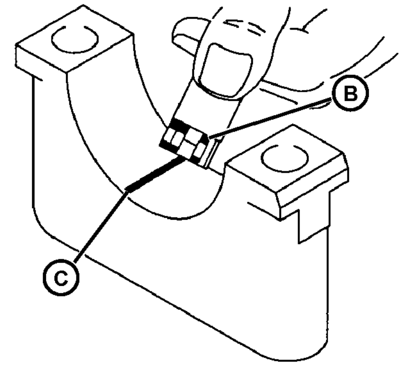
7. Use the graduation marks on the envelope (B) to compare the width of the flattened Plastigage® (C) at its widest point. The number within the graduation marks indicates the bearing clearance in inches or millimeters depending on which side of the envelope is used.
8. Main bearing clearance must be to specification.

Specification

Main Bearing-to-Crankshaft Journal—Oil Clearance....................0.020—0.050 mm (0.001—0.002 in.)

Main Bearing (Wear Limit)—Oil Clearance.................... 0.120 mm (0.005 in.)

9. Remove Plastigage®.



B—Graduation Marks **C—Flattened Plastigage®**

Results

If the clearance exceeds maximum specification, replace the bearing inserts.

BS62576,00017A7 -19-24APR14-2/2

Check Crankshaft End Play—3TNV80F

Reason

To determine proper side clearance between the crankshaft and the engine block.

Special or Required Tools

- Dial Indicator

Procedure

1. Fasten the dial indicator (A) to engine and position indicator tip on end of crankshaft (B).

IMPORTANT: Do not use excessive force when moving crankshaft to avoid damaging bearings.

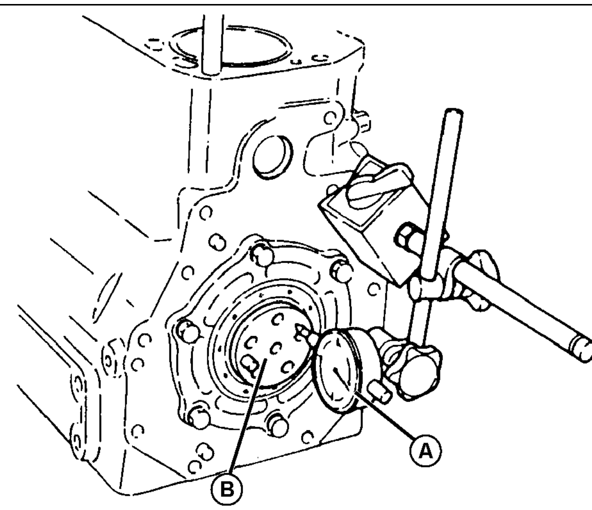
2. Push the crankshaft toward rear as far as possible.
3. Zero the dial indicator.
4. Using a bar, gently pry the crankshaft as far forward as possible.

Results

- If the end play exceeds specification, replace the thrust bearings.

Specification

Crankshaft—End Play....................0.133—0.228 mm (0.0052—0.0090 in.)



A—Dial Indicator **B—Crankshaft**

Crankshaft (Wear Limit)—End Play (Wear Limit)....................0.28 mm (0.0110 in.)

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Remove and Install Clutch and Flywheel—3TNV80F

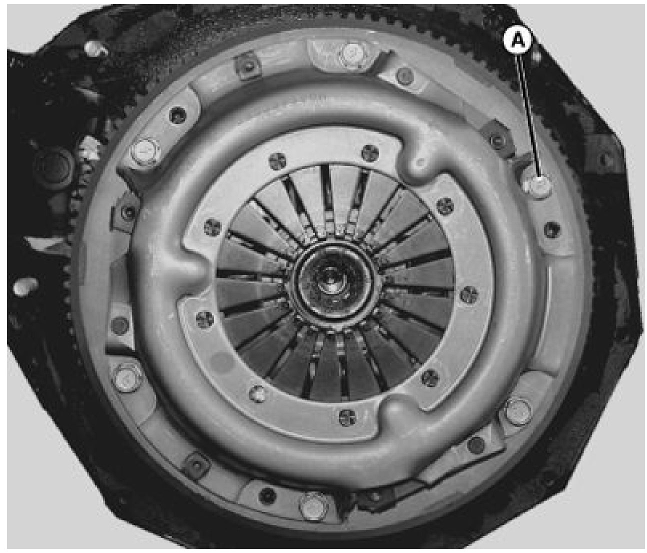
Special or Required Tools

- JDG1331 Clutch Alignment Tool

Procedure

1. Remove engine. (See Remove and Install Engine—3TNV80F.)
2. Alternately loosen cap screws (A) on clutch cover.

A—Cap Screws



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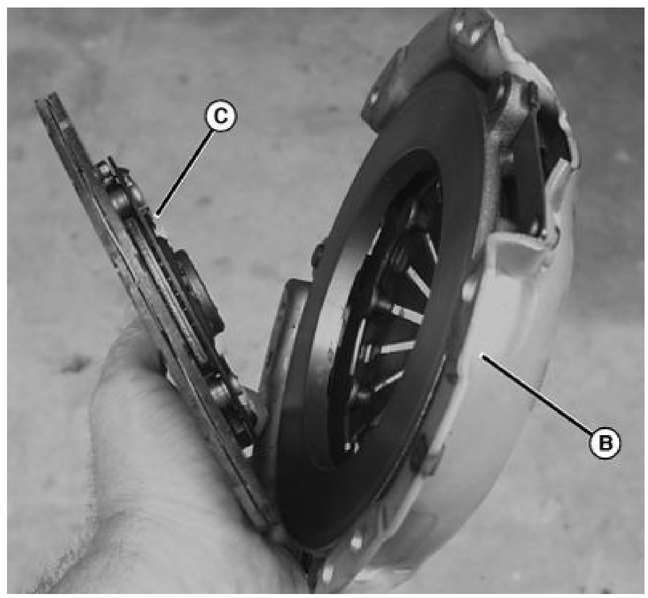
3. Remove clutch cover (B) and clutch disc (C) from flywheel.

B—Clutch Cover **C—Clutch Disc**



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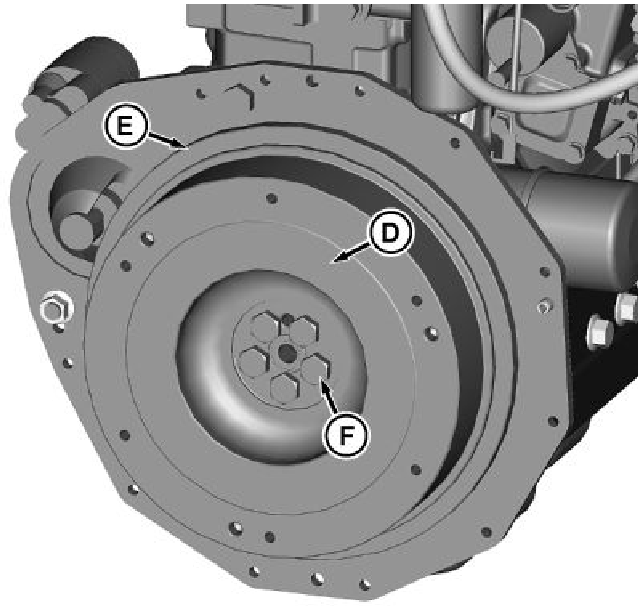
CAUTION: FLYWHEEL IS HEAVY! Do not remove flywheel mounting cap screws unless flywheel is secure. Use a hoist and lift rings to lift flywheel from crankshaft.

4. Remove flywheel.
5. Inspect flywheel for cracks or grooves on clutch wear area (D). Check ring gear (E) for chips and broken teeth. Check pilot bearing (F) for smooth operation. Replace parts as necessary.



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D—Clutch Wear Area
E—Ring Gear
F—Pilot Bearing

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Installation

1. Make sure flywheel and crankshaft mating surfaces are clean.
2. Install flywheel and tighten cap screws to specification.

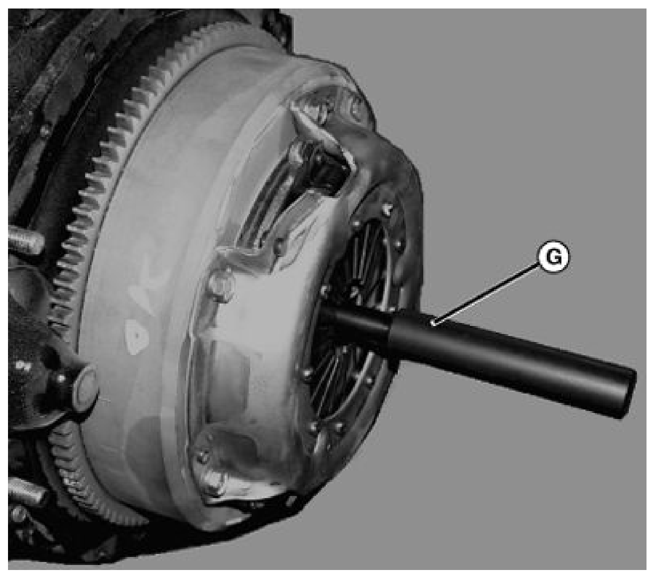
Specification

Flywheel Mounting Cap Screw Torque—Torque.....84 N·m (62 lb.-ft.)

3. Install clutch disk with raised side of hub toward clutch cover. Install clutch cover. Do not tighten cap screws.
4. Using JDG1331 Clutch Alignment Tool (G) or an equivalent, align clutch disk and alternately tighten clutch cover cap screws to specification.

Specification

Clutch Cover Cap Screw—Torque.....23 N·m (200 lb.-in.)



TCAL26182 —UN—15JUN12

G—JDG1331 Clutch Alignment Tool

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Remove and Install Camshaft—3TNV80F

IMPORTANT: Always replace camshaft followers when installing a new camshaft. Always replace camshaft when replacing camshaft followers. The components wear as a set and replacing only one will accelerate the wear of the other.

Special or Required Tools

- D15001NU Magnetic Follower Holder Kit
- Knife-Edge Puller
- Arbor Press
- V-Block (2 used)
- Dial Indicator
- Micrometer
- Bushing Driver Set

Removal

1. Remove engine. (See Remove and Install Engine—3TNV80F.)
2. Remove rocker arm assembly and push rods. (See Remove and Install Rocker Arm Cover—3TNV80F and Remove and Install Rocker Arm Assembly—3TNV80F.)
3. Remove timing gear cover. (See Remove and Install Timing Gear Cover—3TNV80F.)
4. Check camshaft end play. (See Check Camshaft End Play—3TNV80F.)
5. Check backlash of timing gears. (See Check Timing Gear Backlash—3TNV80F.)

NOTE: If camshaft is being removed with cylinder head installed, use a magnetic follower holder tool, or turn engine until oil pan is upward, to hold cam followers away from camshaft.

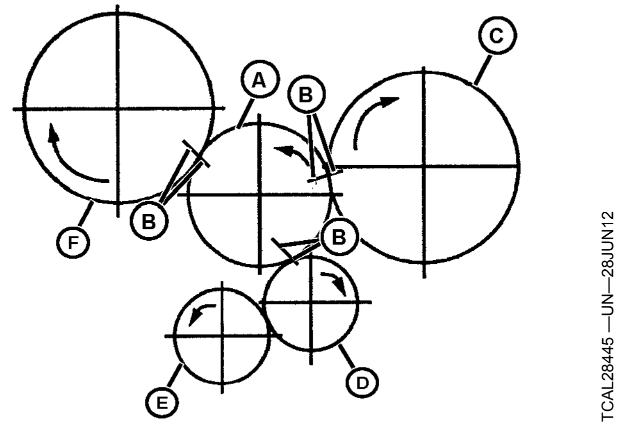
6. Hold cam followers away from camshaft using a magnetic follower holder kit such as D15001NU.
7. Rotate the crankshaft and align the timing marks.

IMPORTANT: Do not allow camshaft lobes to hit bearing surfaces while removing camshaft. Machined surfaces can be damaged.

8. Remove two thrust plate mounting cap screws, the thrust plate, and the camshaft.
9. Inspect all parts for wear or damage. (See Inspect Camshaft—3TNV80F.)

Installation

IMPORTANT: Do not allow camshaft lobes to hit bearing surfaces while installing camshaft. Machined surfaces can be damaged.



Arrows Indicate Direction of Rotation (Viewed from Gear Case)

A—Idler Gear
B—Timing Marks
C—Camshaft Gear
D—Crankshaft Gear
E—Oil Pump Gear
F—Fuel Injection Drive Gear

NOTE: Apply clean engine oil on all parts during installation.

The fuel injection drive gear, camshaft gear, and crankshaft gear all must be correctly timed to the idler gear. It is not necessary to time the oil pump gear. Due to the odd number of teeth on the idler gear, timing marks will only align periodically. (See Check Timing Gear Backlash—3TNV80F.)

1. Rotate the crankshaft to align the timing marks.
2. Install the camshaft.
3. Install the thrust plate and cap screws. Tighten to specification.

Specification

Camshaft Thrust Plate
Cap Screw—Torque.......................................11 N·m
(96 lb.-in.)

4. Install timing gear cover. (See Remove and Install Timing Gear Cover—3TNV80F.)
5. If cam followers were removed, replace into same holes as removed.
6. Install push rods and rocker arm assembly. (See Remove and Install Rocker Arm Assembly—3TNV80F and Remove and Install Rocker Arm Cover—3TNV80F.)

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Inspect Camshaft—3TNV80F

Special or Required Tools

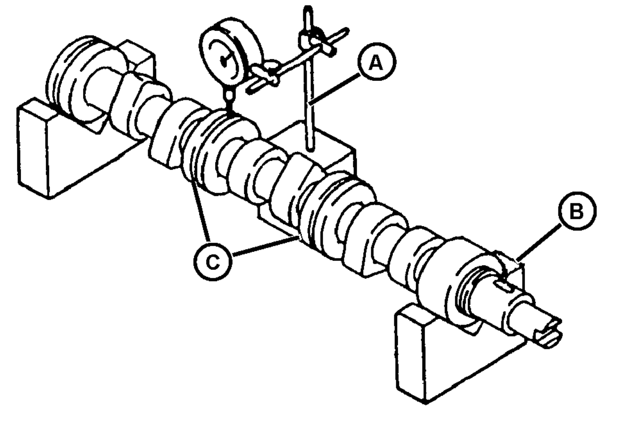
- D15001NU Magnetic Follower Holder Kit
- Knife-Edge Puller
- Arbor Press
- V-Block (2 used)
- Dial Indicator
- Micrometer
- Bushing Driver Set

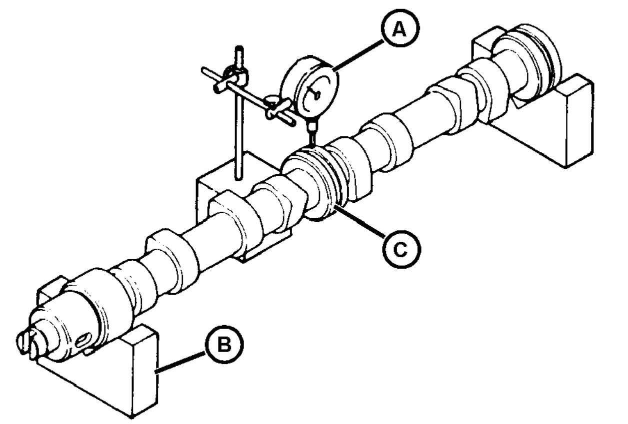
1. Inspect camshaft for bend by using a pair of V-blocks (B) and a dial indicator (A). Turn camshaft slowly and read variation of camshaft bearing journals (C) on indicator. If variation is greater than wear limit, replace camshaft.

Camshaft—Specification

Camshaft—Bend...0.00—0.02 mm (0.00—0.0008 in.)

Camshaft (Wear Limit)—Bend.. 0.05 mm (0.002 in.)





A—V-blocks
B—Dial Indicator
C—Camshaft Bearing Journals

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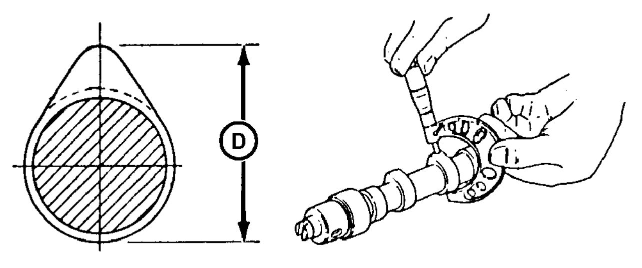
2. Measure camshaft lobe height (D) using a micrometer. If lobe height is less than wear limit, or if there are chips or scratches in lobes or bearing journals, replace camshaft.

Camshaft—Specification

Camshaft Lobe—Height..34.535—34.665 mm (1.3596—1.3647 in.)

Camshaft Lobe (Wear Limit)—Height.. 34.29 mm (1.35 in.)



D—Camshaft Lobe Height

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3. Measure camshaft end journal (E) and intermediate journal (F) outside diameters. If journal diameters are less than wear limit, replace camshaft.

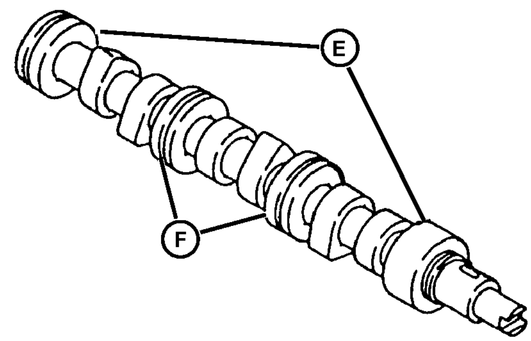
Camshaft Journals—Specification

Intermediate Journal—OD............39.910—39.935 mm (1.571—1.572 in.)

Intermediate Journal (Wear Limit)—OD............39.875 mm (1.569 in.)

Gear Housing and Flywheel End Journals—OD............39.940—39.960 mm (1.572—1.573 in.)

Gear Housing and Flywheel End Journals (Wear Limit)—OD............39.905 mm (1.571 in.)



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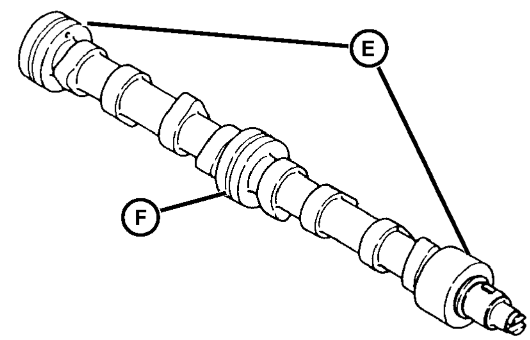

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E—Camshaft End Journal **F—Intermediate Journal**

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4. Measure camshaft bushing diameter (G) at gear housing end. If bushing diameter exceeds wear limit, replace bushing using a driver set.

   a. Align oil holes (H) in new bushing and cylinder block.

   b. Install bushing flush with surface of idler gear.

5. If bushing oil clearance (bushing ID minus camshaft journal OD) exceeds specification, replace bushing, camshaft, or both.

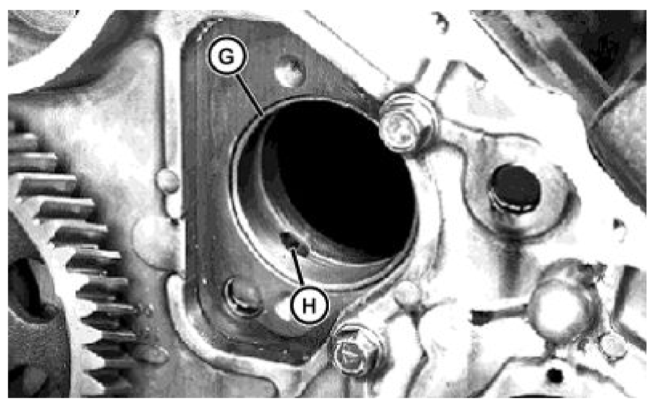
Camshaft Gear End—Specification

Camshaft Bushing—Gear End—ID............40—40.025 mm (1.5748—1.5758 in.)

Camshaft Bushing—Gear End (Wear Limit)—ID............40.150 mm (1.5807 in.)

Camshaft Bushing—Gear End—Oil Clearance............0.040—0.085 mm (0.0016—0.0033 in.)

Camshaft Bushing—Gear End (Wear Limit)—Oil Clearance............0.245 mm (0.0096 in.)



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G—Camshaft Bushing Diameter **H—Oil Holes**

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NOTE: Engine back plate must be removed to measure camshaft intermediate (J) and flywheel end (K) bearing diameters.

6. Remove engine back plate.
7. Remove plug (I).
8. Measure intermediate (J) and flywheel end (K) camshaft bore diameters. If bore diameter exceeds wear limit, replace cylinder block.
9. If bore clearance (bore ID minus camshaft journal OD) exceeds oil clearance specification, replace camshaft, cylinder block, or both.

Camshaft Intermediate Bore—Specification

Camshaft Intermediate Bore—ID .... 40—40.025 mm (1.5748—1.5758 in.)

Camshaft Intermediate Bore (Wear Limit)—ID .... 40.10 mm (1.5787 in.)

Camshaft Intermediate Bore—Oil Clearance .... 0.065—0.115 mm (0.0026—0.0045 in.)

Camshaft Intermediate Bore (Wear Limit)—Oil Clearance .... 0.225 mm (0.0089 in.)

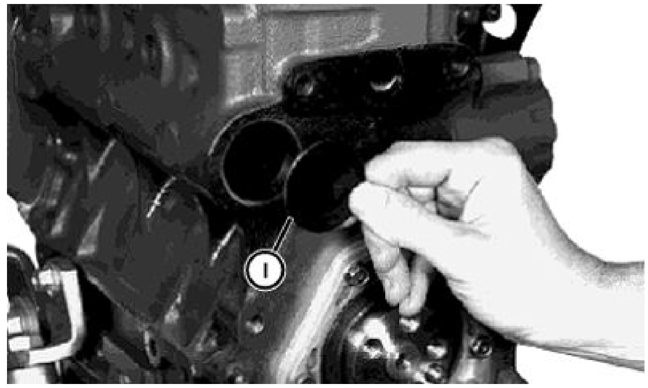
Camshaft Flywheel End Bore—Specification

Camshaft Flywheel-End Bore—ID .... 40—40.025 mm (1.5748—1.5758 in.)

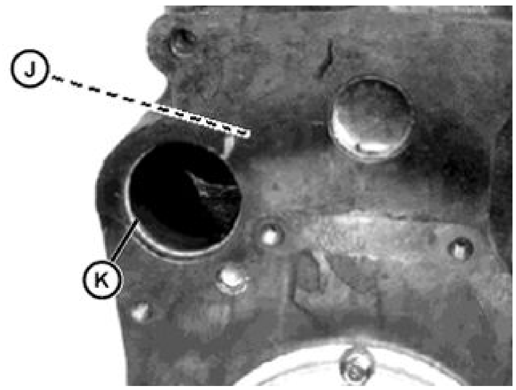
Camshaft Flywheel-End Bore (Wear Limit)—ID .... 40.10 mm (1.5787 in.)

Camshaft Flywheel-End Bore—Oil Clearance .... 0.040—0.085 mm (0.0016—0.0033 in.)

Camshaft Flywheel-End Bore (Wear Limit)—Oil Clearance .... 0.195 mm (0.0077 in.)



TCAL28443 —UN—28JUN12



TCAL28444 —UN—28JUN12

I— Plug
J— Camshaft Intermediate Bore
K—Camshaft Flywheel Bore

10. Apply PM37465 Ultra-Blue RTV Form-in-Place Gasket, or equivalent, on outer edge of plug. Install plug until it bottoms in bore.
11. Install engine back plate.

BS62576,00017AB -19-24APR14-5/5

Check Camshaft End Play—3TNV80F

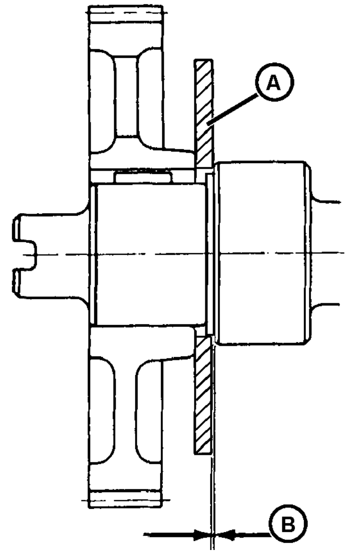
Reason

NOTE: Follow this procedure if camshaft is installed in cylinder block. If camshaft is removed from cylinder block, check end play (B) using a feeler gage between camshaft thrust plate (A) and front side of first camshaft bearing journal.

To determine proper side clearance between camshaft gear end journal and thrust plate.

Special or Required Tools

- Dial Indicator



TCAL28446 —UN—28JUN12

A—Camshaft Thrust Plate **B—End Play**

BS62576,00017AC -19-24APR14-1/2

Procedure

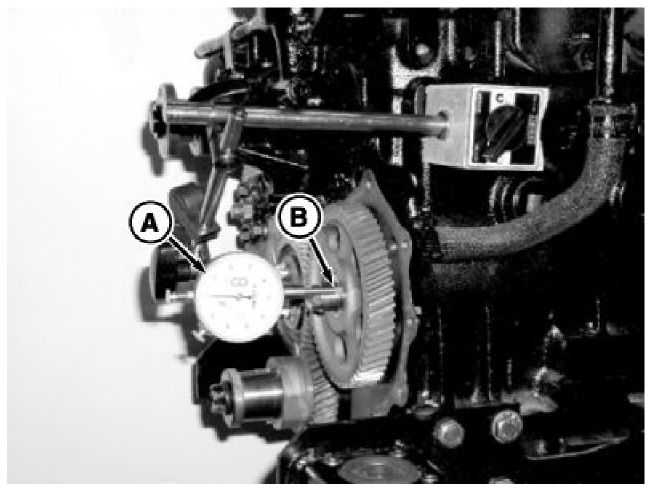
1. Remove the timing gear cover. (See Remove and Install Timing Gear Cover—3TNV80F.)
2. Fasten the dial indicator (A) to the engine and position indicator tip on end of camshaft (B).
3. Push the camshaft toward the rear as far as possible.
4. Zero the dial indicator.
5. Pull the camshaft forward as far as possible.

Results

- If camshaft end play exceeds specification, remove camshaft and inspect thrust plate, camshaft, and camshaft gear for wear. Replace parts as needed. (See Inspect Camshaft—3TNV80F.)

Specification

Camshaft—End Play	0.05—0.15 mm (0.002—0.006 in.)
Camshaft (Wear Limit)—End Play	0.25 mm (0.0098 in.)



TCT006370 —UN—18JAN13

A—Dial Indicator **B—Camshaft**

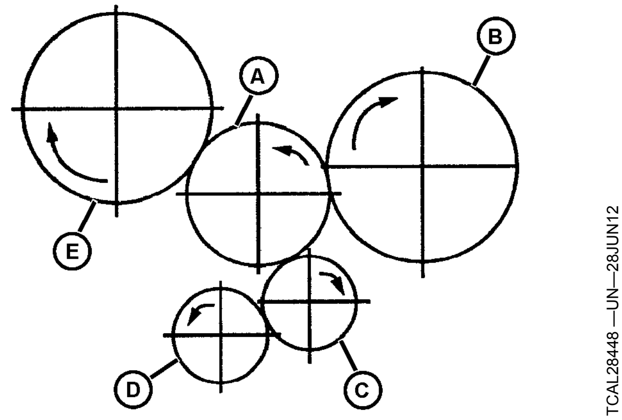
BS62576,00017AC -19-24APR14-2/2

Check Timing Gear Backlash—3TNV80F

1. Remove timing gear cover. (See Remove and Install Timing Gear Cover—3TNV80F.)
2. Place dial indicator magnetic base on cylinder block with tip of indicator on tooth of gear being measured.
3. Holding opposite gear stationary, move measured gear back and forth while measuring backlash between meshing gears.
4. If backlash exceeds specifications, replace worn gears as a complete set.

Specification

Timing Gear—Backlash....................0.06—0.12 mm (0.0024—0.0047 in.)
Timing Gear (Wear Limit)—Backlash....................0.14 mm (0.0055 in.)



Arrows Indicate Direction of Rotation (Viewed from Gear Case)

A—Idler Gear
B—Camshaft Gear
C—Crankshaft Gear
D—Oil Pump Gear
E—Fuel Injection Drive Gear

BS62576,00017AD -19-24APR14-1/1

Remove and Install Camshaft Gear—3TNV80F

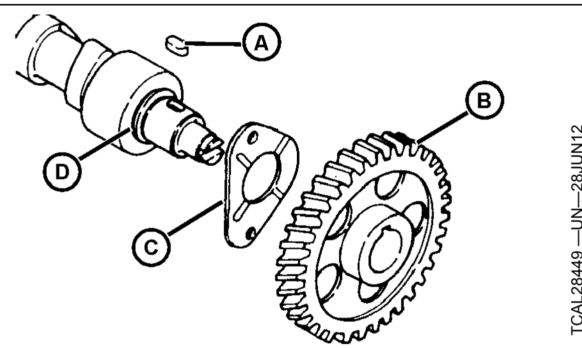
Removal

1. Remove gear from camshaft using a knife-edge puller and an arbor press. Place fat side of puller against camshaft gear.
2. Inspect gear for chipped or broken teeth. Replace if necessary.

Installation

CAUTION: Do not heat oil over 182°C (360°F). Oil fumes or oil can ignite above 193°C (380°F). Use a thermometer. Do not allow a flame or heating element to come in direct contact with the oil. Heat the oil in a well-ventilated area. Plan a safe handling procedure to avoid burns.

1. Heat gear to approximately 150°C (300°F).
2. Install key (A) into slot of camshaft.
3. Install thrust plate (C) onto camshaft, centering onto stepped shoulder (D). (Thrust plate has no “front” or “rear” side.)



A—Key
B—Camshaft Gear
C—Thrust Plate
D—Stepped Shoulder

IMPORTANT: Be sure thrust plate is not trapped between camshaft gear and stepped shoulder while gear is being pressed on.

4. Install heated camshaft gear (B) with longer hub of camshaft gear facing camshaft. Align slot in gear with key in shaft. Press camshaft into gear until hub of gear is tight against camshaft shoulder. Thrust plate must spin freely on camshaft.

BS62576,00017AE -19-24APR14-1/1

Remove and Install Camshaft Follower—3TNV80F

Special or Required Tools

- Magnetic Pick-Up Tool

1. Remove cylinder head. (See Remove and Install Cylinder Head and Valves—3TNV80F.)

IMPORTANT: Cam followers must be installed in the same bores from which they were removed. Put a mark on each cam follower and cylinder block bore to aid in installation.

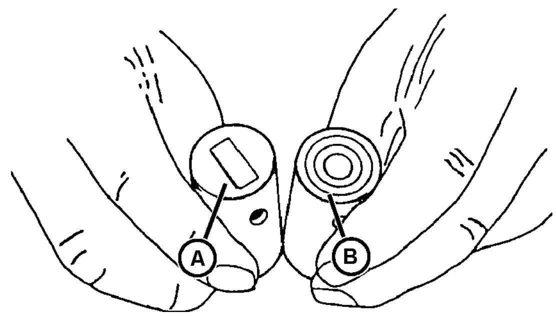
Always replace camshaft when replacing cam followers. Always replace cam followers when installing new camshaft. The components wear as a set and replacing only one will accelerate the wear of the other.

2. Remove cam followers from cylinder block with magnetic pick-up tool.
3. Inspect all parts for wear or damage. (See Inspect Camshaft Follower—3TNV80F.)
4. Apply clean engine oil on all parts during installation.
5. Install cam followers after camshaft is installed. Installation is done in the reverse order of removal.

BS62576,00017AF -19-24APR14-1/1

Inspect Camshaft Follower—3TNV80F

1. Inspect cam follower contact surface for abnormal wear (A). Normal wear (B) has light circular lines and flat surface.



TCAL28450 —UN—28JUN12

A—Abnormal Wear **B—Normal Wear**

BS62576,00017B0 -19-24APR14-1/2

2. Measure cam follower diameter. If outside diameter is less than wear limit, replace cam follower.

TCAL28451 —UN—28JUN12

Specification

Camshaft Followers—OD .... 20.94—20.96 mm (0.824—0.825 in.)
Camshaft Followers (Wear Limit)—OD .... 20.91 mm (0.823 in.)

3. Measure cam follower bore diameter in cylinder block. If cam follower bore diameter exceeds wear limit, replace cylinder block.

Specification

Camshaft Follower Bore—ID .... 21.00—21.02 mm (0.827—0.828 in.)
Camshaft Follower Bore (Wear Limit)—ID .... 21.04 mm (0.828 in.)

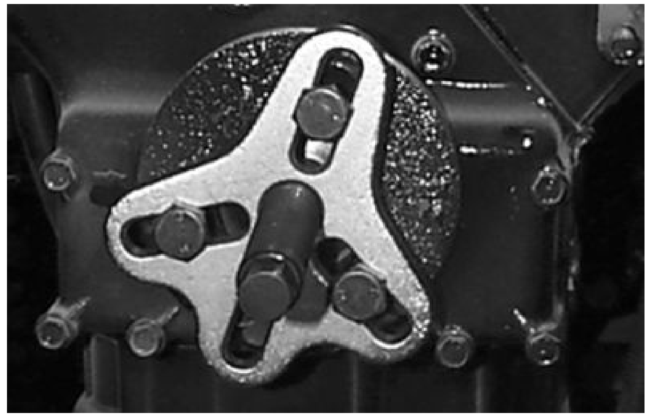
4. If tappet-to-bore oil clearance (bore ID minus follower OD) exceeds specification, replace cam follower, cylinder block, or both.

Specification

Follower to Bore—Oil Clearance .... 0.040—0.082 mm (0.0016—0.0032 in.)
Follower to Bore (Wear Limit)—Oil Clearance .... 0.134 mm (0.0053 in.)

BS62576,00017B0 -19-24APR14-2/2

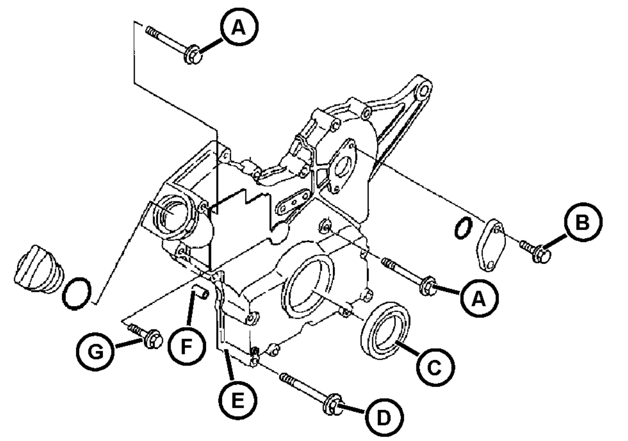
Remove and Install Timing Gear Cover—3TNV80F


TCAL28452 —UN—28JUN12

Procedure

1. Remove alternator. (See Remove and Install Alternator—3TNV80F.)
2. Remove alternator belt. (See Remove and Install Alternator Drive Belt—3TNV80F.)
3. Remove crankshaft sheave mounting cap screw and washer.
4. Install puller to crankshaft sheave and remove sheave.

BS62576,00017B1 -19-19JUN14-1/2



TCAL28453 —UN—28JUN12

A—M8 x 60 Cap Screw (4 used)
B—M8 x 16 Cap Screw (2 used)
C—Seal
D—M8 x 80 Cap Screw (6 used)
E—Cover
F—Dowel Pin (2 used)
G—M8 x 30 Cap Screw (8 used)

5. Remove timing gear cover mounting cap screws.
6. Remove timing gear cover.
7. Clean all old gasket material from timing gear cover and timing gear cover housing on block.
8. Apply a thin bead of PM37465 ULTRA BLUE® RTV Form-in-Place Gasket to timing gear cover prior to installation.
9. Tighten all timing gear cover mounting cap screws to specification.

Specification

Timing Gear Cover Mounting Cap Screw—Torque .... 9 N·m (78 lb.-in.)

10. Install crankshaft sheave, lining up pin on crankshaft. Install flat washer and cap screw and tighten to specification.

Specification

Crankshaft Sheave Cap Screw—Torque .... 88 N·m (65 lb.-ft.)

11. Install alternator and belt. (See Remove and Install Alternator—3TNV80F and Remove and Install Alternator Drive Belt—3TNV80F.)
12. Adjust belt tension. (See Adjust Alternator—Fan and Coolant Pump Drive Belts.)

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BS62576,00017B1 -19-19JUN14-2/2

Remove and Install Idler Gear—3TNV80F

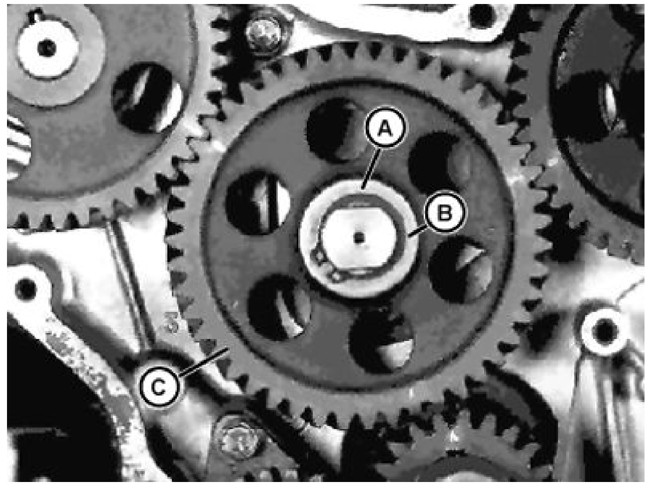
1. Remove timing gear cover. (See Remove and Install Timing Gear Cover—3TNV80F.)
2. Check backlash of timing gears. (See Check Timing Gear Backlash—3TNV80F.)

NOTE: Due to the odd number of teeth on the idler gear, timing marks will only align periodically. When all timing marks on gears align, the piston closest to the water pump, number three, is at TDC on compression stroke. (Number one cylinder is closest to the flywheel.)

3. Rotate crankshaft and align timing marks.

NOTE: Timing mark on crankshaft gear is on front of tooth used for timing, but since gear is spiral cut it will appear to not be aligned with mark on idler gear.

4. Remove snap ring (A), washer (B), and gear (C).
5. Inspect all parts for wear or damage. (See Inspect Idler Gear—3TNV80F.)
6. Installation is done in the reverse order of removal. It is not necessary to time oil pump gear.



TCAL28454 —UN—28JUN12

A—Snap Ring
B—Washer
C—Gear

BS62576,00017B2 -19-24APR14-1/1

Inspect Idler Gear—3TNV80F

Special or Required Tools

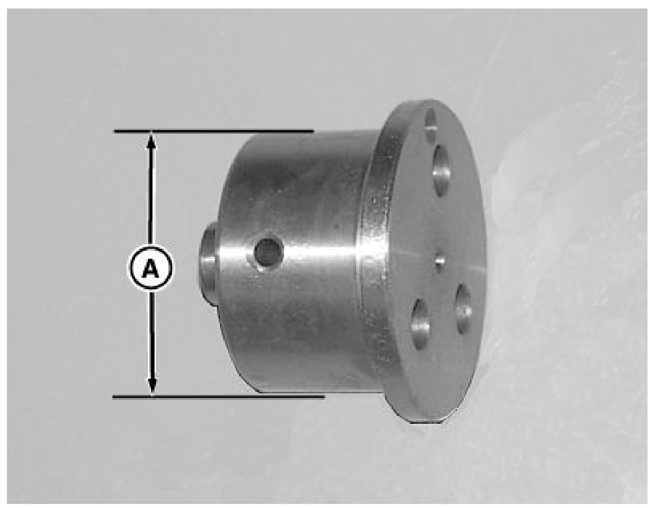
- Bushing Driver Set

1. Inspect gear for chipped or broken teeth. Replace if necessary.
2. Measure idler gear shaft diameter. If shaft diameter is less than wear limit, replace idler gear shaft.

Specification

Idler Gear Shaft—OD	36.950—36.975 mm (1.4547—1.4557 in.)
Idler Gear Shaft (Wear Limit)—OD	36.90 mm (1.4528 in.)

A—Shaft Diameter



TCT006703 —UN—28MAR13

Idler Gear Shaft

Continued on next page

BS62576,00017B3 -19-24APR14-1/2

3. Measure idler gear bushing diameter. If bushing diameter exceeds wear limit, replace bushing using a driver set.

Specification

Idler Gear Bushing—ID..37.0—37.025 mm (1.4567—1.4577 in.)

Idler Gear Bushing (Wear Limit)—ID.. 37.075 mm (1.4596 in.)

a. Align oil holes in bushing and idler gear.

b. Install bushing flush with surface of idler gear.

4. If bushing oil clearance (bushing ID minus shaft OD) exceeds specification, replace bushing, shaft, or both.

Specification

Idler Gear Bushing-to-Shaft—Oil Clearance...0.025—0.075 mm (0.0010—0.0030 in.)

Idler Gear Bushing-to-Shaft (Wear Limit)—Oil Clearance... 0.175 mm (0.0069 in.)

TCT006704 —UN—28MAR13

B—Bushing

BS62576,00017B3 -19-24APR14-2/2

Remove and Install Timing Gear Housing—3TNV80F

Removal

1. Remove engine. (See Remove and Install Engine—3TNV80F.)
2. Remove timing gear cover. (See Remove and Install Timing Gear Cover—3TNV80F.)
3. Remove fuel injection lines from engine. (See Remove, Inspect, and Install Fuel Injection Nozzle—3TNV80F.)
4. Remove engine camshaft. (See Remove and Install Camshaft—3TNV80F.)
5. Remove water pump. (See Remove and Install Water Pump—3TNV80F.)
6. Remove oil pan. (See Remove and Install Oil Pan and Strainer—3TNV80F.)
7. Remove timing gear housing mounting cap screws and remove housing from cylinder block.
8. If replacing timing housing, remove fuel injection pump and governor.

Installation

NOTE: Installation is done in the reverse order of removal.

1. Clean all parts of old gasket sealer, gasket material, oil, and dirt before attempting installation.
2. Install alignment dowels (C) in timing gear housing (B).
3. Replace O-rings (D) between timing gear housing and engine block.

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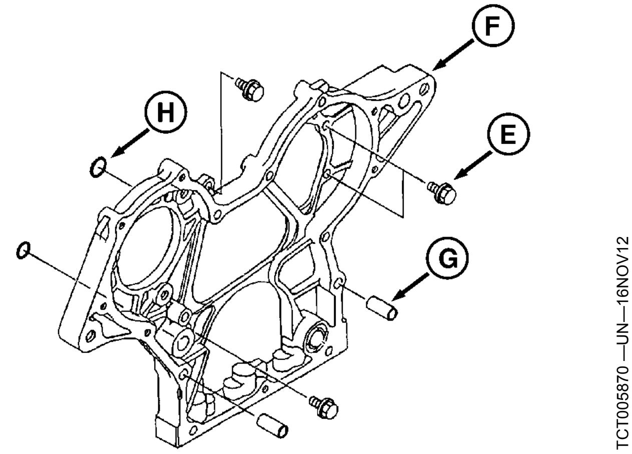


A—PM37465 Ultra-Blue® RTV Form-in-Place Gasket
B—Timing Gear Housing
C—Alignment Dowels
D—O-Rings
E—Cap Screws
F—Timing Gear Housing
G—Alignment Dowels
H—O-Rings

4. Apply PM37465 ULTRA BLUE® RTV Form-in-Place Gasket (A) to timing gear housing when installing to cylinder block.
5. Tighten mounting cap screws to specification.

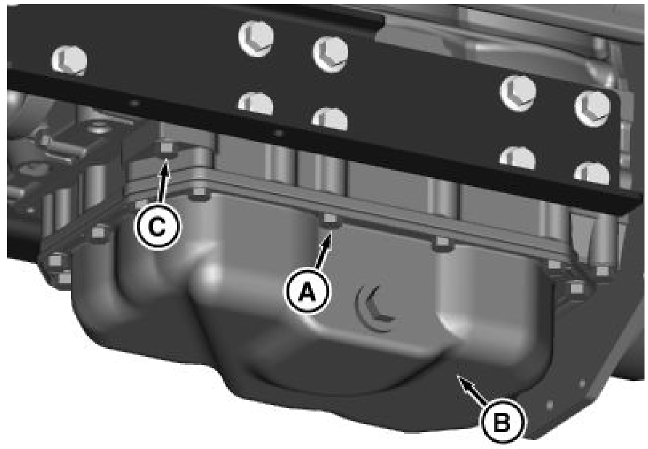
Specification	
Timing Gear Housing Mounting Cap Screw—Torque	11 N·m (96 lb.-in.)

BS62576,00017B4 -19-24APR14-1/1

Remove and Install Oil Pan and Strainer—3TNV80F

NOTE: Engine must be removed from machine to remove oil pan.

1. Remove flywheel and flywheel housing to access oil pan cap screws. (See Remove and Install Clutch and Flywheel—3TNV80F.)
2. Remove cap screws (A) securing oil pan..
3. Remove oil pan (B).
4. Remove cap screws (C) securing oil pan extension. Remove extension from engine.
5. Remove cap screws from strainer and remove strainer and O-ring.



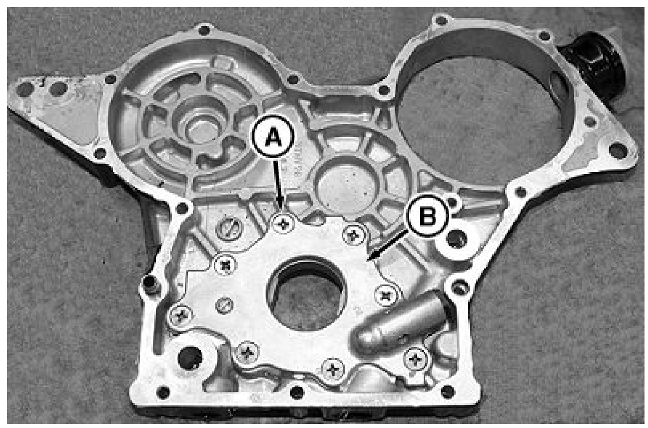
TCT011076 —UN—19MAY14

A—Cap Screw
B—Oil Pan
C—Cap Screw

BS62576,00017B5 -19-19JUN14-1/1

Remove and Install Oil Pump—3TNV80F

1. Remove timing gear cover.
2. Remove the eight screws (A) from oil pump cover (B) and remove cover.



TCT005862 —UN—13NOV12

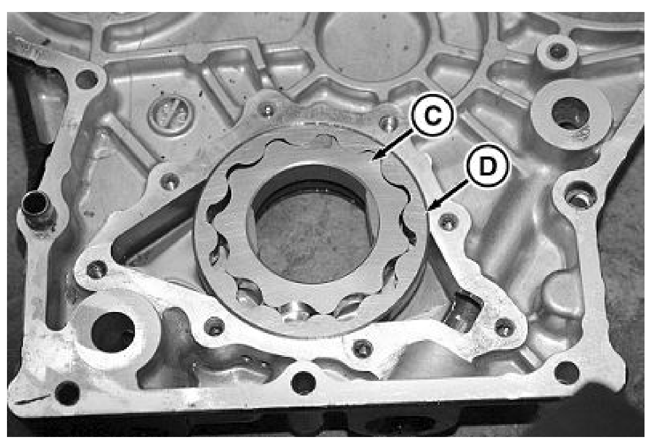
A—Screws
B—Pump Cover

BS62576,00017B6 -19-24APR14-1/2

3. Remove inner rotor (C) and outer rotor (D) and check for wear or damage. Check inside of cover for wear or deep scratches. Replace any worn or damaged parts. (See Inspect Oil Pump—3TNV80F.)

Installation

- Installation is done in the reverse order of removal.
- Apply medium strength thread locking compound to oil pump cover screws and relief valve cap when installing.



TCT005863 —UN—13NOV12

C—Inner Rotor
D—Outer Rotor

BS62576,00017B6 -19-24APR14-2/2

Inspect Oil Pump—3TNV80F

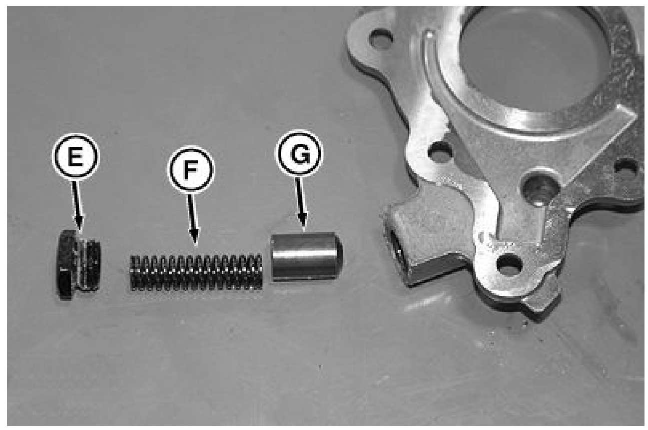
1. Inspect inside of oil pump cover for grooves or deep scratches. Replace cover if worn or damaged.

TCT005864 —UN—13NOV12

Oil Pump Cover

BS62576,00017B7 -19-24APR14-1/5

2. Remove relief valve cap (E), spring (F), and valve (G). Inspect all parts for wear or damage. Replace any worn or damaged parts.



TCT005865 —UN—13NOV12

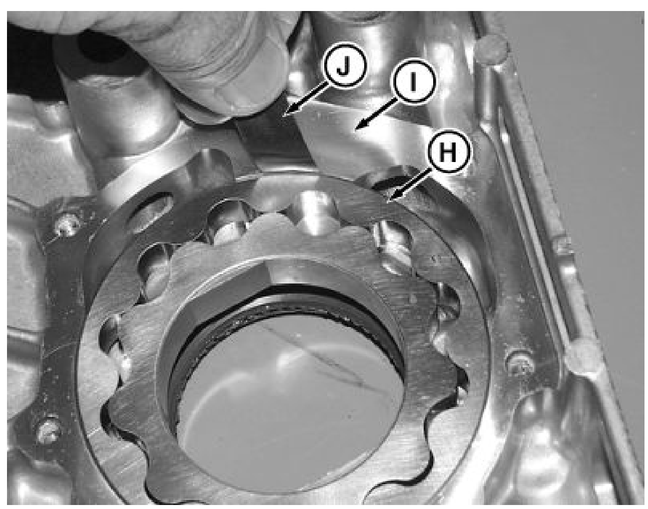
BS62576,00017B7 -19-24APR14-2/5

3. Measure clearance between outer rotor (H) and timing cover (I) with a feeler gauge (J). If clearance exceeds wear limit, replace timing cover and both rotors.

Specification

Oil Pump Rotor Side Clearance—Clearance....................0.12—0.21 mm (0.0047—0.0083 in.)

Oil Pump Rotor Side Clearance (Wear Limit)—Clearance.................... 0.30 mm (0.0118 in.)



TCT005866 —UN—13NOV12

Outer Rotor to Timing Cover Clearance

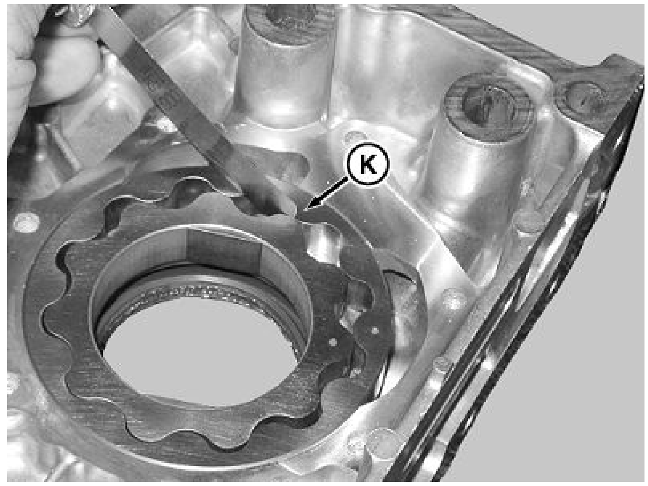
Continued on next page BS62576,00017B7 -19-24APR14-3/5

4. Measure between high spots of inner and outer rotors (K) with a feeler gage. If clearance exceeds specification replace rotors.

Specification

Oil Pump Rotor Inner-to-Outer (Limit)—Clearance.. 0.16 mm (0.006 in.)

K—Clearance Between Rotors



TCT005867 —UN—16NOV12

BS62576,00017B7 -19-24APR14-4/5

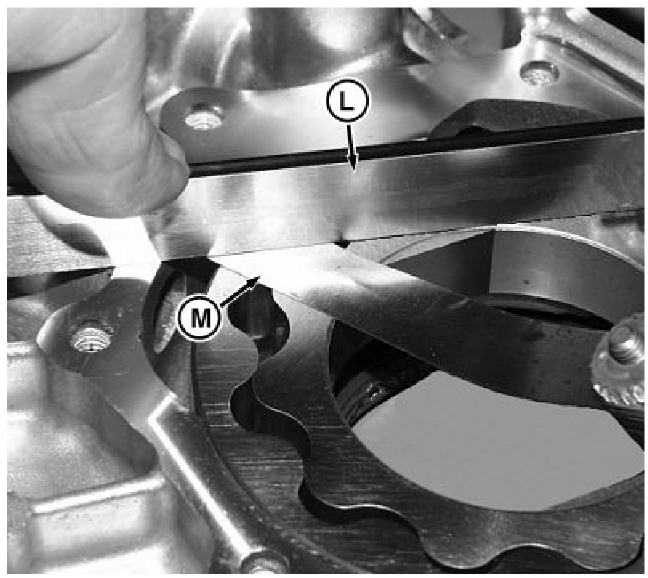
5. Place a straight edge (L) across timing gear cover bosses and measure gap between edge of timing gear cover and the rotors with a feeler gauge (M). If clearance exceeds wear limit replace timing gear cover and rotors.

Specification

Oil Pump Outer Rotor-to-Timing Cover—Clearance..0.02—0.07 mm (0.0008—0.0028 in.)

Oil Pump Outer Rotor-to-Timing Cover (Wear Limit)—Clearance.. 0.12 mm (0.0047 in.)

L—Straightedge **M—Feeler Gauge**



TCT005868 —UN—16NOV12

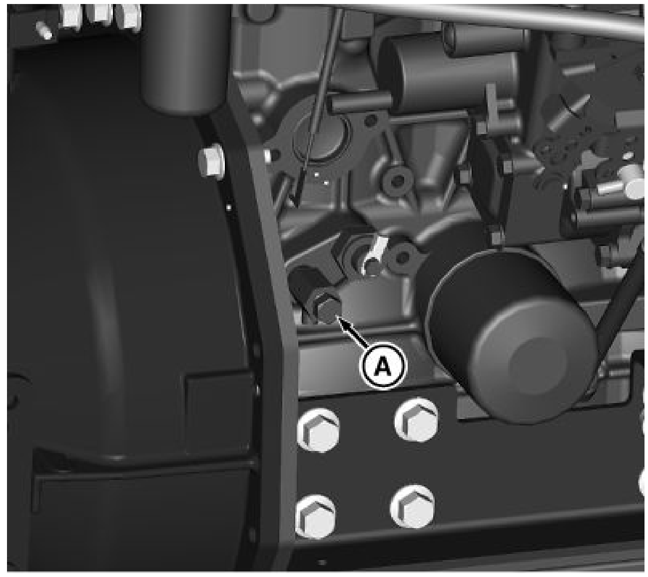
BS62576,00017B7 -19-24APR14-5/5

Remove and Install Thermostat—3TNV80F

Removal

CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns. Shut off engine. Remove filler cap only when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing cap.

1. Park machine safely.
2. Turn key switch to STOP position and allow the engine to cool.
3. Raise hood.
4. Loosen radiator cap to first stop to relieve pressure.
5. Remove radiator cap.
6. Remove air cleaner assembly.
7. Attach a 12 in. hose to drain valve located on lower right side of radiator.
8. Drain coolant from radiator into container large enough to hold full capacity of cooling system.



TCT011077 —UN—19MAY14

A—Drain Plug

9. Drain coolant from engine. Drain plug (A) is located on the left side of the engine near oil pressure switch.

BS62576,00017B8 -19-19MAY14-1/2

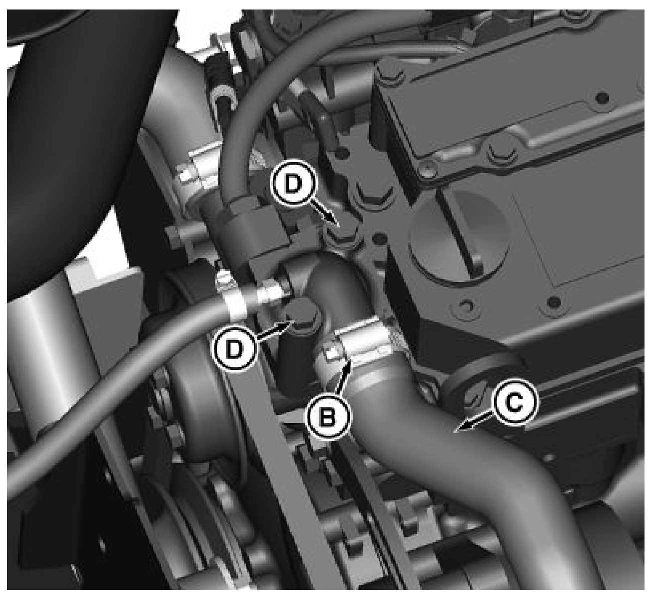
10. Loosen hose clamp (B).
11. Remove radiator hose (C) from thermostat cover.
12. Remove two cap screws (D) from cover and remove cover and gasket.
13. Remove thermostat from housing.
14. If thermostat is to be reinstalled, test thermostat. (See Test Thermostat Opening.)

Installation

Installation is done in reverse order of removal.

- Install thermostat in housing with spring end inside coolant pump.
- Place gasket over thermostat and place cover over thermostat on coolant pump.
- Start engine and watch coolant level in radiator. Add coolant if necessary to bring coolant level up to filler neck.

Specification	
Cooling System—Capacity (Approximate)	6.6 L (7 qt.)



TCT011078 —UN—19MAY14

B—Hose Clamp
C—Radiator Hose
D—Cap Screw

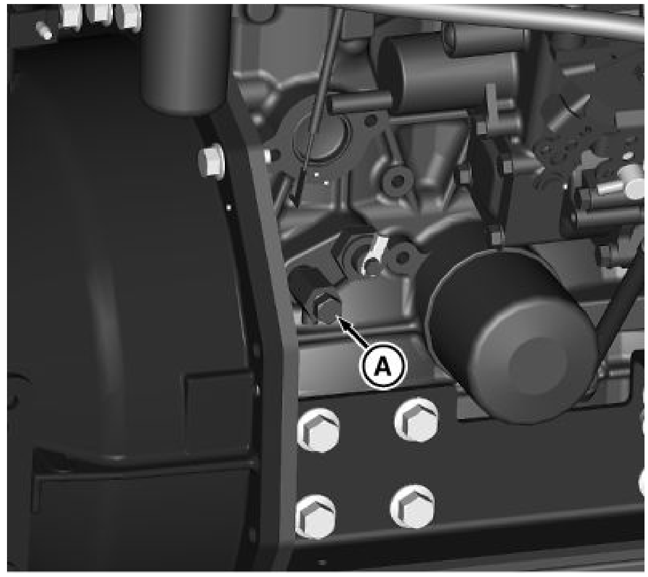
BS62576,00017B8 -19-19MAY14-2/2

Remove and Install Coolant Temperature Switch—3TNV80F

Removal

CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns. Shut off engine. Remove filler cap only when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing cap.

1. Park machine safely.
2. Turn key switch to STOP position and allow the engine to cool.
3. Raise hood.
4. Loosen radiator cap to first stop to relieve pressure.
5. Remove radiator cap.
6. Remove air cleaner assembly.
7. Attach a 12 in. hose to drain valve located on lower right side of radiator.
8. Drain coolant from radiator into container large enough to hold full capacity of cooling system.



TCT011077 —UN—19MAY14

A—Drain Plug

9. Drain coolant from engine. Drain plug (A) is located on the left side of the engine near oil pressure switch.

BS62576,00017B9 -19-19JUN14-1/2

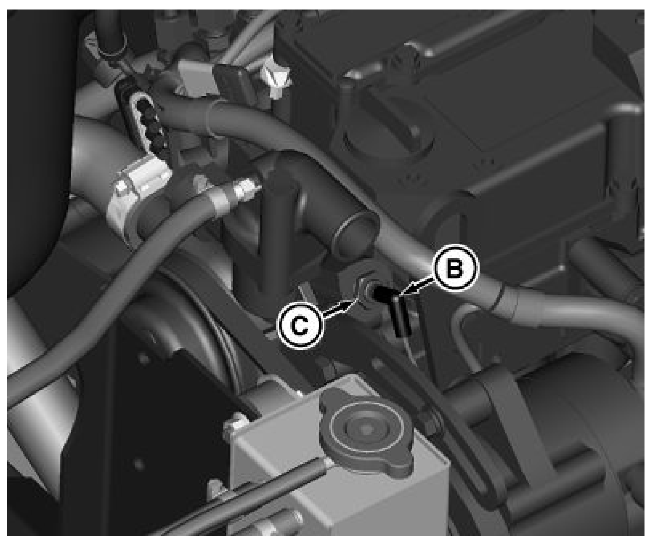
10. Disconnect electrical connector (B).
11. Remove switch (C).
12. Test switch. (See Engine Coolant Temperature Sensor Test.)

Installation

Installation is done in reverse order of removal.

1. Apply PM37397 Pipe Sealant to temperature coolant switch threads.
2. Install switch.
3. Start engine and watch coolant level in radiator. Add coolant if necessary to bring coolant level up to filler neck.

Specification	
Cooling System—Capacity (Approximate)	6.6 L (7 qt.)



TCT010683 —UN—09JUN14

B—Electrical Connector **C—Switch**

BS62576,00017B9 -19-19JUN14-2/2

Inspect Water Pump—3TNV80F

1. Inspect coolant pump for coolant leakage. If origin of leak cannot be determined, pressurize coolant system. (See Test Cooling System Pressure.)

    - If coolant leaks at pulley flange, shaft seal is defective. Replace coolant pump.
    - If coolant leaks between plate and pump housing, gasket between plate and pump housing is defective. Remove plate and replace gasket.
    - If coolant leaks between plate and engine block, remove coolant pump and replace gasket.

2. Inspect coolant pump for worn bearing shaft by removing alternator belt and checking for excessive movement of pulley. Replace coolant pump if excessive movement is noticed.

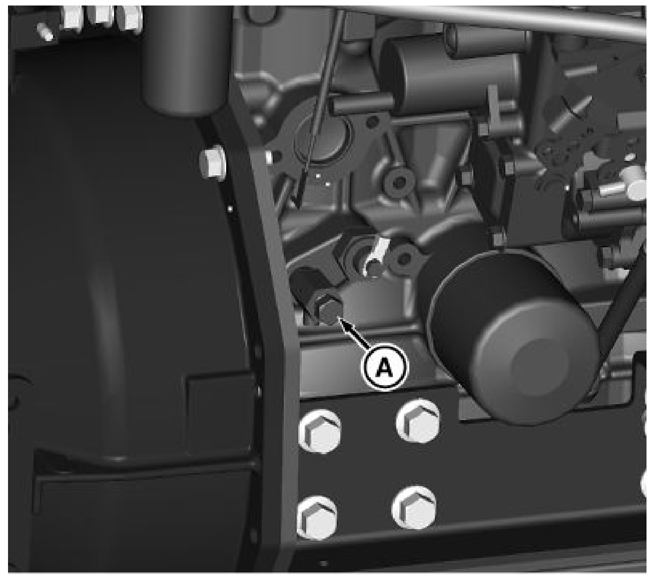
    - If bearing shaft is making noise when operating, check pulley belt tension. (See Adjust Alternator—Fan and Coolant Pump Drive Belts.)

BS62576,00017BA -19-24APR14-1/1

Remove and Install Water Pump—3TNV80F

Removal

1. Park machine on level surface with park brake locked.
2. Allow engine to cool and pressure in cooling system to drop before working on water pump.
3. Disconnect battery negative (-) cable from battery.
4. Open engine drain valve (A) to drain coolant from cylinder block.
5. Disconnect upper and lower radiator hoses from water pump.
6. Loosen tension pulley mounting bolts and remove water pump drive belt.



TCT011077 —UN—19MAY14

A—Engine Drain Valve

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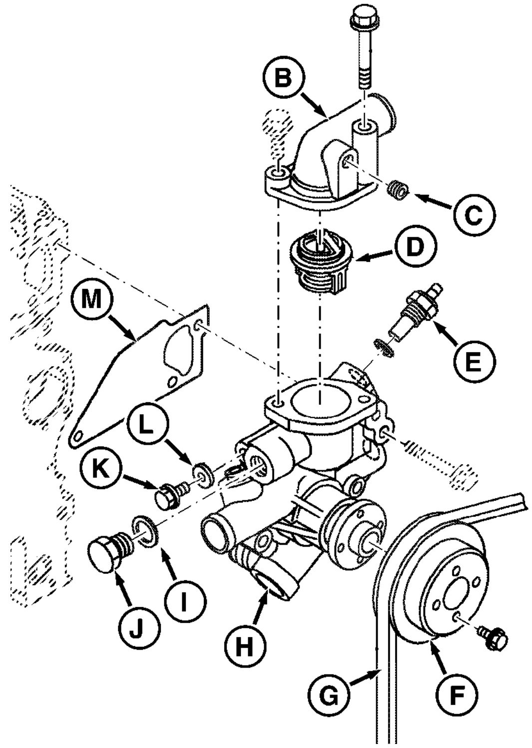
BS62576,00017BB -19-09JUN14-1/2

7. Disconnect coolant temperature switch connector. Remove switch and plug.
8. Remove four cap screws and remove sheave.
9. Remove pump mounting cap screws, pump, and gasket.
10. Inspect all parts for wear or damage.
11. Clean cylinder block mating surfaces of all old gasket material.

Installation

1. Install water pump and thermostat. Installation is done in the reverse order of removal.
2. Install coolant temperature switch and plug.
3. Adjust water pump drive belt tension. (See Adjust Alternator—Fan and Coolant Pump Drive Belts.)
4. Start engine and watch coolant level in radiator. Add coolant if necessary to bring coolant level up to filler neck.



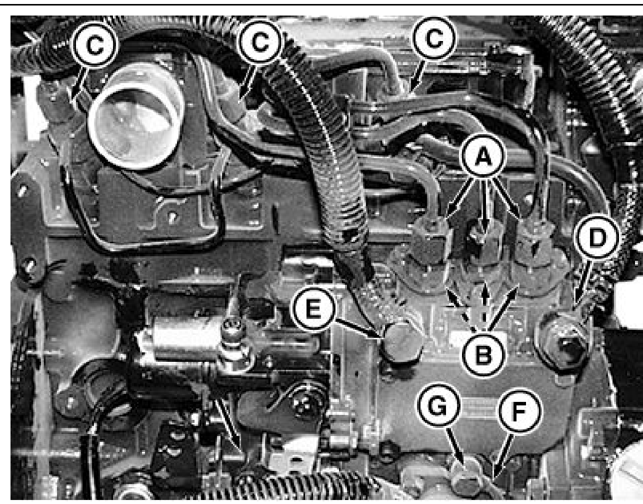
TCT011276 —UN—09JUN14

B—Thermostat Housing
C—Plug
D—Thermostat
E—Coolant Switch
F—Sheave
G—Belt
H—Water Pump
I— Washer
J— Plug
K—Screw
L—Packing
M—Gasket

BS62576,00017BB -19-09JUN14-2/2

Remove and Install Fuel Injection Pump—3TNV80F

1. Park machine safely. See “Parking Safely” in the Safety section.
2. Turn the fuel shutoff valve on the fuel filter and water separator to the CLOSED (“C”) position.
3. Clean the injection pump lines and area around the pump using a parts cleaning solvent or steam cleaner.
4. Remove the air cleaner assembly.
5. Slowly loosen fuel line connectors (A) at injection pump to release pressure in the fuel system. When loosening connectors, use a backup wrench to prevent delivery valves (B) from turning.
6. Remove fuel line connector nuts at the injection pump and the injectors. Remove injector lines.
7. Cover ends of injectors, delivery valves, and fuel lines with plastic caps to prevent dirt from entering system.
8. Disconnect the fuel inlet hose (E) and the return hose (D).
9. Remove the lubrication line (F) by removing the upper (G) and lower banjo bolts.



TCT005871 —UN—16NOV12

A—Injector Line Nuts (Pump End)
B—Delivery Valves
C—Injector Line Nuts (Injector End)
D—Return Fuel Hose
E—Inlet Fuel Hose
F—Lubrication Line
G—Banjo Bolt

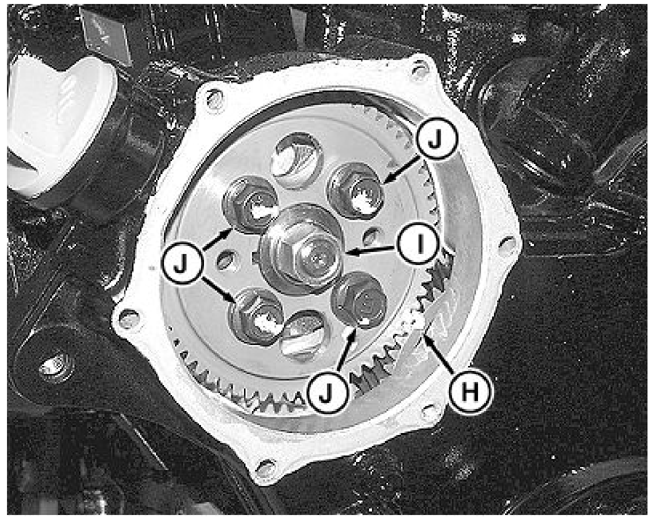
Continued on next page

BS62576,000179D -19-16JUN14-1/3

10. Remove injection pump gear cover on front of timing gear cover.

IMPORTANT: DO NOT loosen four cap screws attaching gear to hub. This assembly times the injection pump camshaft in relation to the crankshaft for precise timing of EPA engines. This procedure is done at the pump manufacturing plant and CAN NOT be duplicated in the field.

11. Rotate crankshaft and align timing marks (H).
12. Remove the nut (I) and using a puller, remove the injection pump gear.
13. Do NOT loosen gear to hub bolts (J).



TCT005872 —UN—16NOV12

H—Timing Marks
I— Injector Pump Camshaft Nut
J— Gear to Hub Bolts (DO NOT LOOSEN)

Continued on next page

BS62576,000179D -19-16JUN14-2/3

14. Note the location of the injection pump timing mark (K) as related to the timing gear housing timing marks (L). The replacement pump must be installed in the exact same location.
15. Remove the three mounting nuts (M) securing the injection pump to the crankcase and remove the injection pump.

Installation

CAUTION: DO NOT attempt to remove or install the fuel injection pump unless you are an EPA Authorized Diesel Service (ADS) Center technician with authorization to service fuel injection engines.

1. Install injection pump, aligning the timing mark to the same mark on the timing gear housing as noted during removal. Tighten nuts to specification.

Specification

Injector Pump Mounting
Nuts—Torque.......................... 22.5—28.4 N·m
(17—21 lb.-ft.)

2. Align the timing gear marks and install injection pump gear and lock nut and tighten to specification.

Specification

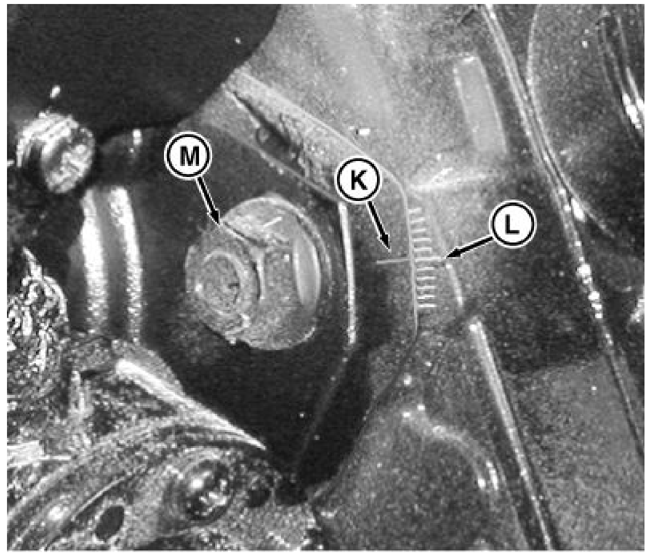
Fuel Injection Pump Drive
Gear Nut—Torque.......................... 58—68 N·m
(43—50 lb.-ft.)

3. Install injection pump gear cover and tighten to specification.

Specification

Fuel Injection Gear Cover
Cap Screws—Torque.......................... 11 N·m
(97 lb.-in.)

4. Install the lubrication line and secure with banjo bolts.
5. Install the fuel input hose and injector nozzle return hose to the injection pump.



TCT005873 —UN—16NOV12

Injector Pump Timing Marks

K—Injector Pump Mark
L—Timing Gear Housing Timing Marks
M—Nut

6. Install fuel lines at the injection pump and the injector nozzles and tighten the connector nuts to specification. When tightening connectors, use a backup wrench to prevent delivery valves from turning.

Specification

Fuel Injection Line
Nuts—Torque.......................... 29.4—34.4 N·m
(22—25 lb.-ft.)

7. Connect the fuel shutoff solenoid wire.
8. Install the air cleaner assembly.
9. Turn the fuel shutoff valve on the fuel filter and water separator to the OPEN (“O”) position.
10. Bleed the fuel system.

BS62576,000179D -19-16JUN14-3/3

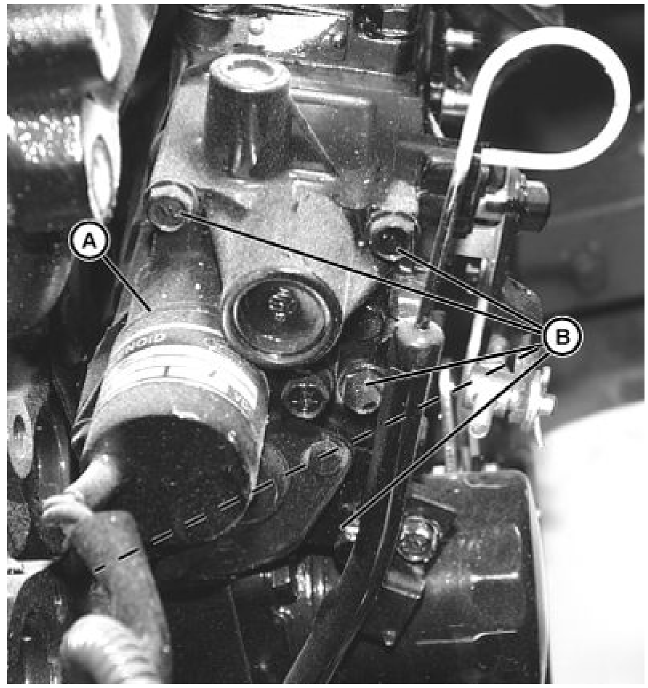
Remove, Inspect, and Install Fuel Injection Pump Camshaft—3TNV80F

Special or Required Tools

- Knife-Edge Puller.
- Press
- 3/4-Inch Deep Well Socket
- Micrometer

Removal

1. Remove timing gear cover. (See Remove and Install Timing Gear Cover—3TNV80F.)
2. Remove fuel injection pump. (See Remove and Install Fuel Injection Pump—3TNV80F.)
3. Disconnect electrical lead and remove fuel shutoff solenoid (A). (See Remove and Install Fuel Shutoff Solenoid—3TNV80F.)
4. Remove five remaining cap screws (B) attaching governor assembly to timing gear housing.
5. Remove governor housing assembly.

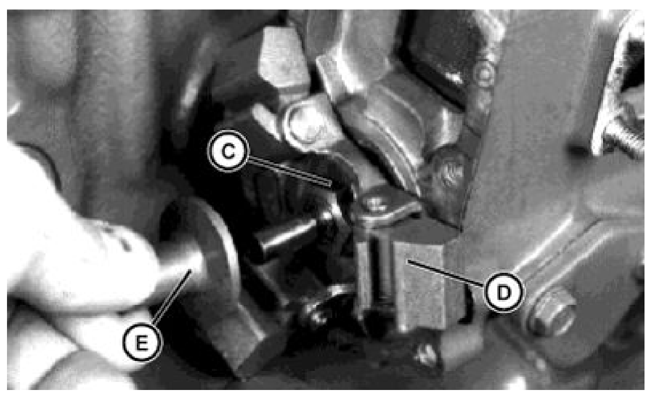


TCAL28477 —UN—28JUN12

A—Fuel Shutoff Solenoid **B—Cap Screws**

BS62576,000179E -19-16JUN14-1/8

6. Remove sleeve (E), nut (C), and governor weights (D) from end of injection pump camshaft.

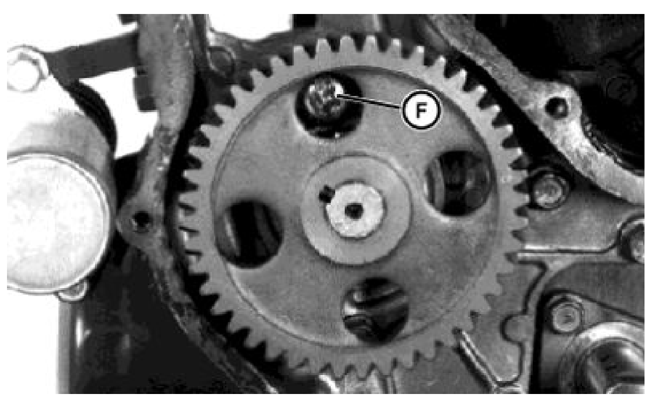


TCAL28478 —UN—28JUN12

C—Nut
D—Governor Weights
E—Sleeve

BS62576,000179E -19-16JUN14-2/8

7. Remove bearing retaining screw (F).



TCAL28479 —UN—28JUN12

F—Bearing Retaining Screw

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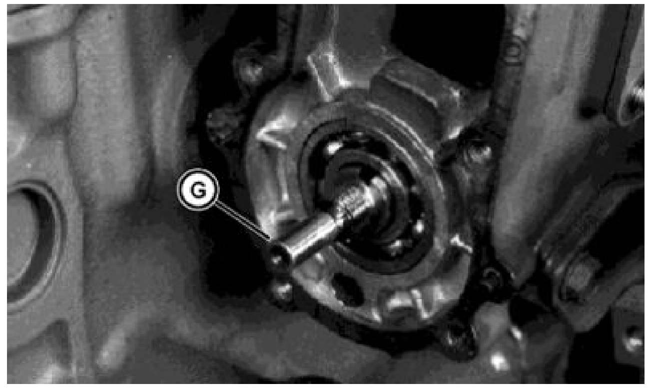
BS62576,000179E -19-16JUN14-3/8

8. Carefully tap the rear of camshaft (G) with a plastic hammer to remove camshaft from housing.
9. Disassemble and inspect all parts for wear or damage. (See Disassembly and Inspection procedures.)

G—Camshaft



TCAL28480 —UN—28JUN12

BS62576,000179E -19-16JUN14-4/8

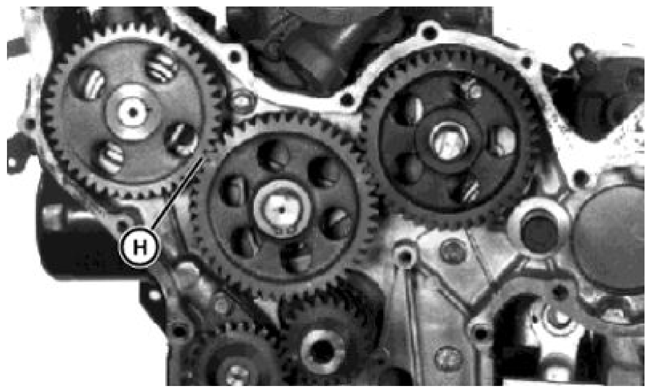
Installation

1. Install fuel injection pump camshaft. Installation is done in the reverse order of removal.
2. After installing camshaft assembly into housing, tap on end of camshaft gear with a plastic hammer to seat bearings in bores.
3. Align timing marks (H) on injection pump gear and idler gear when installing camshaft.

Disassembly

IMPORTANT: Hold camshaft while removing gear and bearings. Shaft can be damaged if dropped.

NOTE: Gear and bearings are press fit on shaft.



TCAL28481 —UN—28JUN12

H—Timing Marks

BS62576,000179E -19-16JUN14-5/8

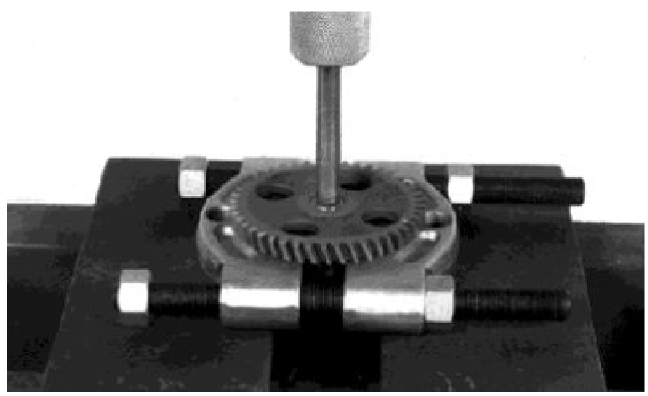
1. Remove gear using knife-edge puller and a press.
2. Remove key.
3. Remove bearings using a knife-edge puller and a press.
4. Inspect all parts for wear or damage. (See Inspection procedure.)

Assembly

IMPORTANT: When pressing bearings, apply pressure on the inner bearing race only.

NOTE: Install large bearing on gear end.

1. Install bearings on ends of camshaft using a 3/4-in. deep well socket and a press. Press until bearing races bottom on camshaft shoulder.
2. Install key.



TCAL28482 —UN—28JUN12

3. Put camshaft gear on a flat surface and press camshaft assembly into gear. Press until gear shoulder bottoms against inner bearing race.

Continued on next page

BS62576,000179E -19-16JUN14-6/8

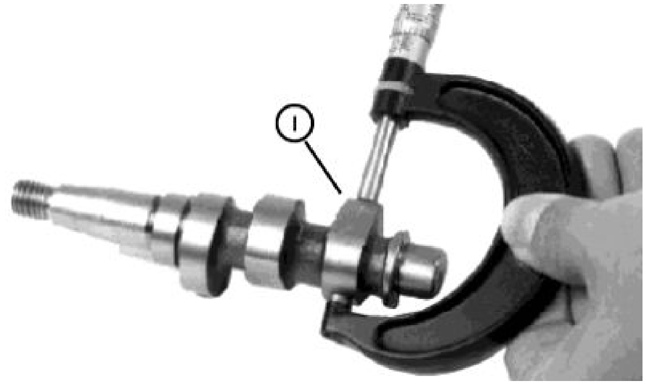
Inspection

1. Measure height of each camshaft lobe (I). Replace camshaft if lobe height is less than specification.

Specification

Camshaft Lobe—Height (Minimum)........ 30.90 mm (1.217 in.)

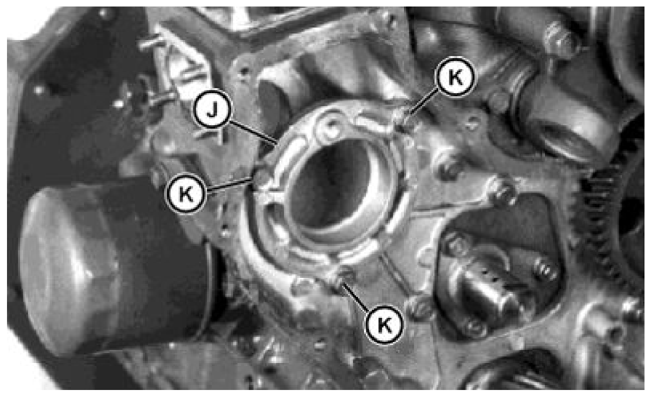
I— Camshaft Lobe Height



BS62576,000179E -19-16JUN14-7/8

2. Inspect camshaft bearing supports (J) in timing gear housing. Check for cracks, damage, or indications that bearings have spun support.
   - If rear bearing bore is damaged, replace timing gear housing.
   - If front bearing bore is damaged, remove three cap screws (K) and replace support.
3. Inspect parts for wear or damage. Replace as needed.

J— Camshaft Bearing Supports **K—Cap Screws**



BS62576,000179E -19-16JUN14-8/8

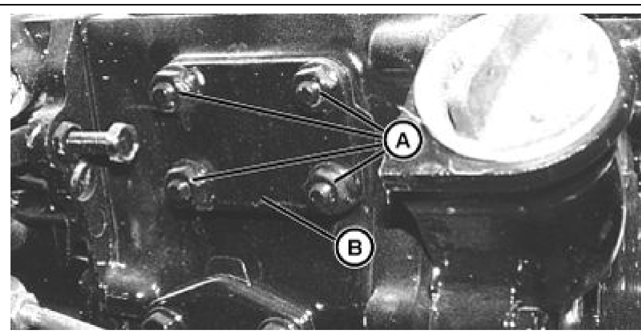
Remove and Install Fuel Control and Governor Linkage—3TNV80F

Special or Required Tools

- Micrometer

Removal

1. Disconnect and remove fuel shutoff solenoid. (See Remove and Install Fuel Shutoff Solenoid—3TNV80F.)
2. Remove four nuts (A), governor linkage cover (B), and gasket.



A—Nuts (4) **B—Governor Linkage Cover**

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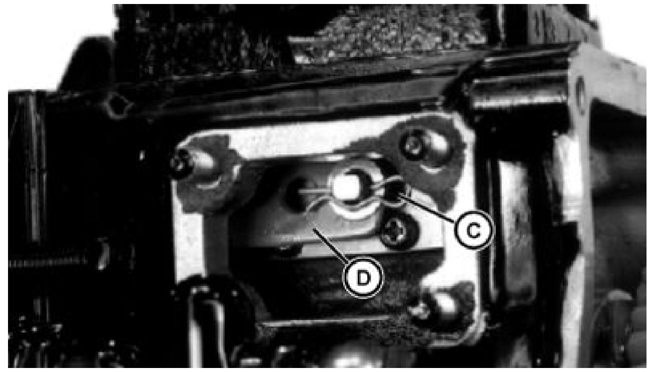
BS62576,000179F -19-16JUN14-1/4

NOTE: Washer may or may not be fixed to linkage. Do not drop spring pin or washer during removal.

3. Remove spring pin and washer (C) to disconnect governor linkage (D).

C—Spring Pin and Washer **D—Governor Linkage**

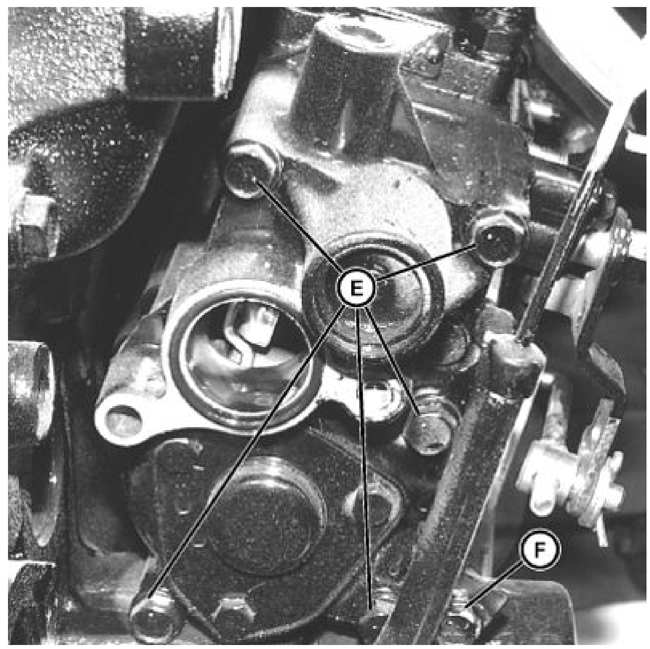


TCAL28486 —UN—28JUN12

BS62576,000179F -19-16JUN14-2/4

4. Remove cap screw securing dipstick tube (F) and remove dipstick tube.
5. Remove five cap screws (E) attaching governor housing.
6. Remove governor housing and gasket.

E—Cap Screw **F—Dipstick Tube**



TCAL28487 —UN—28JUN12

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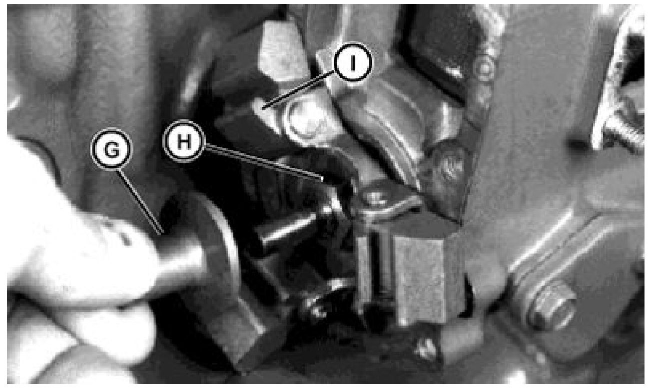
BS62576,000179F -19-16JUN14-3/4

7. Remove sleeve (G).
8. Remove nut (H) and governor weights (I).
9. Disassemble and inspect all parts for wear or damage per specifications.

Fuel Control and Governor Linkage—Specification

Governor Shaft—OD (Wear Limit)	8.01 mm (0.315 in.)
Governor Shaft Bore—Clearance	0.09 mm (0.003 in.)
Governor Shaft Bore—ID (Wear Limit)	8.50 mm (0.33 in.)
Sleeve Bore—ID (Wear Limit)	9.00 mm (0.354 in.)
Injection Pump Camshaft—OD (Wear Limit)	7.90 mm (0.311 in.)
Injection Pump Camshaft—Clearance	0.15 mm (0.006 in.)



TCAL28488 —UN—28JUN12

G—Sleeve
H—Nut
I— Governor Weights

Installation

NOTE: Do not drop spring pin or washer into housing during installation. Place a small amount of engine assembly grease on washer to help it stick in place while assembling.

1. Install fuel control and governor linkage. Installation is done in the reverse order of removal.
2. Governor linkage has two holes. Connect governor linkage to injection pump rack using hole closest to front of engine.
3. Check and adjust slow idle settings. (See Adjust Slow Idle.)

BS62576,000179F -19-16JUN14-4/4

Remove, Inspect, and Install Fuel Injection Nozzle—3TNV80F

Special or Required Tools

- JDF13 Nozzle Cleaning Kit
- Inspection Magnifier

Removal

CAUTION: Escaping fluid under pressure can penetrate the skin causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body from high-pressure fluids.

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

IMPORTANT: Never steam clean or pour cold water on injection pump while the pump is running or engine is warm. Doing so can damage the pump.

When removing injection lines, Do not turn pump delivery valve fittings. Turning fittings may damage pump internally. Always use a backup wrench when removing lines.

A—Fuel Line Connectors **B—Backup Wrench**

1. Clean the injection pump lines and area around the pump using a parts cleaning solvent or steam cleaner (cold engine).

NOTE: Nozzles are matched to the cylinders. If removing more than one nozzle, tag each nozzle according to the cylinder from which it was removed.

2. Loosen fuel line connectors (A) at injection pump to release pressure in the fuel system. When loosening connectors, use a backup wrench (B) to prevent delivery valves from turning.

BS62576,00017A0 -19-16JUN14-1/6

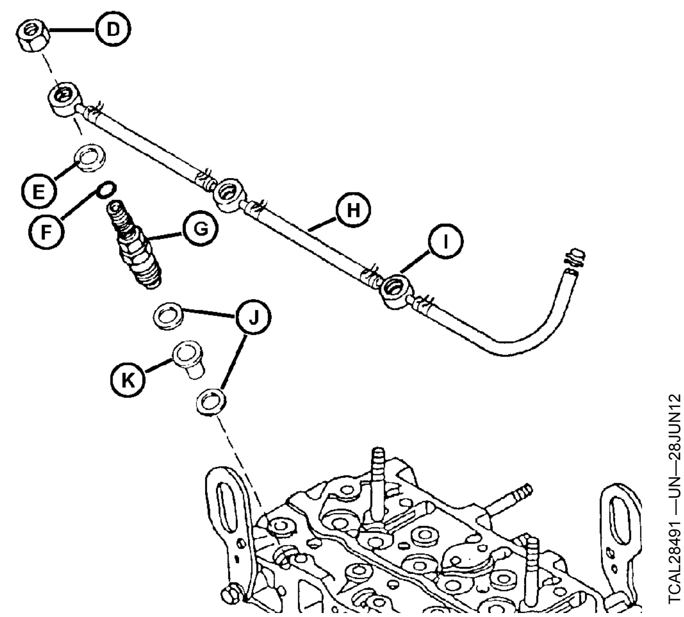
3. Remove fuel line nuts at injection nozzles (C) and remove injection lines.

C—Fuel Line Nuts

Continued on next page

BS62576,00017A0 -19-16JUN14-2/6

4. Remove three nuts (D) and leak-off hoses (H) and fittings (I).
5. Remove bronze washers (E) and O-rings (F).
6. Remove injection nozzle (G), washers (J), and heat protector (K).
7. Test injection nozzles. (See Test Fuel Injection Nozzle.)



D—Nuts (3)
E—Bronze Washers
F—O-Rings
G—Injection Nozzle
H—Leak-Off Hoses
I— Fittings
J— Washers
K—Heat Protector

Installation

NOTE: Installation is done in the reverse order of removal.

1. Replace heat protectors, washers, and O-rings.
2. Tighten injection nozzle body to specification.

Specification

Injection Nozzle Body—Torque	50 N·m (37 lb.-ft.)

3. Tighten leak-off fitting nut to specification.

Specification

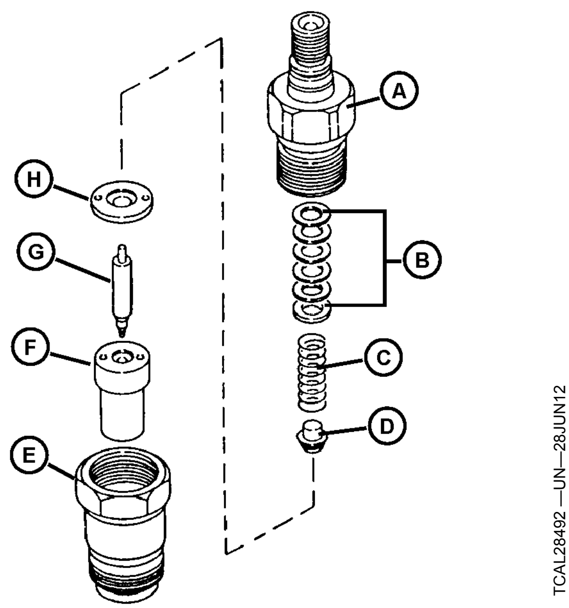
Leak-Off Fitting—Torque	40 N·m (30 lb.-ft.)

Repair

IMPORTANT: If injection nozzles are disassembled to be cleaned, the same number and thickness of shims must be installed.

NOTE: If servicing more than one nozzle, keep parts for each nozzle separate from one another.

- Clean and inspect nozzle assembly. (See Cleaning and Inspection procedure.)
- After assembly is complete, test injection nozzle. (See Test Fuel Injection Nozzle.)



A—Injector Body
B—Shims (as required)
C—Spring
D—Spring Seat
E—Nozzle Fitting
F—Nozzle Body
G—Nozzle Valve
H—Separator Plate

Continued on next page

BS62576,00017A0 -19-16JUN14-3/6

Injection Nozzle Cross Section

Cleaning and Inspection

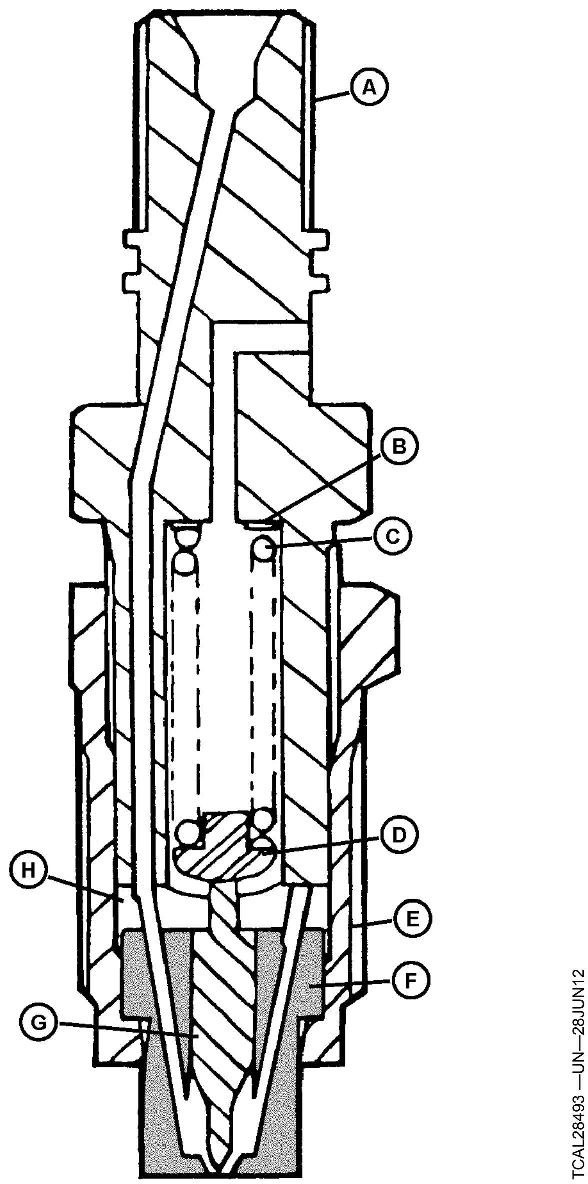
NOTE: To clean nozzles properly, JDF13 Nozzle Cleaning Kit is recommended. The cleaning kit is available through the John Deere™ SERVICEGARD™ Catalog.

1. Remove anti-corrosive grease from new or reconditioned nozzles by washing them thoroughly in diesel fuel.

IMPORTANT: Never use a steel brush to clean nozzles, as this will distort the spray hole.

2. Remove carbon from used nozzles, and clean by washing in diesel fuel. If parts are coated with hardened carbon or lacquer, it may be necessary to use a brass wire brush (supplied in JDF13 Nozzle Cleaning Kit).
3. After removing carbon or lacquer from the exterior of nozzle, inspect sealing surfaces between separator plate and nozzle body for nicks or scratches.

Specification	
Separator Plate—Contact Surface	0.10 mm (0.0039 in.)



A—Injector Body
B—Shims (as required)
C—Spring
D—Spring Seat
E—Nozzle Fitting
F—Nozzle Body
G—Nozzle Valve
H—Separator Plate

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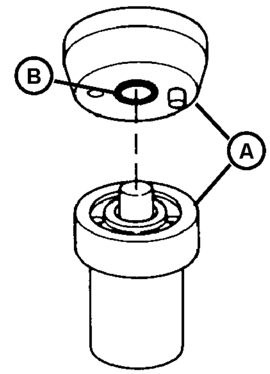
BS62576,00017A0 -19-16JUN14-4/6

4. Inspect condition of separator plate and nozzle body. Contact area of separator plate (A) (both parts) must not be scored or pitted. Use an inspection magnifier (No. 16487 or equivalent) to aid in making the inspection.

5. Check nozzle contact surface (B) on separator plate for wear. If contact surface is more than the specified measurement, replace nozzle assembly.



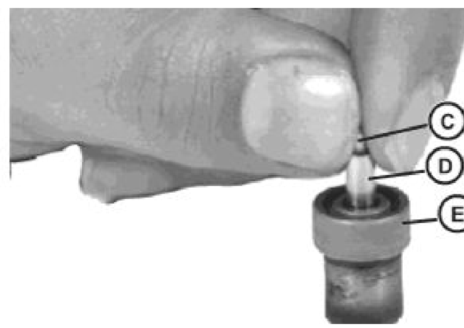
A—Separator Plate **B—Nozzle Body**

BS62576,00017A0 -19-16JUN14-5/6

6. Inspect the piston (D) (large) part of nozzle valve to see that it is not scratched or scored and that lower (tip) end of valve is not broken. If any of these conditions are present, replace the nozzle assembly.

7. Further inspect the nozzle assembly by performing a slide test.
   - Dip the nozzle valve (C) in clean diesel fuel. Insert valve in nozzle body (E).
   - Hold nozzle vertical, and pull valve out about 1/3 of its engaged length.
   - Release valve. Valve should slide down to its seat by its own weight.

8. Replace nozzle assembly if the valve does not slide freely to its seat.



C—Nozzle Valve
D—Piston
E—Nozzle Body

BS62576,00017A0 -19-16JUN14-6/6

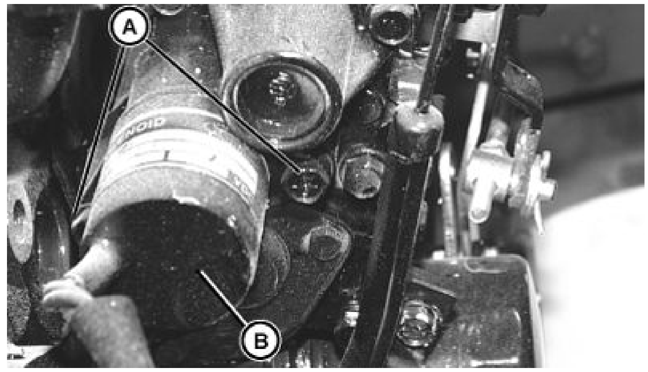
Remove and Install Fuel Shutoff Solenoid—3TNV80F

Removal

1. Park machine on level surface, park brake locked, key switch in OFF position.
2. Clean around the fuel shutoff solenoid using a parts cleaning solvent or steam cleaner.
3. Disconnect the electrical lead to the fuel shutoff solenoid.
4. Disconnect electrical lead and remove fuel shutoff solenoid.
5. Remove the two solenoid mounting cap screws (A) and remove solenoid (B) from governor housing.
6. Test fuel solenoid. (S Fuel Shutoff Solenoid Test—Diesel Engine.)

Installation

NOTE: Check condition of O-ring on solenoid before installing.



TCAL28496 —UN—28JUN12

A—Solenoid Mounting Cap Screws **B—Solenoid**

Install fuel shutoff solenoid. Installation is done in the reverse order of removal.

BS62576,00017A1 -19-19JUN14-1/1

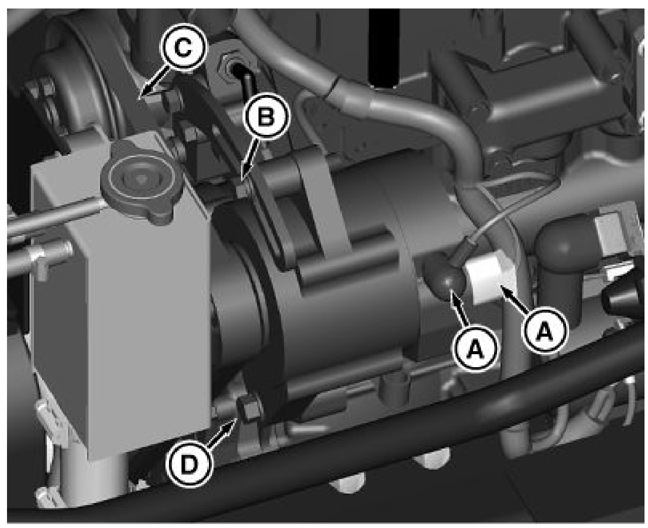
Remove and Install Alternator—3TNV80F

1. Disconnect negative (-) battery cable.
2. Disconnect terminals (A) from alternator.
3. Loosen bolt (B), push in alternator, and remove belt (C).
4. Remove bolt (B) and washer.
5. Remove bolt (D) and remove alternator.

Installation is the reverse order of removal.

- Adjust belt tension. (See Adjust Alternator—Fan and Coolant Pump Drive Belts.)

A—Wiring Harness Terminals **C—Belt**
B—Bolt **D—Bolt**



TCT011277 —UN—11JUN14

BS62576,000178E -19-11JUN14-1/1

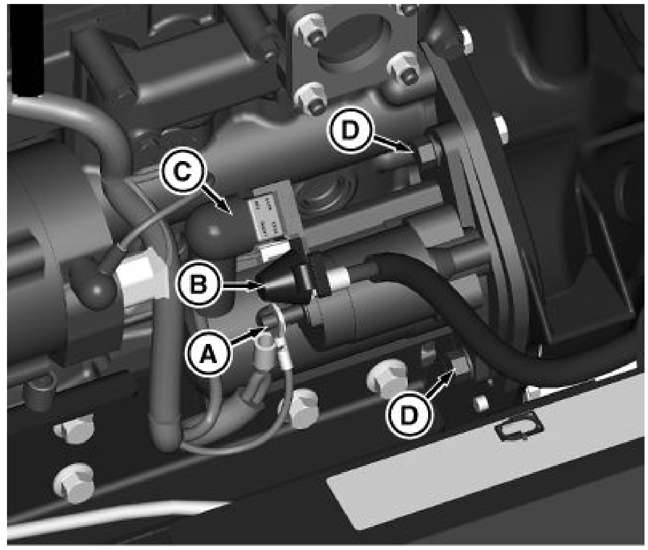
Remove and Install Starting Motor—3TNV80F

Removal

1. Disconnect battery.
2. Disconnect wires (C) to starting motor.
3. Remove starting motor mounting cap screws (D) and nuts.

Installation

Installation is done in the reverse order of removal.



TCT011278 —UN—11JUN14

A—Cap Screws
B—Wires
C—Cap Screws
D—Bolts

BS62576,000178F -19-11JUN14-1/1

Repair Starting Motor—3TNV80F

Analyze Condition

The starter overheats because of:

- Long cranking
- Armature binding

The starter operates poorly because of:

- Armature binding
- Dirty or damaged starter drive.
- Badly worn brushes or weak brush springs
- Excessive voltage drop in cranking system
- Battery or wiring defective
- Shorts, opens or grounds in armature

NOTE: Starter repair is limited to brushes, end caps and starter drive. If housing, solenoid, or armature is damaged, replace starter.

Disassembly

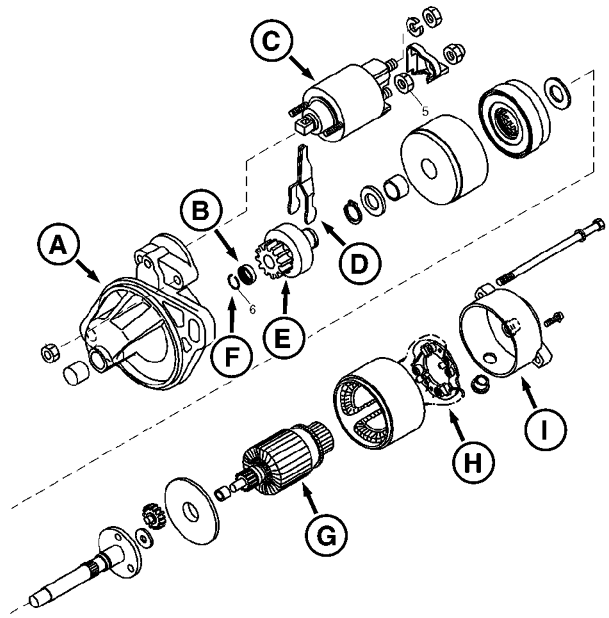
1. Mark body and covers for correct alignment during reassembly.
2. Remove the two nuts securing the solenoid to the front cover.
3. Tip the terminal end of the solenoid in toward the starter housing while pulling the solenoid away from the front cover.
4. Remove the two screws from the end cover.
5. Remove the through bolts securing the starting motor body together.
6. Carefully pull the sections apart.
7. Inspect parts for wear or damage.
8. Test solenoid, starter armature and brushes. See following Inspection and Test.

Assembly

Assembly is done in the reverse order of disassembly.

Apply a thin coat of multipurpose grease to:

- Sliding surfaces of armature and solenoid shiftlever
- Armature shaft spline
- Points where end shafts contact cover bushings



TCT011279 —UN—11JUN14

A—Front Cover
B—Pinion Stopper
C—Solenoid
D—Shift Lever
E—Pinion Drive
F—Retaining Clip
G—Armature
H—Brush Holder
I— End Cover

Continued on next page

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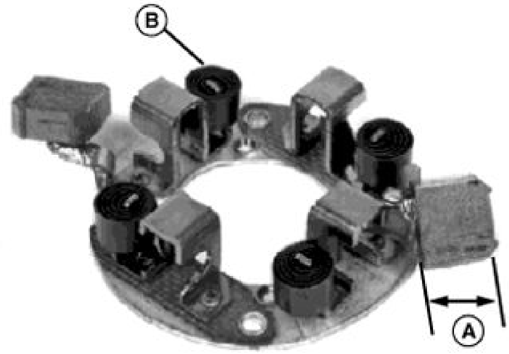
Inspection and Test

1. Measure field coil brush lengths (A). If any one brush length is less than 10.5 mm (0.413 in.), replace all four brushes.
2. Inspect brush springs (B) for wear or damage. Replace if necessary.

A—Field Coil Brush Length B—Brush Springs



LVAL23649 —UN—07MAY12

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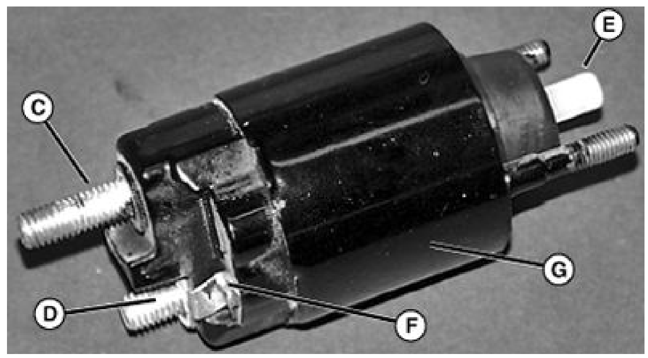
3. Test solenoid terminals (C and D) for continuity. There should be no continuity.
4. Depress switch plunger (E). There should be continuity when plunger is fully depressed.
5. Test for open circuits between terminal (D) and tang (F). There should be continuity.
6. Test for open circuits between tang (F) and body (G). There should be continuity.
7. If solenoid fails any test, it is defective and must be replaced.

C—Solenoid Terminal C
D—Solenoid Terminal E
E—Switch Plunger
F—Solenoid Tang
G—Solenoid Body



LVAL23650 —UN—07MAY12

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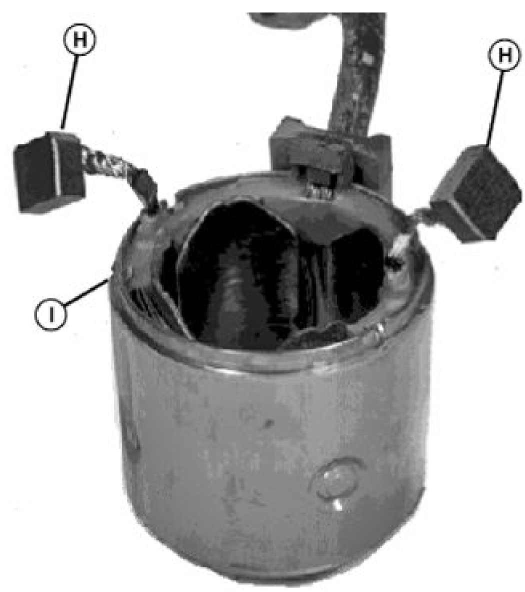
8. Test for grounded field winding:
   - Touch one probe of tester to field coil brush (H) and other probe to field coil housing (I).
   - Be sure the brush lead is not touching the frame. If there is continuity, the coil is grounded and the field coil housing assembly must be replaced.
9. Test for open field coil:
   - Touch one probe of tester to each field coil brush (H).
   - If there is no continuity, the field coil is open and the field coil housing assembly must be replaced.

IMPORTANT: Avoid Damage! DO NOT clean armature with solvent. Solvent can damage insulation on windings. Use only mineral spirits and a brush.

H—Field Coil Brush I— Field Coil Housing

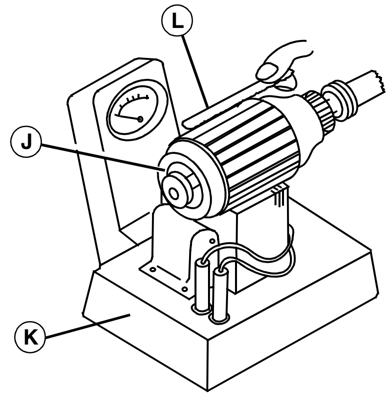


LVAL23651 —UN—07MAY12

Continued on next page BS62576,0001794 -19-11JUN14-4/6

NOTE: Shorts between bars are sometimes caused by dirt or copper between bars. Inspect for this condition.

10. Locate short circuits by rotating armature (J) on a growler (K) while holding a hacksaw blade or steel strip (L) on armature. The hacksaw blade will vibrate in area of short circuit.
11. If test indicates short-circuited windings, clean the commutator of dust and filings. Check armature again. If test still indicates short circuit, replace armature.



LVAL23652 —UN—07MAY12

J— Armature
K—Growler
L—Steel Strip

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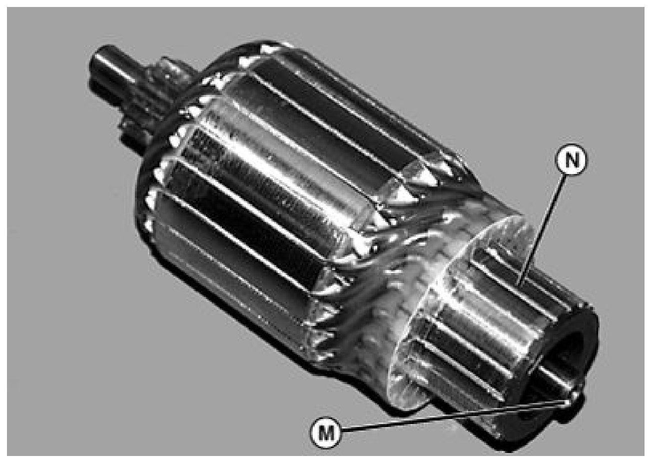
12. Test for grounded windings using an ohmmeter. Touch one probe to the armature shaft (M) and the other probe on each commutator bar (N). Armature windings are connected in parallel, so each commutator bar needs to be checked. If test shows continuity, a winding is grounded and the armature must be replaced.
13. Test for open-circuited windings using an ohmmeter. Touch one probe on a commutator bar (N) and the other probe on each remaining commutator bar. Armature windings are connected in parallel, so each commutator bar needs to be checked. If test shows no continuity, there is an open circuit and the armature must be replaced.



LVAL23653 —UN—07MAY12

M—Armature Shaft
N—Commutator Bar

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Section 50
Electrical

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Theory Of Operation Information

The theory of operation stories divide the electrical system into individual circuits by function. Each circuit is isolated from the main wiring schematic and only shows the components that are used in it. The story contains information on function, operating conditions, and theory of operation. The circuit schematics are drawn with the components in the operating position, with the power, or battery positive, into them across the top and the ground, or battery negative, across the bottom.

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Diagnostic Information

The diagnostic procedures is used to test the complete circuit regardless of the problem or complaint. Select a symptom or system from the quick check or troubleshooting chart and follow the test procedures under that heading.

The diagnostic procedure lists:

- Test conditions
- Test sequence
- Test location
- Normal reading
- Check or test to perform if reading is not normal

When performing the test or check, be sure to set your machine up to the “Test Conditions” listed in the beginning of the procedure and follow the sequence carefully.

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Wire Color Abbreviation Chart

Abbreviation	Color
Blk	Black
Blu	Blue
Brn	Brown
Grn	Green
Gry	Gray
Org	Orange
Pnk	Pink
Pur	Purple
Red	Red
Tan	Tan
Wht	White
Yel	Yellow
Blk/Wht	Black/White
Blu/Wht	Blue/White
Brn/Wht	Brown/White
Brn/Yel	Brown/Yellow
Dk Blu	Dark Blue
Dk Brn/Lt Grn	Dark Brown/Light Green
Dk Brn/Red	Dark Brown/Red
Dk Brn/Yel	Dark Brown/Yellow
Dk Grn	Dark Green
Lt Blue	Light Blue
Lt Grn	Light Green
Org/Wht	Orange/White
Pnk/Blk	Pink/Black
Pur/Wht	Purple/White
Red/Blk	Red/Black
Red/Wht	Red/White
Wht/Blk	White/Black
Wht/Red	White/Red
Yel/Blk	Yellow/Black
Yel/Red	Yellow/Red
Yel/Wht	Yellow/White

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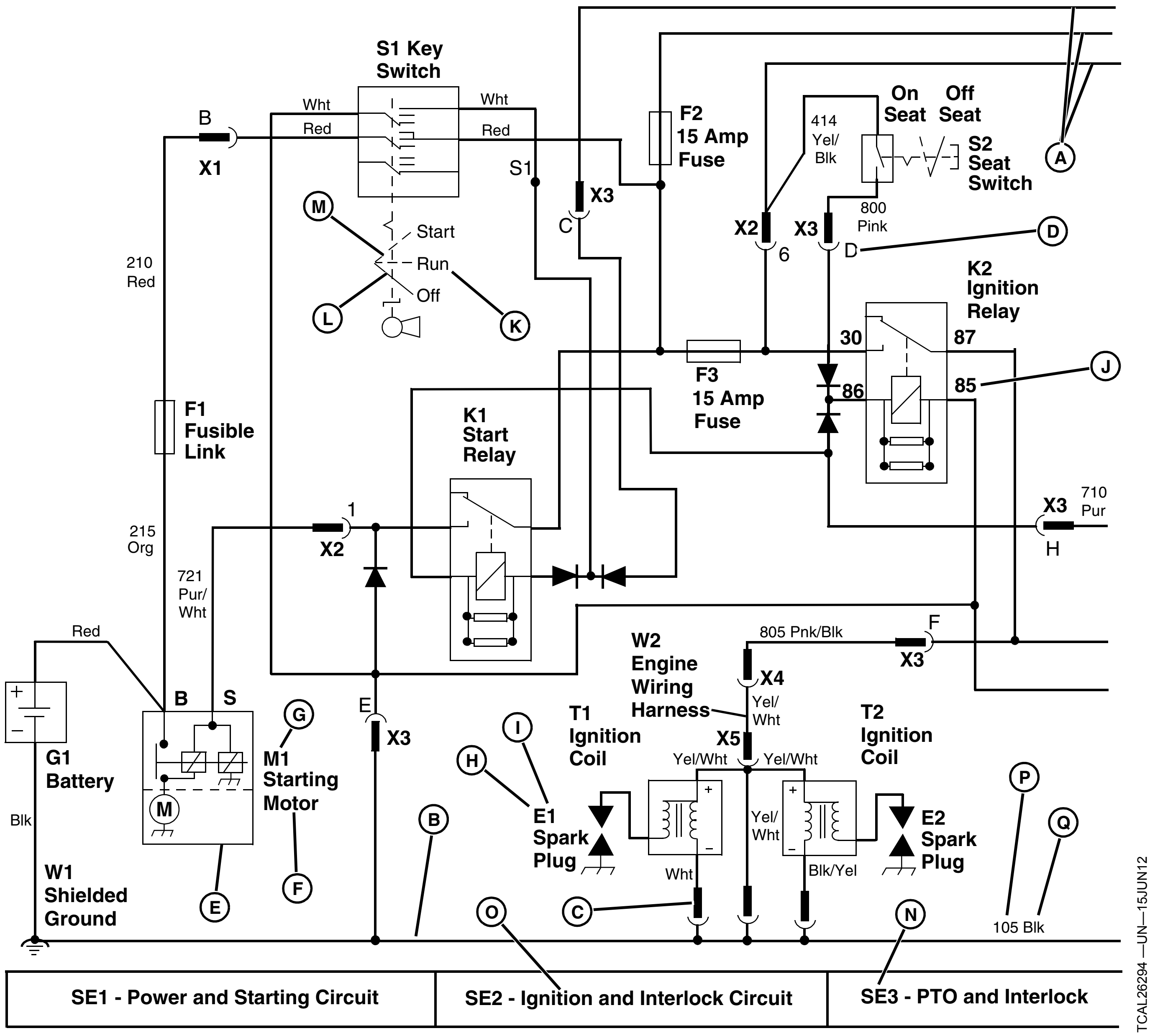
Reading Electrical Schematics



The schematic is made up of individual circuits laid out in a sequence of related functions. It is formatted with all power wires (A) across the top and all ground wires (B) across the bottom. Current flow is generally from top to bottom through each circuit and component. All components are shown in the OFF position. The diagram does not list connector (C) information unless needed to avoid confusion. If the connector is shown, the number next to it is the terminal pin location (D) in the connector.

Each component is shown by a symbol (E), its name (F), and an identification code (G). The identification code contains a device identifying letter (H) and number (I).

The identifying letter is always the same for a specific component, but the identifying numbers are numbered consecutively from upper left to lower right. The terminal designation (J) is placed directly outside the symbol next to the connecting wire path. Switch positions (K) are also placed directly outside the symbol. The solid line (L) shows the position the switch is currently in, and dash lines (M) represent other switch positions.

Each circuit is identified at the bottom of the drawing by a section number (N) and section name (O).

The circuit number (P) and wire color (Q) are shown directly next to the wire path.

The same component name and identification code are used consistently on all diagrams in this section. Components can be easily cross-referenced.

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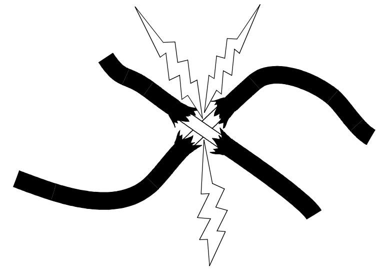
Common Circuit Tests

Shorted Circuit:

A shorted circuit may result in the wrong component operating (i.e. improper wire-to-wire contact). To test for a shorted or improperly wired circuit:



TCAL26295 —UN—15JUN12

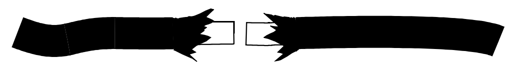
1. Turn component switch ON.
2. Start at the controlling switch of the component that should not be operating.
3. Follow the circuit and disconnect wires at connectors until component stops operating.
4. Shorted or improper connections will be the last two wires disconnected.

RB14256,000098B -19-18JUN12-1/3

High Resistance or Open Circuit:

High resistance or open circuits usually result in slow, dim or no component operation (i.e. poor, corroded, or disconnected connections). Voltage at the component will be low when the component is in operation. To test for high resistance and open circuits:

TCAL26296 —UN—15JUN12

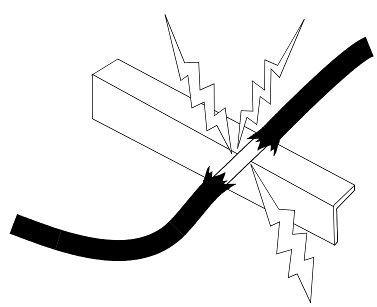


1. Check all terminals and grounds of the circuit for corrosion.
2. If terminals are not corroded or loose, the problem is in the component or wiring.

RB14256,000098B -19-18JUN12-2/3

Grounded Circuit:

Grounded circuits usually result in no component operation or a blown fuse.



TCAL26297 —UN—15JUN12

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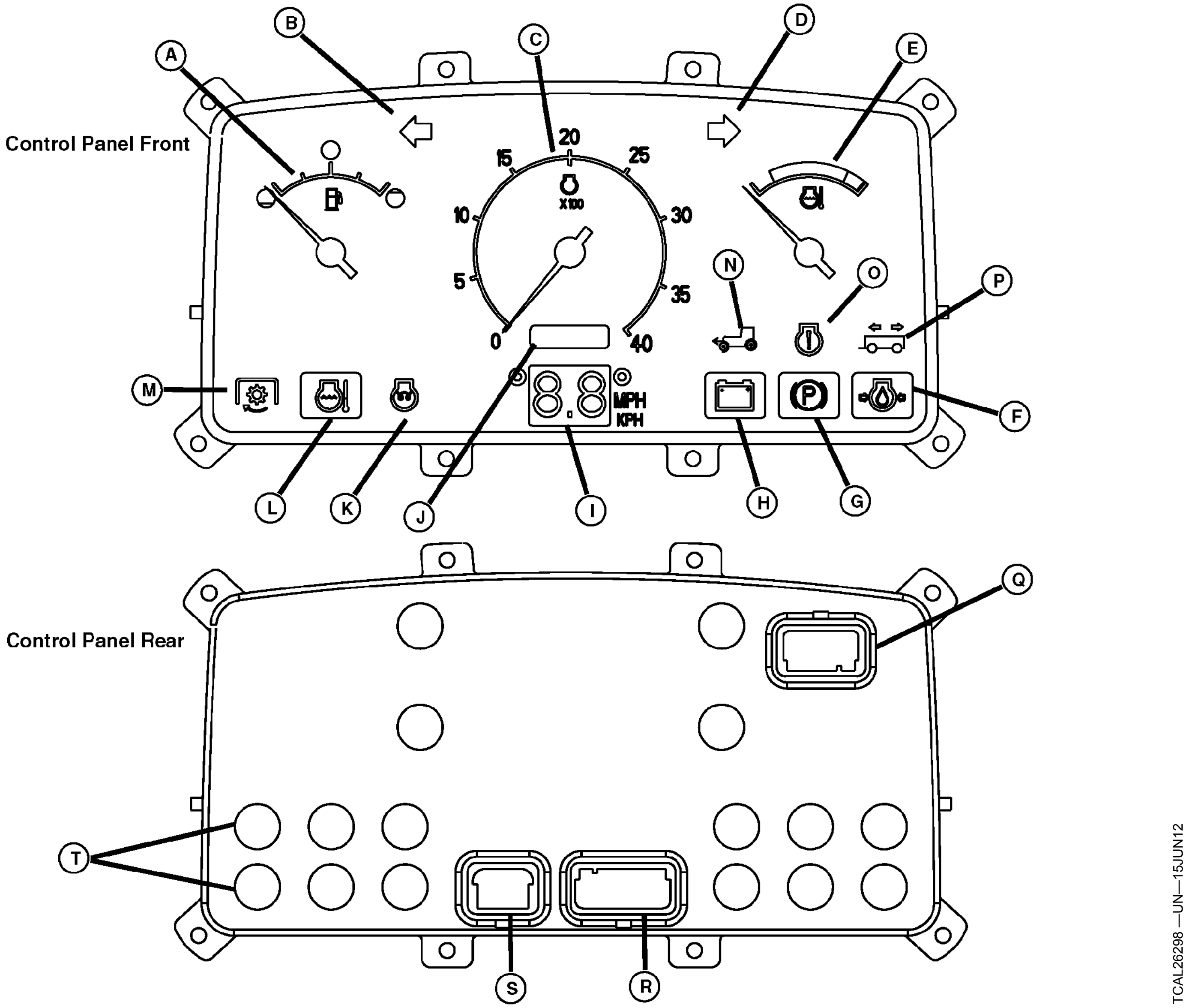
Conductors For 12 Volt Circuits

Stranded Conductors For 12 Volt Circuits						
Sae Wire Size (Gauge)	20	18	16	14	12	10
Metric Wire Size (MM)	0.5	0.8	1.0	2.0	3.0	5.0
Typical Stranding	7 X 28	16 X 30	19 X 29	19 X 27	19 X 25	19 X 23
Minimum Conductor Area In Circular MilS	1072	1537	2336	3702	5833	9343

RB14256,000098C -19-18JUN12-1/1

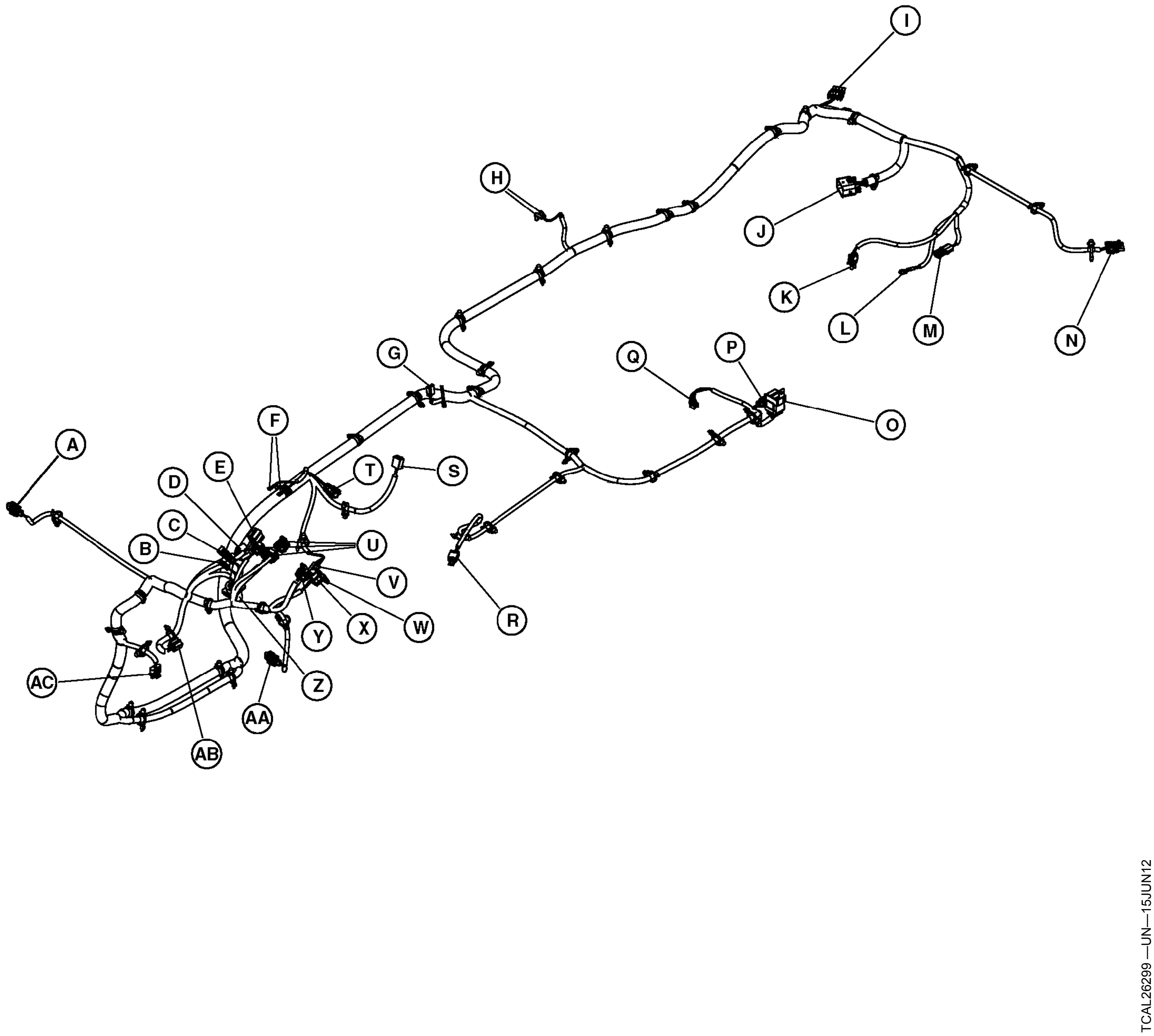
Component Location - Instrument Panel



A—Fuel Gauge
B—Left Turn Signal/Hazard Light
C—Engine Tachometer
D—Right Turn Signal/Hazard Light
E—Coolant Temperature Gauge
F—Engine Oil Pressure Light
G—Park Brake Light
H—Discharge Light
I—Speedometer
J—Hour Meter
K—Preheat Light (Diesel)
L—Coolant Temperature Light
M—PTO Engaged Light
N—Four Wheel Drive Indicator (if equipped)
O—Check Engine - Malfunction Indicator Lamp (MIL) (Gas Models)
P—Not Used
Q—J3 Connector
R—J1 Connector
S—J2 Connector
T—Indicator Lights

RB14256,000098D -19-18JUN12-1/1

Component Location - W1 Main Wiring Harness - Gasoline



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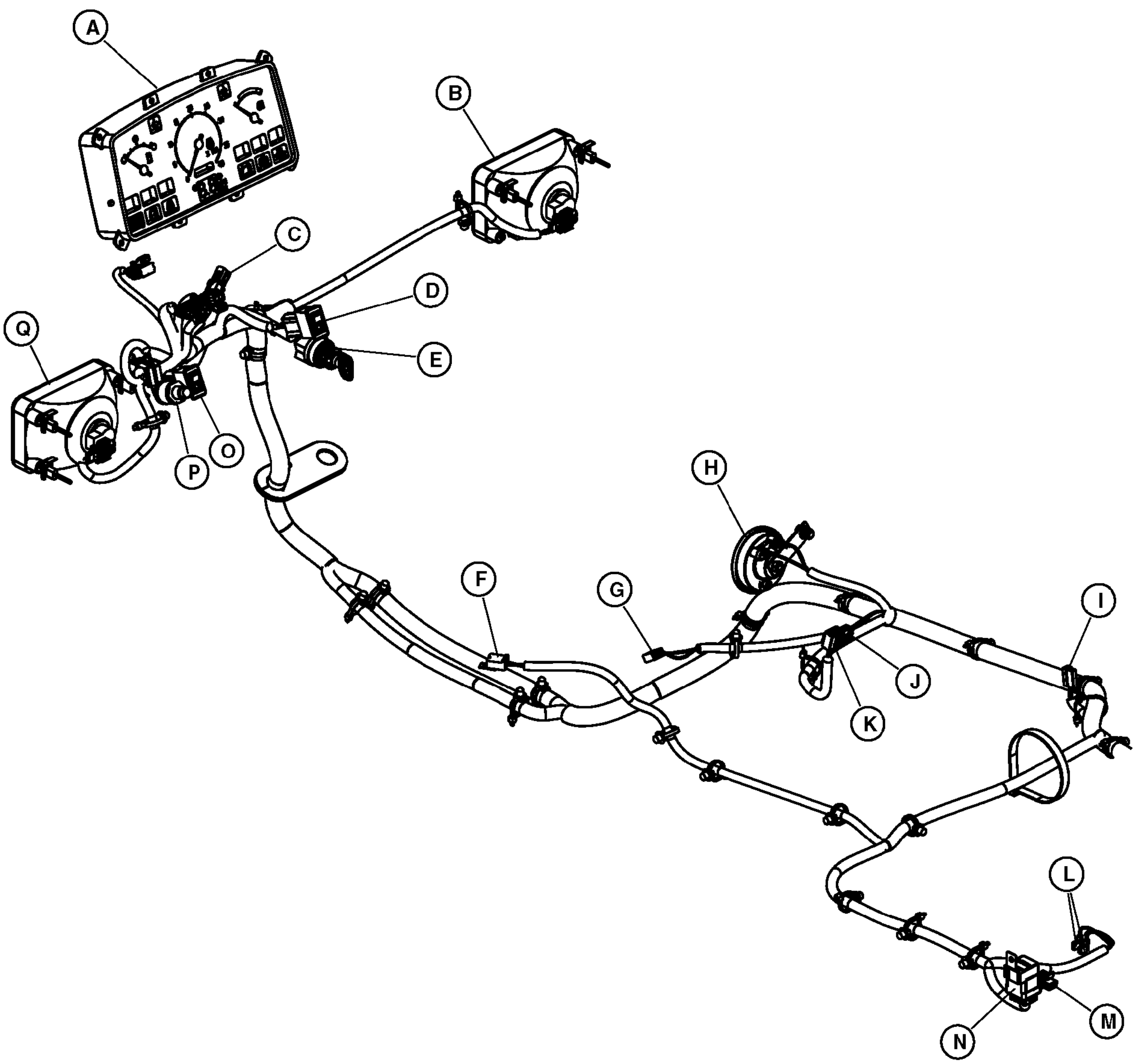
RB14256,000098E -19-18JUN12-1/2

A—E9 LH Headlight
B—Front Auxiliary Power
C—T3 Speed Sensor
D—S5 Ignition Switch
E—S1 Worklight Switch
F—H5 Horn
G—Connector W3 Work Light Harness
H—B3 Fuel Gauge Sensor
I— E24 RH Tail Light
J— Connector W2 Engine Wiring Harness
K—S27 Neutral Switch
L—Ground
M—T26 Speed Sensor
N—E25 RH Tail Light
O—K20 Fan Relay
P—M18 Radiator Fan
Q—B1 Hydraulic Overtemp Switch
R—S17 Seat Switch
S—S14 PTO Switch
T—S15 Park Brake Switch
U—A1 Instrument Cluster
V—S21 4-Wheel Drive Switch
W—S2 Horn Switch
X—S4 Headlight Switch
Y—A30 Multi Mode Throttle
Z—Diagnostic Connector
AA—E11 RH Headlight
AB—S13 Brake Switch
AC—S28 Foot Pedal Switch

RB14256,000098E -19-18JUN12-2/2

Component Location - W1 Main Wiring Harness - Diesel (Front)



A—A1 Instrument Cluster
B—E11 RH Headlight
C—T3 Speed Sensor
D—S1 Worklight Switch
E—S5 Ignition Switch
F—S12 Seat Switch
G—S21 4-Wheel Drive Switch
H—H5 Horn
I— Connector W3 Work Light Harness
J—S15 Park Brake Switch
K—S14 PTO Switch
L—B1 Hydraulic Overtemp Switch
M—M18 Radiator Fan
N—K20 Fan Relay
O—S4 Headlight Switch
P—S2 Horn Switch
Q—E9 LH Headlight

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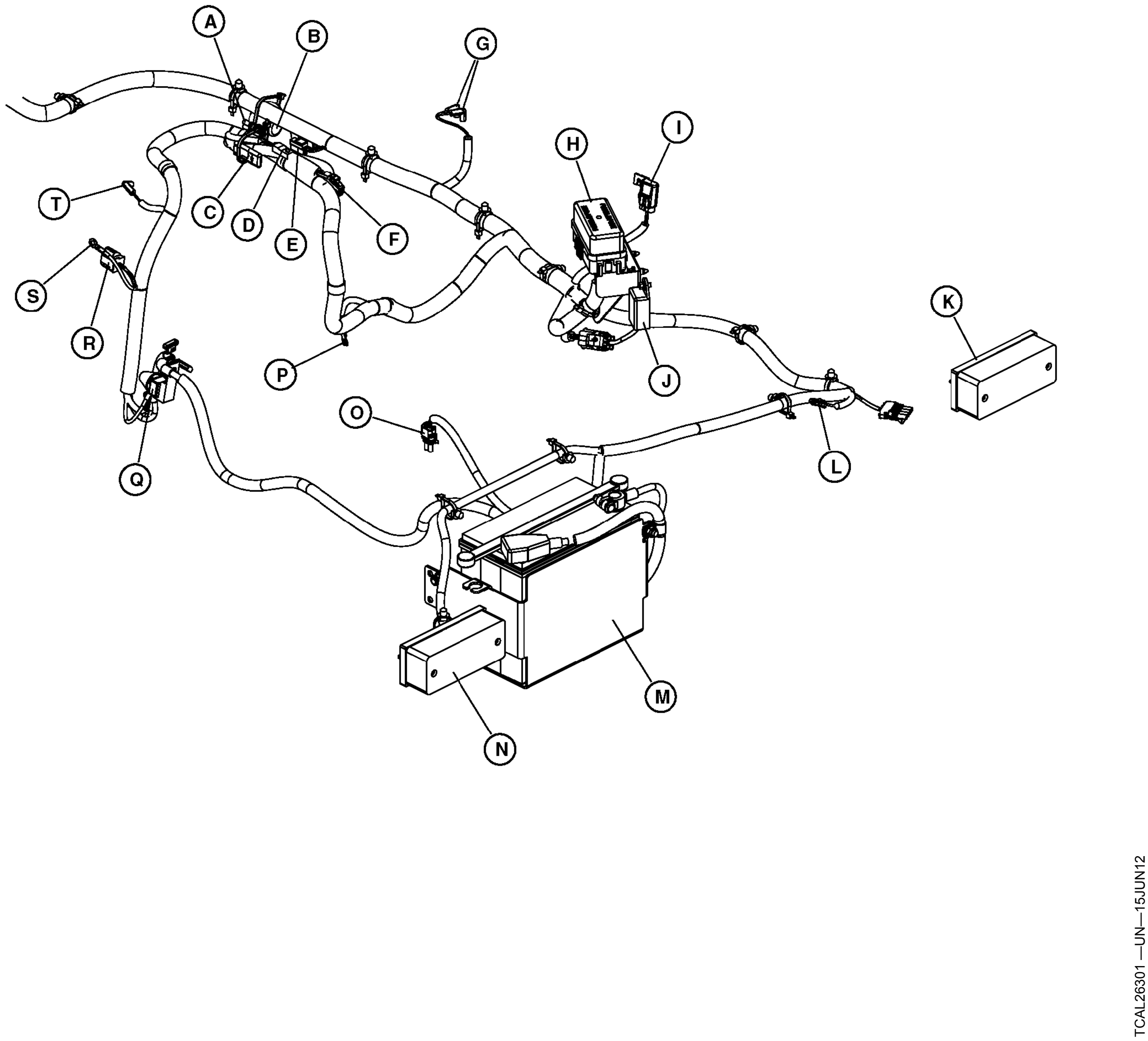
Component Location - W1 Main Wiring Harness - Diesel (Rear)



A—S28 Fan Overtemp Switch
B—A34 Seat Delay Module
C—V37 Fuel Shutoff Diode
D—Connector W2 Glow Plug Harness
E—M33 Fuel Pump
F—Y30 Fuel Shutoff Solenoid
G—B3 Fuel Gauge Sensor
H—Load Center
I— F16 Fan Fuse
J—A23 Glow Plug Control Module
K—E24 RH Tail Light
L—Connector Rear Auxiliary Power
M—G1 Battery
N—E25 RH Tail Light
O—S27 Neutral Switch
P—B13 Oil Pressure Switch
Q—F4 Bussman Fuse
R—G32 Alternator
S—G32 Alternator (B+)
T—T12 Temperature Gauge Sensor

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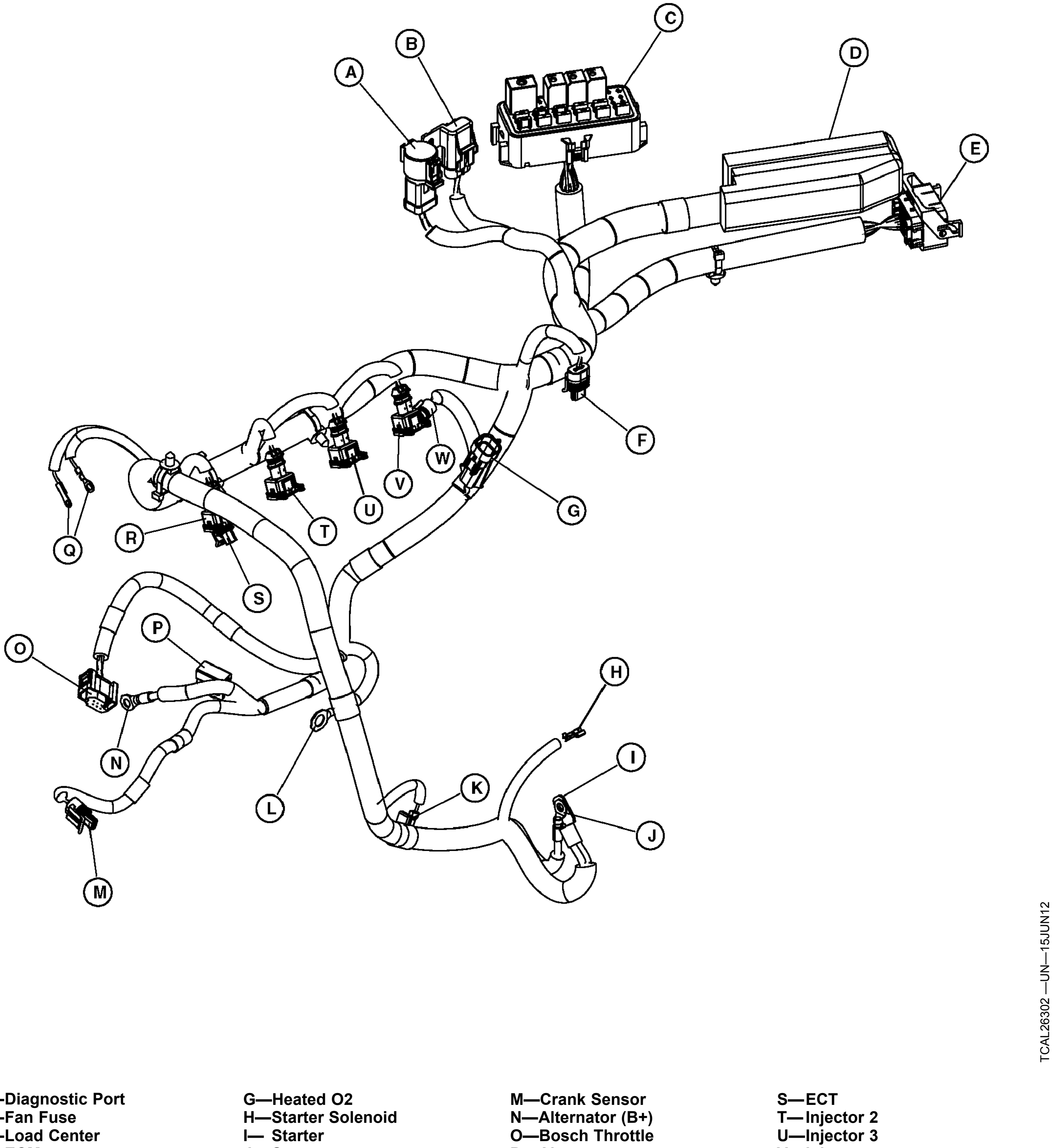
Component Location - W2 Engine Wiring Harness (Gasoline)



A—Diagnostic Port
B—Fan Fuse
C—Load Center
D—ECM
E—Main Harness Connector
F—Coil Pack
G—Heated O2
H—Starter Solenoid
I— Starter
J— Starter
K—Oil Pressure Switch
L—Engine Ground
M—Crank Sensor
N—Alternator (B+)
O—Bosch Throttle
P—Alternator
Q—Fuel Pump
R—Injector 1
S—ECT
T—Injector 2
U—Injector 3
V—Injector 4
W—TMAP Sensor

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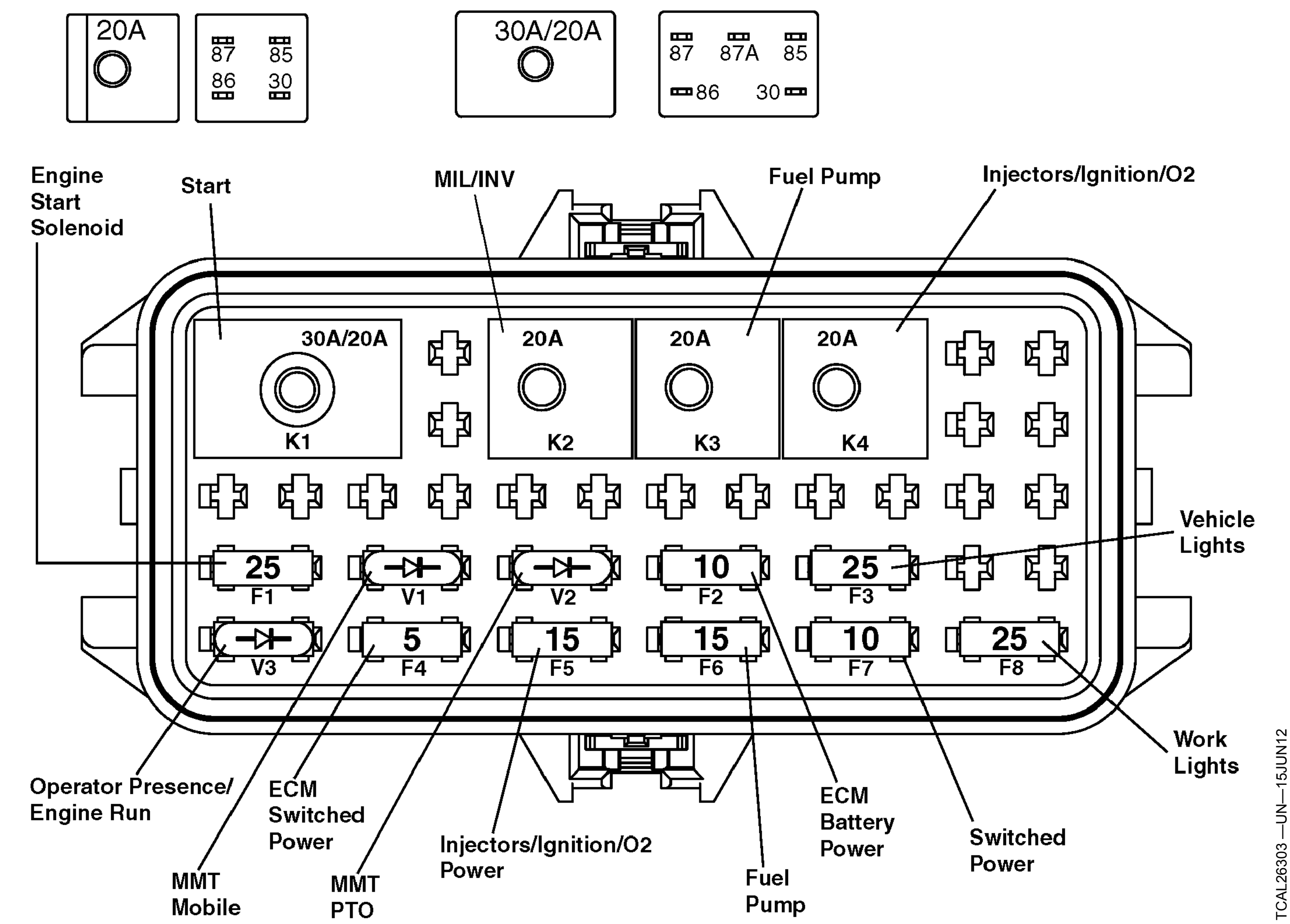
Component Location - Load Center (Gasoline)



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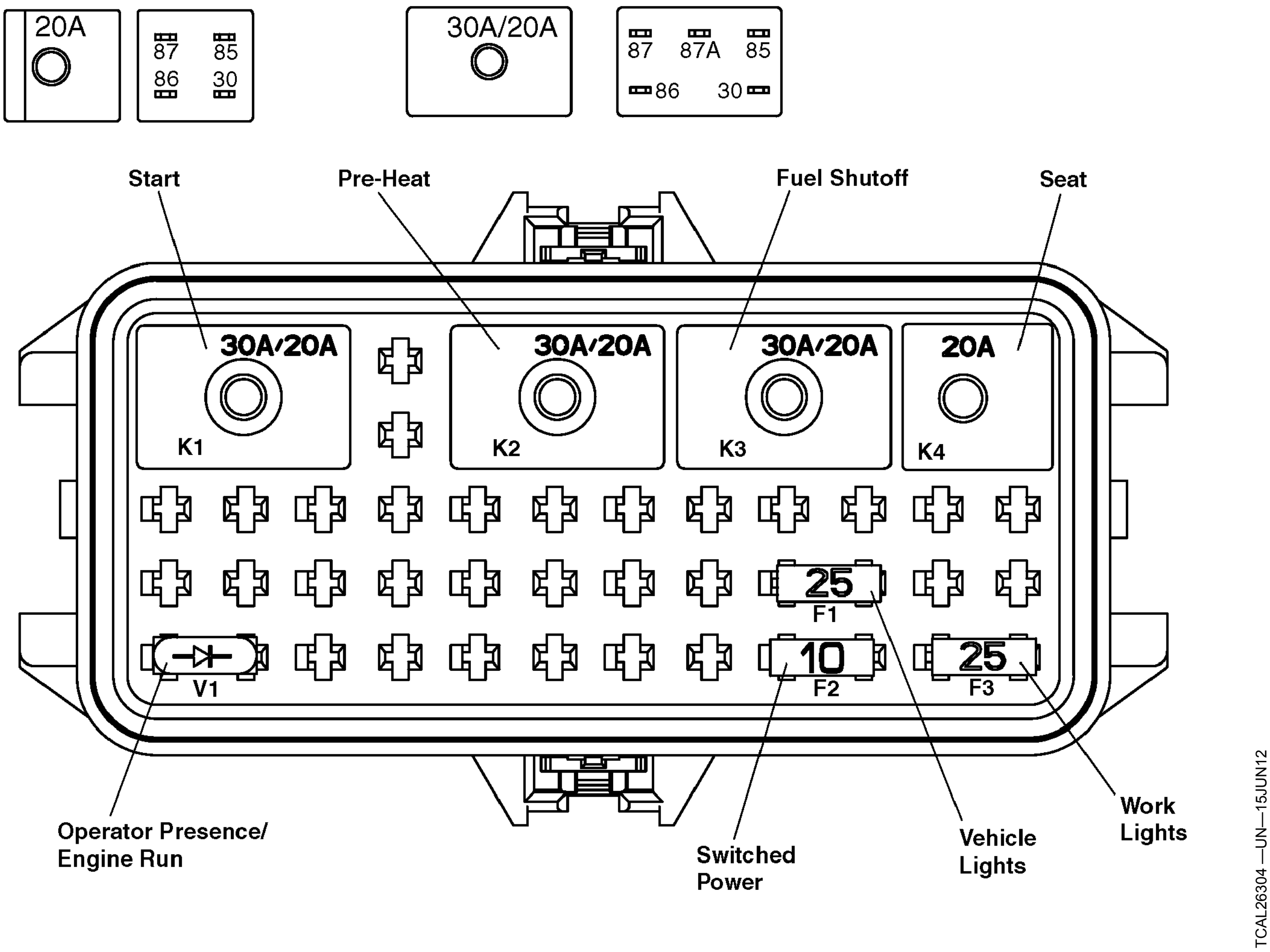
Component Location - Load Center (Diesel) (S.N. -080000)



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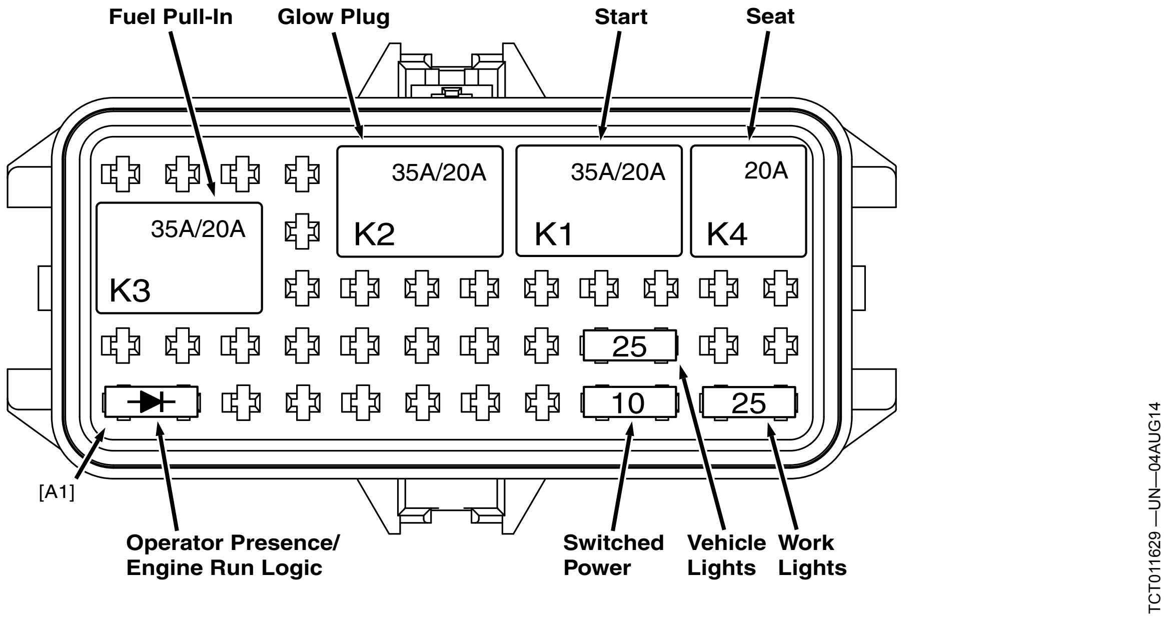
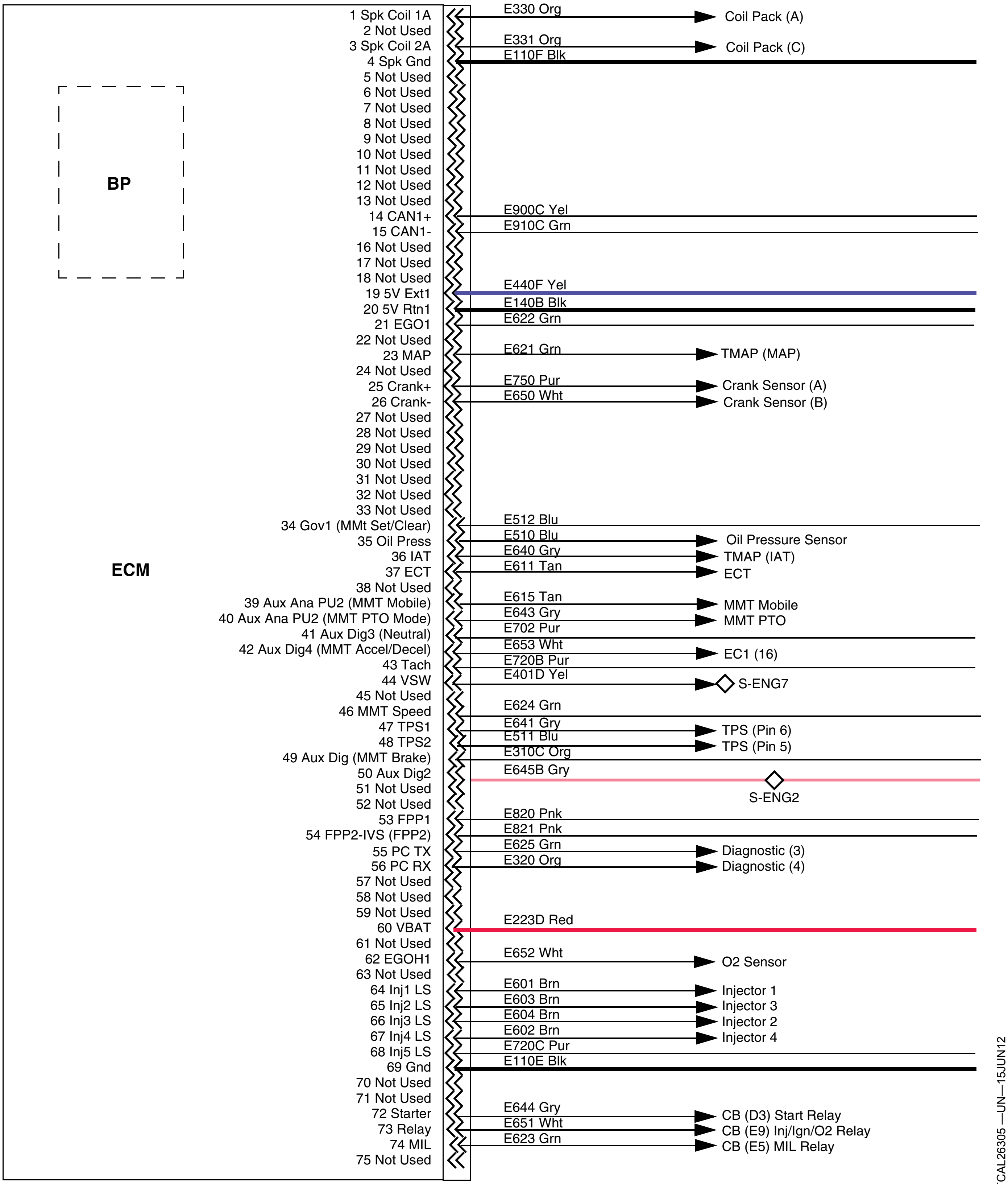
Component Location - Load Center (Diesel) (S.N. 080001-)



SH24924,0000241 -19-18AUG14-1/1

W1 Main Wiring Harness Schematic



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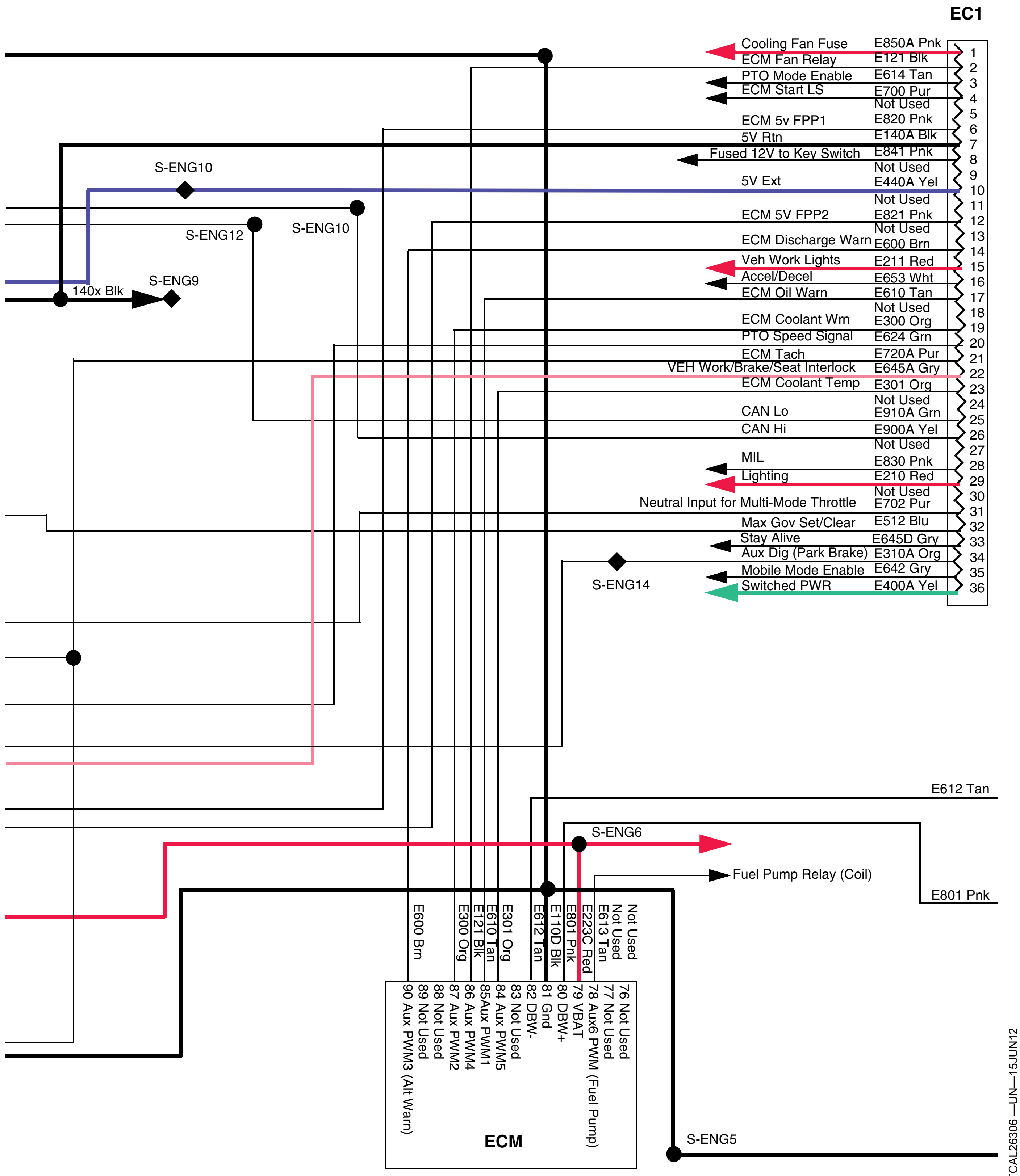

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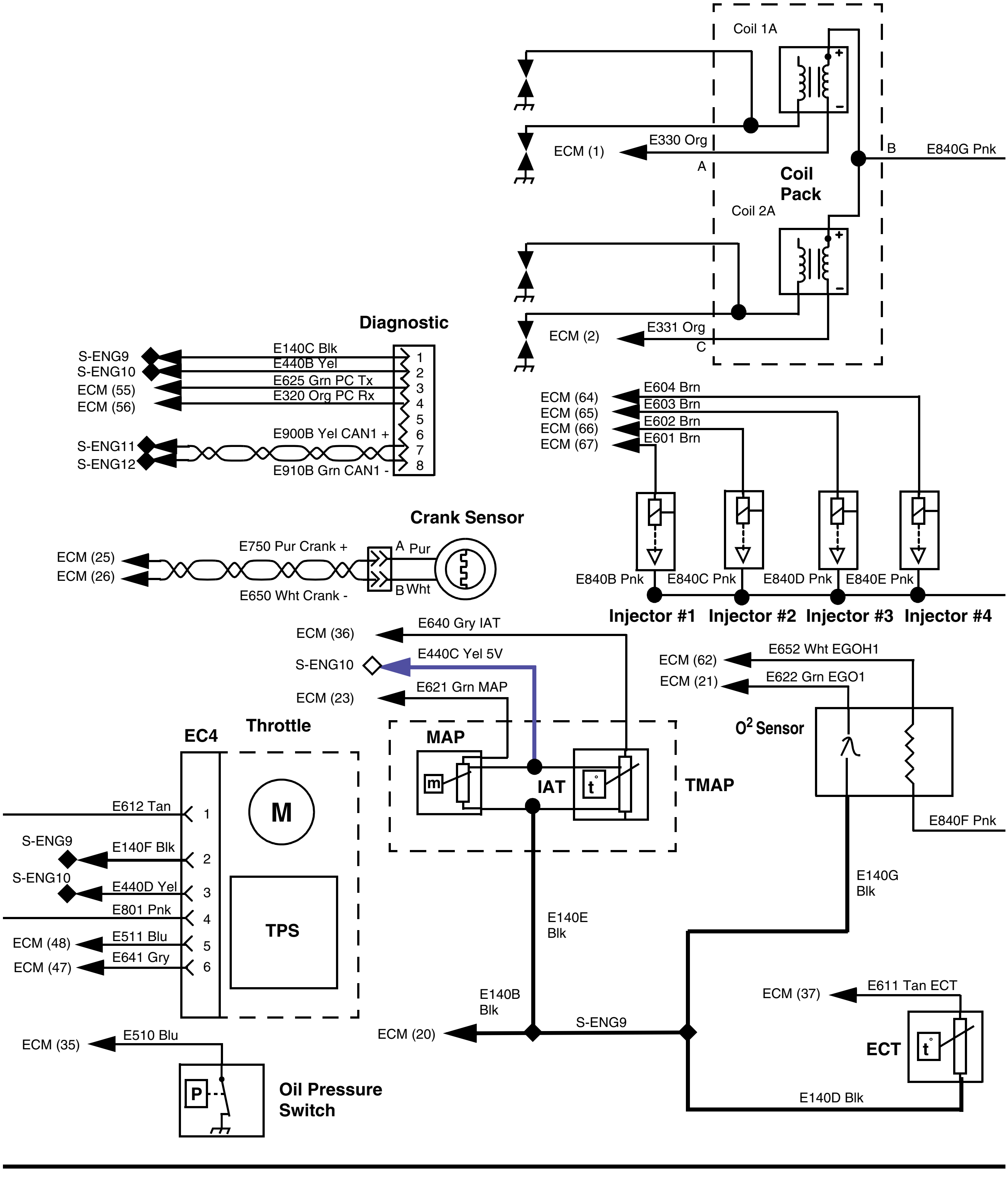

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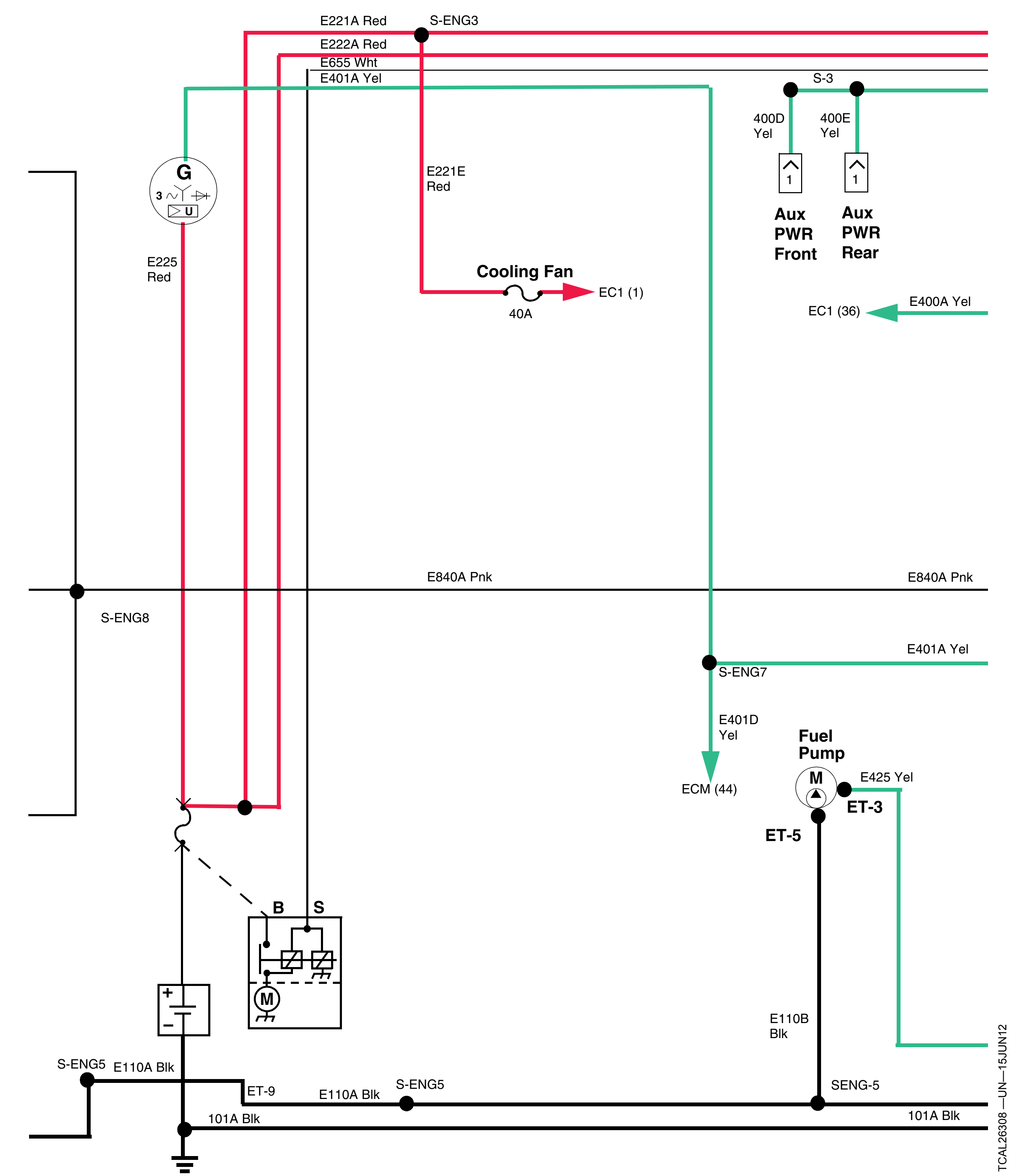

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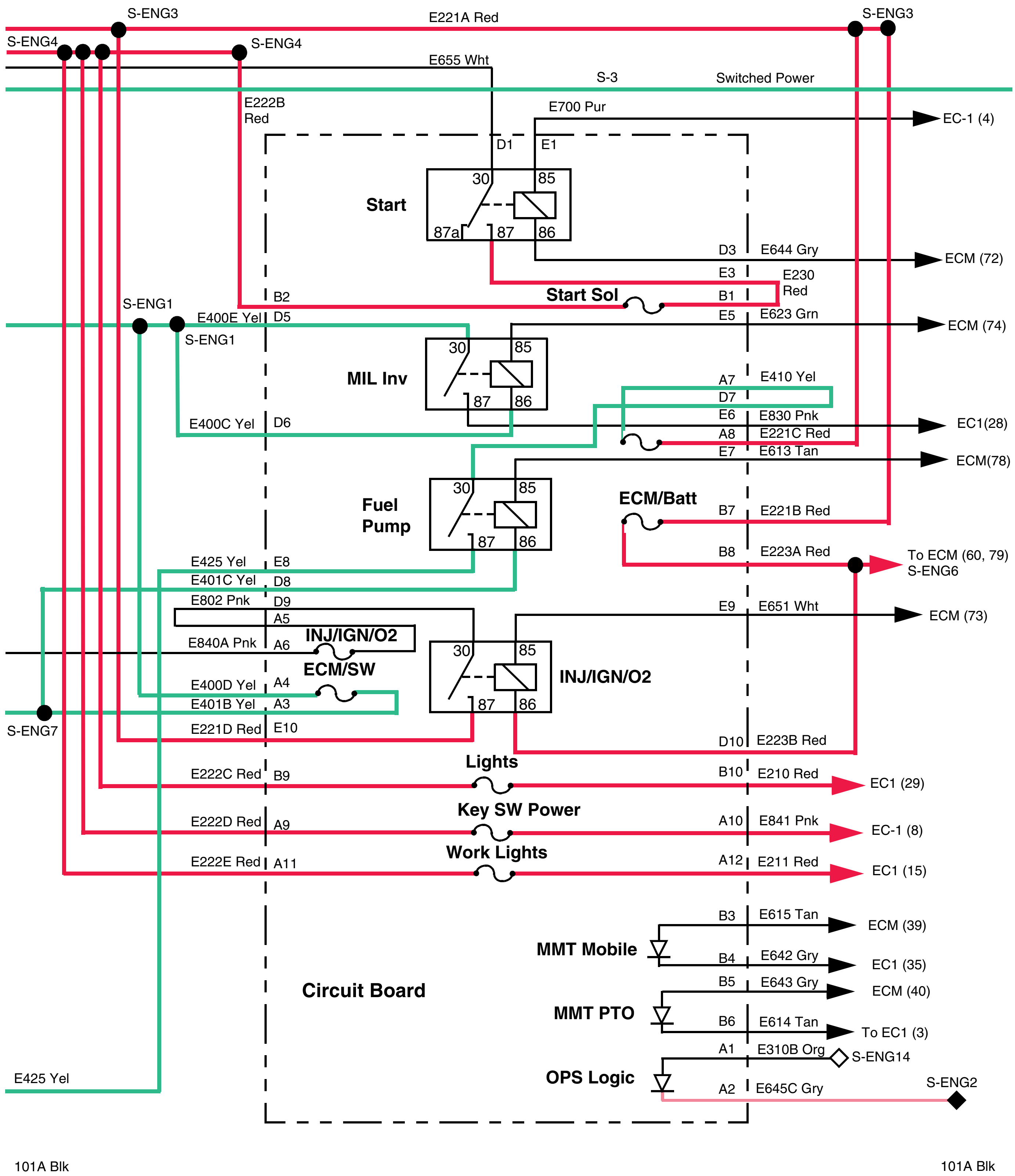

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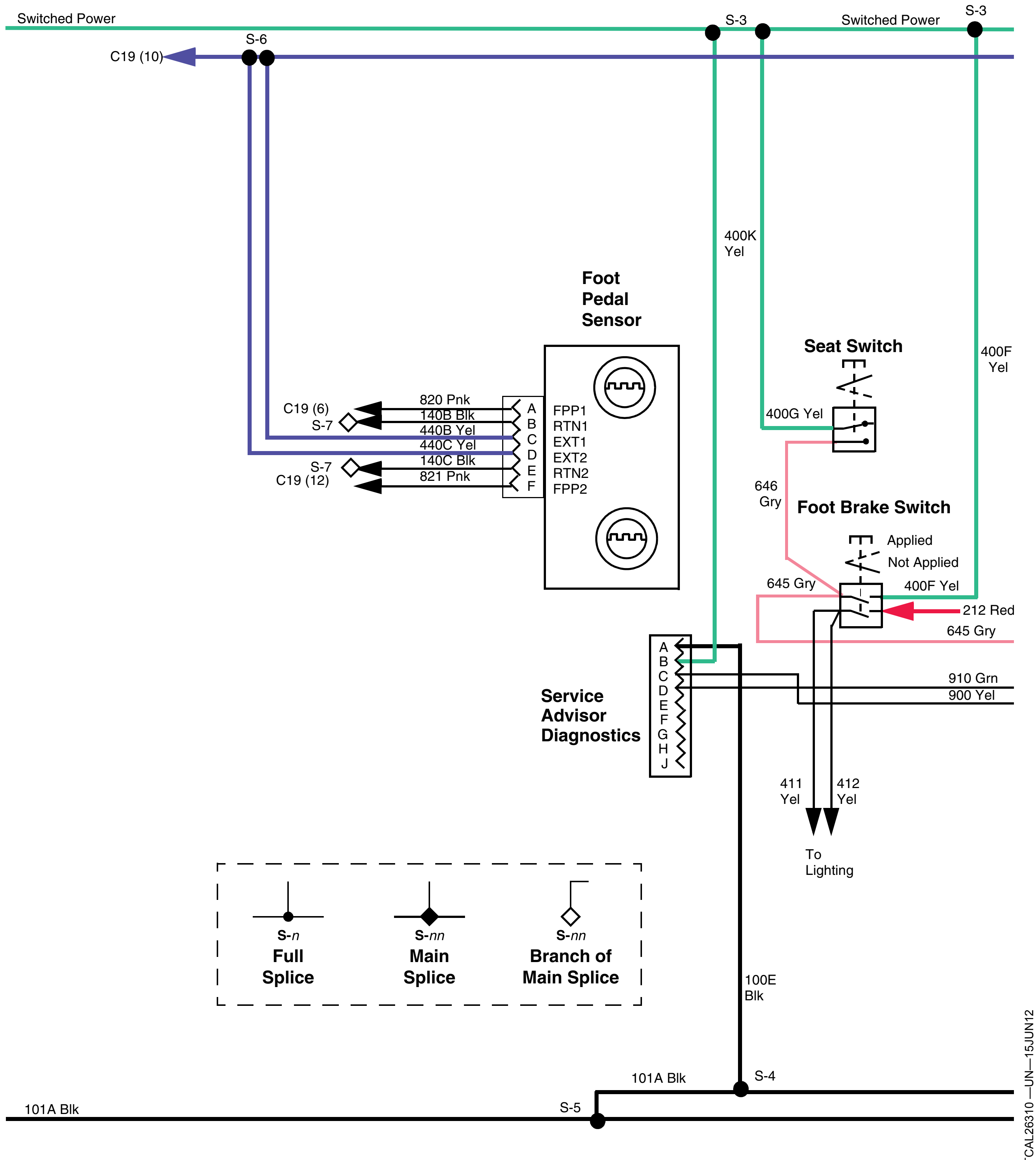

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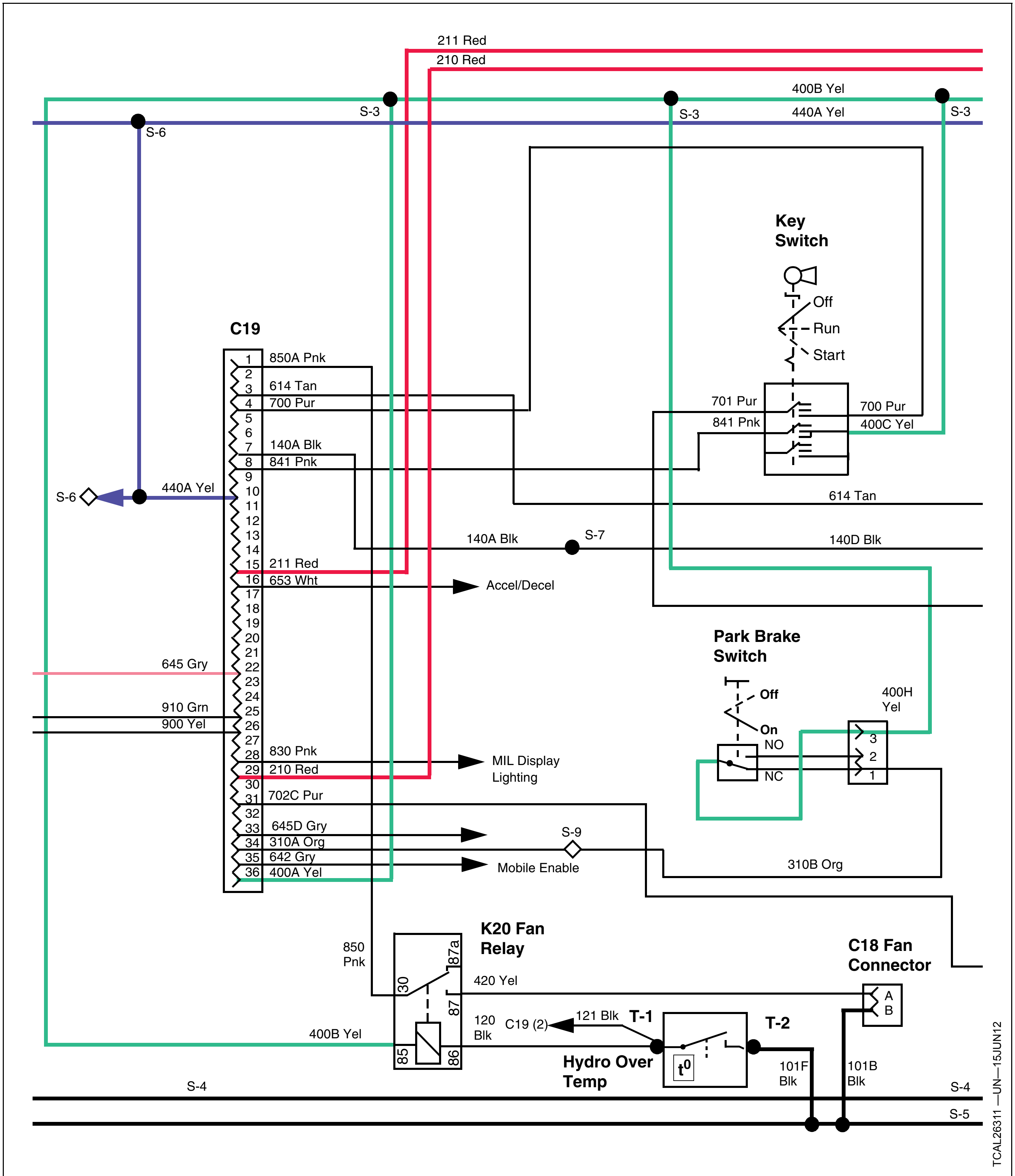

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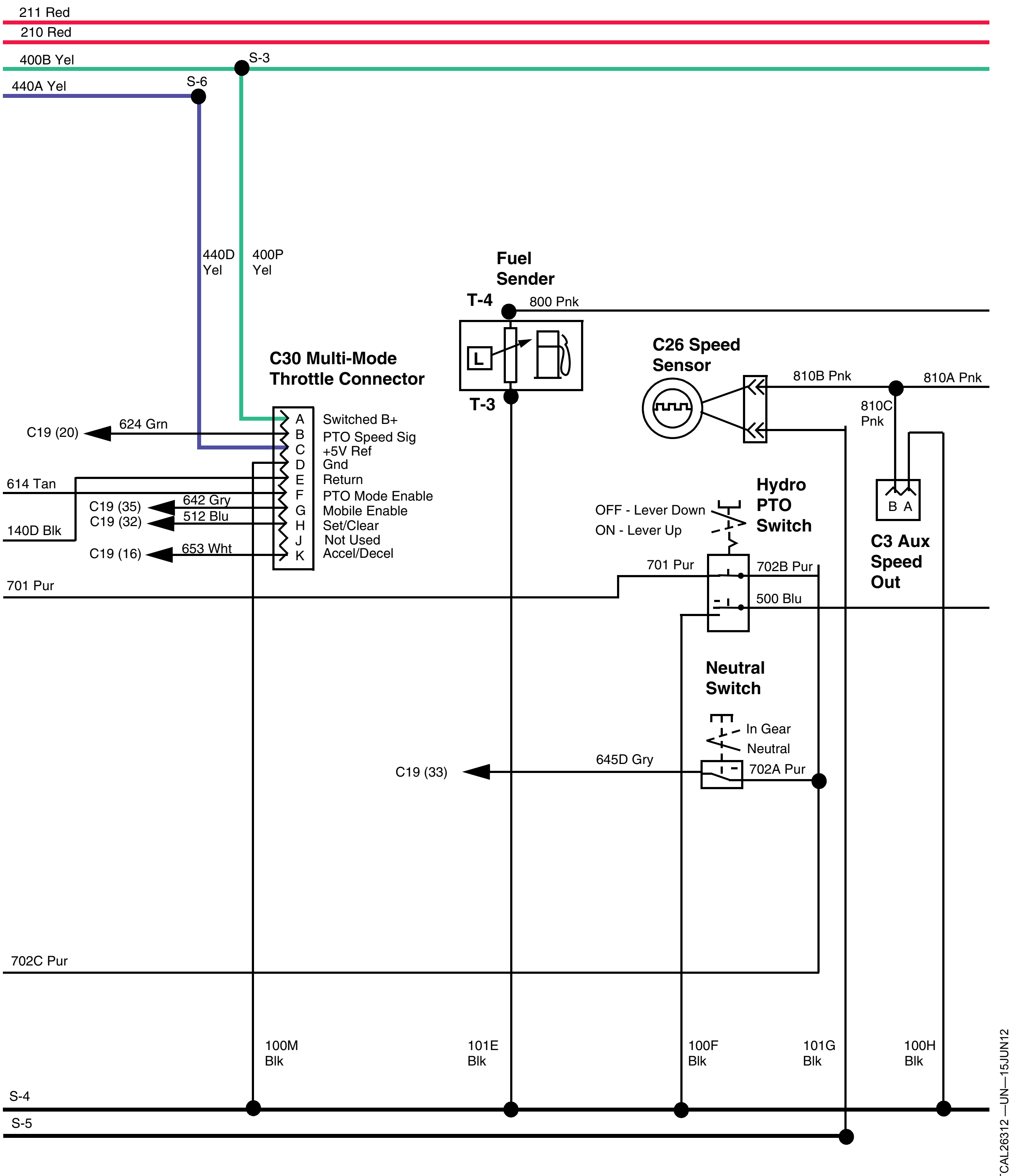

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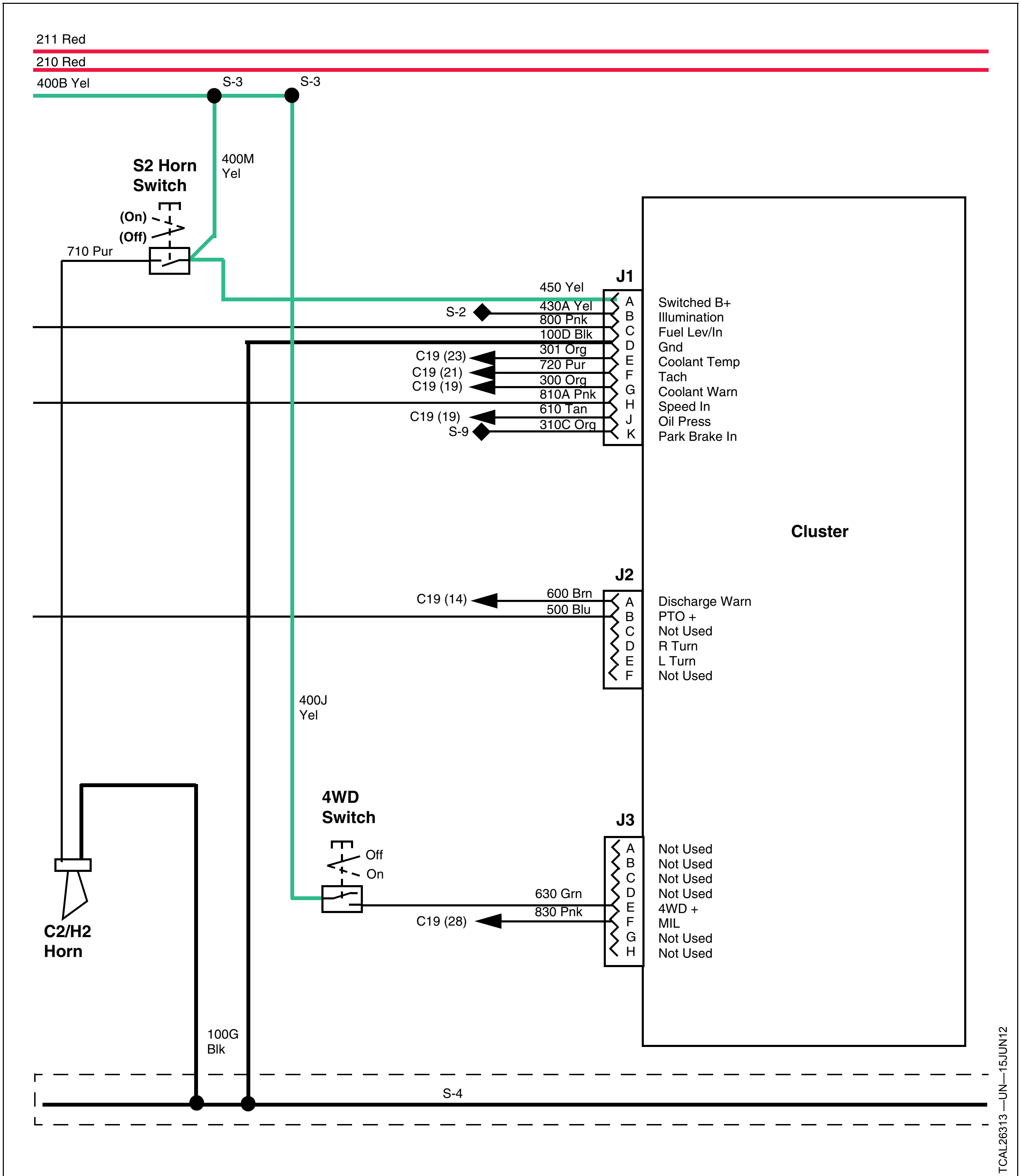

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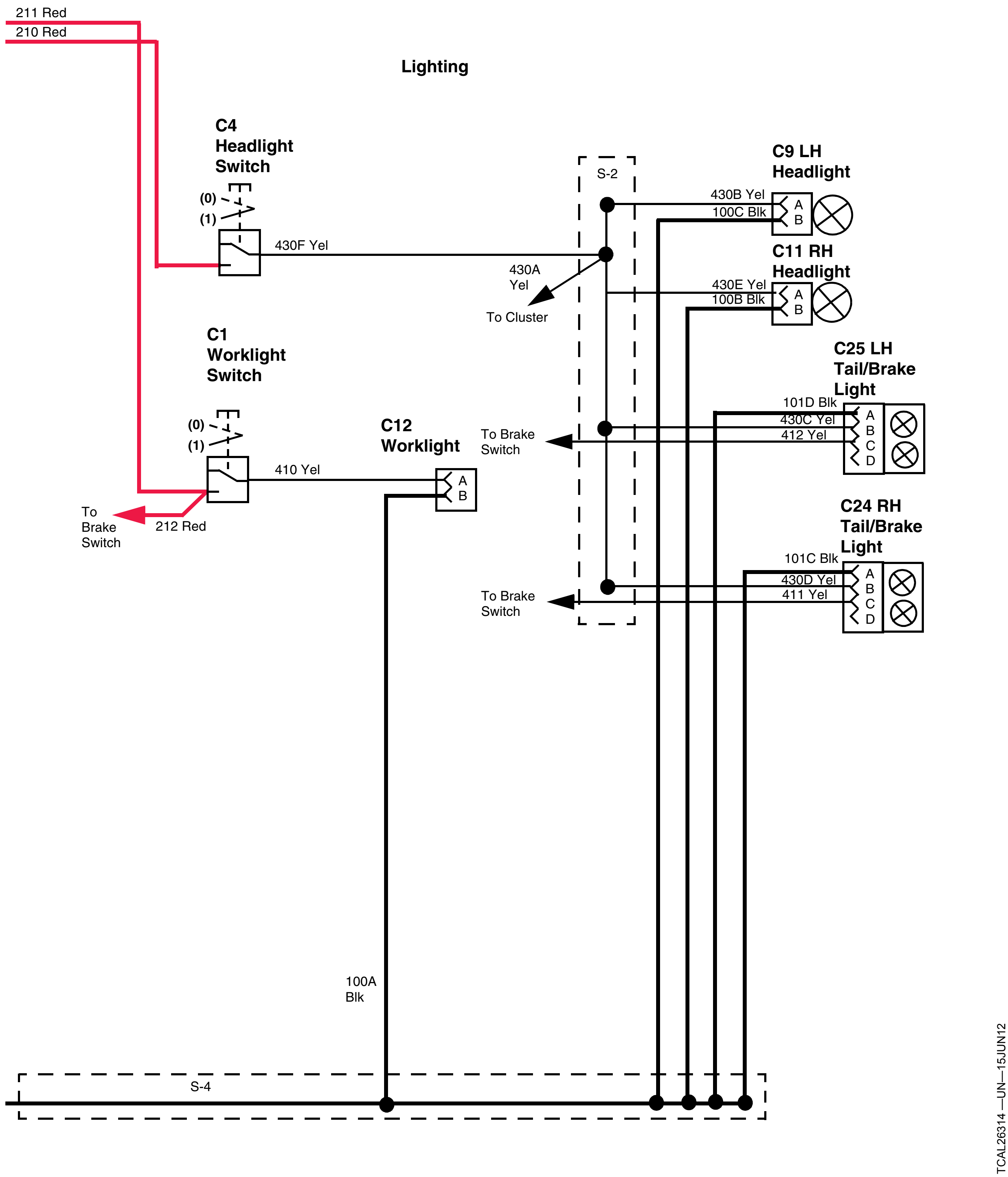
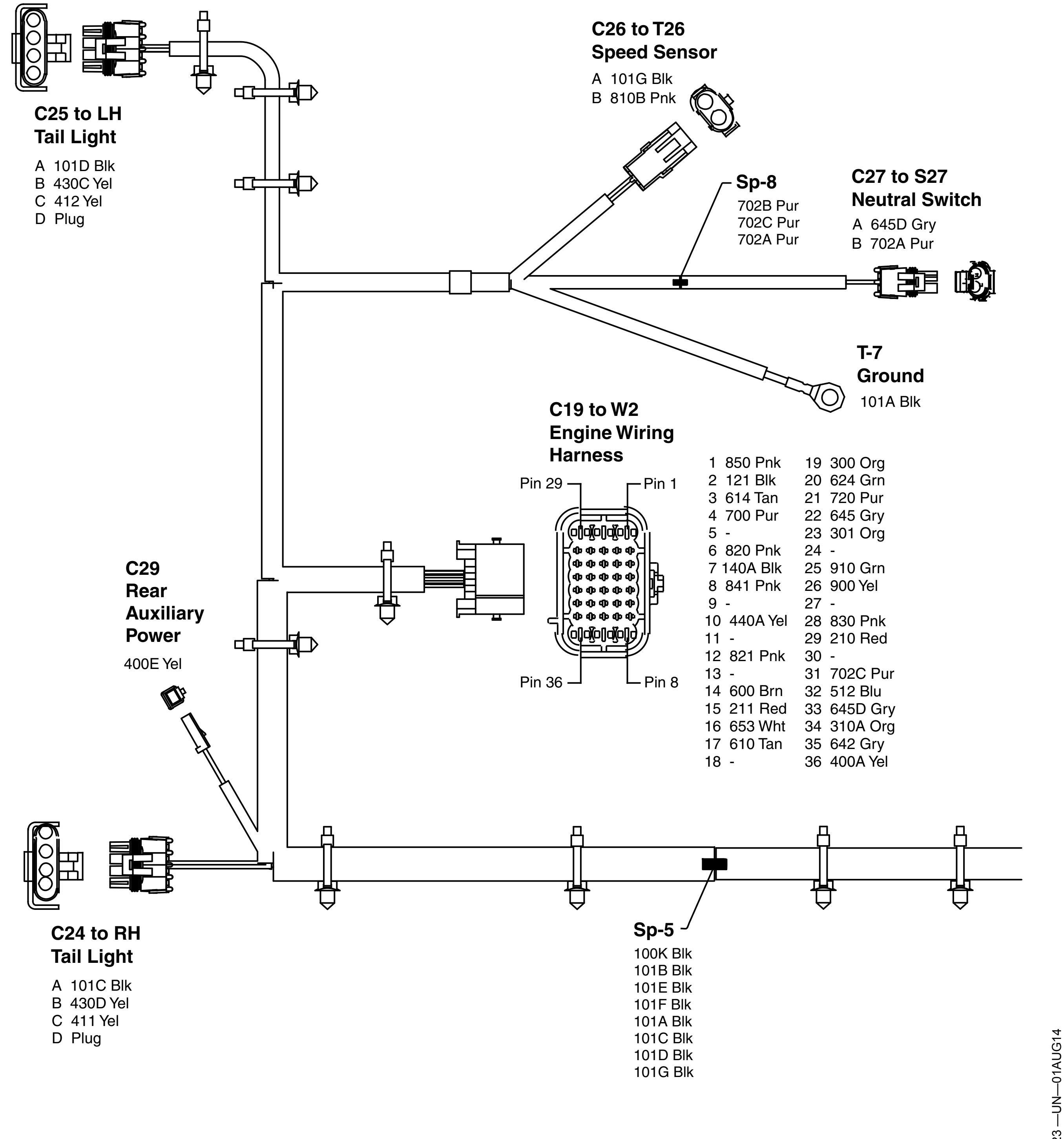


RB14256,0000994 -19-18JUN12-10/10

W1 Main Wiring Harness



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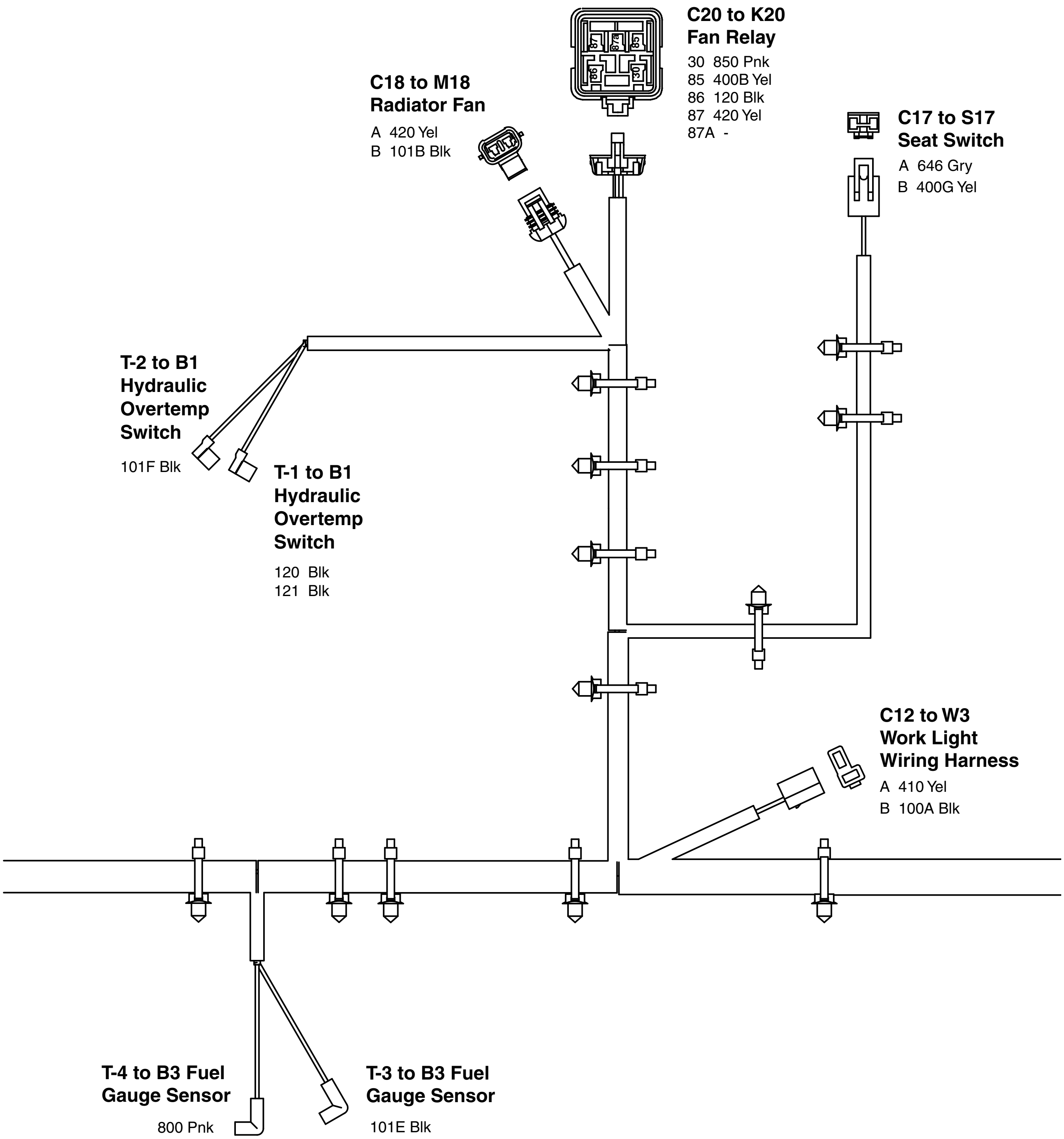

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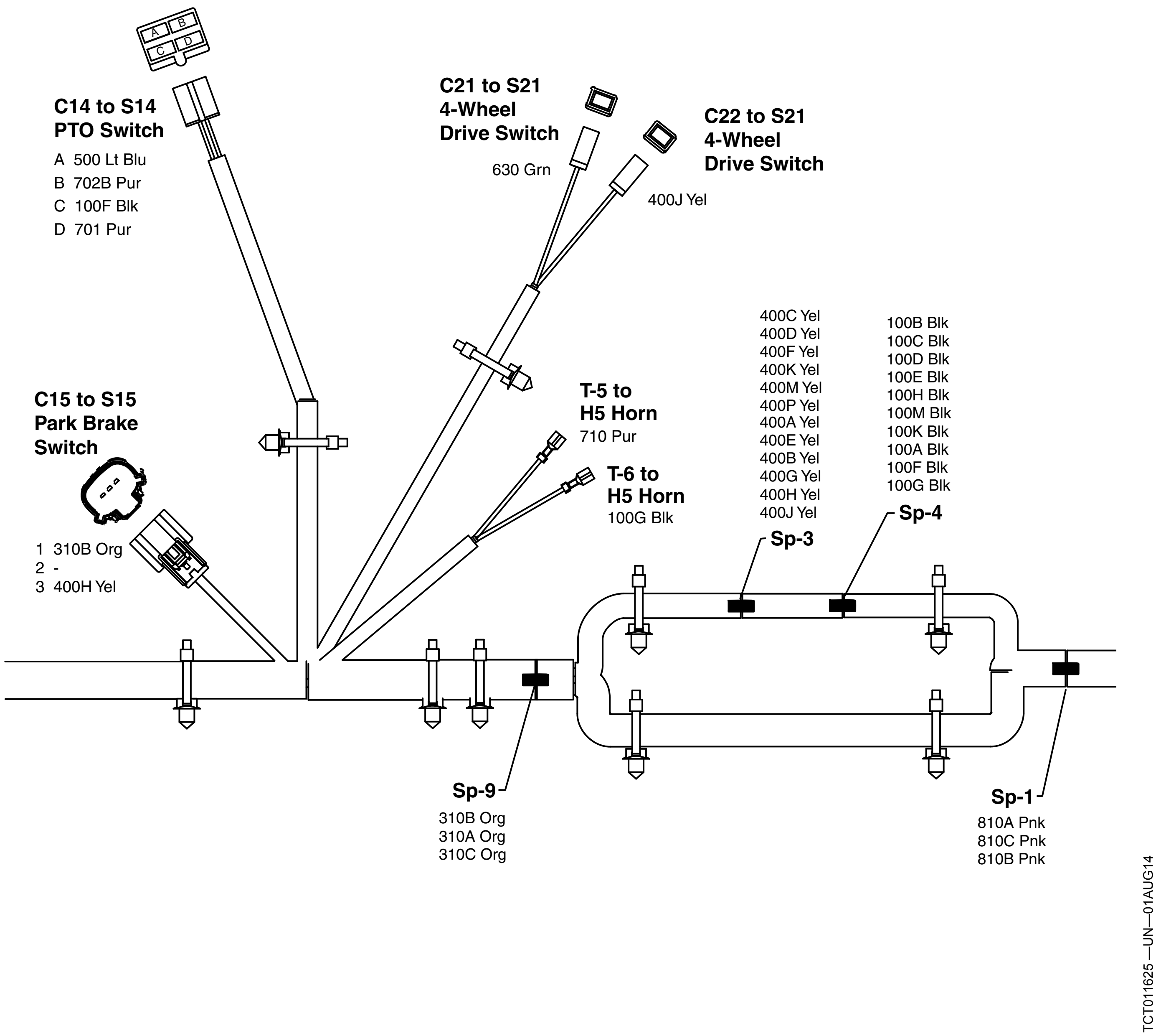

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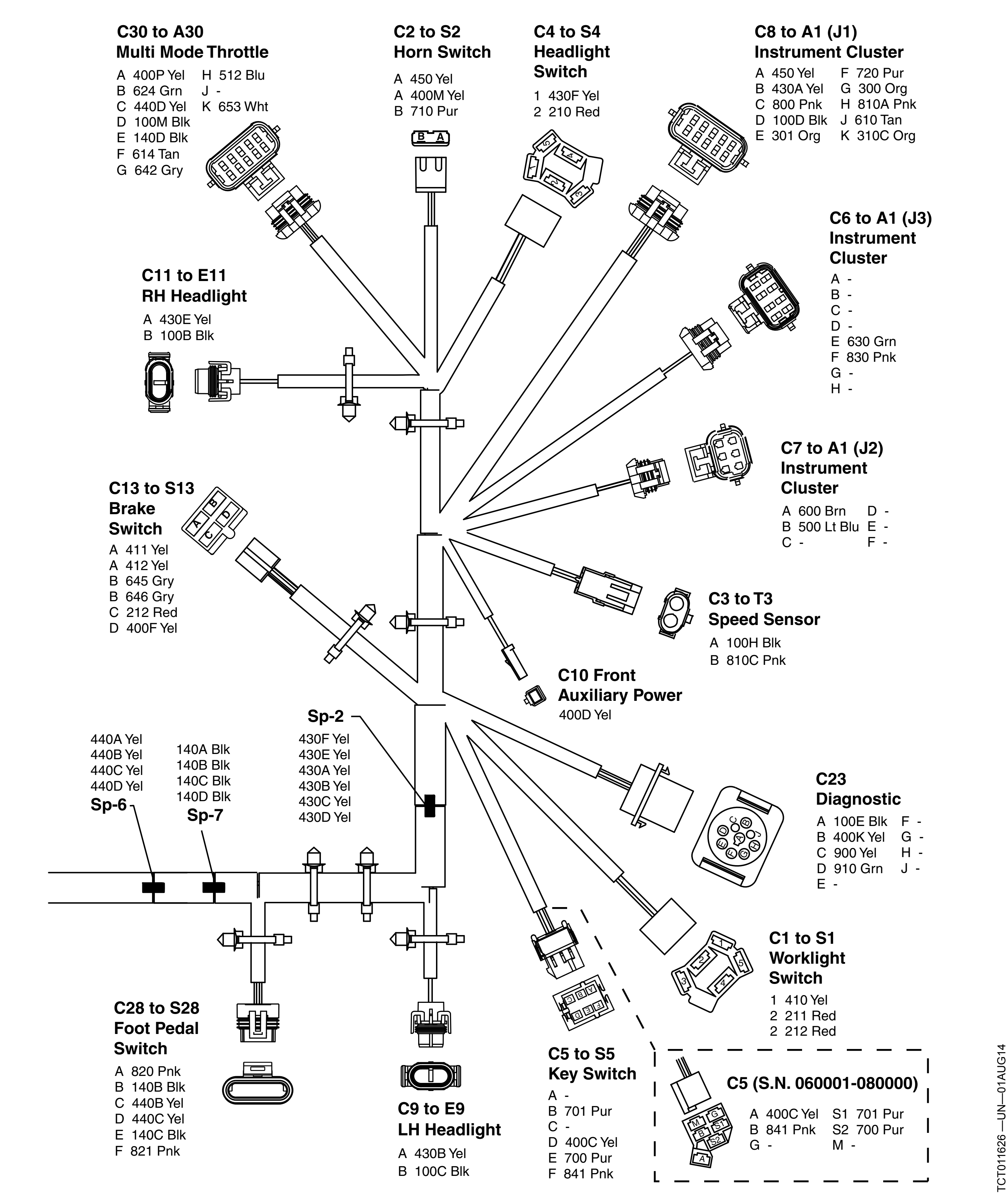

RB14256,0000995 -19-01AUG14-4/4

W1 Main Wiring Harness Wire Color Codes

Circuit Number	Wire Size	Color
120	0.8	Blk
121	0.8	Blk
210	2.0	Red
211	2.0	Red
212	2.0	Red
300	0.8	Org
301	0.8	Org
410	1.0	Yel
411	0.8	Yel
412	0.8	Yel
420	3.0	Yel
450	0.8	Yel
500	0.8	Lt Blu
512	0.8	Blu
600	0.8	Brn
610	0.8	Tan
614	0.8	Tan
624	0.8	Grn
630	0.8	Grn
642	0.8	Gry
645	1.0	Gry
646	0.8	Gry
653	0.8	Wht
700	0.8	Pur
701	0.8	Pur
710	0.8	Pur
720	0.8	Pur
800	0.8	Pnk
820	0.8	Pnk
821	0.8	Pnk
830	0.8	Pnk
841	2.0	Pnk
850	2.0	Pnk
900	0.8	Yel
910	0.8	Grn
100A	1.0	Blk
100B	1.0	Blk
100C	1.0	Blk
100D	0.8	Blk
100E	0.8	Blk
100F	0.8	Blk
100G	0.8	Blk
100H	0.8	Blk
100K	5.0	Blk
100M	0.8	Blk
101A	5.0	Blk
101B	3.0	Blk
101C	0.8	Blk
101D	0.8	Blk
101E	0.8	Blk

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Circuit Number	Wire Size	Color
101F	0.8	Blk
101G	0.8	Blk
140A	0.8	Blk
140B	0.8	Blk
140C	0.8	Blk
140D	0.8	Blk
310A	0.8	Org
310B	0.8	Org
310C	0.8	Org
400A	2.0	Yel
400B	0.8	Yel
400C	2.0	Yel
400D	1.0	Yel
400E	1.0	Yel
400F	1.0	Yel
400G	0.8	Yel
400H	0.8	Yel
400J	0.8	Yel
400K	0.8	Yel
400M	0.8	Yel
400P	0.8	Yel
430A	0.8	Yel
430B	1.0	Yel
430C	2.0	Yel
430D	1.0	Yel
430E	1.0	Yel
430F	1.0	Yel
440A	0.8	Yel
440B	0.8	Yel
440C	0.8	Yel
440D	0.8	Yel
645D	0.8	Gry
702A	0.8	Pur
702B	0.8	Pur
702C	0.8	Pur
810A	0.8	Pnk
810B	0.8	Pnk
810C	0.8	Pnk

RB14256,0000996 -19-18JUN12-2/2

Main Wiring Harness Splice Table

Splice No.	Circuit
S-1	810A Pnk
	810B Pnk
	810C Pnk
S-2	430F Yel
	430E Yel
	430A Yel
	430B Yel
	430C Yel
	430D Yel
S-3	400C Yel
	400D Yel
	400F Yel
	400K Yel
	400M Yel
	400P Yel
	400A Yel
	400E Yel
	400B Yel
	400G Yel
	400H Yel
	400J Yel
	400N Yel
S-4	100B Blk
	100C Blk
	100D Blk
	100E Blk
	100H Blk
	100M Blk
	100K Blk
	100A Blk
	100F Blk
	100G Blk
S-5	100K Blk
	101B Blk
	101E Blk
	101F Blk
	101A Blk
	101C Blk
	101D Blk
	101G Blk
S-6	440A Yel
	440B Yel
	440C Yel
	440D Yel
S-7	140A Blk
	140B Blk
	140C Blk
	140D Blk
S-8	702B Pur
	702C Pur

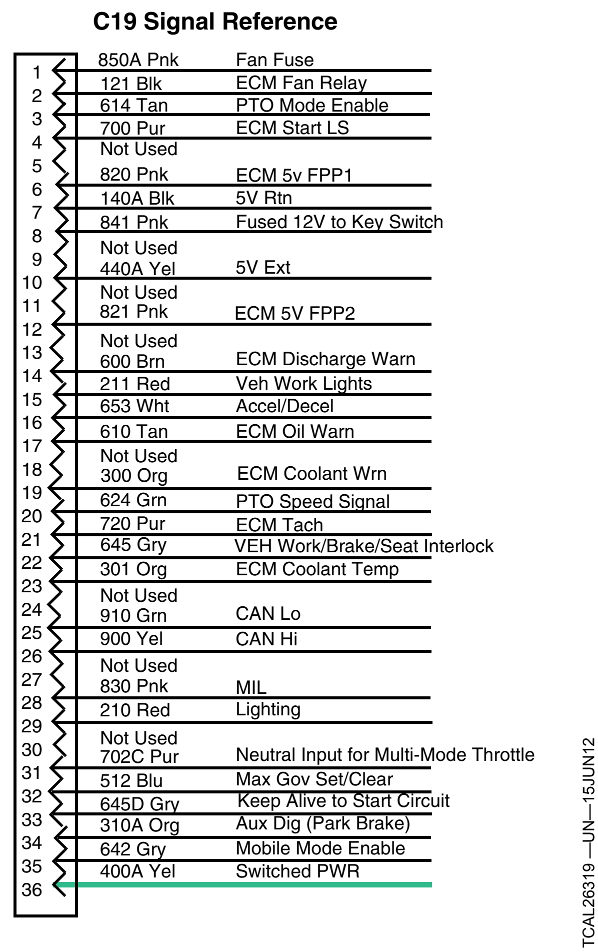
Continued on next page

RB14256,0000997 -19-18JUN12-1/2

Splice No.	Circuit
	702A Pur
S-9	310B Org
	301A Org
	310C Org

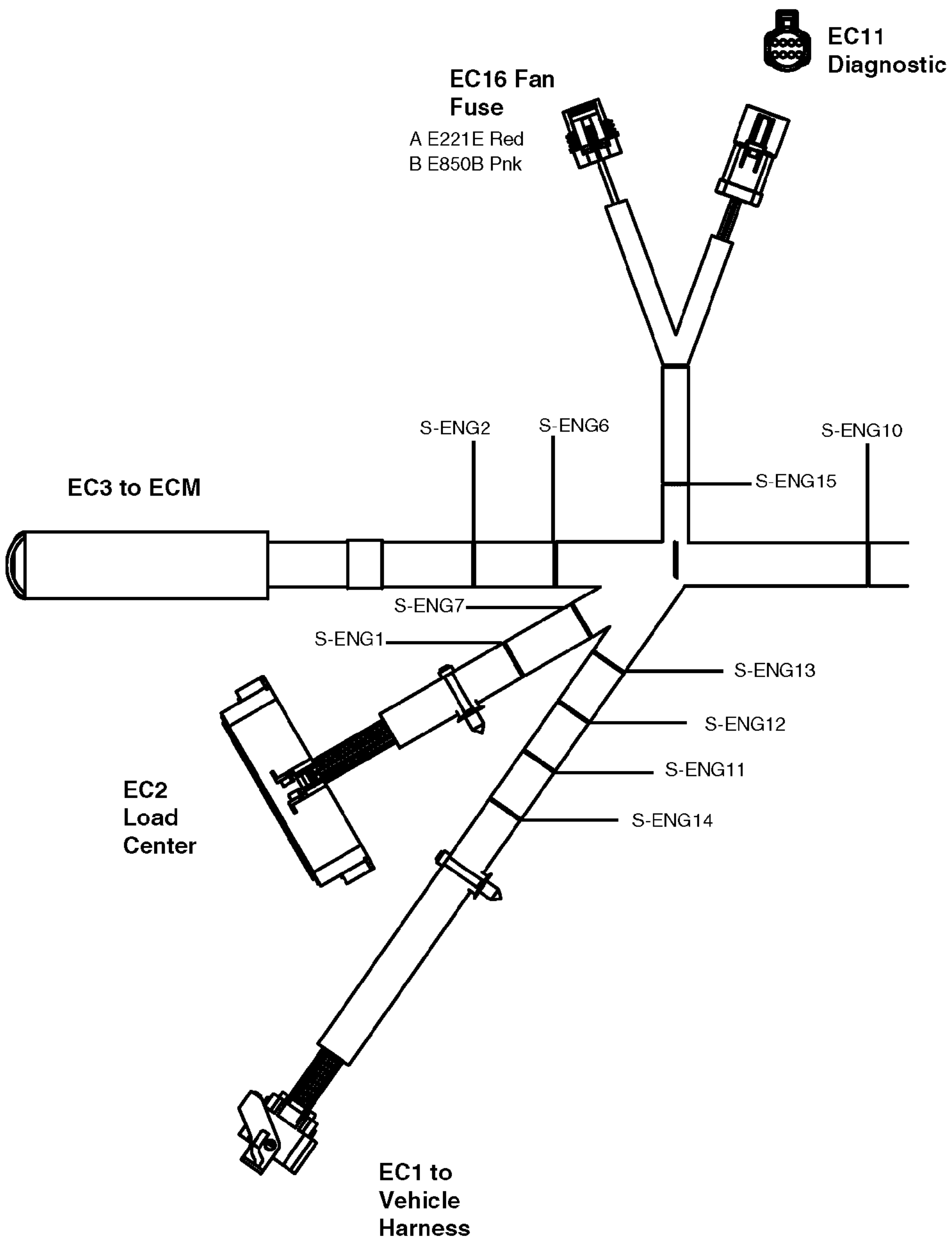
RB14256,0000997 -19-18JUN12-2/2

Main Harness C19 Signal Reference



RB14256,0000998 -19-18JUN12-1/1

W2 Engine Wiring Harness



TCAL26320 —UN—15JUN12

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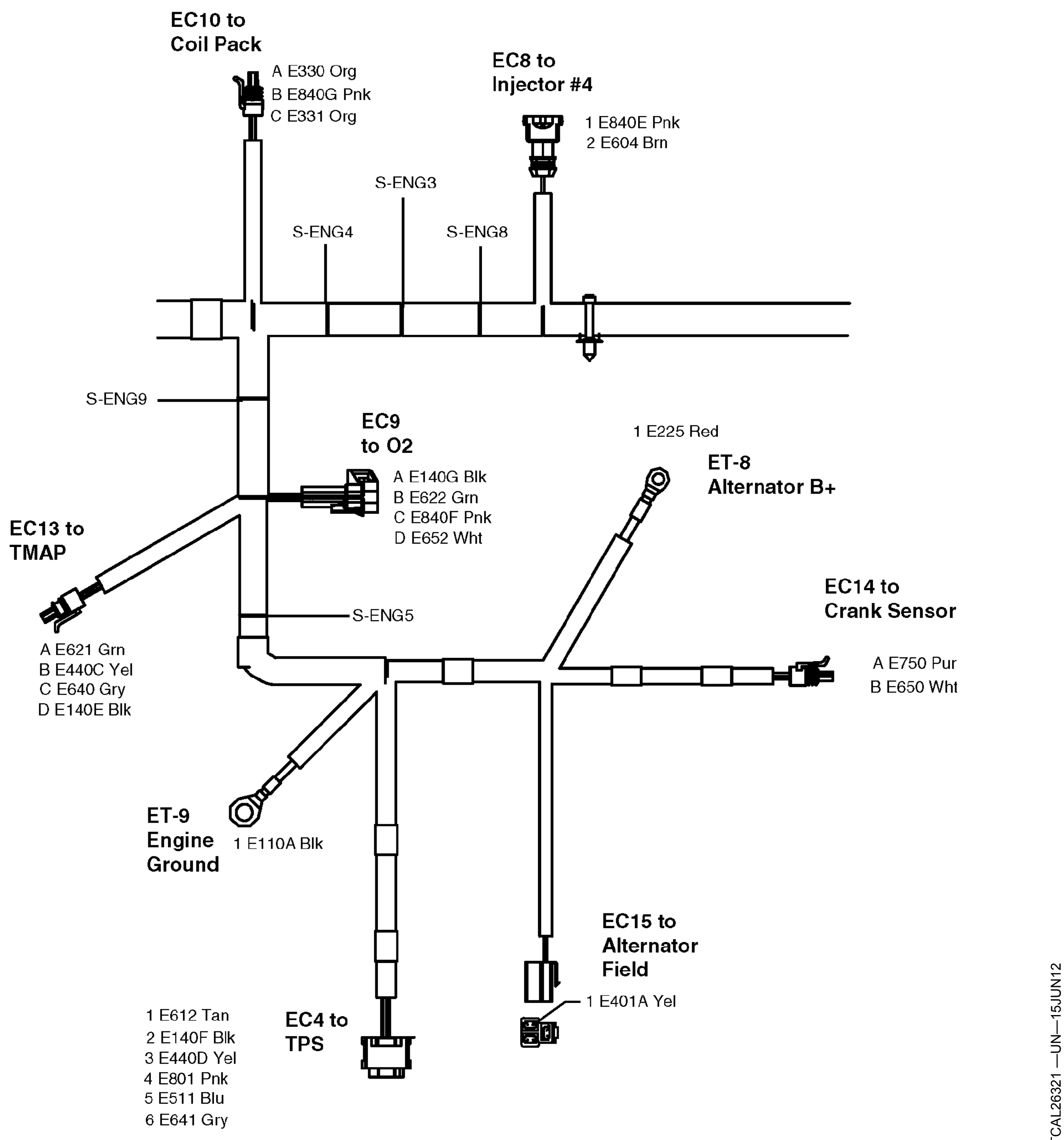
RB14256,0000999 -19-18JUN12-1/3



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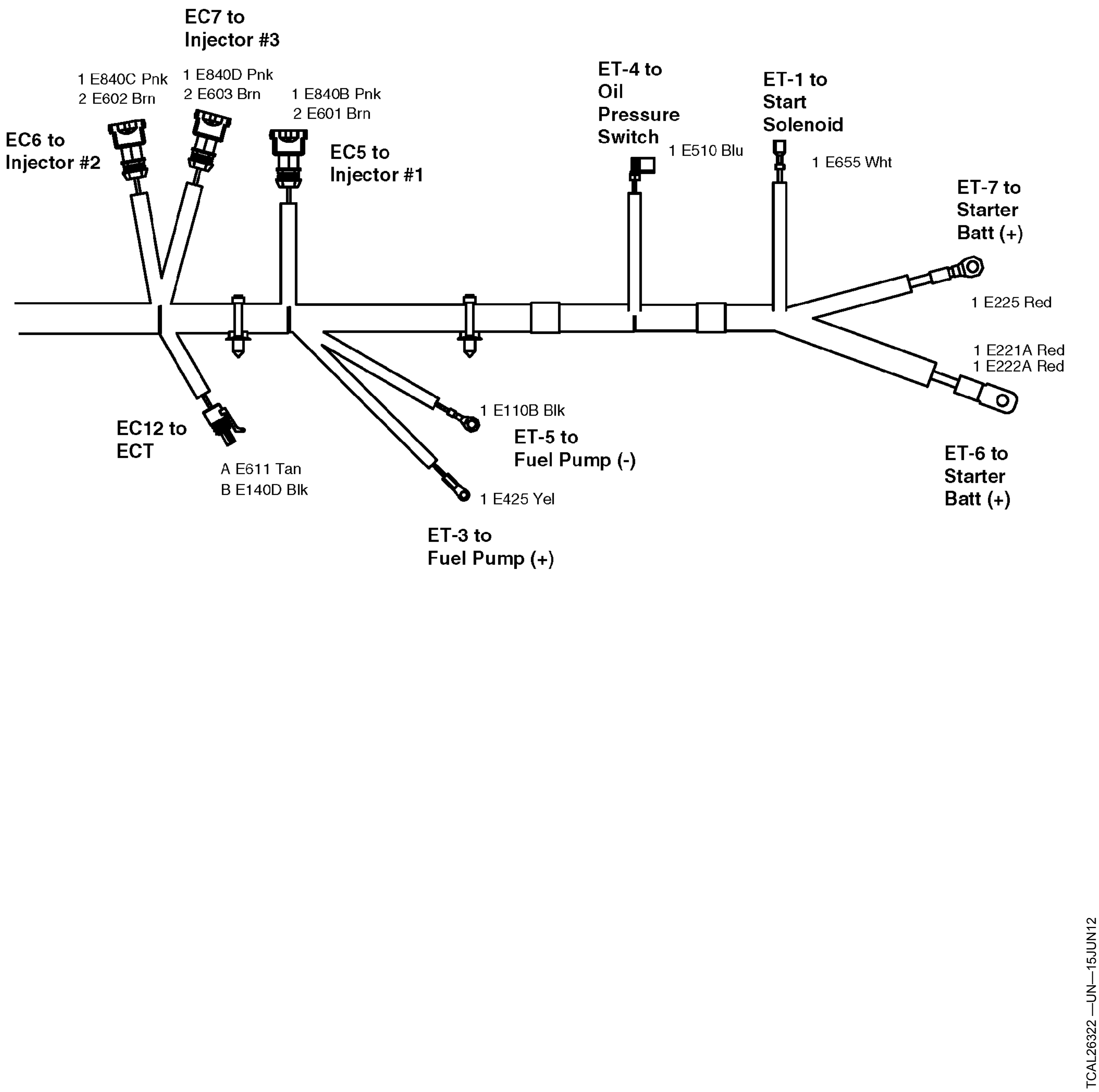
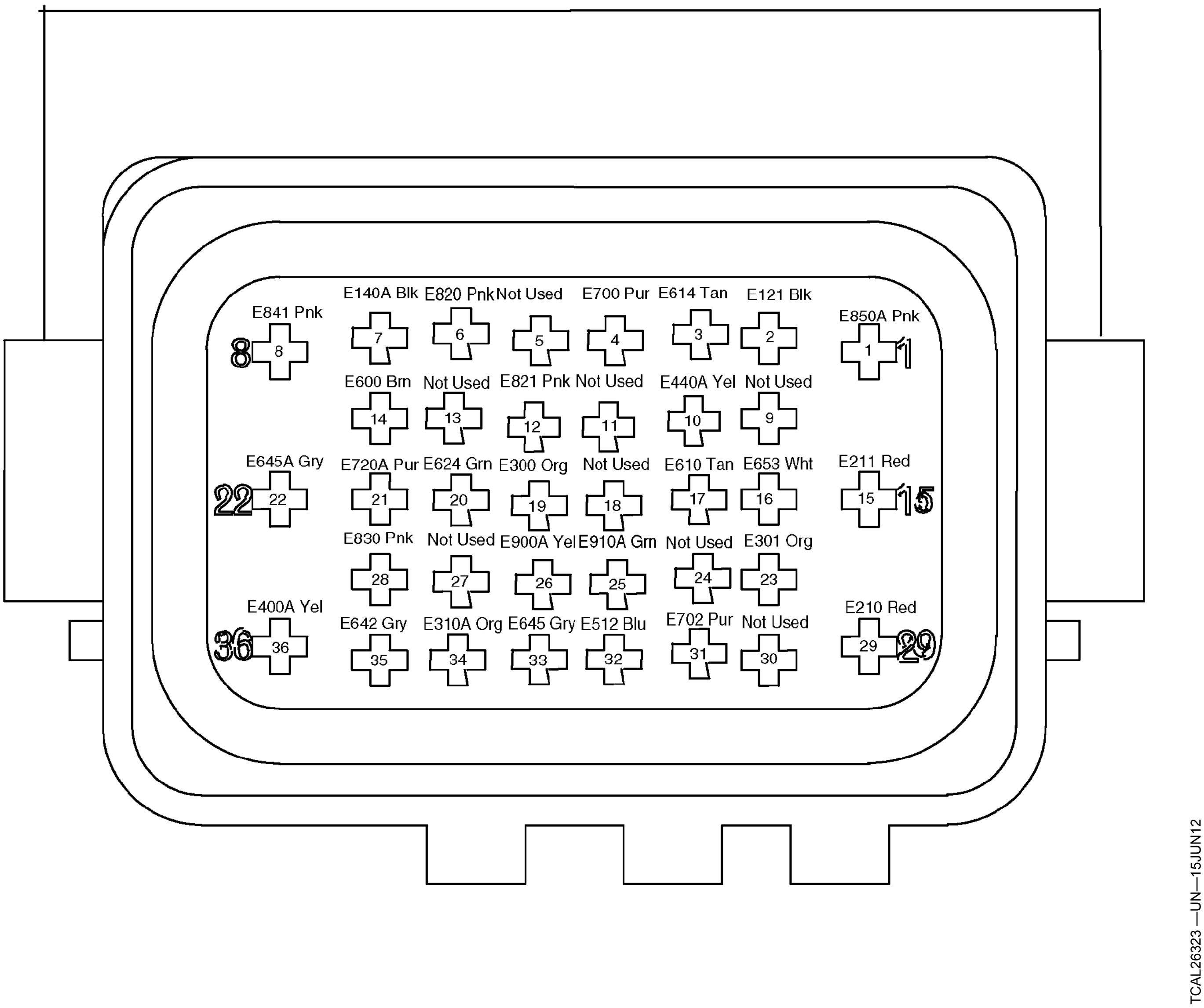
RB14256,0000999 -19-18JUN12-2/3



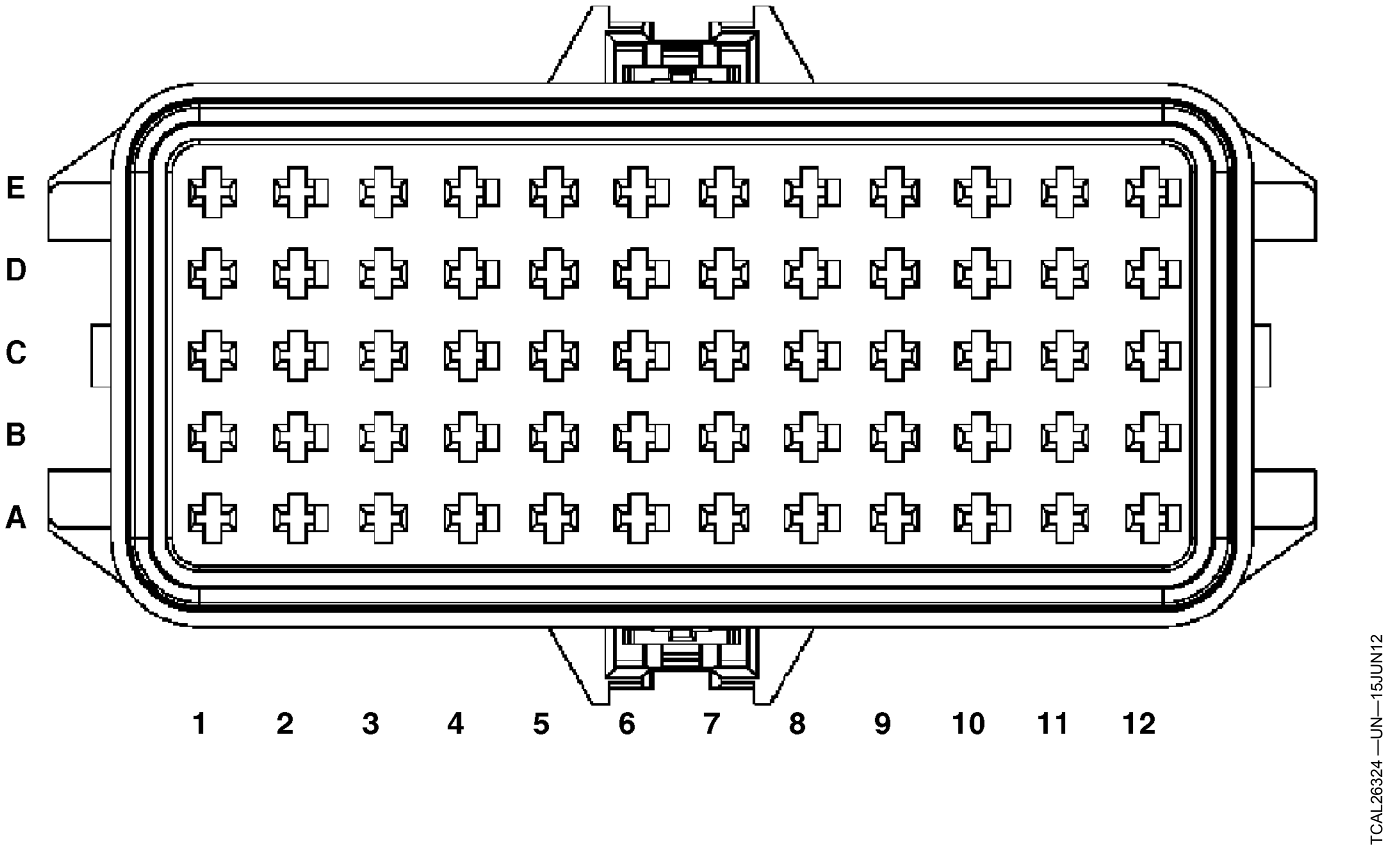
RB14256,0000999 -19-18JUN12-3/3

Engine/Vehicle Harness Interface Connector Pinout



RB14256,000099A -19-18JUN12-1/1

Engine Load Center Pinout



- A1 - E310B Org
- A2 - E645C Gry
- A3 - E401B Yel
- A4 - E400D Yel
- A5 - E802 Pnk
- A6 - E840A Pnk
- A7 - E410 Yel
- A8 - E221C Red
- A9 - E222D Red
- A10 - E841 Pnk
- A11 - E222E Red
- A12 - E211 Red
- B1 - E230 Red
- B2 - E222B Red
- B3 - E615 Tan
- B4 - E642 Gry
- B5 - E643 Gry
- B6 - E614 Tan
- B7 - E221B Red
- B8 - E223A Red
- B9 - E222c Red
- B10 - E210 Red
- B11 - Not Used
- B12 - Not Used
- C1~C12 - Not Used
- D1 - E655 Wht
- D2 - Not Used
- D3 - E644 Gry
- D4 - Not Used
- D5 - E400E Yel
- D6 - E400C Yel
- D7 - E410 Yel
- D8 - E401C Yel
- D9 - E802 Pnk
- D10 - E223B Red
- D11 - Not Used
- D12 - Not Used
- E1 - E700 Pur
- E2 - Not Used
- E3 - E230 Red
- E4 - Not Used
- E5 - E623 Grn
- E6 - E830 Pnk
- E7 - E613 Tan
- E8 - E425 Yel
- E9 - E651 Wht
- E10 - E221D Red
- E11 - Not Used
- E12 - Not Used

RB14256,000099B -19-18JUN14-1/1

Engine Wiring Harness Wire Color Codes

Size/No./Color	Wire Connection Points
5.0 E110A Blk	S-ENG5, ET-9
0.8 E110B Blk	S-ENG5, ET-5
1.0 E110D Blk	S-ENG5, EC3 (81)
1.0 E110E Blk	S-ENG5, EC3 (69)
1.0 E110F Blk	S-ENG5, EC3 (4)
0.8 E121 Blk	EC3 (86), EC1 (2)
0.8 E140A Blk	S-ENG9, EC1 (7)
0.8 E140B Blk	S-ENG9, EC3 (20)
0.8 E140C Blk	S-ENG9, EC11 (1)
0.8 E140D Blk	S-ENG9, EC12 (B)
0.8 E140E Blk	S-ENG9, EC13 (D)
0.8 E140F Blk	S-ENG9, EC4 (2)
0.8 E140G Blk	S-ENG9, EC9 (A)
2.0 E210 Red	EC1 (29), EC2 (B10)
2.0 E211 Red	EC1 (15), EC2 (A12)
8.0 E221A Red	S-ENG3, ET-6
2.0 E221B Red	S-ENG3, EC2 (B7)
0.8 E221C Red	S-ENG3, EC2 (E8)
1.0 E221D Red	S-ENG3, EC2 (E10)
3.0 E221E Red	S-ENG3, EC16 (A)
8.0 E222A Red	S-ENG4, ET-6
2.0 E222B Red	S-ENG4, EC2 (B2)
2.0 E222C Red	S-ENG4, EC2 (B9)
2.0 E222D Red	S-ENG4, EC2 (A9)
2.0 E222E Red	S-ENG4, EC2 (A11)
2.0 E223A Red	S-ENG6, EC2 (B8)
0.8 E223B Red	S-ENG6, EC2 (B10)
1.0 E223C Red	S-ENG6, EC3 (79)
1.0 E223D Red	S-ENG6, EC3 (60)
8.0 E225 Red	ET-7, ET-8
0.8 E300 Org	EC1 (19), EC3 (87)
0.8 E301 Org	EC1 (23), EC3 (84)
0.8 E310A Org	S-ENG14, EC1 (34)
0.8 E310B Org	S-ENG14, EC2 (A1)
0.8 E310C Org	S-ENG14, EC3 (49)
0.8 E320 Org	EC3 (56), EC11 (4)
0.8 E330 Org	EC3 (1), EC10 (A)
0.8 E331 Org	EC3 (3), EC10 (C)
2.0 E400A Yel	S-ENG1, EC1 (36)
0.8 E400C Yel	S-ENG1, EC2 (D6)
0.8 E400D Yel	S-ENG1, EC2 (A4)
0.8 E400E Yel	S-ENG1, EC2 (D5)

Size/No./Color	Wire Connection Points
0.8 E401A Yel	S-ENG7, EC15 (2)
0.8 E401B Yel	S-ENG7, EC2 (A3)
0.8 E401C Yel	S-ENG7, EC2 (D8)
0.8 E401D Yel	S-ENG7, EC3 (44)
0.8 E425 Yel	EC2 (A8), ET-3
0.8 E440A Yel	S-ENG10, EC1 (10)
0.8 E440B Yel	S-ENG10, EC11 (2)
0.8 E440C Yel	S-ENG10, EC13 (B)
0.8 E440D Yel	S-ENG10, EC4 (3)
0.8 E440F Yel	S-ENG10, EC3 (19)
0.8 E510 Blu	EC3 (35), ET-4
0.8 E511 Blu	EC3 (48), EC4 (5)
0.8 E512 Blu	EC3 (34), EC1 (32)
0.8 E600 Brn	EC3 (90), EC1 (14)
1.0 E601 Brn	EC3 (64), EC5 (2)
1.0 E602 Brn	EC3 (67), EC6 (2)
1.0 E603 Brn	EC3 (65), EC7 (2)
1.0 E604 Brn	EC3 (66), EC8 (2)
0.8 E610 Tan	EC3 (85), EC1 (17)
0.8 E611 Tan	EC3 (37), EC12 (A)
0.8 E612 Tan	EC3 (82), EC4 (1)
0.8 E613 Tan	EC3 (78), EC2 (E7)
0.8 E614 Tan	EC2 (B6), EC1 (3)
0.8 E615 Tan	EC3 (39), EC2 (B3)
0.8 E621 Grn	EC3 (23), EC13 (A)
0.8 E622 Grn	EC3 (21), EC9 (B)
0.8 E623 Grn	EC3 (74), EC2 (E5)
0.8 E624 Grn	EC3 (46), EC1 (20)
0.8 E625 Grn	EC3 (55), EC11 (3)
0.8 E640 Gry	EC3 (36), EC13 (C)
0.8 E641 Gry	EC3 (47), EC4 (6)
0.8 E642 Gry	EC2 (B4), EC1 (35)
0.8 E643 Gry	EC3 (40), EC2 (B5)
0.8 E644 Gry	EC3 (72), EC2 (D3)
1.0 E645A Gry	S-ENG2, EC1 (22)
0.8 E645B Gry	S-ENG2, EC3 (50)
0.8 E645C Gry	S-ENG2, EC2 (A2)
0.8 E650 Wht	EC3 (26), EC14 (B)
0.8 E651 Wht	EC3 (73), EC2 (E9)
0.8 E652 Wht	EC3 (62), EC9 (D)
0.8 E653 Wht	EC3 (42), EC1 (16)
1.0 E655 Wht	EC2 (D1), ET-1
0.8 E700 Pur	EC2 (E1), EC-1 (4)
0.8 E702 Pur	EC3 (41), EC1 (31)
0.8 E720A Pur	S-ENG13, EC1 (21)
0.8 E720B Pur	S-ENG13, EC3 (43)
0.8 E720C Pur	S-ENG13, EC3 (68)
0.8 E750 Pur	EC3 (25), EC14 (A)

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RB14256,000099C -19-18JUN14-1/3

Size/No./Color	Wire Connection Points
0.8 E801 Pnk	EC3 (80), EC4 (4)
0.8 E820 Pnk	EC3 (53), EC1 (6)
0.8 E821 Pnk	EC3 (54), EC1 (12)
0.8 E830 Pnk	EC2 (E6), EC1 (28)
1.0 E840A Pnk	S-ENG8, EC2 (A6)
1.0 E840B Pnk	S-ENG8, EC5 (1)
1.0 E840C Pnk	S-ENG8, EC6 (1)
1.0 E840D Pnk	S-ENG8, EC7 (1)
1.0 E840E Pnk	S-ENG8, EC8 (1)
0.8 E840F Pnk	S-ENG8, EC9 (C)
1.0 E840G Pnk	S-ENG8, EC10 (B)
2.0 E841 Pnk	EC2 (A10), EC1 (8)
2.0 E850A Pnk	S-ENG15, EC1 (1)
3.0 E850B Pnk	S-ENG15, EC16 (B)
0.8 E900A Yel	S-ENG11, EC1 (26)
0.8 E900B Yel	S-ENG11, EC11 (7)
0.8 E900C Yel	S-ENG11, EC3 (14)
0.8 E910A Grn	S-ENG12, EC1 (25)
0.8 E910B Grn	S-ENG12, EC11 (8)
0.8 E910C Grn	S-ENG12, EC3 (15)

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RB14256,000099C -19-18JUN14-2/3

Engine Wiring Harness Splice Table

Splice No.	Circuit
S-ENG1	E400C Yel
	E400D Yel
	E400E Yel
	E400A Yel
S-ENG10	E440D Yel
	E440A Yel
	E440C Yel
	E440B Yel
	E440F Yel
S-ENG11	E900B Yel
	E900C Yel
	E900A Yel
S-ENG12	E910B Grn
	E910C Grn
	E910A Grn
S-ENG13	E720B Pur
	E720C Pur
	E720A Pur
S-ENG14	E310B Org
	E310C Org
	E310A Org
S-ENG15	E850B Pnk
	E850A Pnk
S-ENG2	E645A Gry
	E645C Gry
	E645D Gry
	E645B Gry
S-ENG3	E221A Red
	E221E Red
	E221B Red
	E221D Red
	E221C Red
S-ENG4	E222A Red
	E222B Red
	E222C Red
	E222D Red
	E222E Red
S-ENG5	E110A Blk
	E110D Blk
	E110E Blk
	E110F Blk
	E110B Blk
S-ENG6	E223B Red
	E223C Red
	E223A Red
	E223D Red

Splice No.	Circuit
S-ENG7	E401B Yel
	E401C Yel
	E401A Yel
	E401D Yel
S-ENG8	E840A Pnk
	E840G Pnk
	E840F Pnk
	E840B Pnk
	E840C Pnk
	E840D Pnk
	E840E Pnk
S-ENG9	E140E Blk
	E140F Blk
	E140G Blk
	E140A Blk
	E140B Blk
	E140C Blk
	E140D Blk

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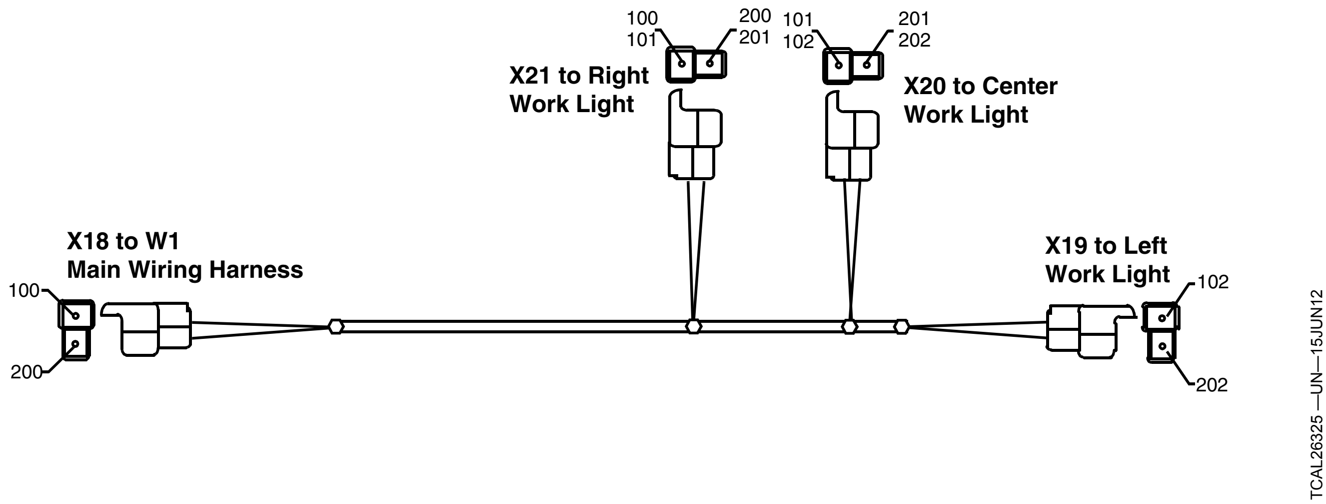
RB14256,000099D -19-18JUN14-1/2

W3 Work Light Wiring Harness



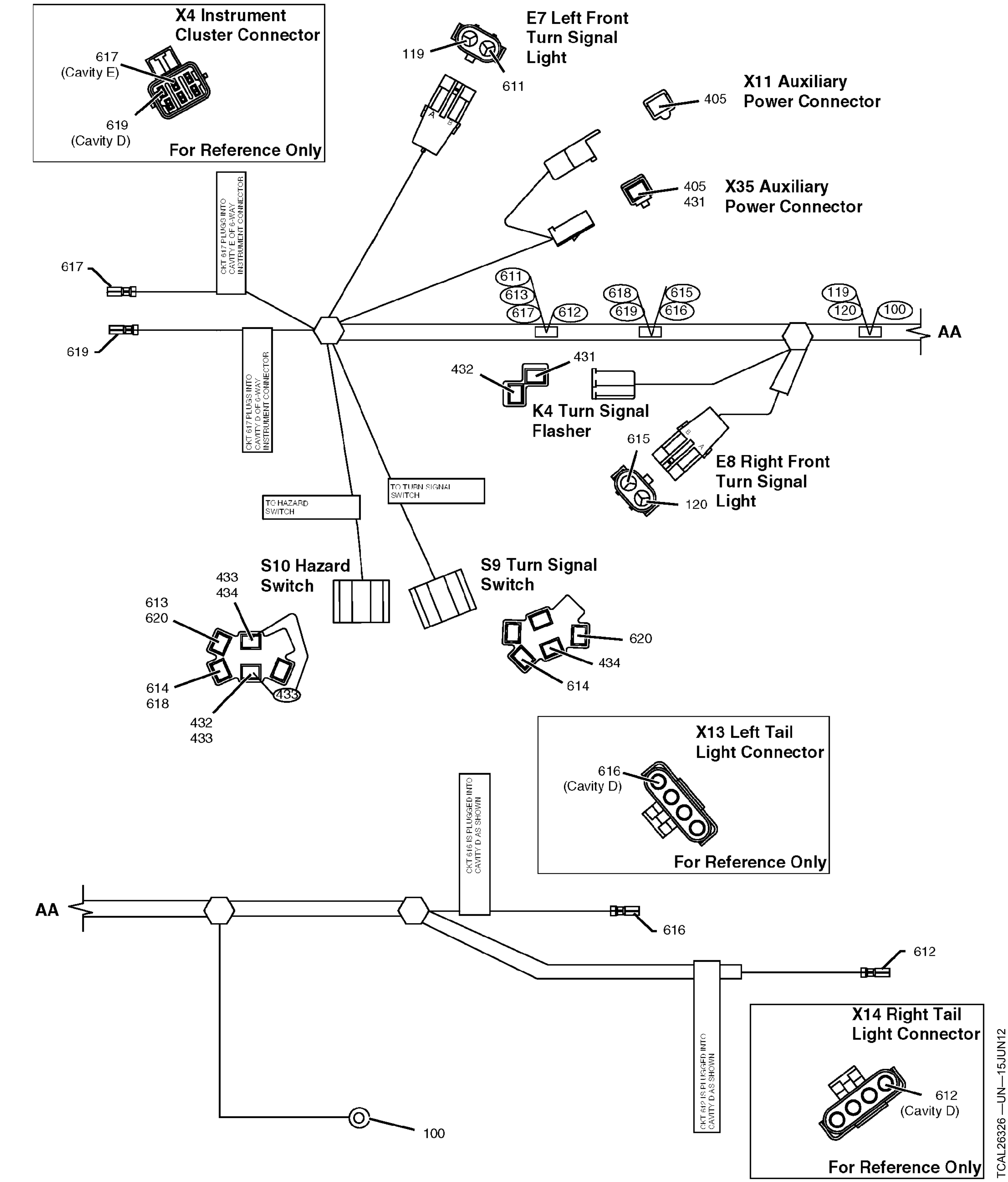
RB14256,000099E -19-18JUN12-1/1

W3 Work Light Wiring Harness Wire Color Codes

Circuit Number	Wire Size	Color	Termination Points
100	1.0	Blk	W1, Splice
119	0.8	Blk	Splice, E7
120	0.8	Blk	Splice, E8
405	1.0	Yel	X11, X35
431	1.0	Yel	X35, K4
432	1.0	Yel	K4, S10

RB14256,000099F -19-18JUN12-1/1

W4 Optional Signal Light Wiring Harness



RB14256,00009A0 -19-18JUN12-1/1

W4 Optional Signal Light Wiring Harness Wire Color Codes

Circuit Number	Wire Size	Color	Termination Points
100	1.0	Blk	W1, Splice
119	0.8	Blk	Splice, E7
120	0.8	Blk	Splice, E8
405	1.0	Yel	X11, X35
431	1.0	Yel	X35, K4
432	1.0	Yel	K4, S10
433	1.0	Yel	S10, S10
434	0.8	Yel	S10, S9
611	0.8	Org	Splice, E7
612	0.8	Red	Splice, X14
613	0.8	Tan	S10, Splice
614	0.8	Grn	S10, S9
615	0.8	Tan	Splice, E8
616	0.8	Red	Splice, X13
617	0.8	Grn	Splice, X4
618	0.8	Tan	S10, Splice
619	0.8	Grn	Splice, X4
620	0.8	Tan	S10, S9

RB14256,00009A1 -19-18JUN12-1/1

Electrical Schematic and Wiring Harness Legend

Components

A1 - Instrument Cluster (SE5, W1)

A23 - Glow Plug Control Module (SE2, W1)

A34 - Off Seat Delay Module (SE4, W1)

B1 - Hydraulic Oil Over Temperature Switch (SE2, W1)

B3 - Fuel Tank Sender (SE5, W1)

B12 - Engine Coolant Temperature Sensor (SE2, W1)

B13 - Engine Oil Pressure Switch (SE2, W1)

B28 - Fan/Over Temperature Switch (SE2, W1)

E1 - Right Work Light (optional) (SE6, W1)

E2 - Center Work Light (optional) (SE6, W1)

E3 - Left Work Light (optional) (SE6, W1)

E4 - Left Front Turn Signal Light (optional) (W4)

E5 - Right Front Turn Signal Light (optional) (W4)

E6 - Left Rear Turn Signal Light (optional) (W4)

E7 - Right Rear Turn Signal Light (optional) (W4))

E9 - Left Headlight (SE6, W1)

E11 - Right Headlight (SE6, W1)

E12 - Left Rear Stop/Tail Light (optional) (W4)

E13 - Right Rear Stop/Tail Light (optional) (W4)

E24 - Right Stop/Tail Light (SE6, W1)

E25 - Left Stop/Tail Light (SE6, W1)

F1 - Fuse - 25 amp (SE1, W1)

F2 - Fuse - 10 amp (SE1, W1)

F3 - Fuse - 25 amp (SE1, W1)

F4 - Fuse - 80 amp (SE1, W1)

F5 - Fuse - 40 amp (SE1, W1)

G1 - Battery (SE1, W1)

G32 - Alternator (SE1, W1)

H5 - Horn (SE6, W1)

K1 - Start Relay (SE1, W1)

K2 - Glow Plug Relay (SE1, W1)

K3 - Fuel Shut-off (SE1, W1)

K4 - Seat Relay (SE1, W1)

K6 - Turn Signal Flasher (optional) (W4)

K20 - Radiator Fan Relay (SE2, W1)

M18 - Radiator Fan Motor (SE2, W1)

M33 - Fuel Pump (SE2, W1)

M36 - Starting Motor (SE1, W1)

S1 - Work Light Switch (option) (SE6, W1)

S2 - Horn Switch (SE6, W1)

S4 - Headlight Switch (SE6, W1)

S5 - Keyswitch (SE3, W1)

S9 - Turn Signal Switch (optional) (W4)

S10 - Hazard Switch (optional) (W4)

S13 - Brake Switch (SE3, W1)

S14 - PTO Switch (SE4, W1)

S15 - Park Brake Switch (SE4, W1)

S17 - Seat Switch (SE4, W1)

S21 - 4-Wheel Drive Switch (SE4, W1)

S27 - Neutral Switch (SE4, W1)

T3 - Auxiliary Speed Out Sensor (SE5, W1)

T26 - Speed Sensor - Transmission (SE5, W1)

V1 - Seat Diode (SE1, W1)

V37 - Fuel Shut-off Diode (SE2, W1)

W1 - Battery Frame Ground (SE1, W1)

Y30 - Fuel Shutoff Solenoid (SE2, W1)

Y36 - Starting Motor Solenoid (SE1, W1)

Connectors - W1 Main Harness

C1 - Work Lights Switch (Optional) (S1)

C2 - Horn Switch (S2)

C3 - Auxiliary Speed Out Sensor (T3) (Optional)

C4 - Headlight Switch (S4)

C5 - Key Switch (S5)

C6 - Instrument Cluster - J3 (A1)

C7 - Instrument Cluster - J2 (A1)

C8 - Instrument Cluster - J1 (A1)

C9 - Left Headlight (E9)

C10 - Front Auxiliary Power

C11 - Right Headlight (E11)

C12 - W1 Main Wiring Harness to W3 Work Lights Wiring Harness (Optional)

C13 - Brake Switch (S13)

C14 - PTO Switch (S14)

Continued on next page RB14256,00009A2 -19-18JUN12-1/2

C15 - Park Brake Switch (S15)

C16 - 40 Amp Fan Fuse (F16)

C17 - Seat Switch (S17)

C18 - Fan (M18)

C20 - Fan Relay (K20)

C21 - 4WD Switch (S21)

C22 - 4WD Switch (S21)

C23 - Glow Plug Control Module (R1, R2, R3)

C24 - Right Stop/Tail Light (E24)

C25 - Left Stop/Tail Light (E25)

C26 - Speed Sensor (T26)

C27 - Neutral Switch (S27)

C28 - Fan/Over Temperature Switch (B28)

C29 - Rear Auxiliary Power

C30 - Fuel Shut-off Solenoid (Y30)

C31 - W1 Main Wiring Harness to W2 Glow Plug Wiring Harness

C32 - Alternator (G32)

C33 - Fuel Pump (M33)

C34 - Off Seat Delay Module (A34)

C35 - Load Center (K1, K2, K3, K4, F1, F2, F3, V1)

C36 - Starter Solenoid (Y36)

C37 - 6 Amp Diode (V37)

T-1 - Hydraulic Oil Over Temperature Switch (B1)

T-2 - Hydraulic Oil Over Temperature Switch (B1)

T-3 - Fuel Tank Sender (B3)

T-4 - Fuel Tank Sender (B3)

T-5 - Horn (H5)

T-6 - Horn (H5)

T-7 - Frame Ground (W1)

T-8 - 80 Amp Bussman Fuse (F4)

T-9 - 80 Amp Bussman Fuse (F4)

T-11 - Alternator B+ (G32)

T-12 - Coolant Temperature Sender (Gauge) (B12)

T-13 - Oil Pressure Switch (B13)

Connectors - W3 Optional Work Lights Harness

NOTE: This is the same harness as used on prior model years.

WLC1 - To W1 Main Wiring Harness

WLC2 - Right Work Light (E1)

WLC3 - Center Work Light (E2)

WLC4 - Left Work Light (E3)

Connectors - W4 Optional Signal Lights Harness

NOTE: This is the same harness as used on prior model years.

SLC1 - To W1 Main Wiring Harness

SLC2 - Auxiliary Power

SLC4 - Left Front Turn Signal Light (E4)

SLC5 - Right Front Turn Signal Light (E5)

SLC6 - Flasher Relay (K6)

SLC9 - Turn Signal Switch (S9)

SLC10 - Hazard Switch (S10)

SLT-1 - To W1 Main Wiring Harness (C7)

SLT-2 - To W1 Main Wiring Harness (C7)

SLT-5 - Ground

SLT-6 - To W1 Main Wiring Harness (C25)

SLT-7 - To W1 Main Wiring Harness (C24)

Wiring Harnesses

W1 - Main Wiring Harness

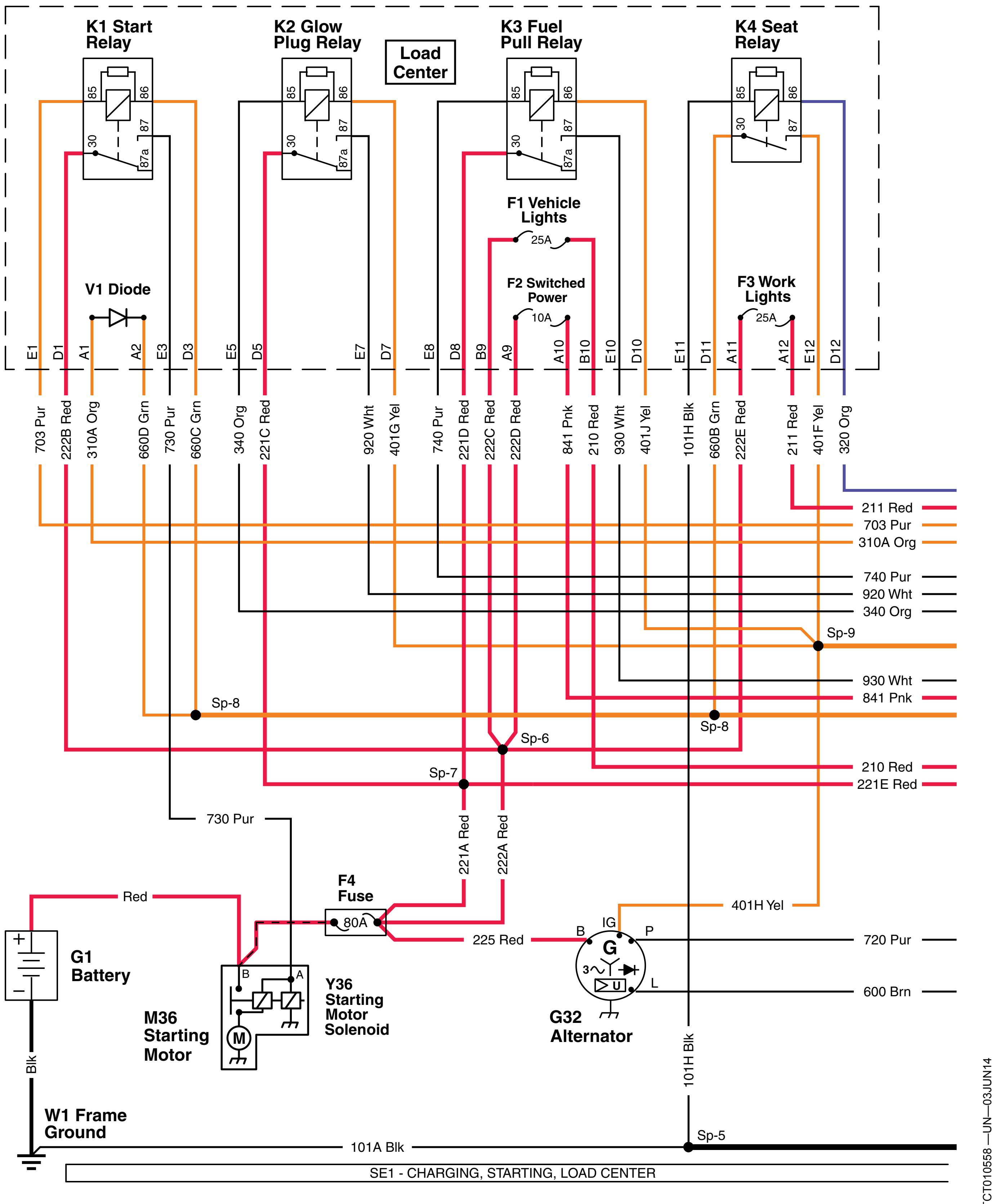
W2 - Glow Plug Wiring Harness

W3 - Optional Work Lights Wiring Harness

W4 - Optional Signal Light Wiring Harness

RB14256,00009A2 -19-18JUN12-2/2

W1 Main Wiring Harness Schematic (S.N. -080000)



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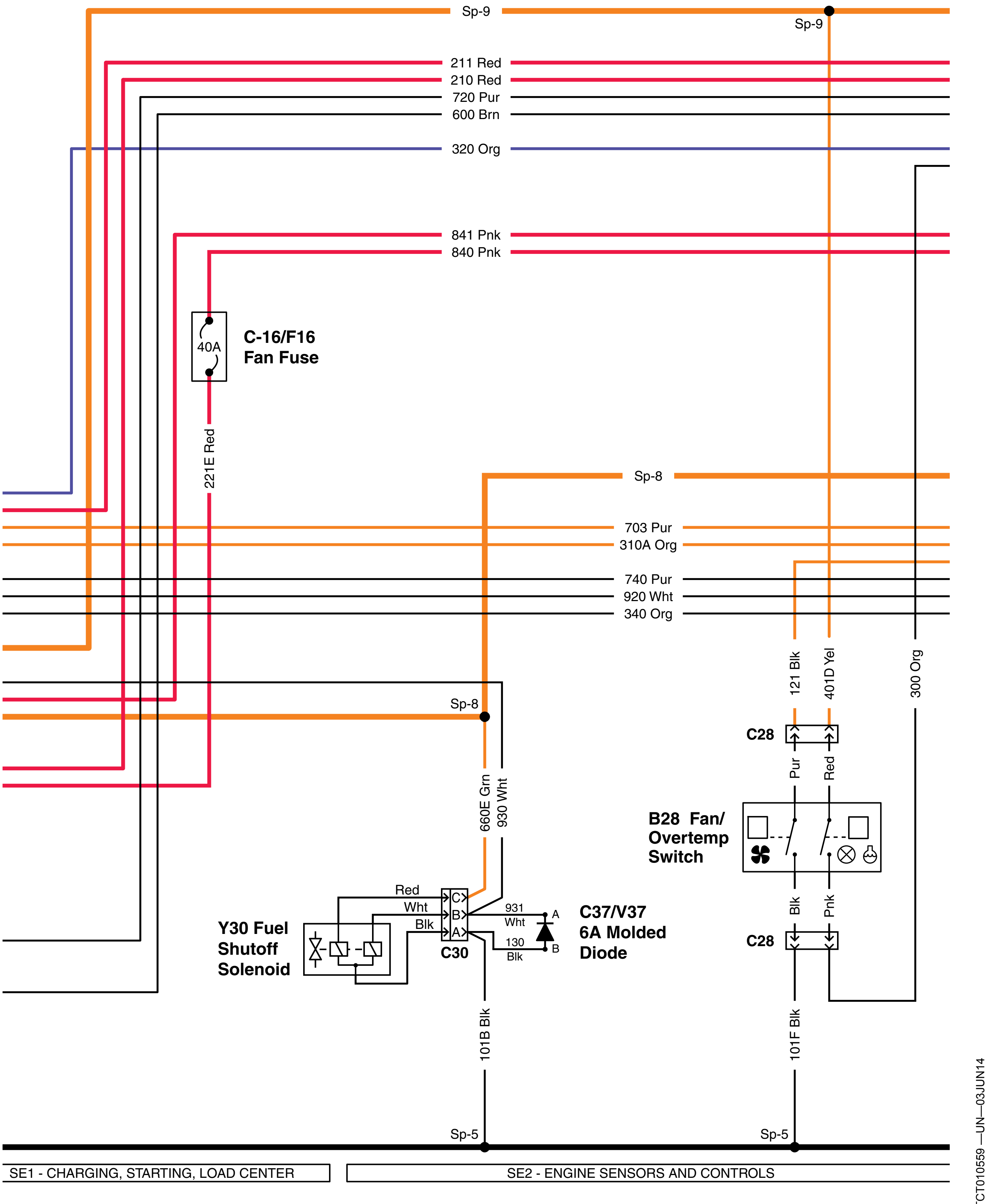
RB14256,00009A3 -19-18AUG14-1/8

Main Schematic Diesel S.N. -080000 (2 of 8)



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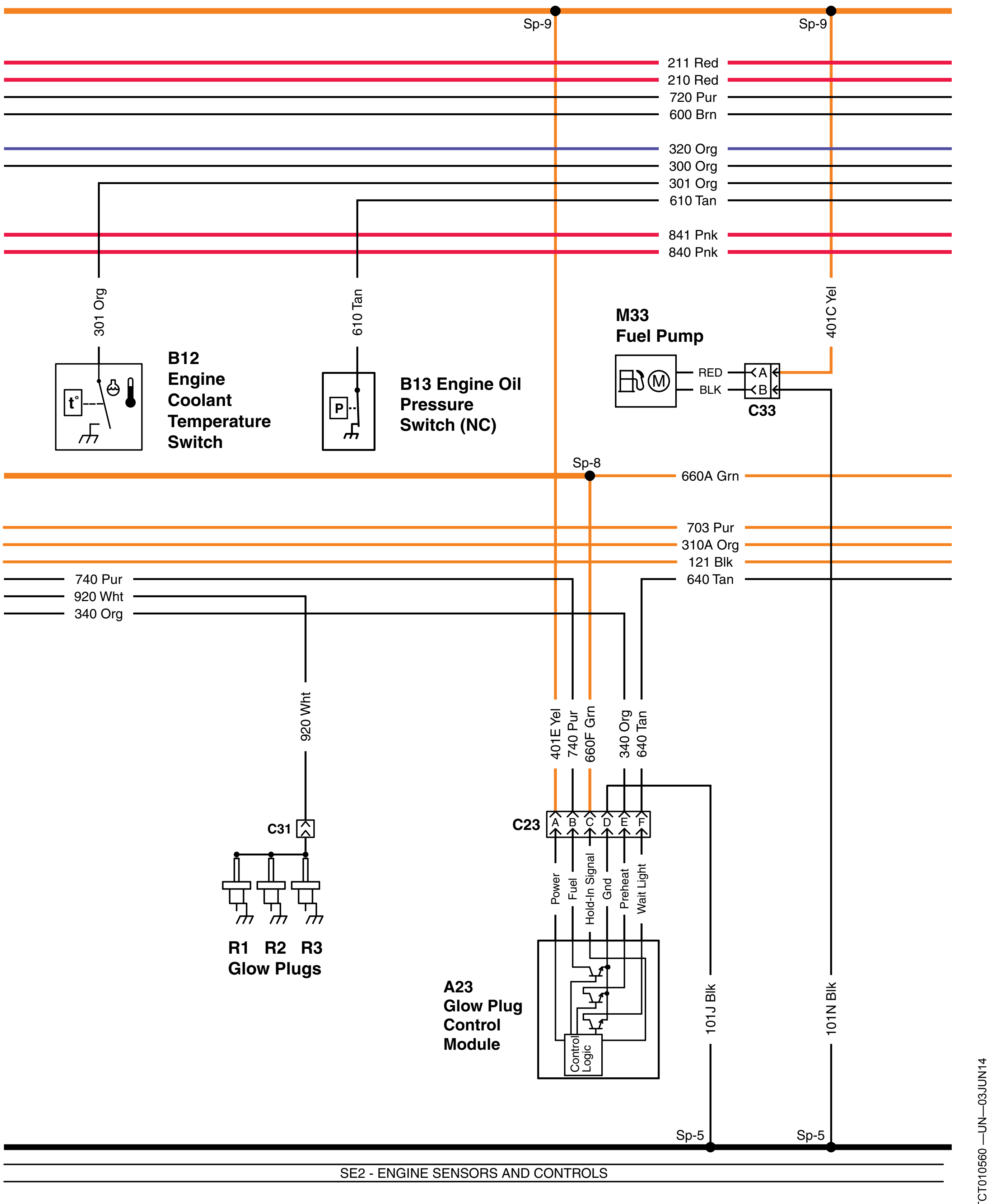
RB14256,00009A3 -19-18AUG14-2/8

Main Schematic Diesel S.N. -080000 (3 of 8)



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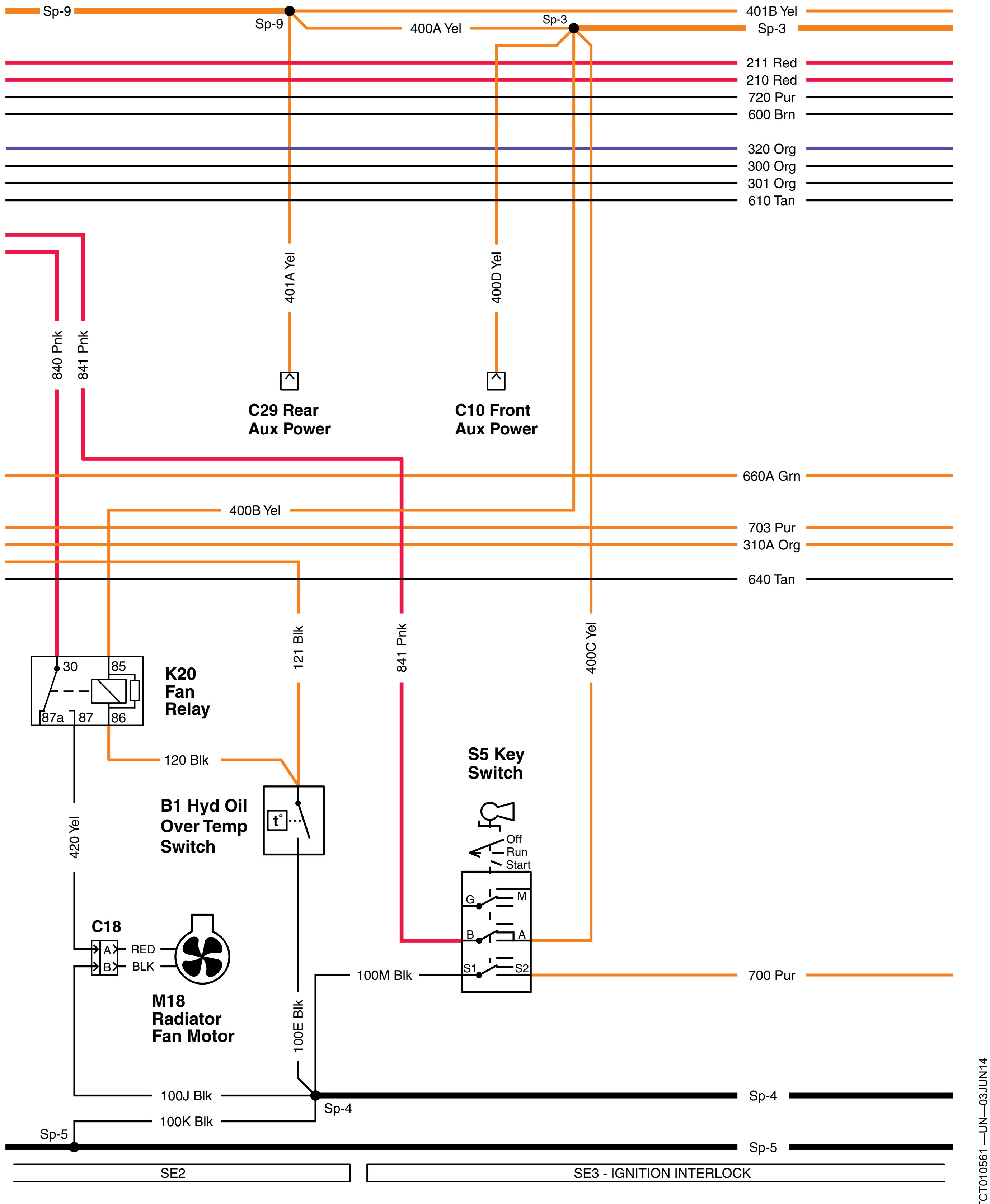
RB14256,00009A3 -19-18AUG14-3/8

Main Schematic Diesel S.N. -080000 (4 of 8)



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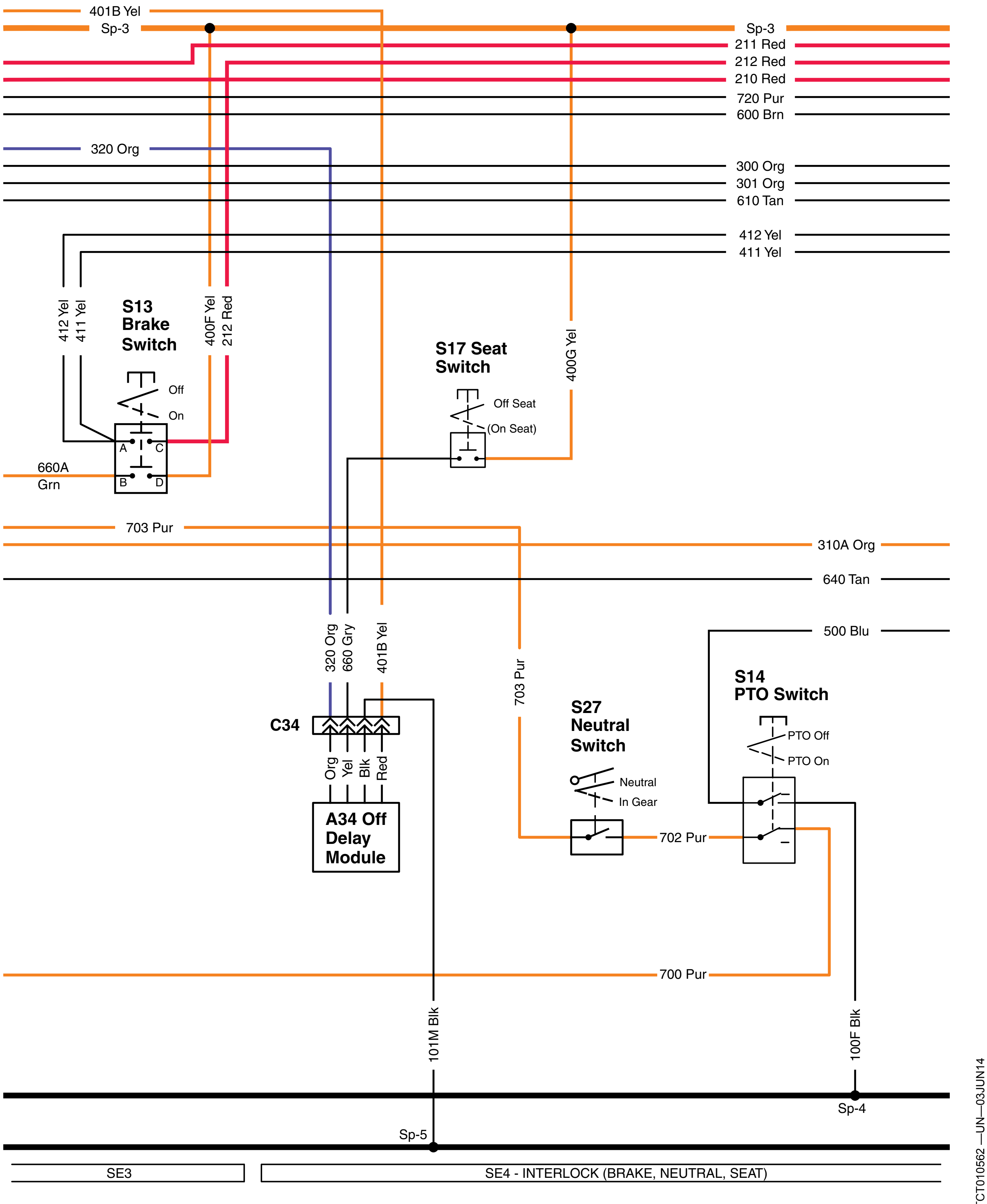
RB14256,00009A3 -19-18AUG14-4/8

Main Schematic Diesel S.N. -080000 (5 of 8)



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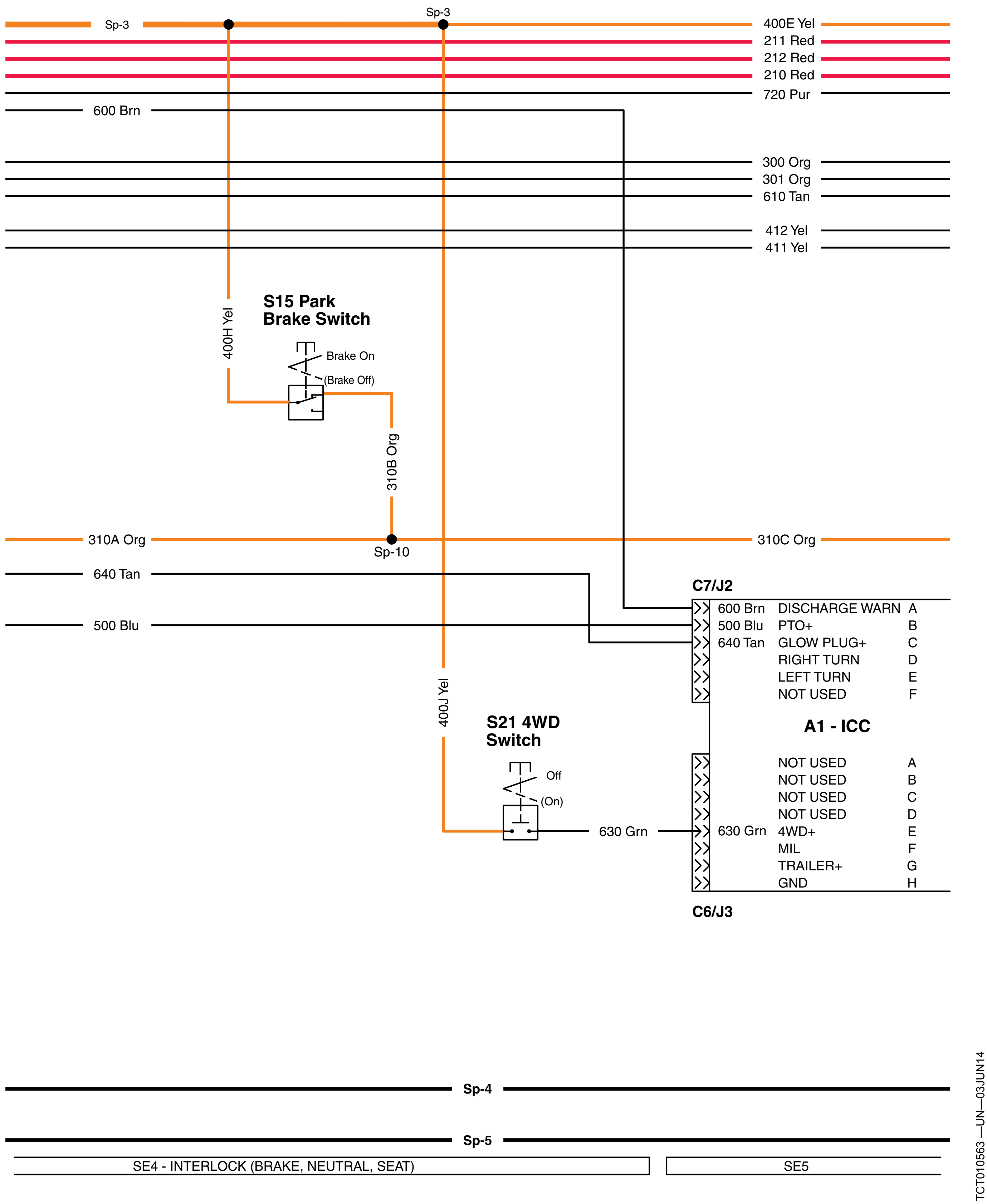
RB14256,00009A3 -19-18AUG14-5/8

Main Schematic Diesel S.N. -080000 (6 of 8)



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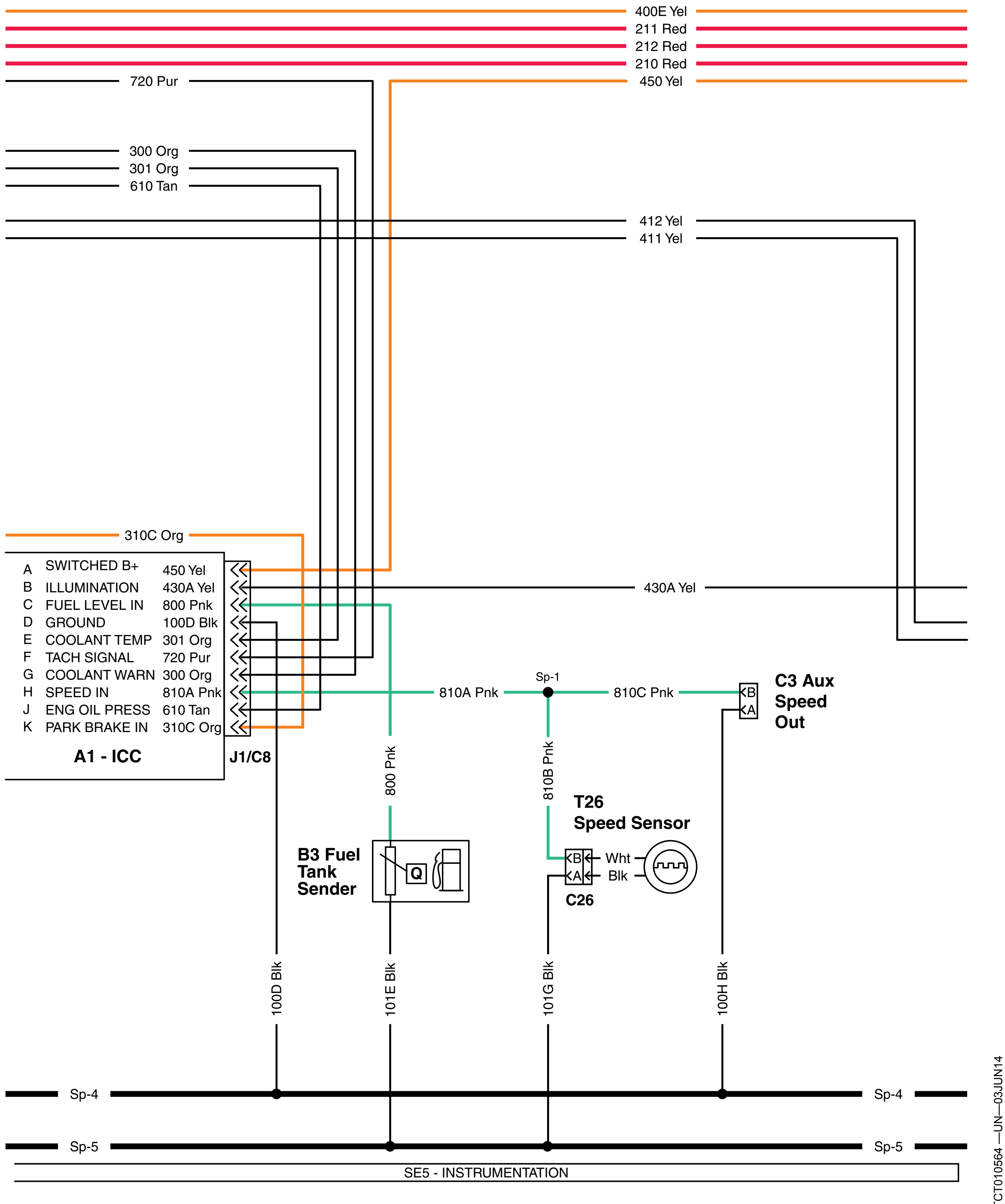
RB14256,00009A3 -19-18AUG14-6/8

Main Schematic Diesel S.N. -080000 (7 of 8)



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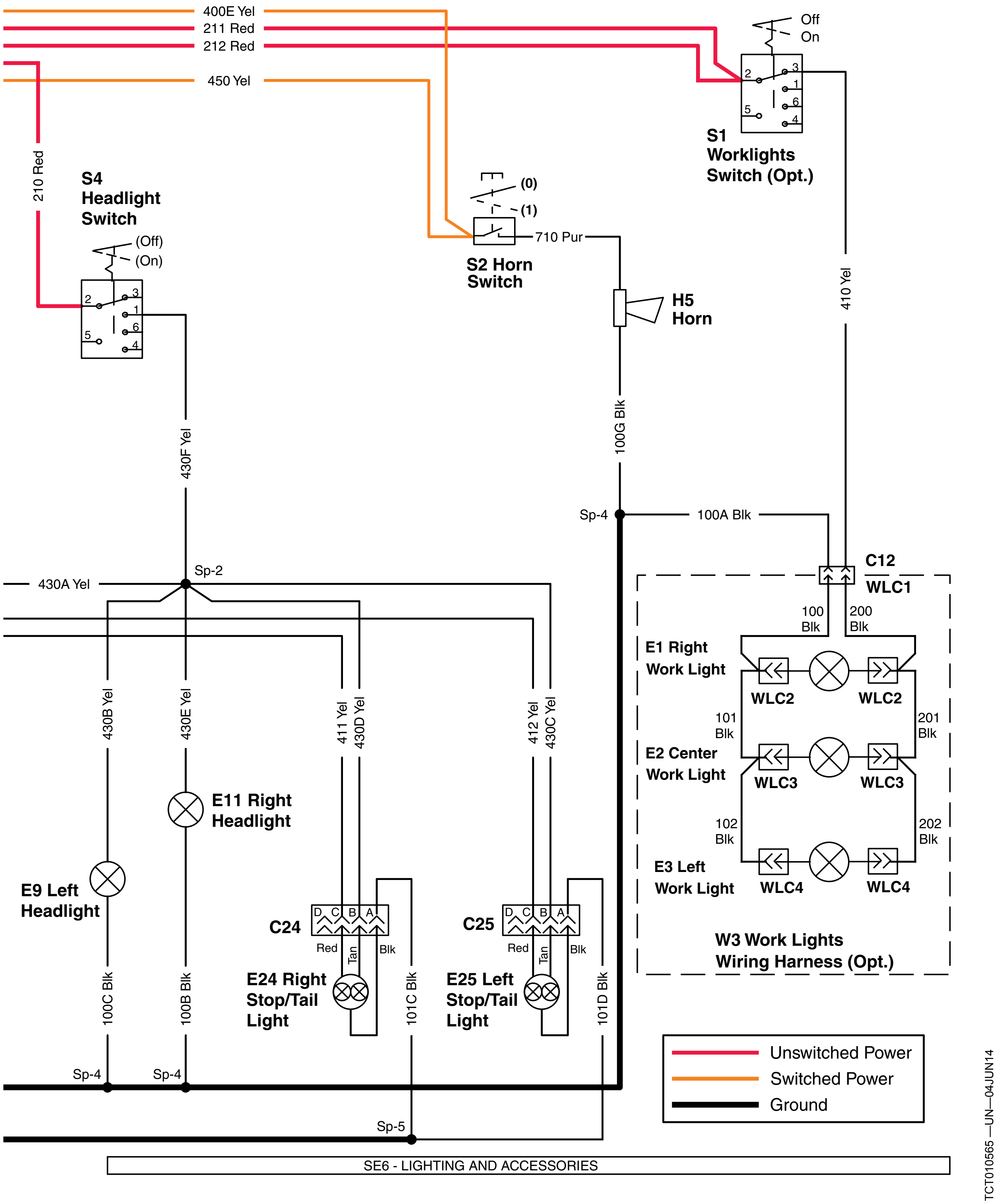
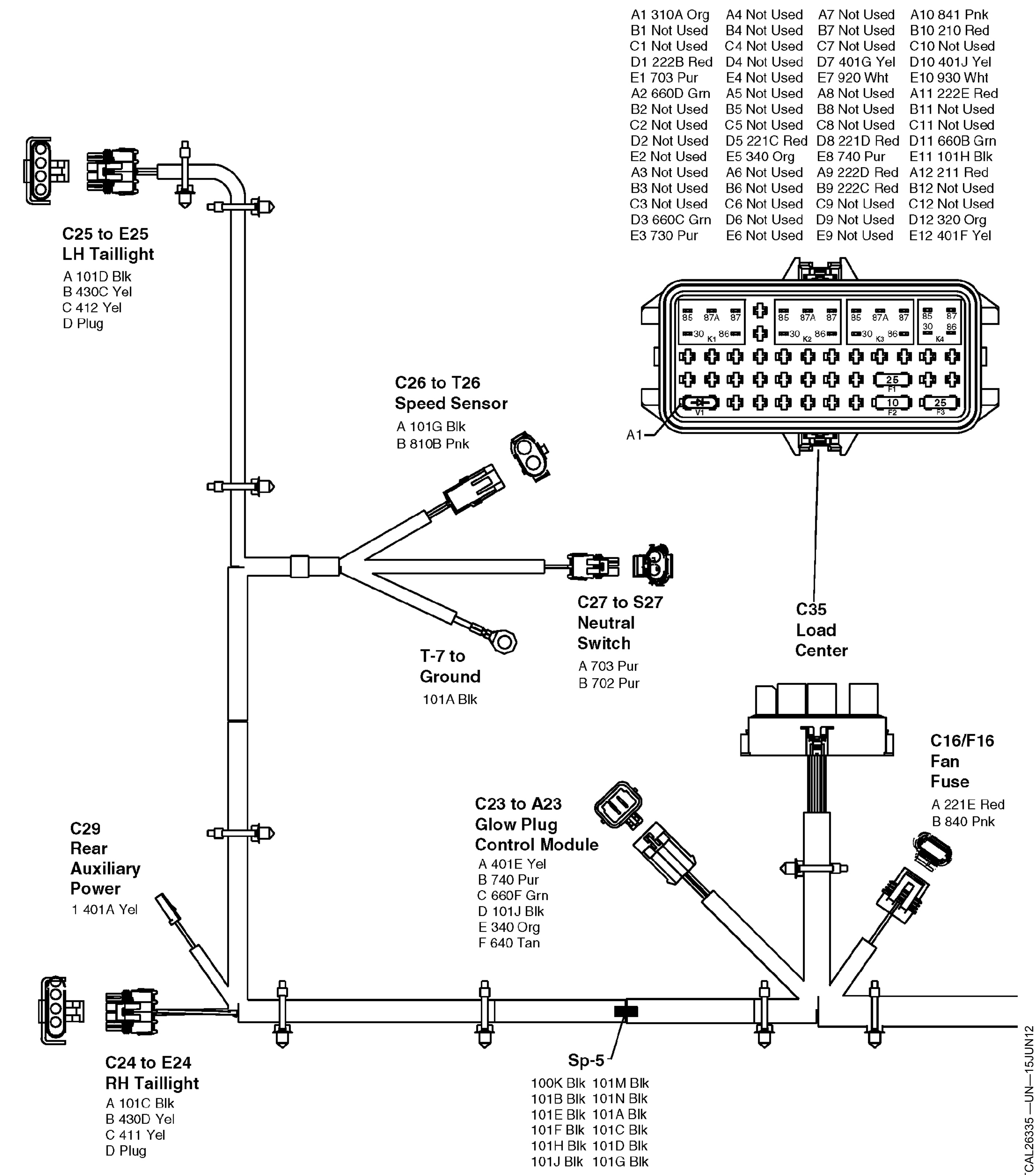
RB14256,00009A3 -19-18AUG14-7/8

Main Schematic Diesel S.N. -080000 (8 of 8)



RB14256,00009A3 -19-18AUG14-8/8

W1 Main Wiring Harness (S.N. -080000)



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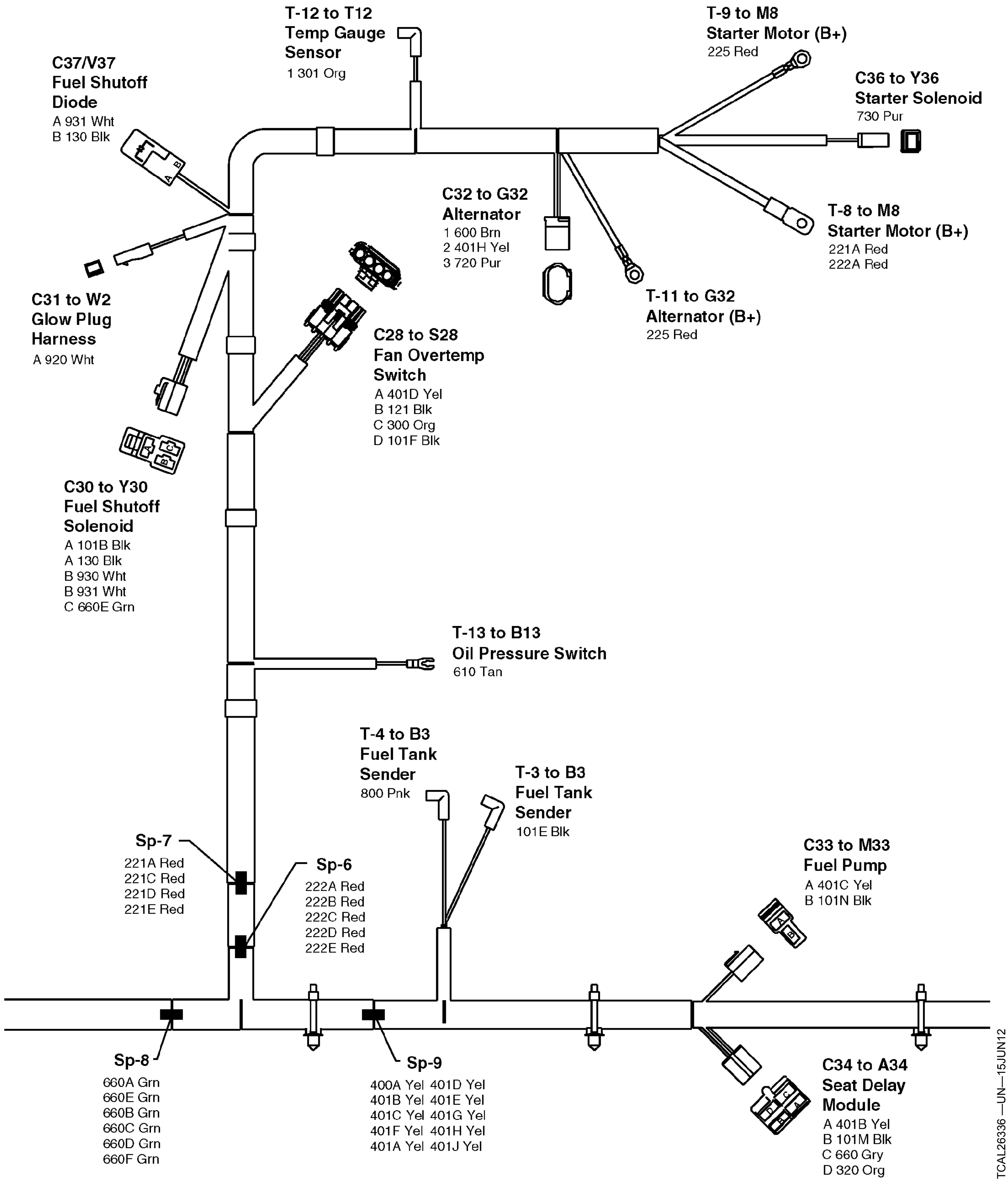
RB14256,00009A4 -19-18AUG14-1/5

Main Wiring Harness (S.N. -080000) (2 of 5)



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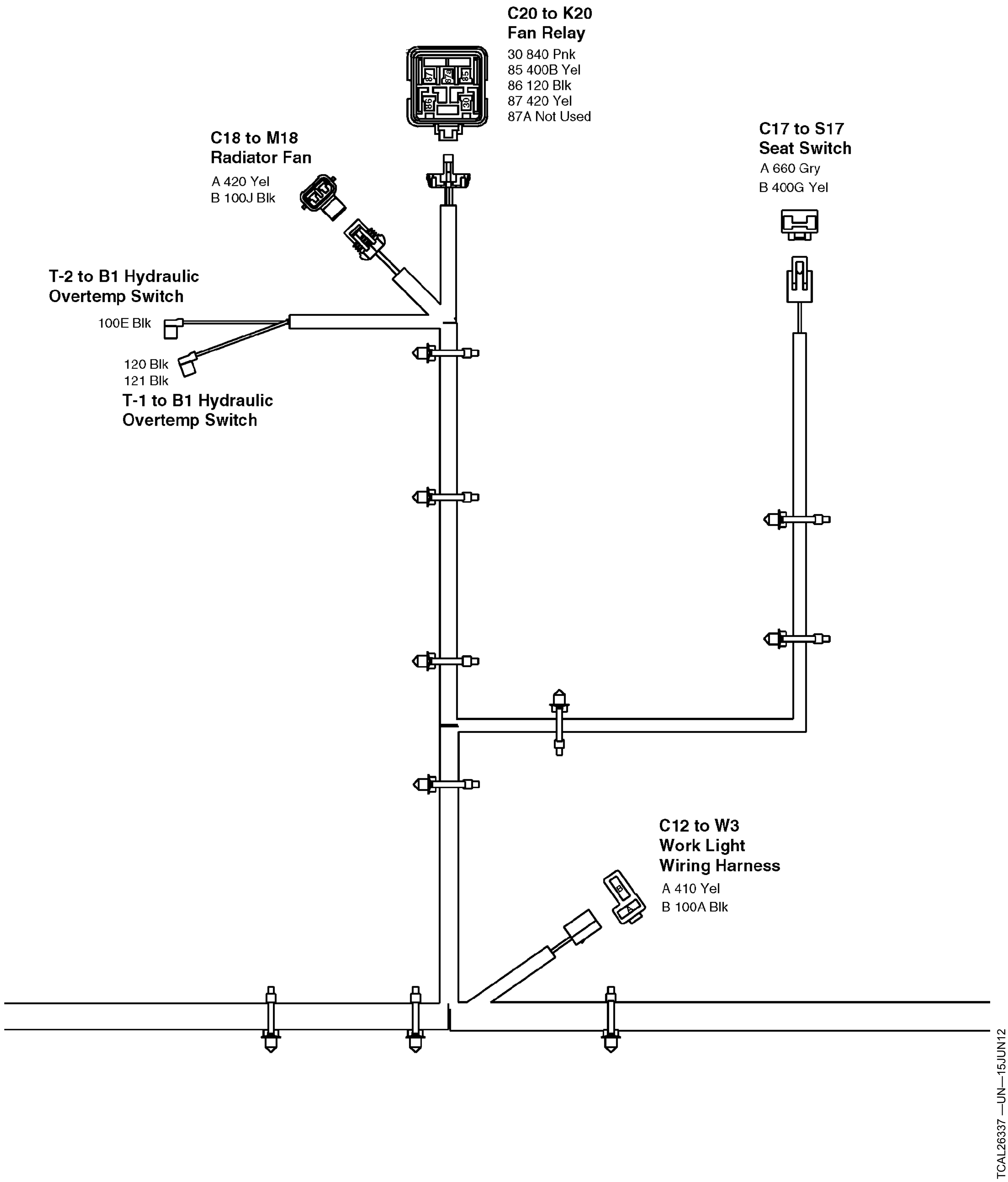
RB14256,00009A4 -19-18AUG14-2/5

Main Wiring Harness (S.N. -080000) (3 of 5)



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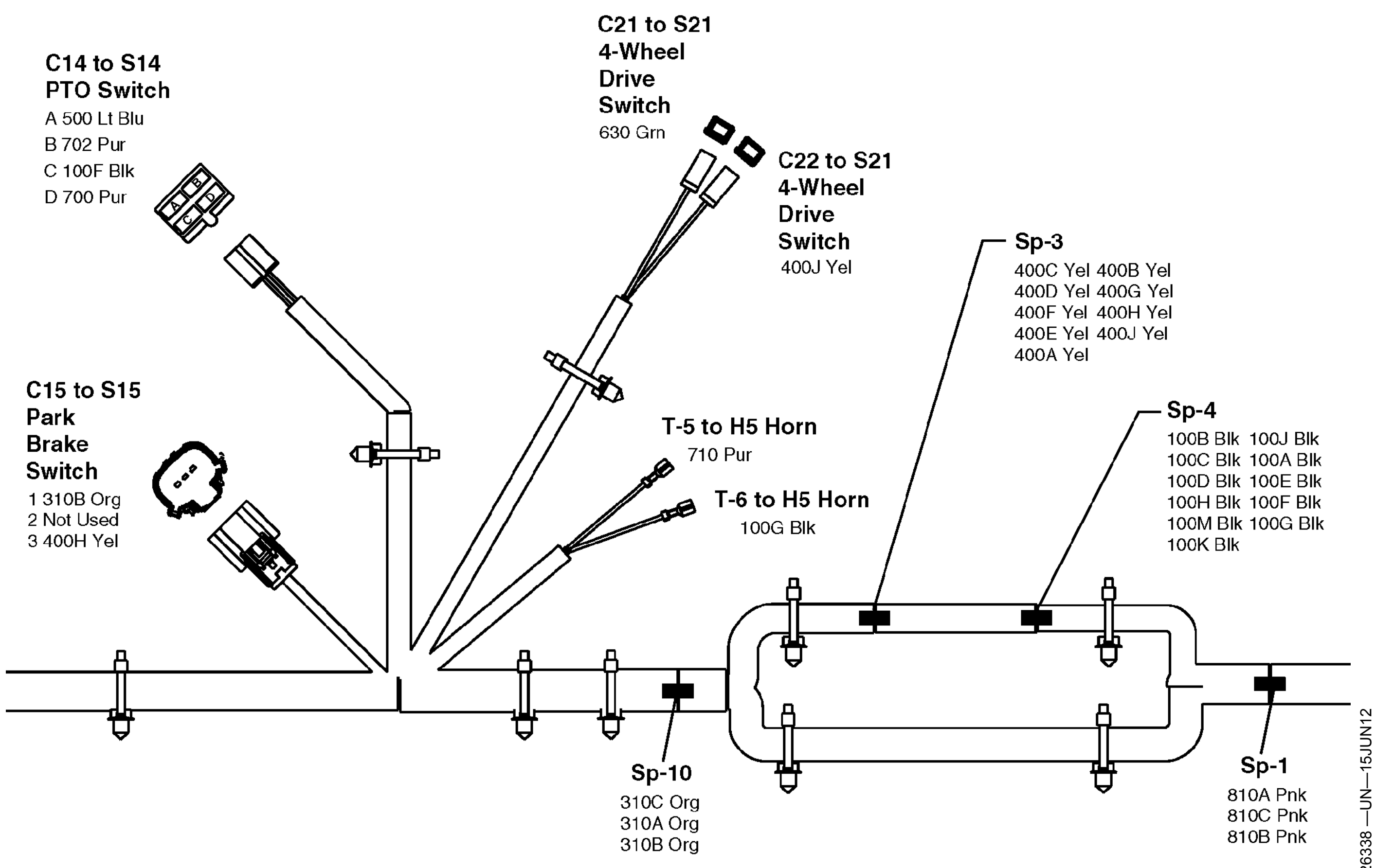
RB14256,00009A4 -19-18AUG14-3/5

Main Wiring Harness (S.N. -080000) (4 of 5)



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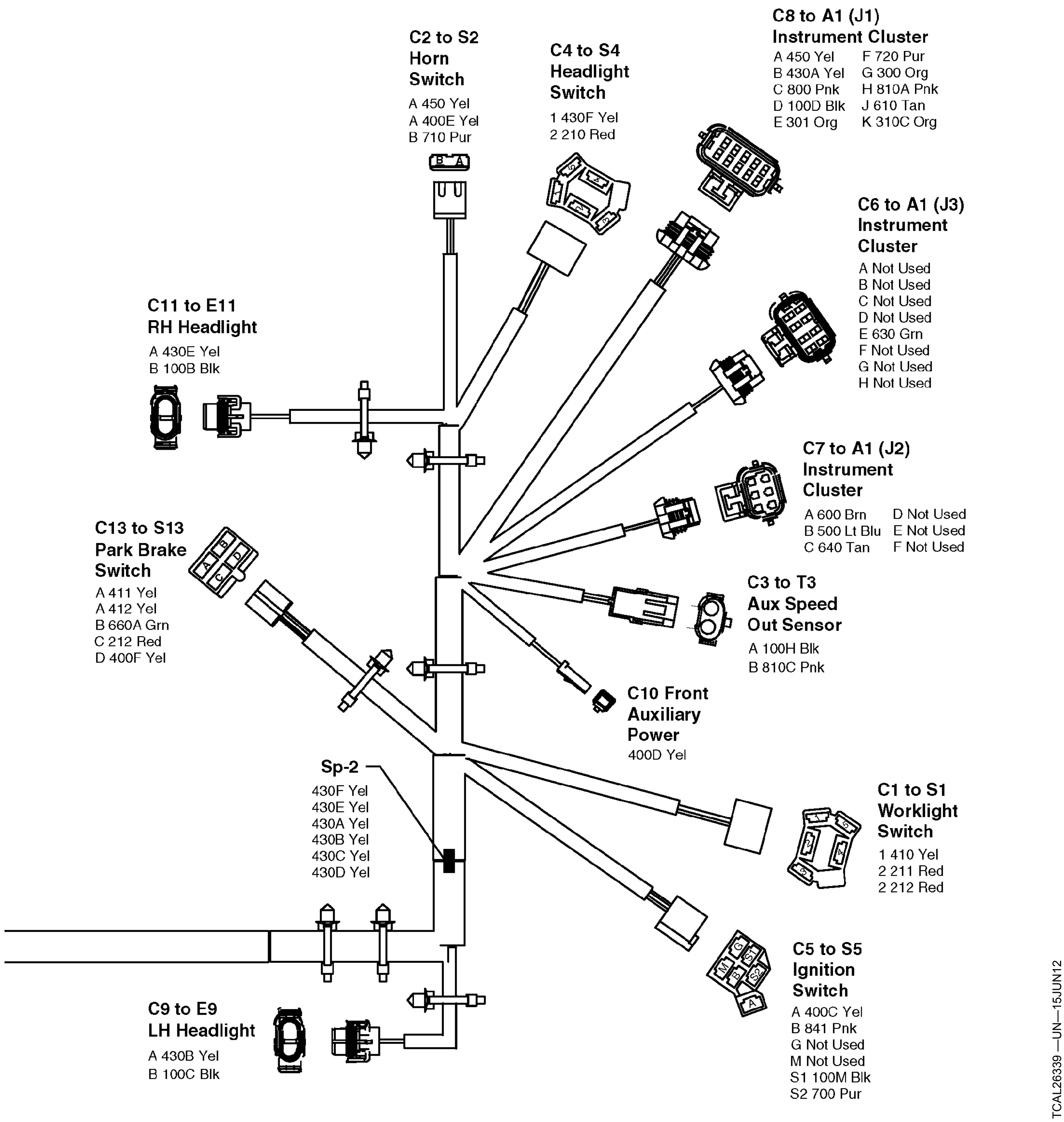
RB14256,00009A4 -19-18AUG14-4/5

Main Wiring Harness (S.N. -080000) (5 of 5)



RB14256,00009A4 -19-18AUG14-5/5

Main Wiring Harness Wire Color Codes (S.N. -080000)

Circuit Number	Wire Size	Color	Termination Points
120	0.8	Blk	C20 (K20), T-1 (B1)
121	0.8	Blk	C28 (B28), T-1 (B1)
130	2.0	Blk	C30 (Y30), C37 (V37)
210	3.0	Red	C4 (S4), C35
211	2.0	Red	C1 (S1), C35
212	2.0	Red	C13 (S13), C1 (S1)
225	5.0	Red	T-9 (F4), T-11 (G32)
300	0.8	Org	C8 (A1), C28 (B28)
301	0.8	Org	C8 (A1), T-12 (B12)
320	0.8	Org	C35, C34 (A34)
340	0.8	Org	C35, C23 (A23)
410	1.0	Yel	C12, C1 (S1)
411	0.8	Yel	C13 (S13), C24 (E24)
412	0.8	Yel	C13 (S13), C25 (E25)
420	3.0	Yel	C20 (K20), C18 (M18)
450	0.8	Yel	C2 (S2), C8 (A1)
500	0.8	Blu	C7 (A1), C14 (S14)
600	0.8	Brn	C7 (A1), C32 (G32)
610	0.8	Tan	C8 (A1), T-13 (B13)
630	0.8	Grn	C6 (A1), C21 (S21)
640	0.8	Tan	C7 (A1), C23 (A23)
660	0.8	Gry	C17 (S17), C34 (A34)
700	0.8	Pur	C5 (S5), C14 (S14)
702	0.8	Pur	C14 (S14), C27 (S27)
703	0.8	Pur	C27 (S27), C35
710	0.8	Pur	C2 (S2), T-5 (H5)
720	0.8	Pur	C8 (A1), C32 (G32)
730	3.0	Pur	C36 (Y36), C35
740	0.8	Pur	C35, C23 (A23)
800	0.8	Pnk	C8 (A1), T-4 (B3)
840	3.0	Pnk	C20 (K20), C16 (F16)
841	2.0	Pnk	C5 (S5), C35
920	3.0	Wht	C31 (R1, R2, R3),C35
930	3.0	Wht	C30 (Y30), C35
931	2.0	Wht	C30 (Y30), C37 (V37)
100A	1.0	Blk	Splice Sp-4, C12
100B	1.0	Blk	C11 (E11), Splice Sp-4
100C	1.0	Blk	Splice Sp-4, C9 (E9)
100D	0.8	Blk	C8 (A1), Splice Sp-4
100E	0.8	Blk	Splice Sp-4, T-2 (B1)
100F	0.8	Blk	Splice Sp-4, C14 (S14)
100G	0.8	Blk	Splice Sp-4, T-6 (H5)
100H	0.8	Blk	C3 (T3), Splice Sp-4
100J	3.0	Blk	Splice Sp-4, C18 (M18)
100K	5.0	Blk	Splice Sp-4, Splice Sp-5
100M	0.8	Blk	C5 (S5), Splice Sp-4
101A	5.0	Blk	Splice Sp-5, T-7 (W1)
101B	3.0	Blk	Splice Sp-5, C30 (Y30)
101C	0.8	Blk	Splice Sp-5, C24 (E24)

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RB14256,00009A5 -19-18AUG14-1/3

Circuit Number	Wire Size	Color	Termination Points
101D	0.8	Blk	Splice Sp-5, C25 (E25)
101E	0.8	Blk	Splice Sp-5, T-3 (B3)
101F	0.8	Blk	Splice Sp-5, C28 (B28)
101G	0.8	Blk	Splice Sp-5, C26 (T26)
101H	0.8	Blk	Splice Sp-5, C35
101J	0.8	Blk	Splice Sp-5, C23 (A23)
101M	0.8	Blk	Splice Sp-5, C34 (A34)
101N	0.8	Blk	Splice Sp-5, C33 (M33)
221A	8.0	Red	Splice Sp-7, T-8 (F4)
221C	3.0	Red	C35, Splice Sp-7
221D	3.0	Red	C35, Splice Sp-7
221E	3.0	Red	Splice Sp-7, C16 (F16)
222A	8.0	Red	Splice Sp-6, T-8 (F4)
222B	3.0	Red	C35, Splice Sp-6
222C	3.0	Red	C35, Splice Sp-6
222D	3.0	Red	C35, Splice Sp-6
222E	2.0	Red	C35, Splice Sp-6
310A	0.8	Org	C35, Splice Sp-10
310B	0.8	Org	Splice Sp-10, C15 (S15)
310C	0.8	Org	C8 (A1), Splice Sp-10
400A	3.0	Yel	Splice Sp-3, Splice Sp-9
400B	0.8	Yel	Splice Sp-3, C20 (K20)
400C	2.0	Yel	C5 (S5), Splice Sp-3
400D	1.0	Yel	C10, Splice Sp-3
400E	0.8	Yel	C2 (S2), Splice Sp-3
400F	1.0	Yel	C13 (S13), Splice Sp-3
400G	0.8	Yel	Splice Sp-3, C17 (S17)
400H	0.8	Yel	Splice Sp-3, C15 (S15)
400J	0.8	Yel	Splice Sp-3, C22 (S21)
401A	1.0	Yel	C29, Splice Sp-9
401B	0.8	Yel	Splice Sp-9, C34 (A34)
401C	0.8	Yel	Splice Sp-9, C33 (M33)
401D	0.8	Yel	C28 (B28), Splice Sp-9
401E	0.8	Yel	C23 (A23), Splice Sp-9
401F	2.0	Yel	C35, Splice Sp-9
401G	0.8	Yel	C35, Splice Sp-9
401H	0.8	Yel	Splice Sp-9, C32 (G32)
401J	0.8	Yel	C35, Splice Sp-9
430A	0.8	Yel	C8 (A1), Splice Sp-2
430B	1.0	Yel	Splice Sp-2, C9 (E9)
430C	1.0	Yel	Splice Sp-2, C25 (E25)
430D	1.0	Yel	Splice Sp-2, C24 (E24)
430E	1.0	Yel	C11 (E11), Splice Sp-2
430F	3.0	Yel	C4 (S4), Splice Sp-2
660A	1.0	Grn	C13 (S13), Splice Sp-8
660B	0.8	Grn	C35, Splice Sp-8
660C	0.8	Grn	C35, Splice Sp-8
660D	0.8	Grn	C35, Splice Sp-8
660E	1.0	Grn	C30 (Y30), Splice Sp-8
660F	0.8	Grn	C23 (A23), Splice Sp-8
810A	0.8	Pnk	C8 (A1), Splice Sp-1

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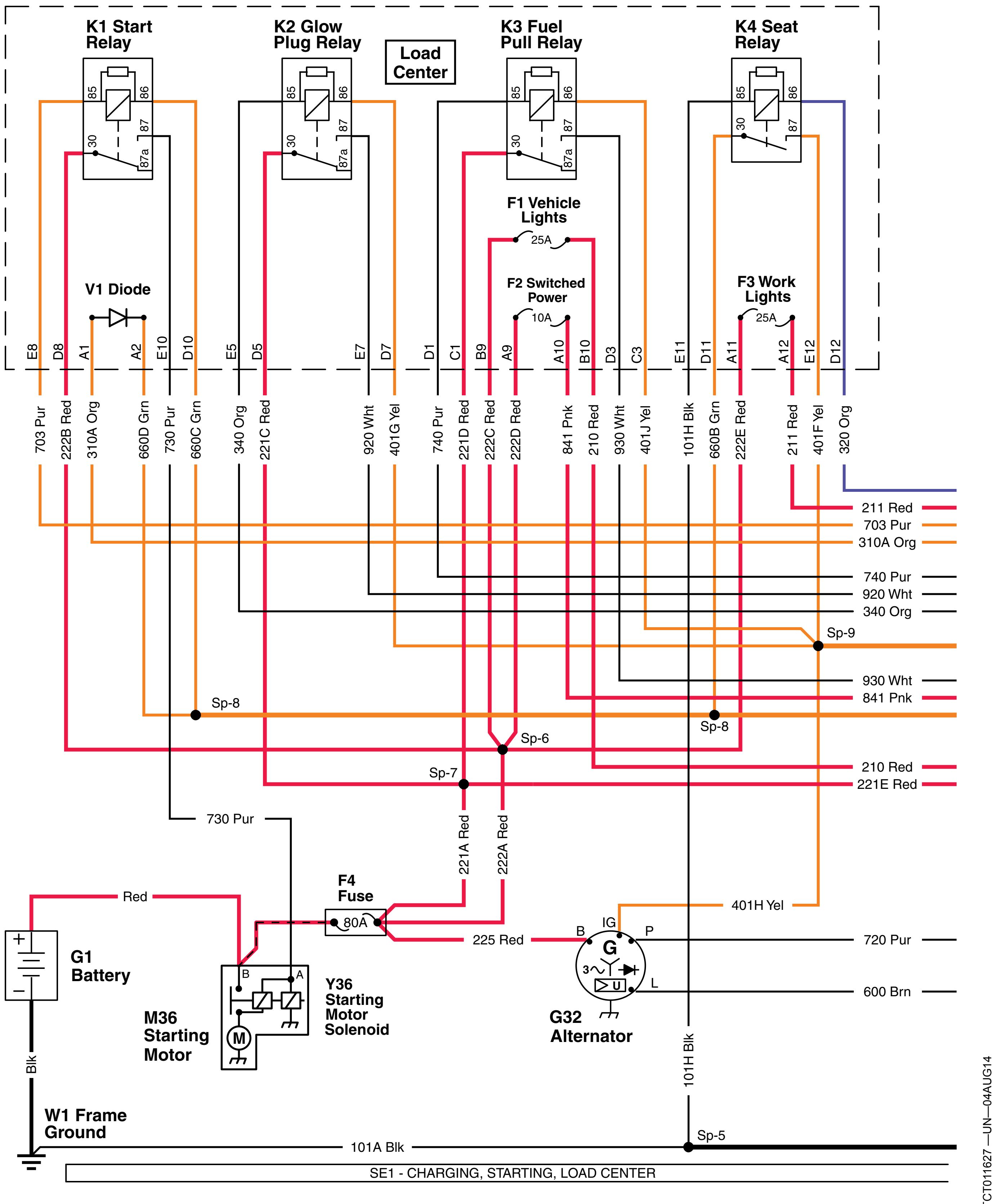
RB14256,00009A5 -19-18AUG14-2/3

Circuit Number	Wire Size	Color	Termination Points
810B	0.8	Pnk	Splice Sp-1, C26 (T26)
810C	0.8	Pnk	C3 (T3), Splice Sp-1

RB14256,00009A5 -19-18AUG14-3/3

Main Wiring Harness Schematic (S.N. 080001-)



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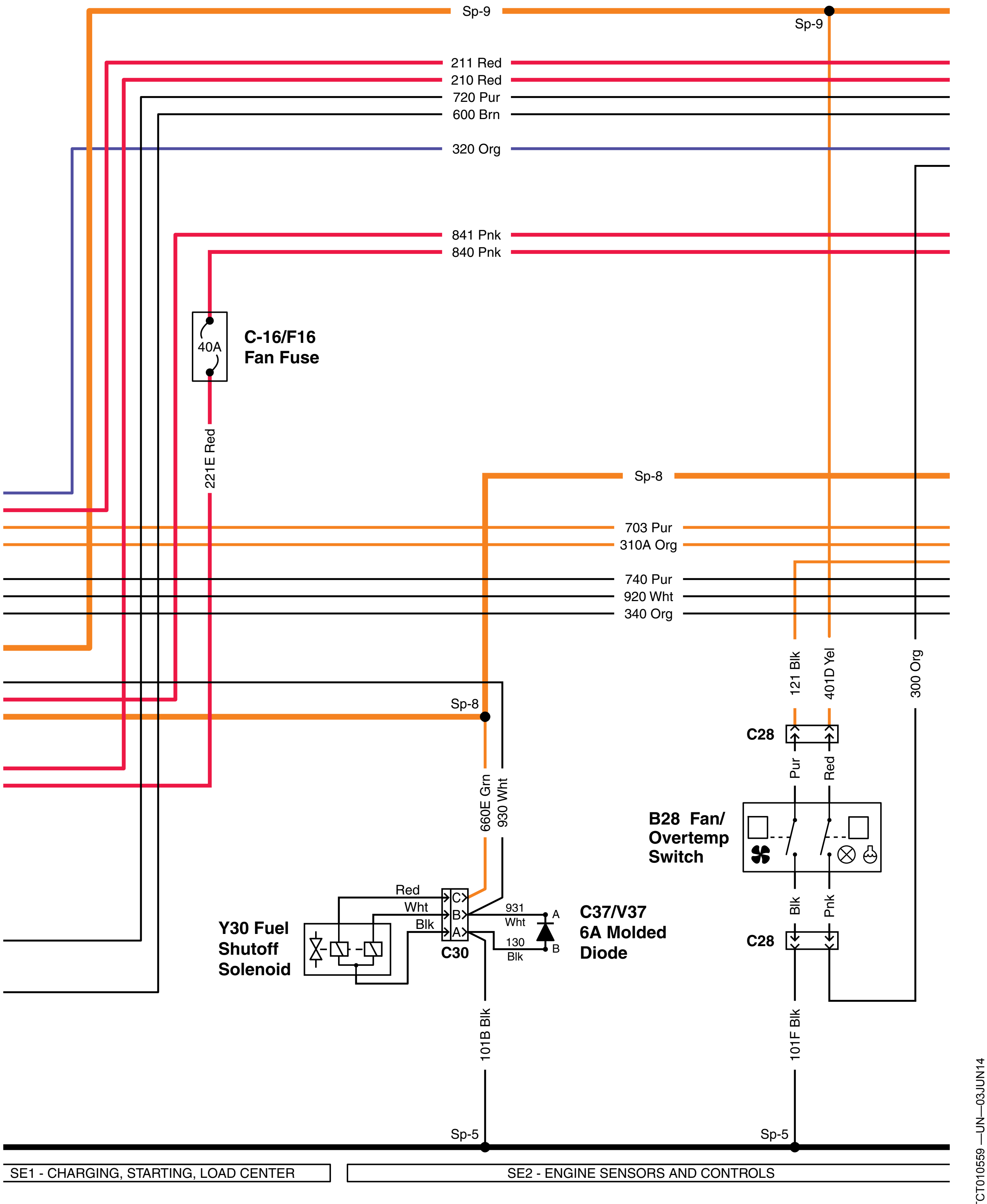
SH24924,0000242 -19-18AUG14-1/8

Main Schematic Diesel S.N. 080001- (2 of 8)



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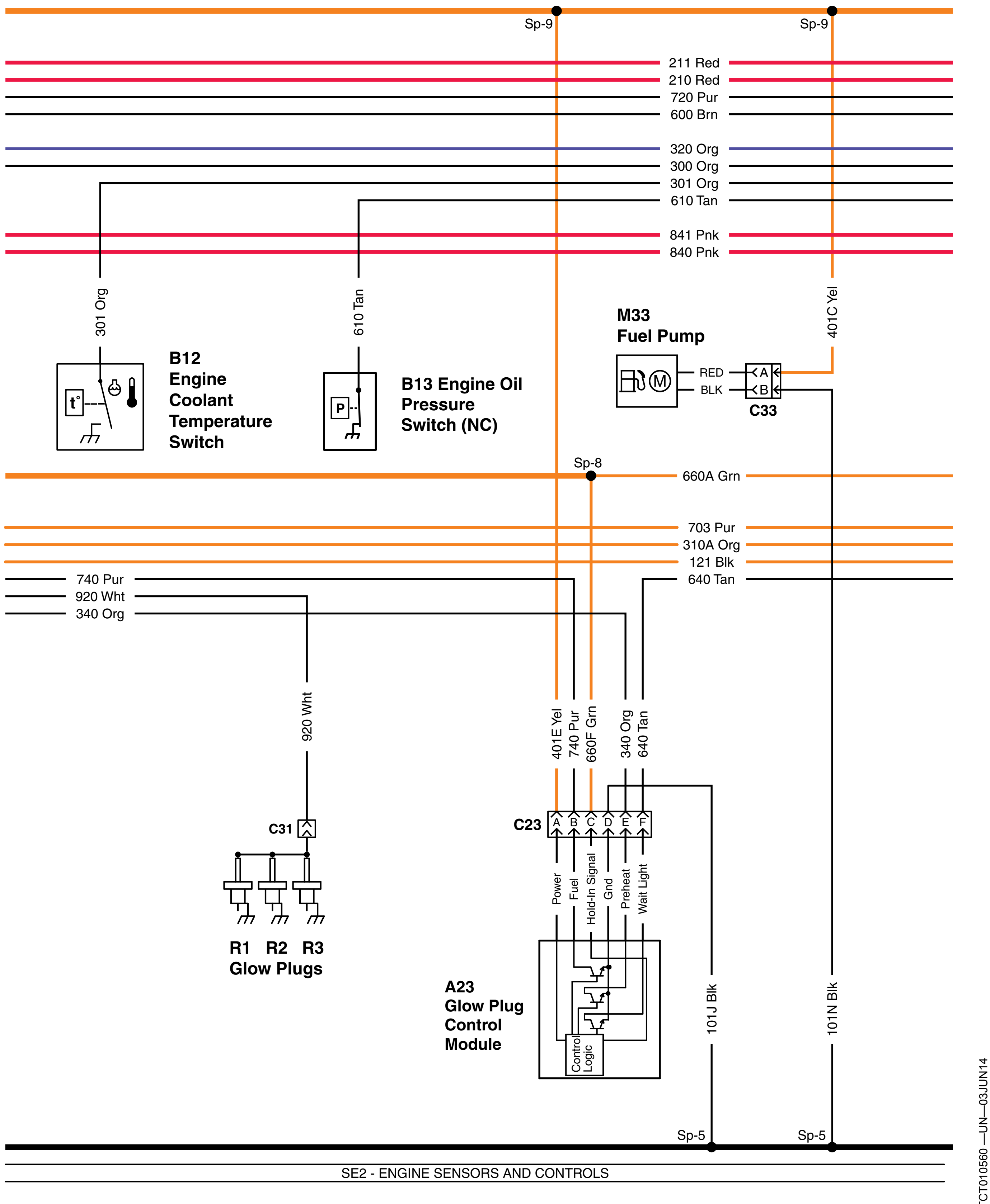
Main Schematic Diesel S.N. 080001- (3 of 8)



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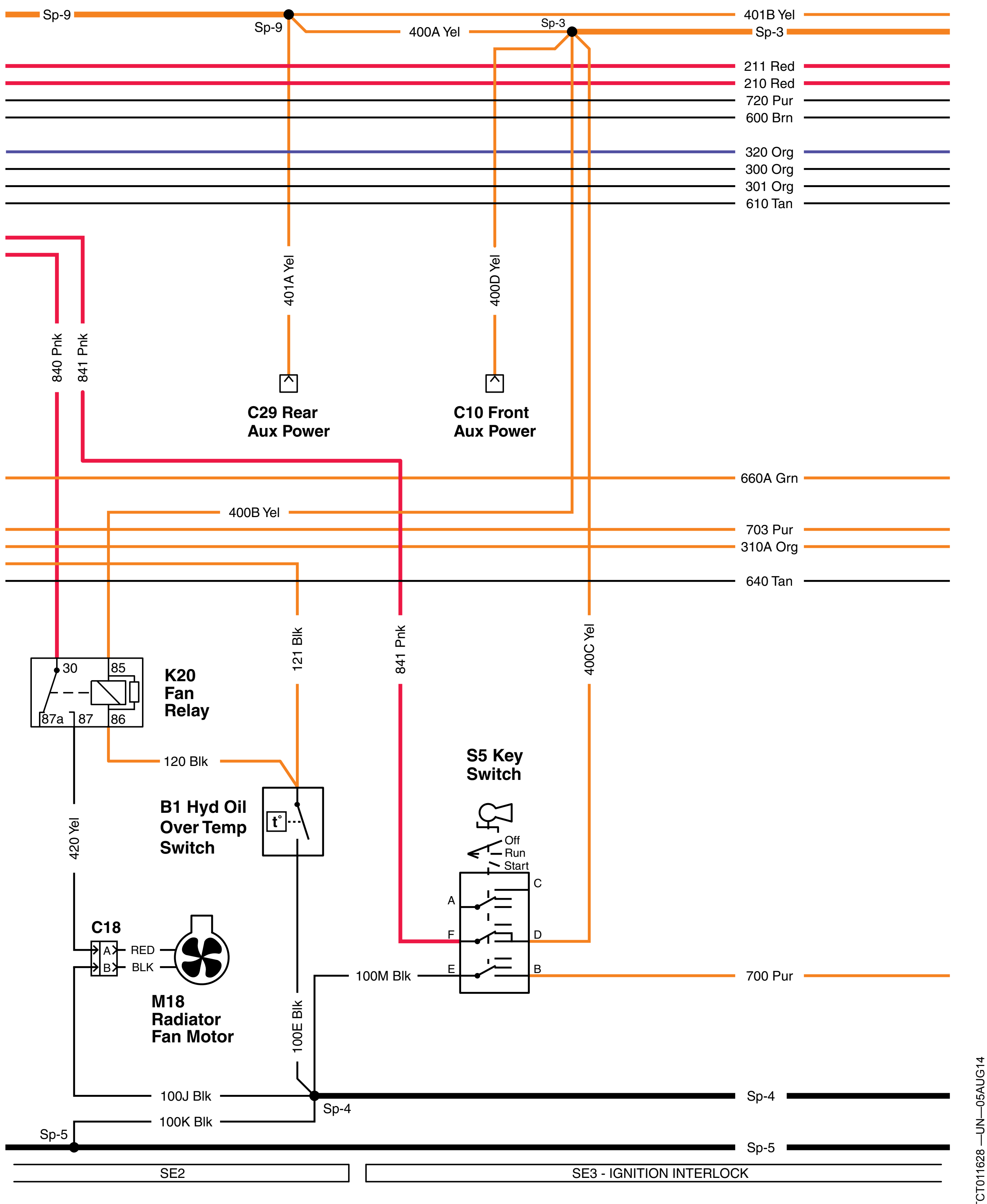
SH24924,0000242 -19-18AUG14-3/8

Main Schematic Diesel S.N. 080001- (4 of 8)



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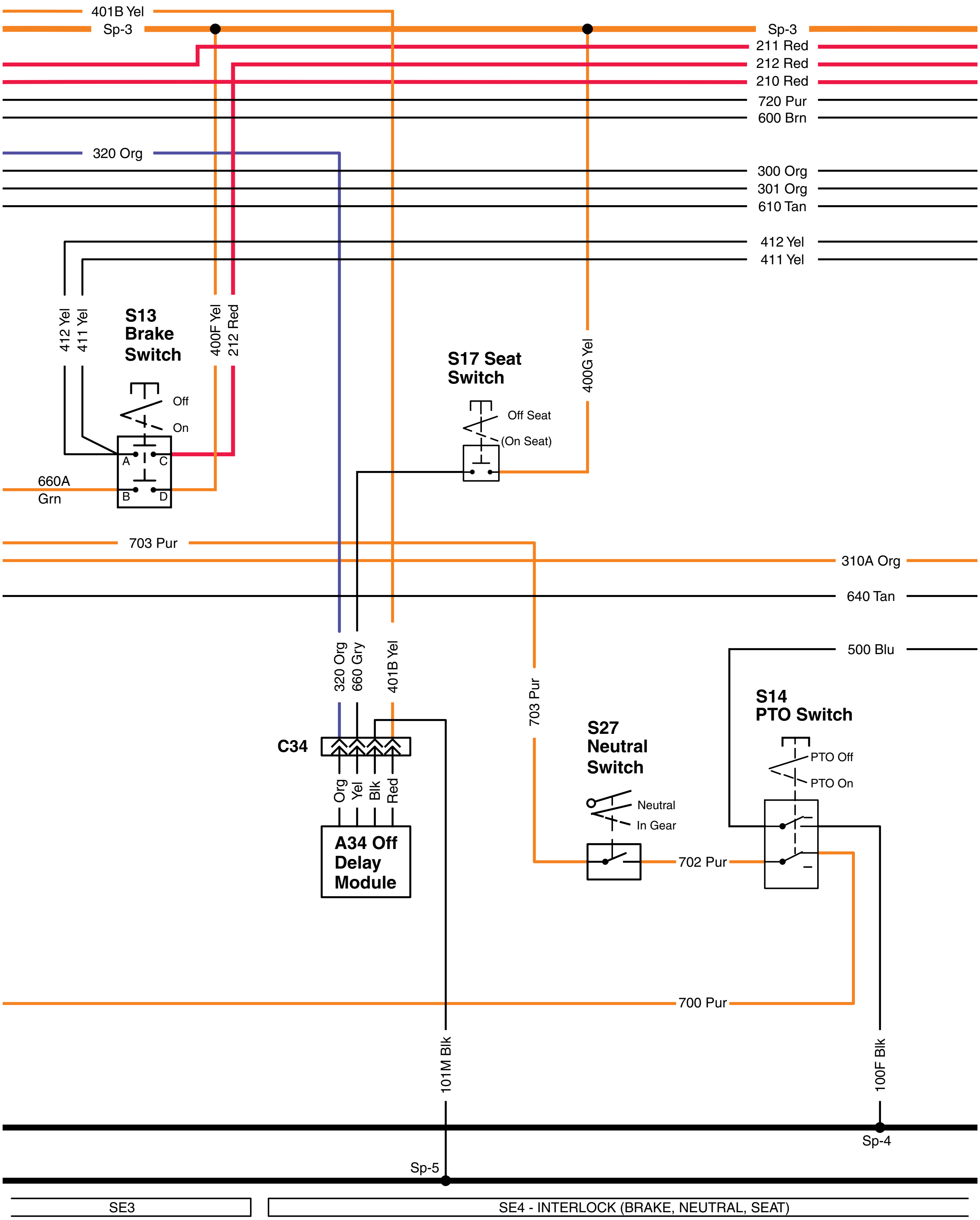
SH24924,0000242 -19-18AUG14-4/8

Main Schematic Diesel S.N. 080001- (5 of 8)



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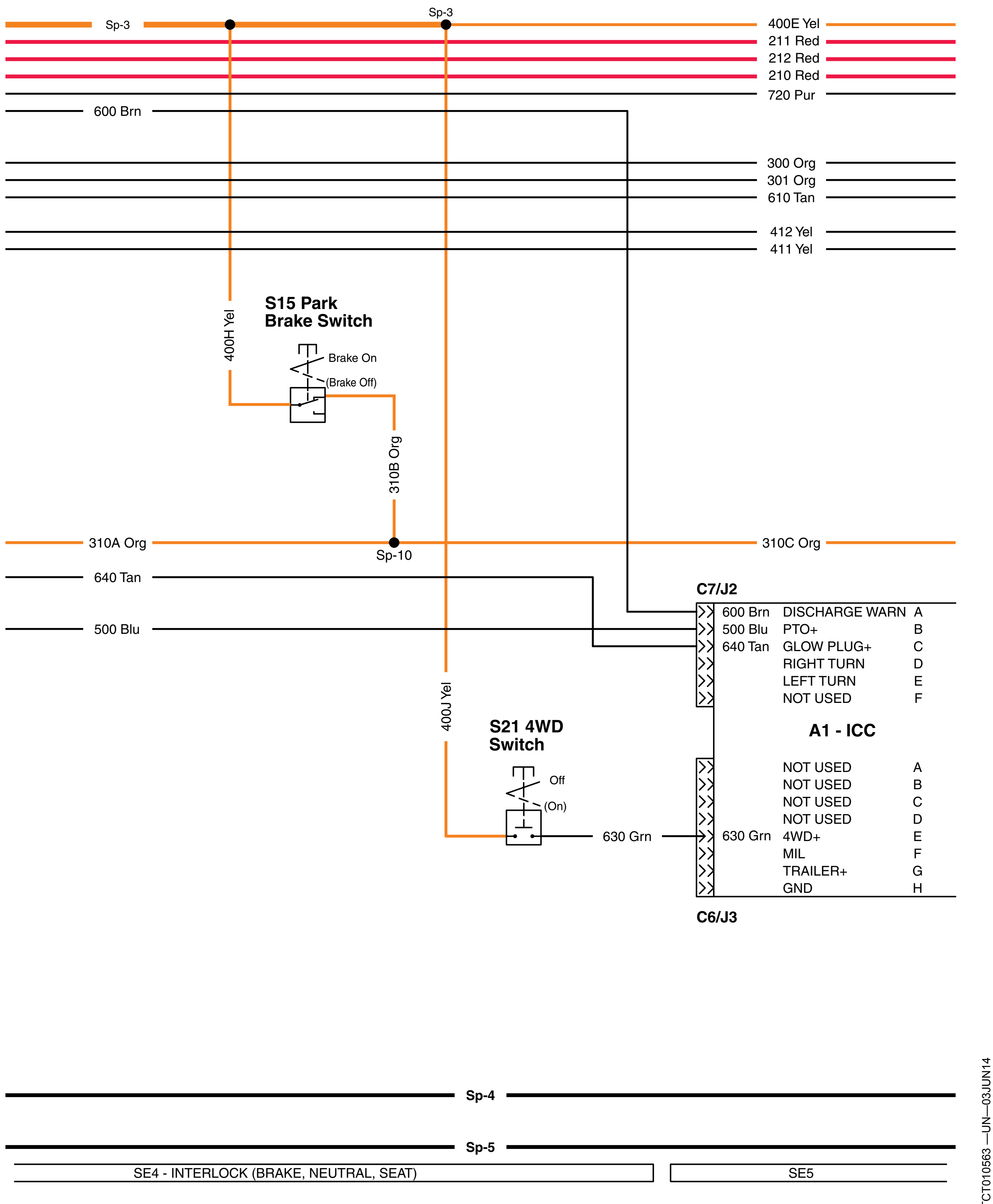
SH24924,0000242 -19-18AUG14-5/8

Main Schematic Diesel S.N. 080001- (6 of 8)



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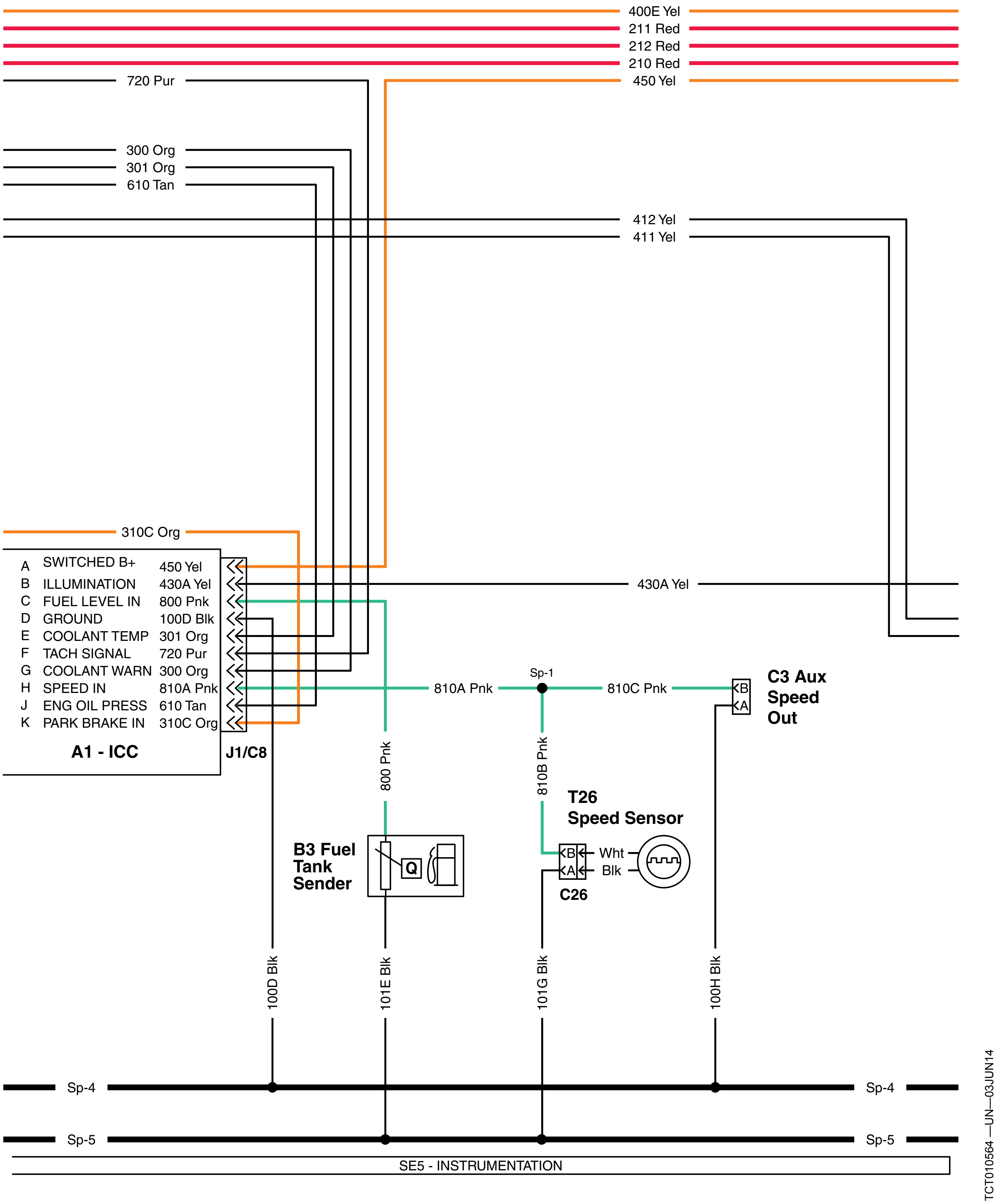
SH24924,0000242 -19-18AUG14-6/8

Main Schematic Diesel S.N. 080001- (7 of 8)



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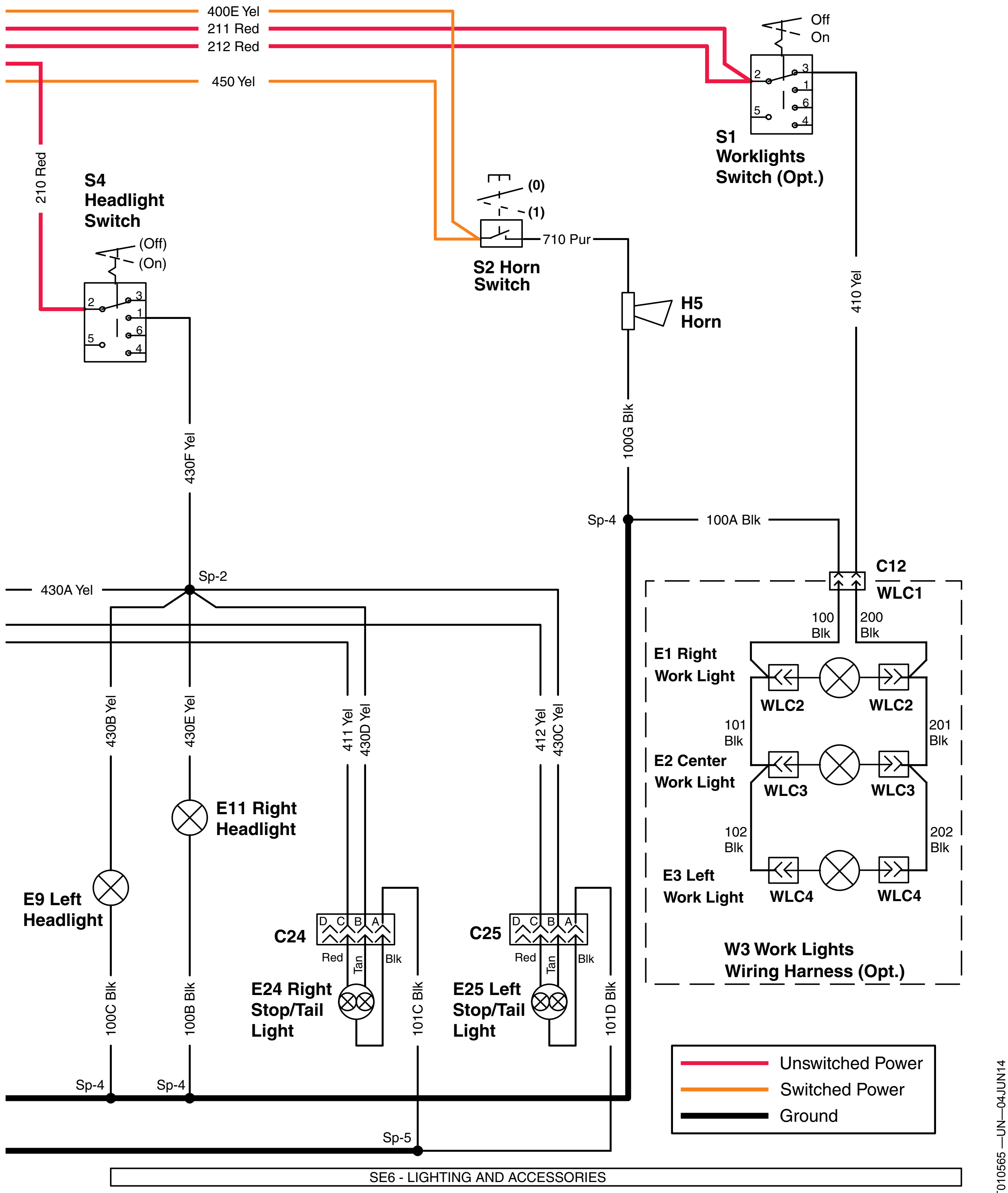
SH24924,0000242 -19-18AUG14-7/8

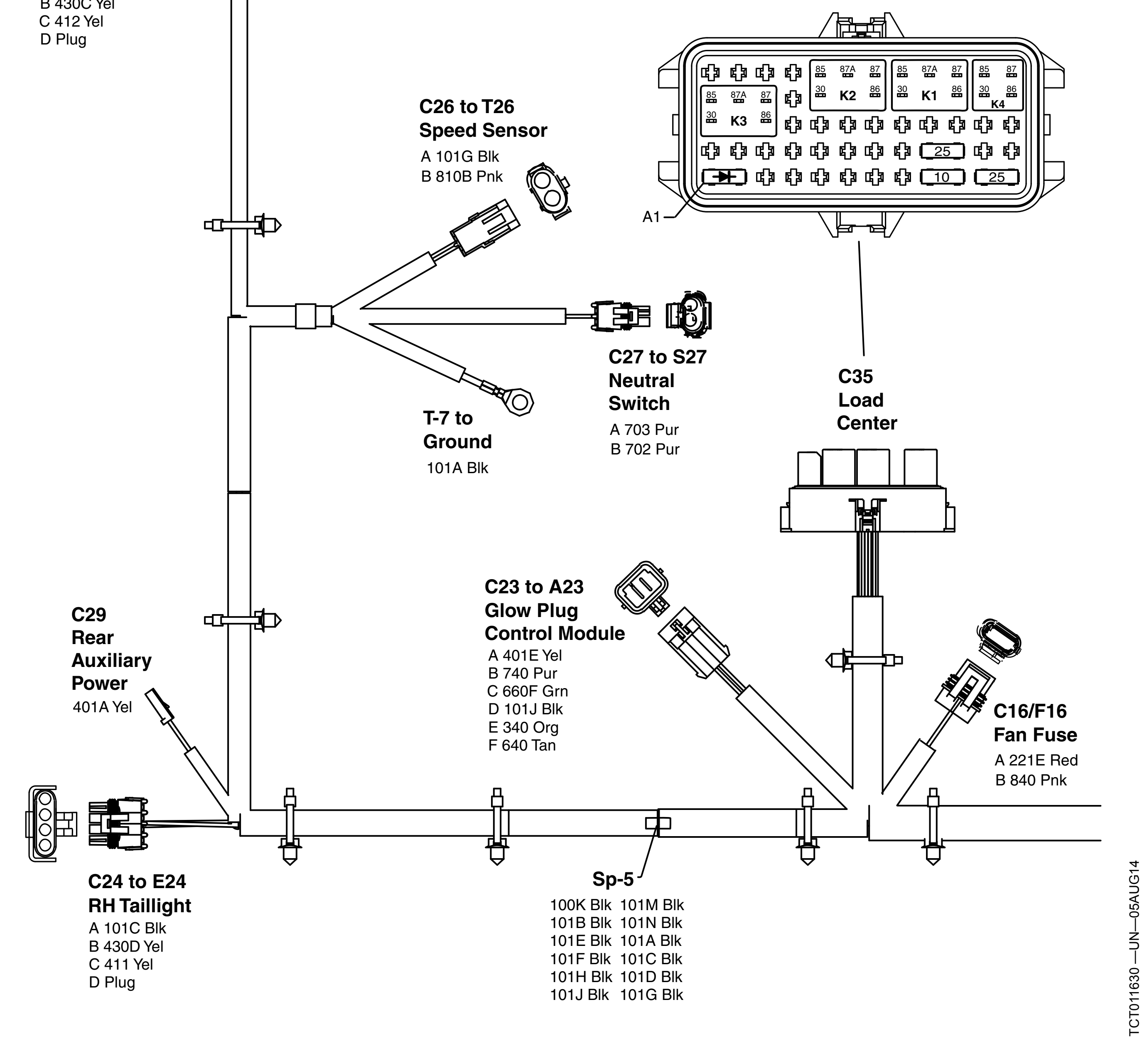
Main Schematic Diesel S.N. 080001- (8 of 8)



SH24924,0000242 -19-18AUG14-8/8

Main Wiring Harness (S.N. 080001-)

A1 310A Org	B1 –	C1 221D Red	D1 740Pur	E1 –
A2 660D Grn	B2 –	C2 –	D2 –	E2 –
A3 –	B3 –	C3 401J Yel	D3 930 Wht	E3 –
A4 –	B4 –	C4 –	D4 –	E4 –
A5 –	B5 –	C5 –	D5 221C Red	E5 340 Org
A6 –	B6 –	C6 –	D6 –	E6 –
A7 –	B7 –	C7 –	D7 401G Yel	E7 920 Wht
A8 –	B8 –	C8 –	D8 222B Red	E8 703 Pur
A9 222D Red	B9 222C Red	C9 –	D9 –	E9 –
A10 841 Pnk	B10 210 Red	C10 –	D10 660C Grn	E10 730 Pur
A11 222E Red	B11 –	C11 –	D11 660B Grn	E11 101H Blk
A12 211 Red	B12 –	C12 –	D12 320 Org	E12 401F Yel



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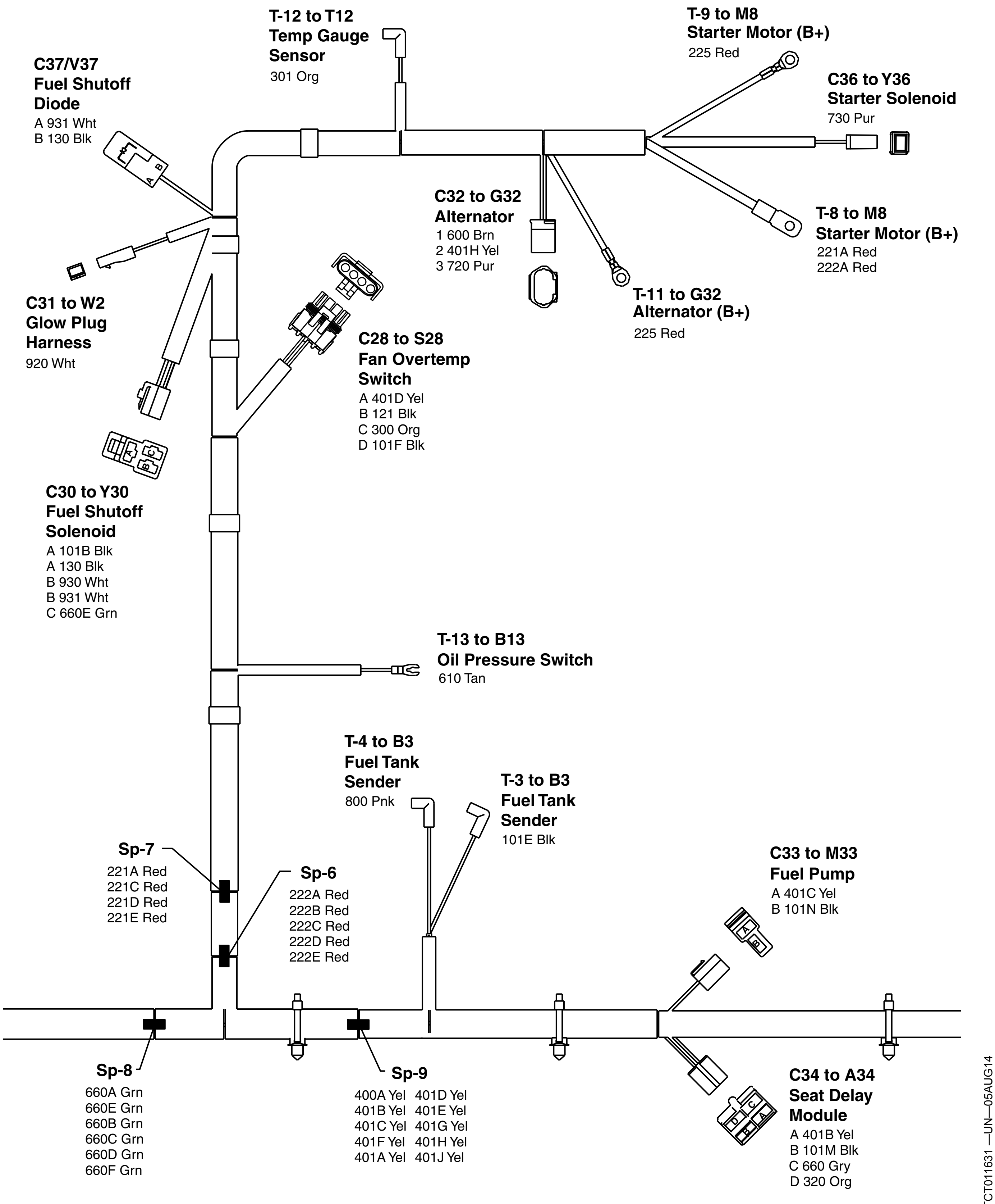
SH24924,0000244 -19-18AUG14-1/5

Main Wiring Harness (S.N. 080001-) (2 of 5)



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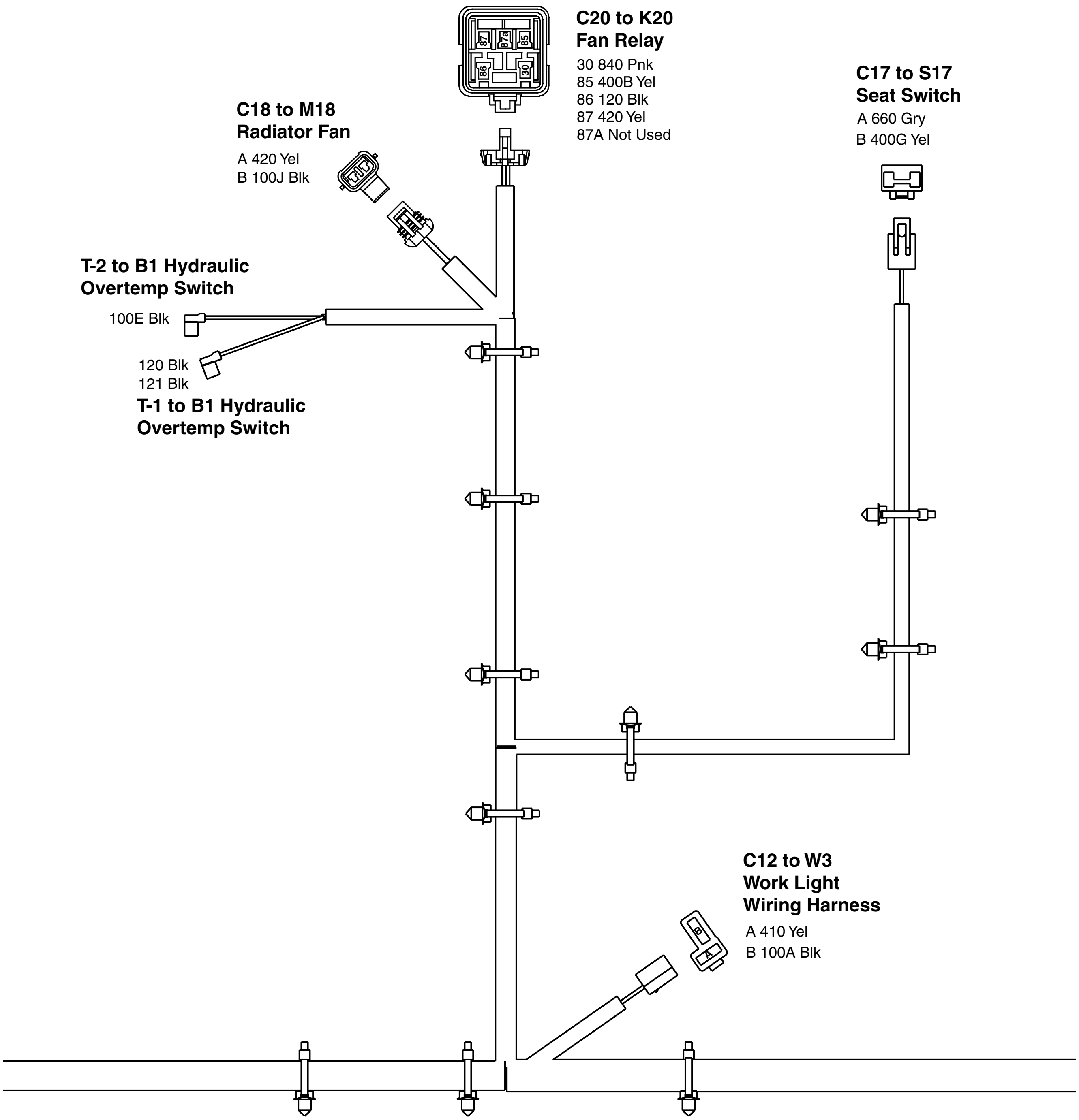
SH24924,0000244 -19-18AUG14-2/5

Main Wiring Harness (S.N. 080001-) (3 of 5)



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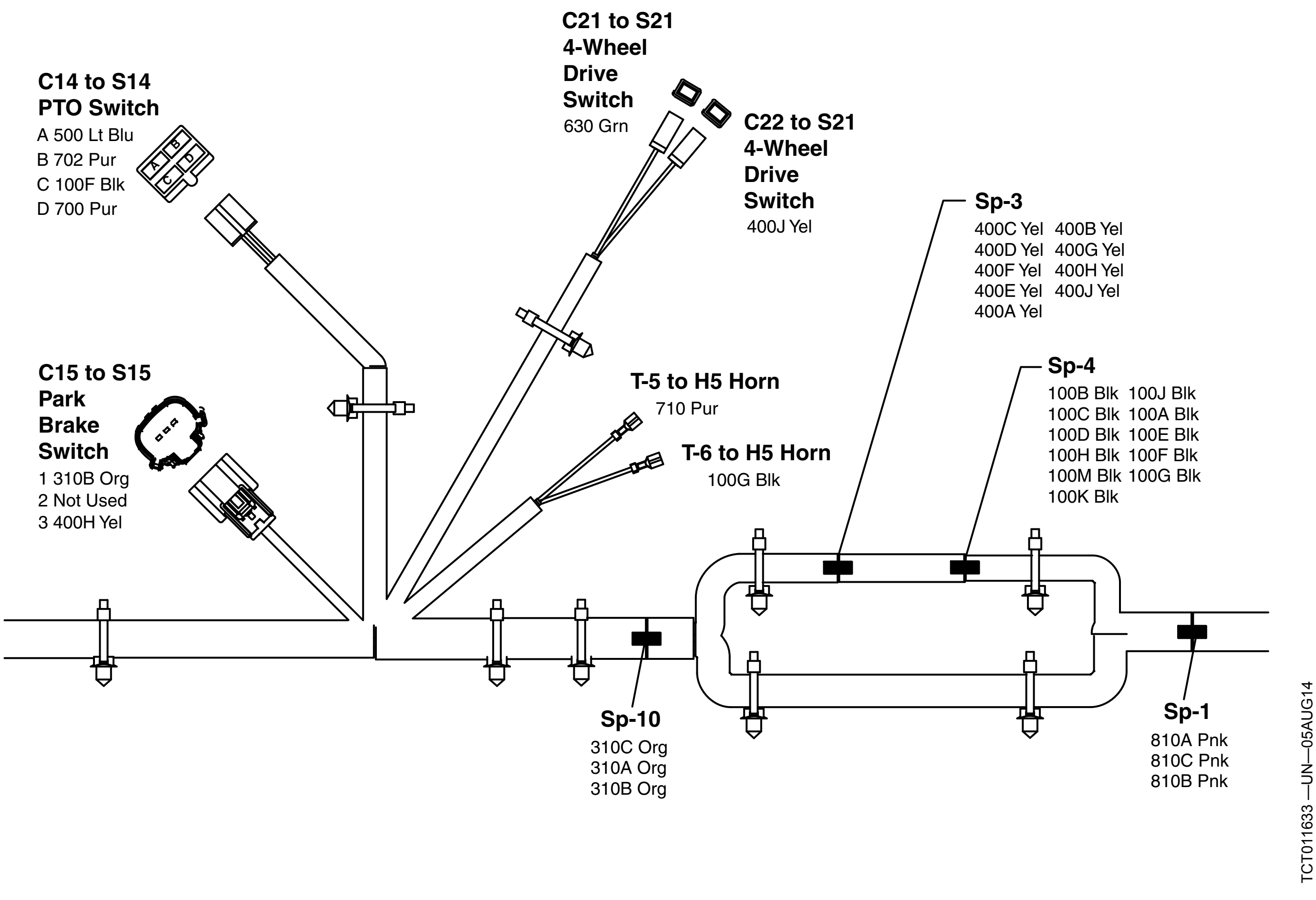
SH24924,0000244 -19-18AUG14-3/5

Main Wiring Harness (S.N. 080001-) (4 of 5)



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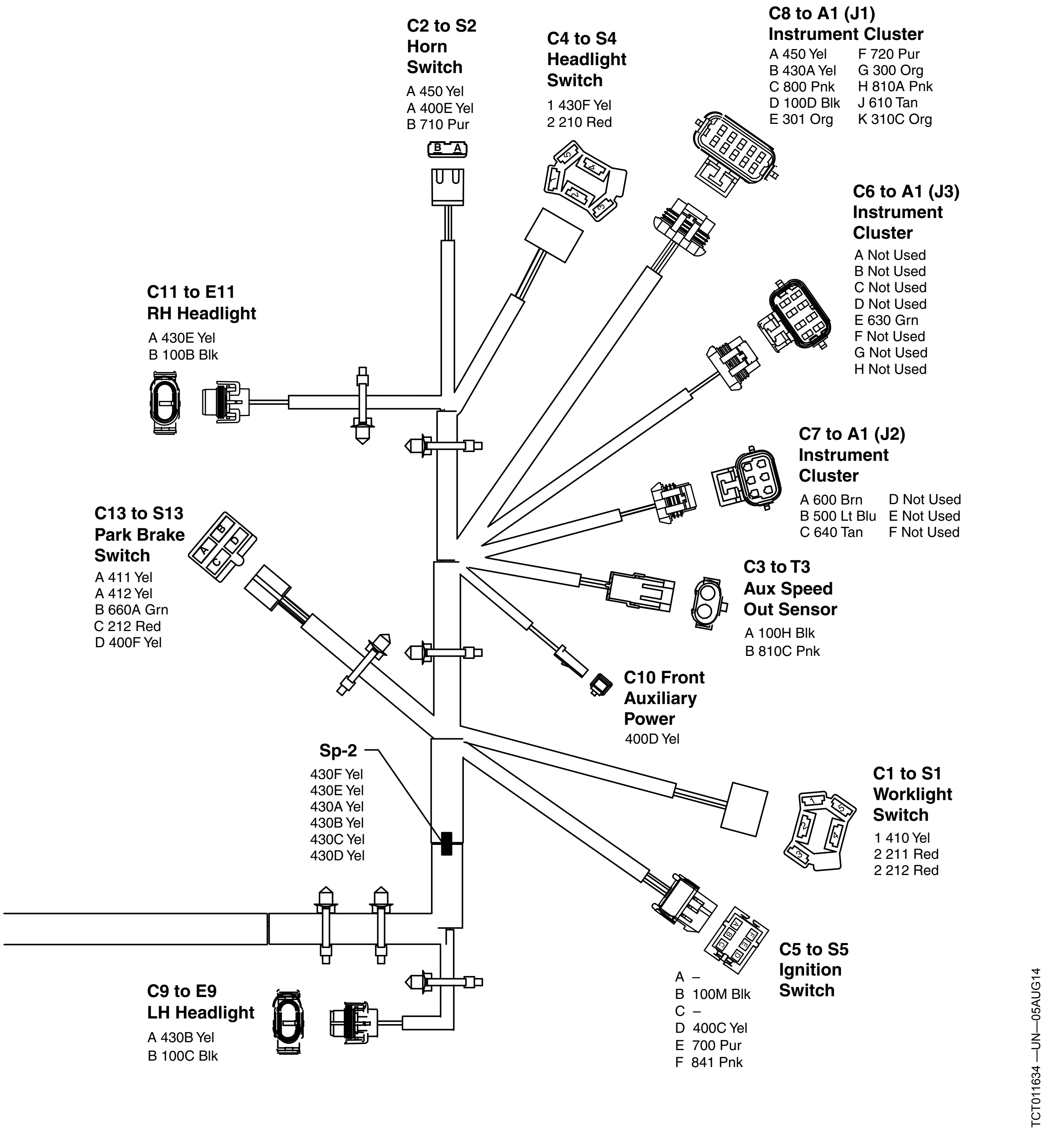
SH24924,0000244 -19-18AUG14-4/5

Main Wiring Harness (S.N. 080001-) (5 of 5)



SH24924,0000244 -19-18AUG14-5/5

Main Wiring Harness Wire Color Codes (S.N. 080001-)

Size (mm²)/No./Color	Connection Points
0.8 120 Blk	T-1, C20 (86)
0.8 121 Blk	T-1, C28 (B)
2.0 130 Blk	C30 (A), C37 (B)
3.0 210 Red	C4 (2), C35 (B10)
2.0 211 Red	C1 (2), C35 (A12)
2.0 212 Red	C1 (2), C13 (C)
5.0 225 Red	T-9, T-11
0.8 300 Org	C8 (G), C28 (C)
0.8 301 Org	T-12, C8 (E)
0.8 320 Org	C34 (D), C35 (D12)
0.8 340 Org	C23 (E), C35 (E5)
1.0 410 Yel	C1 (1), C12 (A)
0.8 411 Yel	C13 (A), C24 (C)
0.8 412 Yel	C13 (A), C25 (C)
3.0 420 Yel	C18 (A), C20 (87)
0.8 450 Yel	C2 (A), C8 (A)
0.8 500 Lt Blu	C7 (B), C14 (A)
0.8 600 Brn	C7 (A), C32 (1)
0.8 610 Tan	C8 (J), T-13
0.8 630 Grn	C6 (E), C21 (1)
0.8 640 Tan	C7 (C), C23 (F)
0.8 660 Gry	C17 (A), C34 (C)
0.8 700 Pur	C5 (E), C14 (D)
0.8 702 Pur	C14 (B), C27 (B)
0.8 703 Pur	C27 (A), C35 (E8)
0.8 710 Pur	C2 (B), T-5
0.8 720 Pur	C8 (F), C32 (3)
3.0 730 Pur	C36 (1), C35 (E10)
0.8 740 Pur	C23 (B), C35 (D1)
0.8 800 Pnk	C8 (C), T-4
3.0 840 Pnk	C16 (B), C20 (30)
2.0 841 Pnk	C5 (F), C35 (A10)
3.0 920 Wht	C31 (A), C35 (E7)
3.0 930 Wht	C30 (B), C35 (D3)
2.0 931 Wht	C30 (B), C37 (A)
1.0 100A Blk	C12 (B), Splice Sp-4
1.0 100B Blk	C11 (B), Splice Sp-4
1.0 100C Blk	C9 (B), Splice Sp-4
0.8 100D Blk	C8 (D), Splice Sp-4
0.8 100E Blk	T-2, Splice Sp-4
0.8 100F Blk	C14 (C), Splice Sp-4
0.8 100G Blk	T-6, Splice Sp-4
0.8 100H Blk	C3 (A), Splice Sp-4
3.0 100J Blk	C18 (B), Splice Sp-4
5.0 100K Blk	Splice Sp-4, Splice Sp-5
0.8 100M Blk	C5 (B), Splice Sp-4
5.0 101A Blk	T-7, Splice Sp-5
3.0 101B Blk	C30 (A), Splice Sp-5
0.8 101C Blk	C24 (A), Splice Sp-5
0.8 101D Blk	C25 (A), Splice Sp-5
0.8 101E Blk	T-3, Splice Sp-5
0.8 101F Blk	C28 (D), Splice Sp-5
0.8 101G Blk	C26 (B), Splice Sp-5
0.8 101H Blk	Splice Sp-5, C35 (E11)
0.8 101J Blk	C23 (D), Splice Sp-5
0.8 101M Blk	C34 (B), Splice Sp-5
0.8 101N Blk	C33 (B), Splice Sp-5
8.0 221A Red	T-8, Splice Sp-7
3.0 221C Red	Splice Sp-7, C35 (D5)
3.0 221D Red	Splice Sp-7, C35 (C1)
3.0 221E Red	C16 (A), Splice Sp-7
8.0 222A Red	T-8, Splice Sp-6
3.0 222B Red	Splice Sp-6, C35 (D8)
3.0 222C Red	Splice Sp-6, C35 (B9)
3.0 222D Red	Splice Sp-6, C35 (A9)
3.0 222E Red	Splice Sp-6, C35 (A11)
0.8 310A Org	Splice Sp-10, C35 (A1)
0.8 310B Org	C15 (1), Splice Sp-10
0.8 310C Org	C8 (K), Splice Sp-10
3.0 400A Yel	Splice Sp-3, Splice Sp-9
0.8 400B Yel	C20 (85), Splice Sp-3
2.0 400C Yel	C5 (D), Splice Sp-3
1.0 400D Yel	C10 (1), Splice Sp-3
0.8 400E Yel	C2 (A), Splice Sp-3
1.0 400F Yel	C13 (D), Splice Sp-3
0.8 400G Yel	C17 (B), Splice Sp-3
0.8 400H Yel	C15 (3), Splice Sp-3
0.8 400J Yel	C22 (1), Splice Sp-3
1.0 401A Yel	C29 (1), Splice Sp-9
0.8 401B Yel	C34 (A), Splice Sp-9
0.8 401C Yel	C33 (A), Splice Sp-9
0.8 401D Yel	C28 (A), Splice Sp-9
0.8 401E Yel	C23 (A), Splice Sp-9
2.0 401F Yel	Splice Sp-9, C35 (E12)
0.8 401G Yel	Splice Sp-9, C35 (D7)
0.8 401H Yel	C32 (2), Splice Sp-9
0.8 401J Yel	Splice Sp-9, C35 (C3)
0.8 430A Yel	C8 (B), Splice Sp-2
1.0 430B Yel	C9 (A), Splice Sp-2
1.0 430C Yel	C25 (B), Splice Sp-2
1.0 430D Yel	C24 (B), Splice Sp-2
1.0 430E Yel	C11 (A), Splice Sp-2
3.0 430F Yel	C4 (1), Splice Sp-2
1.0 660A Grn	C13 (B), Splice Sp-8
0.8 660B Grn	Splice Sp-8, C35 (D11)
0.8 660C Grn	Splice Sp-8, C35 (D10)
0.8 660D Grn	Splice Sp-8, C35 (A2)
1.0 660E Grn	C30 (C), Splice Sp-8
0.8 660F Grn	C23 (C), Splice Sp-8
0.8 810A Pnk	C8 (H), Splice Sp-1

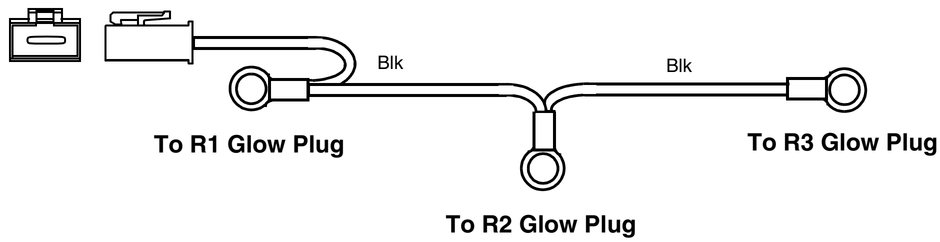
Continued on next page

SH24924,0000243 -19-18AUG14-1/2

Size (mm²)/No./Color	Connection Points
0.8 810B Pnk	C26 (A), Splice Sp-1
0.8 810C Pnk	C3 (B), Splice Sp-1

SH24924,0000243 -19-18AUG14-2/2

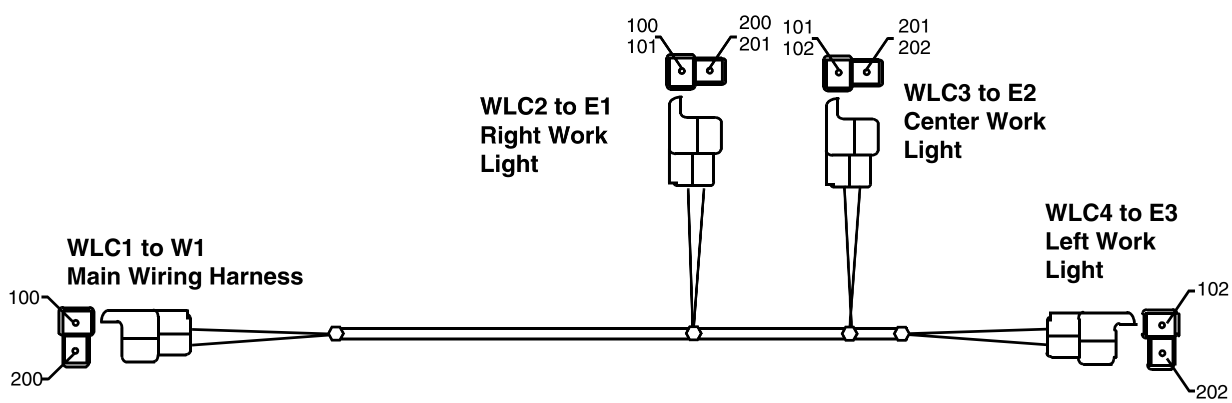
W2 Glow Plug Wiring Harness



TCAL26340 —UN—15JUN12

RB14256,00009A6 -19-18JUN12-1/1

W3 Work Light Wiring Harness



TCAL26341 —UN—15JUN12

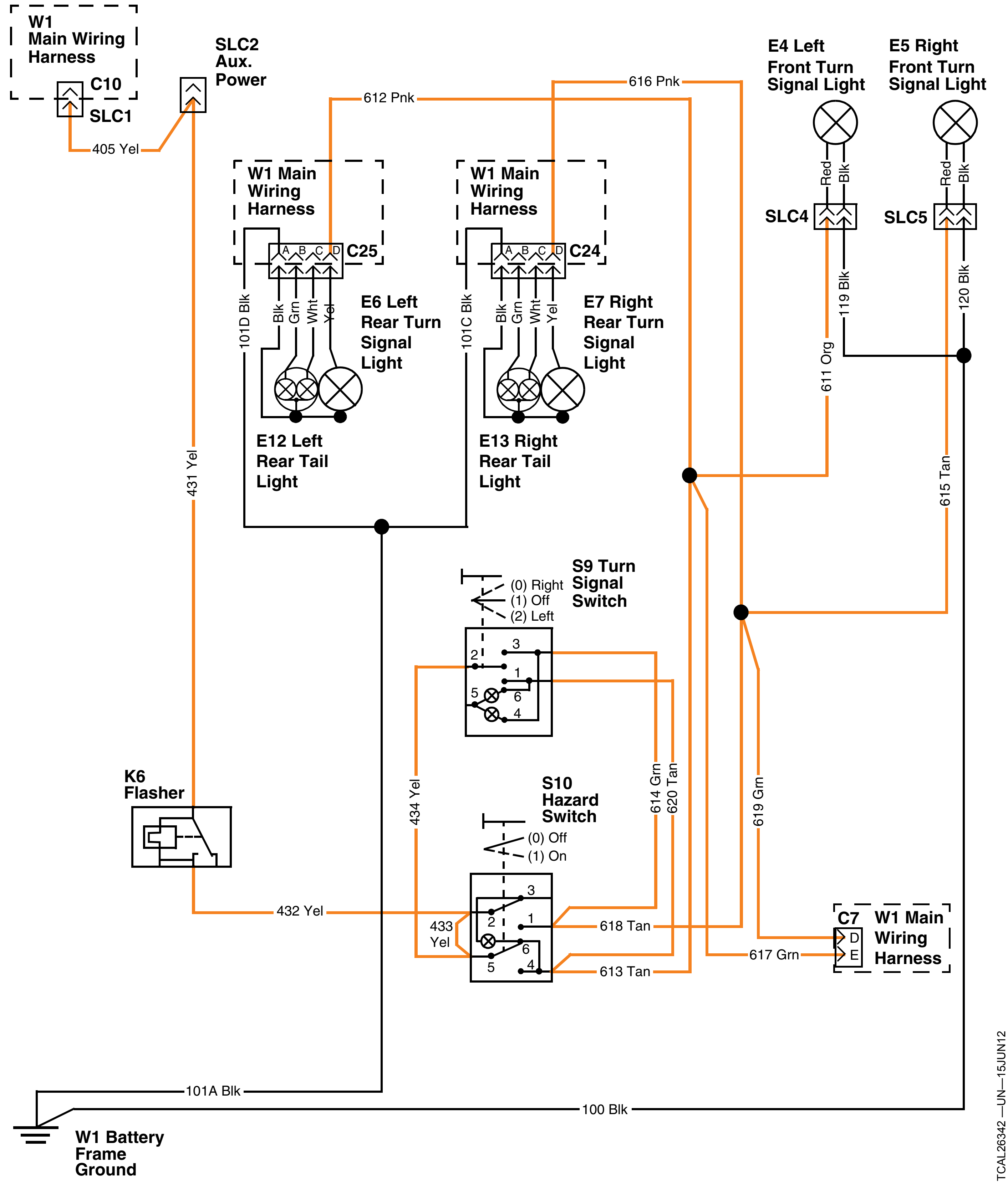
RB14256,00009A7 -19-18JUN12-1/1

W3 Work Light Wiring Harness Wire Color Codes

Circuit No.	Wire Size	Color	Termination Points
100	2.0	Blk	WLC1, WLC2 (E1)
101	1.0	Blk	WLC2 (E1), WLC3 (E2)
102	1.0	Blk	WLC3 (E2), WLC4 (E3)
200	2.0	Blk	WLC1, WLC2 (E1)
201	1.0	Blk	WLC2 (E1), WLC3 (E2)
202	1.0	Blk	WLC3 (E2), WLC4 (E3)

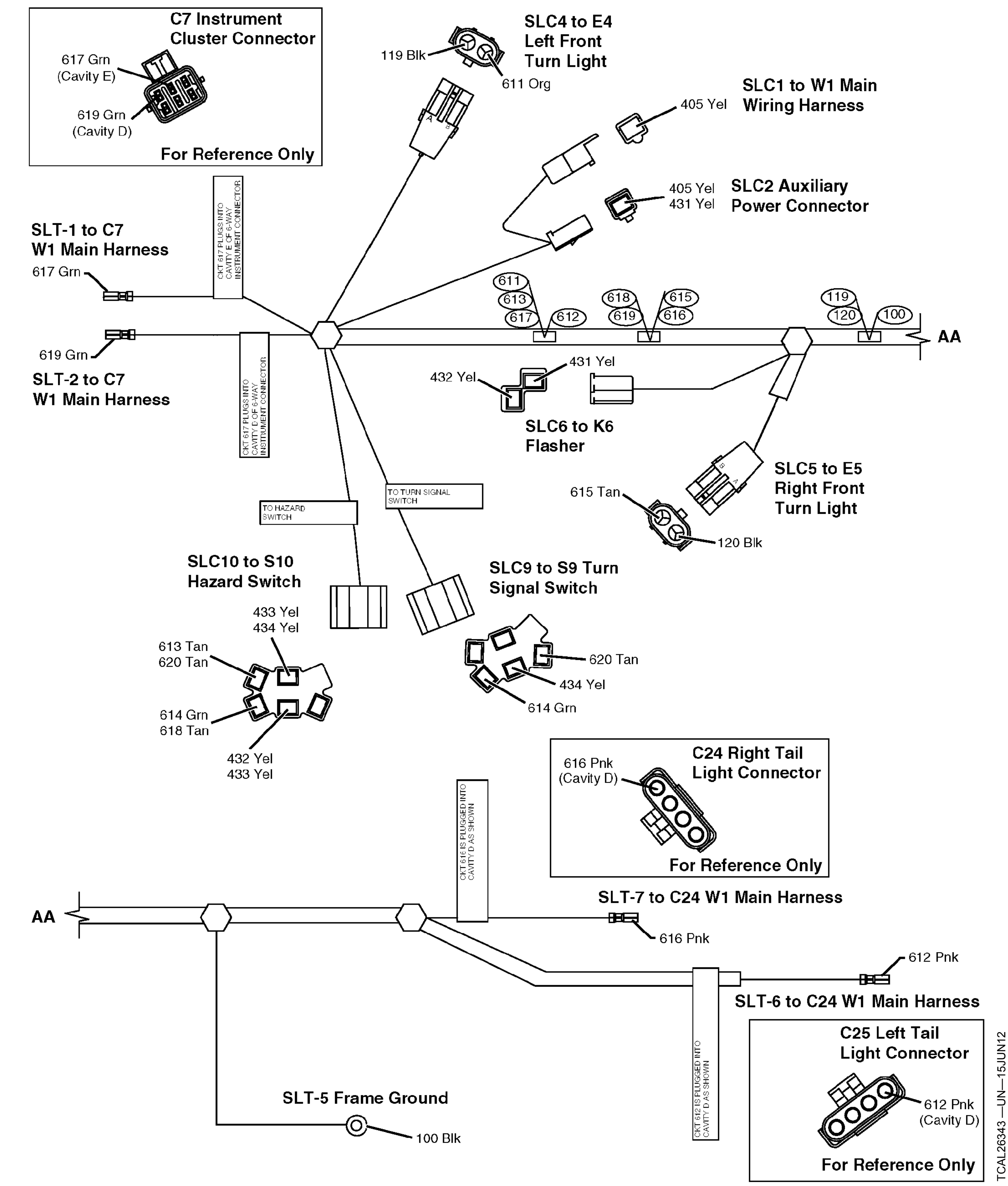
RB14256,00009A8 -19-18JUN12-1/1

W4 Optional Signal Light Wiring Harness Schematic



RB14256,00009A9 -19-18JUN12-1/1

W4 Optional Signal Light Wiring Harness



RB14256,00009AA -19-18JUN12-1/1

W4 Optional Signal Light Wiring Harness Wire Color Codes

Circuit Number	Wire Size	Color	Termination Points
100	1.0	Blk	SLT-5 (W1), Splice
119	0.8	Blk	Splice, SLC4 (E4)
120	0.8	Blk	Splice, SLC5 (E5)
405	1.0	Yel	SLC1, SLC2
431	1.0	Yel	SLC2, SLC6 (K6)
432	1.0	Yel	SLC6 (K6), SLC10 (S10)
433	1.0	Yel	SLC10 (S10), SLC10 (S10)
434	0.8	Yel	SLC9 (S9), SLC10 (S10)
611	0.8	Org	Splice, SLC4 (E4)
612	0.8	Pnk	Splice, SLT-6 (C25)
613	0.8	Tan	SLC10 (S10), Splice
614	0.8	Grn	SLC9 (S9), SLC10 (S10)
615	0.8	Tan	Splice, SLC5 (E5)
616	0.8	Pnk	Splice, SLT-7 (C24)
617	0.8	Grn	Splice, SLT-1 (C7)
618	0.8	Tan	SLC10 (S10), Splice
619	0.8	Grn	Splice, SLT-2 (C7)
620	0.8	Tan	SLC9 (S9), SLC10 (S10)

RB14256,00009AB -19-18JUN12-1/1

Power Circuit Operation - Gasoline Engine

Function

The power circuit provides unswitched power to the primary components whenever the battery is connected and switched power to the operational components whenever the key switch is in either the RUN or START position.

Unswitched Power

Voltage must be present at the following components with the key switch in the OFF position:

- Battery Positive Terminal
- Starting Motor Solenoid Terminal “B”
- Alternator Terminal “B”
- Seat Switch (Park Brake ON)
- Key Switch
- Headlight Switch
- Work Light Switch
- Brake Switch
- ECM pins 79 and 60
- Fan Fuse
- 25A Work Lights Fuse
- 80A Main Fuse
- Oil Pressure Engine Run Logic Diode
- Start Relay
- Fuel Pump Relay
- Injector/Ignition/O2 Relay
- 10A ECM Fuse
- 25A Vehicle Lighting Fuse
- 10A Keyswitch Power Fuse
- 25A Start Solenoid Fuse

The positive battery cable connects the battery to the starting motor solenoid. The starting motor solenoid “B” terminal is used as the 12-Volt DC tie point for the rest of the electrical system.

The battery cables and the starting motor solenoid tie point connections must be in good condition for the vehicle electrical system to work properly. The ground cable and positive cable connections are equally important. Proper starting motor operation depends on these cables and connections to carry high current.

The entire electrical system is initially protected by the 80A main fuse, and all individual individual circuits have sub fuses for protection.

Switched Power - Run

In addition to the voltage present at the locations of the unswitched power circuits, voltage must be present at the components listed below with the key switch in the RUN position:

- MIL Relay
- 5A ECM Switched Power Fuse
- 15A Injector/Ignition/O2 Fuse
- 1Alternator Field Excite Connector5A Fuel Pump Fuse
- Alternator Field Excite Connector
- Fuel Pump
- ECM pin 44
- Fan Relay
- Key Switch
- Front Auxiliary Power Connector
- Rear Auxiliary Power Connector
- Brake Switch
- Neutral Switch
- Seat Switch
- Park Brake Switch
- 4WD Switch
- Instrument Cluster, J1 pins A and B
- Multi Mode Throttle Control
- Horn Switch Foot Pedal pins C and D
- LH Headlight
- RH Headlight
- LH Tail Light
- RH Tail Light

With voltage present at the components listed above, the vehicle’s operating circuits will be prepared for operation. In addition, with the various switches positioned as described above, no relays or additional circuits will be activated.

5V Sensor Power

As the switched power is turned on, the ECM powers up and provides 5Vdc to various components and sensors.

- ECM pin 19
- Throttle pin 3
- TMAP Sensor (Feeding both MAP and IAT)
- Engine Diagnostics
- Multi Mode Throttle pin C

RB14256,00009AC -19-18JUN12-1/1

Power Circuit Operation - Diesel Engine

Function

The power circuit provides unswitched power to the primary components whenever the battery is connected and switched power to the operational components whenever the key switch is in either the RUN or START position.

Unswitched Power

Voltage must be present at the following components with the key switch in the OFF position:

- G1 Battery Positive Terminal
- Y1 Starting Motor Solenoid Terminal “B”
- G2 Alternator Terminal “B”
- K20 Radiator Fan Relay (840 Pnk wire
- F1 Fuse (25 amp)
- S4 Headlight Switch (210 Red wire)
- S1 Work Light Switch (212 Red wires)
- S13 Brake Switch (400F Yel wire)
- S5 Key Switch (841 Pnk wire)
- K1 Start Relay (222B Red wire)

The positive battery cable connects the battery to the starting motor solenoid. The starting motor solenoid “B” terminal is used as the 12-Volt DC tie point for the rest of the electrical system.

The battery cables and the starting motor solenoid tie point connections must be good for the vehicle electrical system to work properly. The ground cable and positive cable connections are equally important. Proper starting motor operation depends on these cables and connections to carry high current.

With the exception of the “B” terminal of the alternator, the electrical circuit is protected by the fuse link beyond the starting motor solenoid tie point. The fuse link is a short piece of wire that is designed to fail if current load is too high or a short occurs.

Switched Power - Run

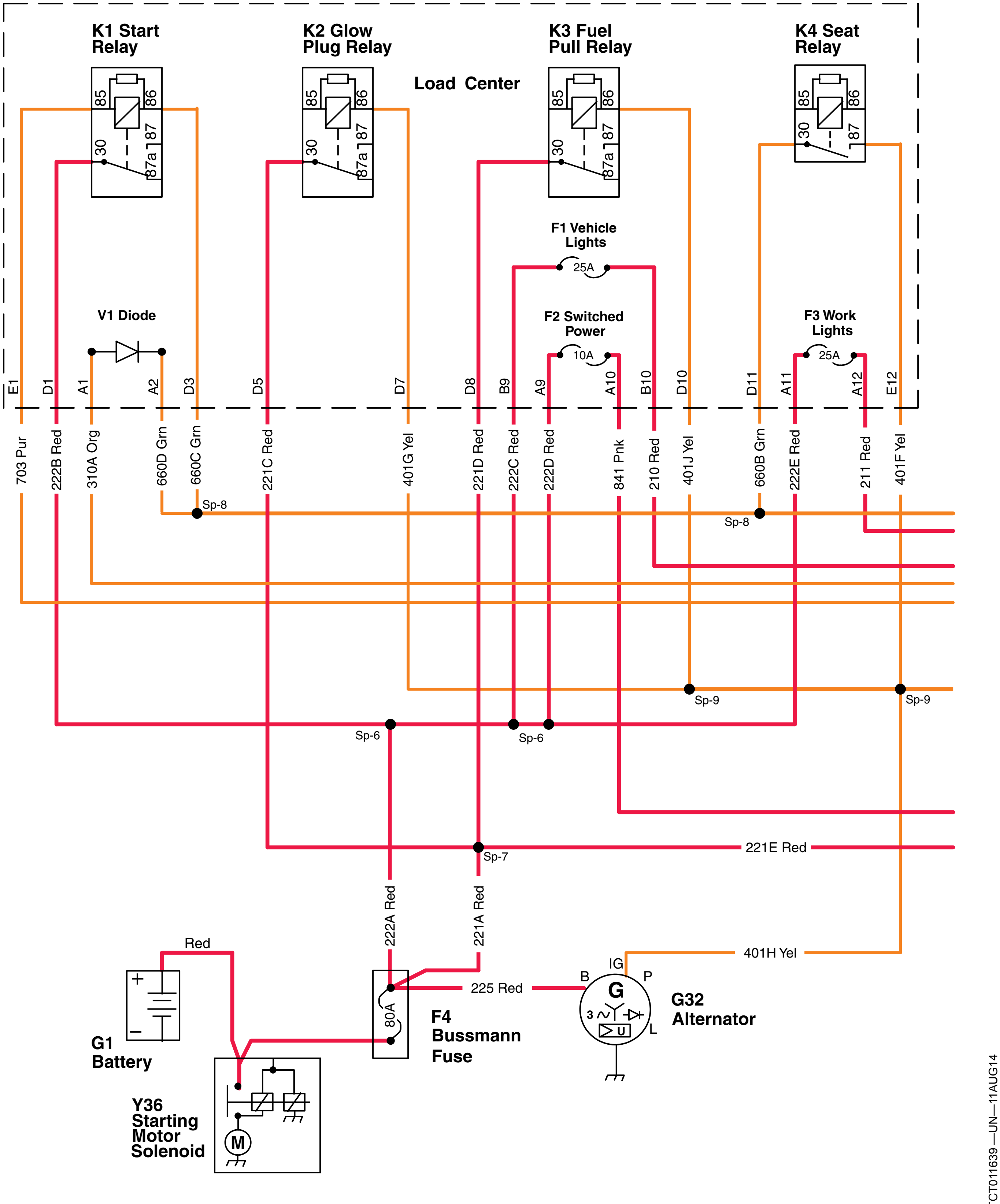
In addition to the voltage present at the locations of the unswitched power circuits, voltage must be present at the components listed with the key switch in the RUN position:

- S5 Key Switch (400C Yel wire)
- F2 Fuse (10 amp)
- S13 Brake Switch (400F Yel wire)
- C10 and C29 Auxiliary Power Connectors (400D and 401A Yel wire)
- Splice #9
- G2 Alternator (401H Yel wire)
- S2 Horn Switch (400E and 450 Yel wires)
- C8 Instrument Panel Connector (450 Yel wire)
- K20 Radiator Fan Relay (400B Yel wire)
- A23 Glow Plug Timer Module (401E Yel wire)
- B28 Fan/Over Temperature Switch (401D Yel wire)
- M33 Fuel Pump (401C Yel wire)
- S15 Park Brake Switch (400H Yel wire)
- S17 Seat Switch (400G Yel wire)
- K4 Seat Relay (401F Yel wire)
- A23 Off Delay Module (401E Pnk wire)
- S21 4-Wheel Drive Switch (400J Yel wire)

With voltage present at the components listed above, the vehicle’s operating circuits will be prepared for operation. In addition, with the various switches positioned as described above, no relays or additional circuits will be activated.

RB14256,00009AD -19-18JUN12-1/1

Power Circuit Schematic - Diesel Engine (S.N. -080000)



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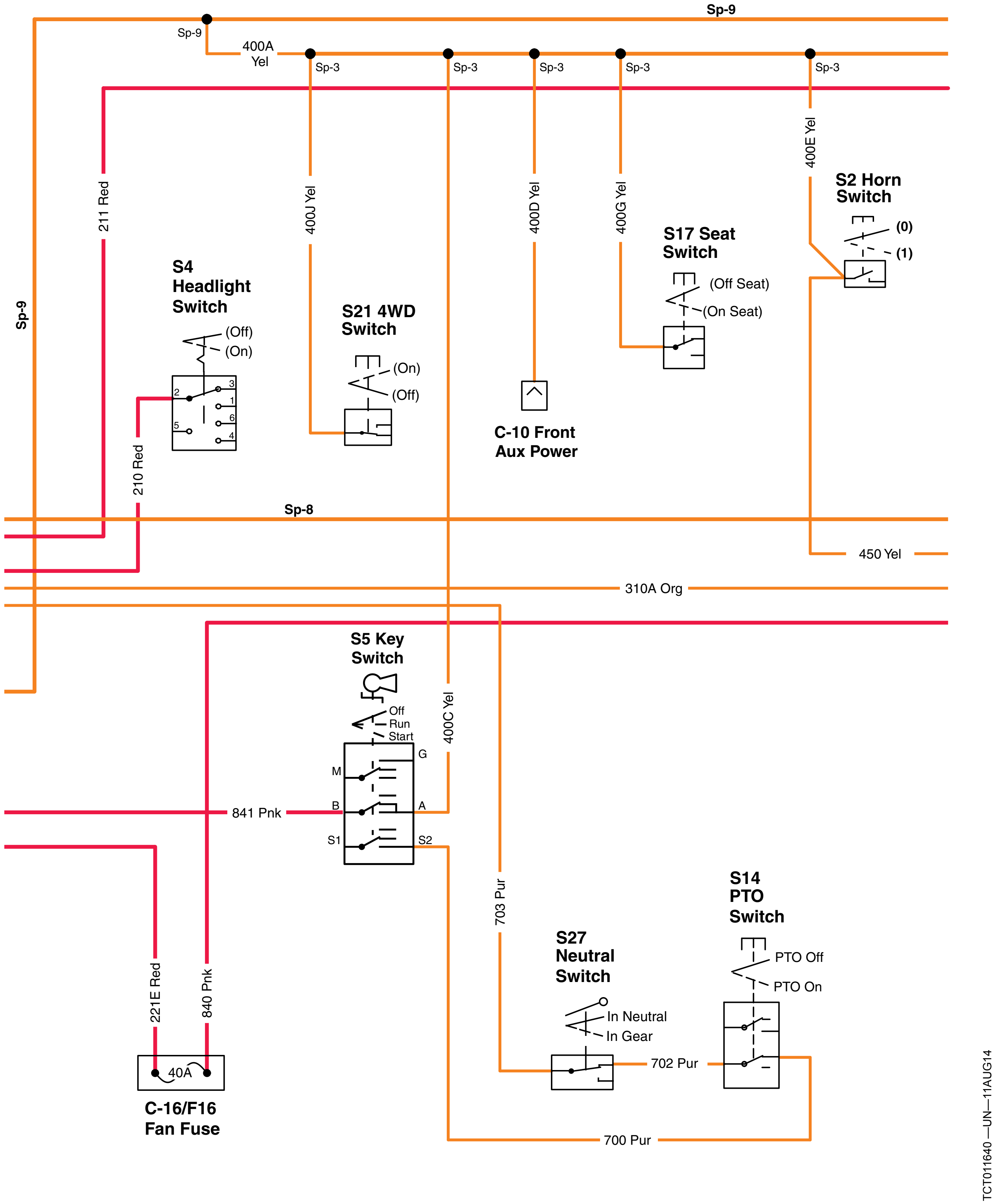
RB14256,00009AE -19-18AUG14-1/4



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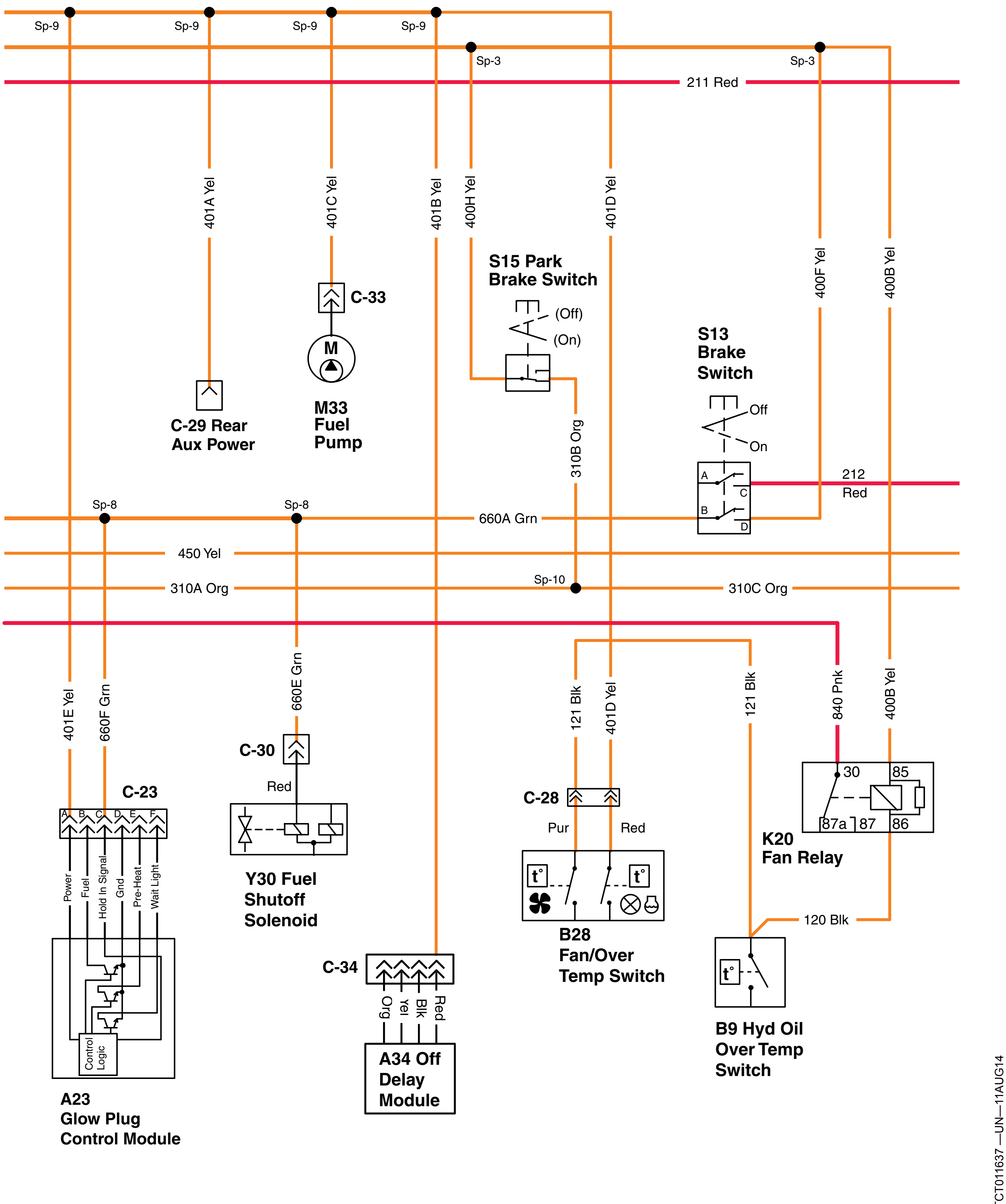
RB14256,00009AE -19-18AUG14-2/4



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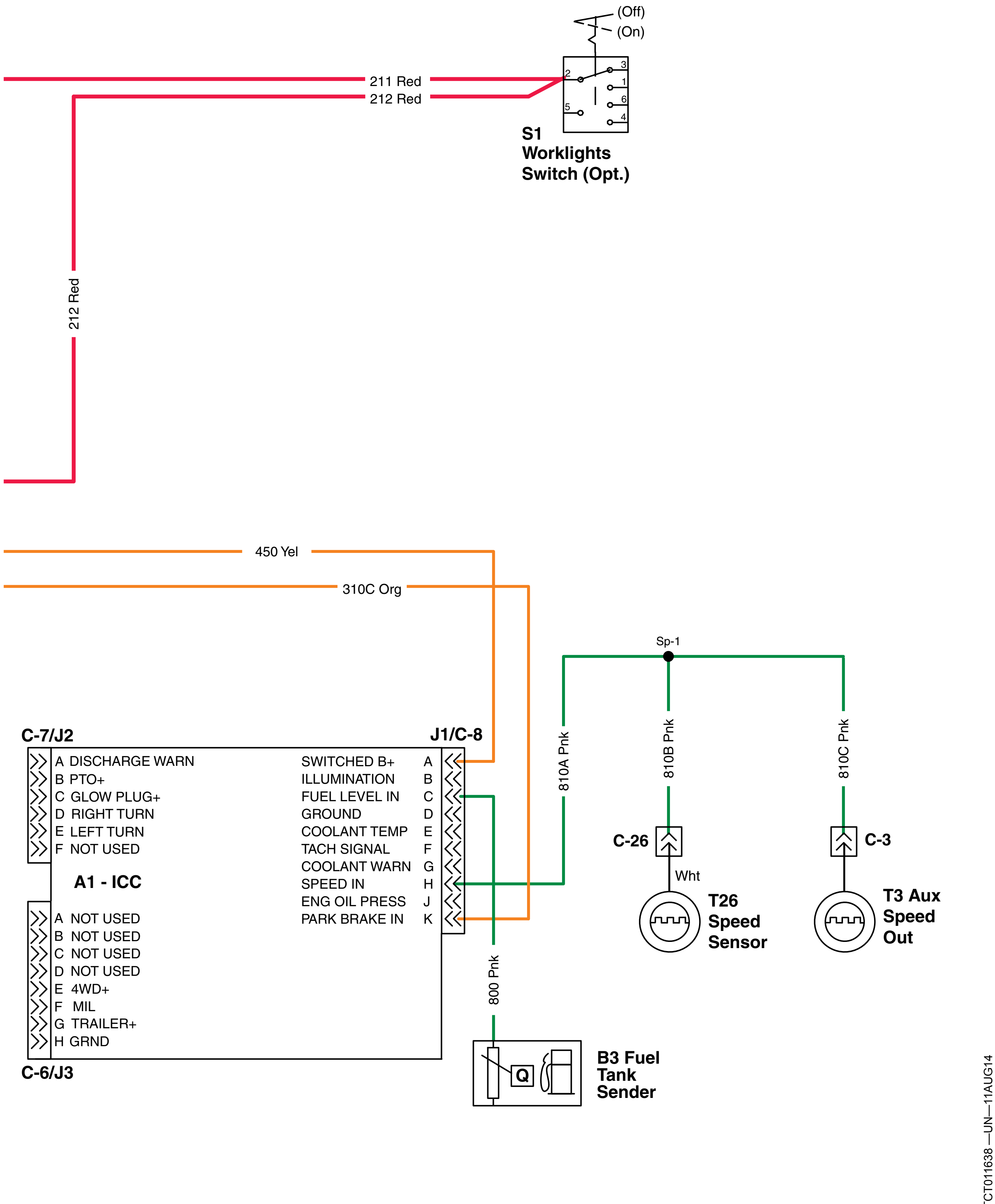
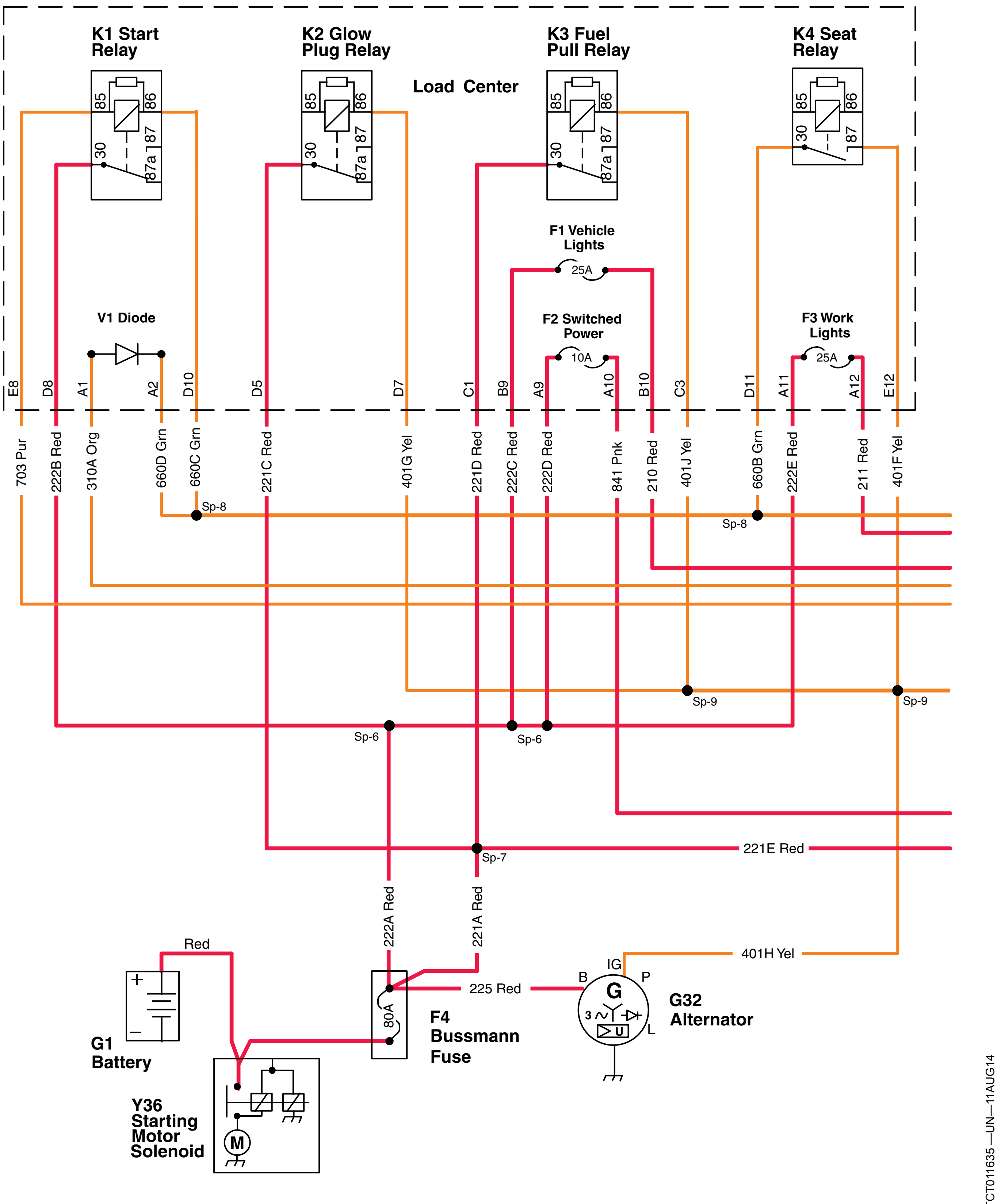
RB14256,00009AE -19-18AUG14-3/4



RB14256,00009AE -19-18AUG14-4/4

Power Circuit Schematic - Diesel Engine (S.N. 080001-)



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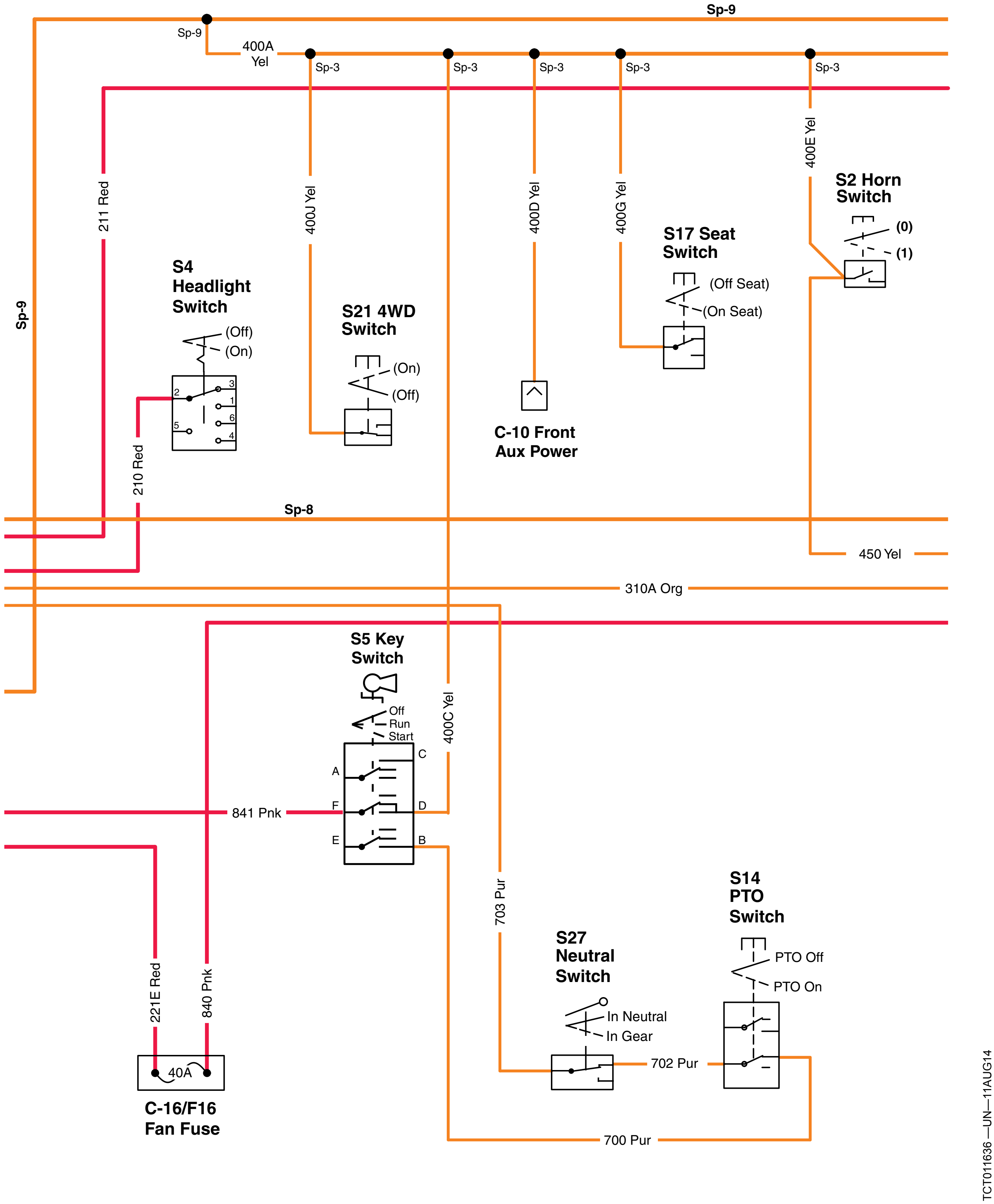
SH24924,0000246 -19-18AUG14-1/4



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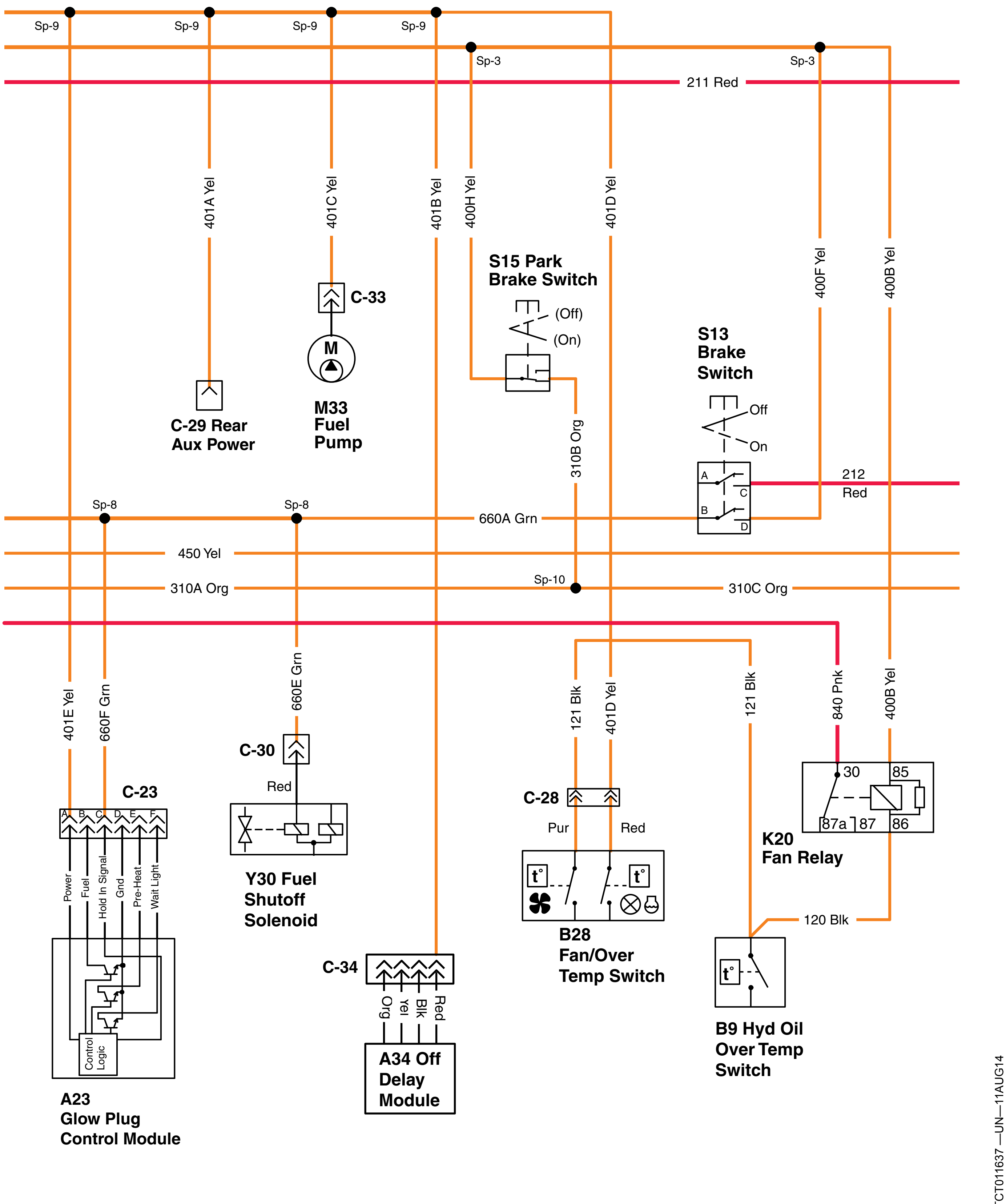
SH24924,0000246 -19-18AUG14-2/4



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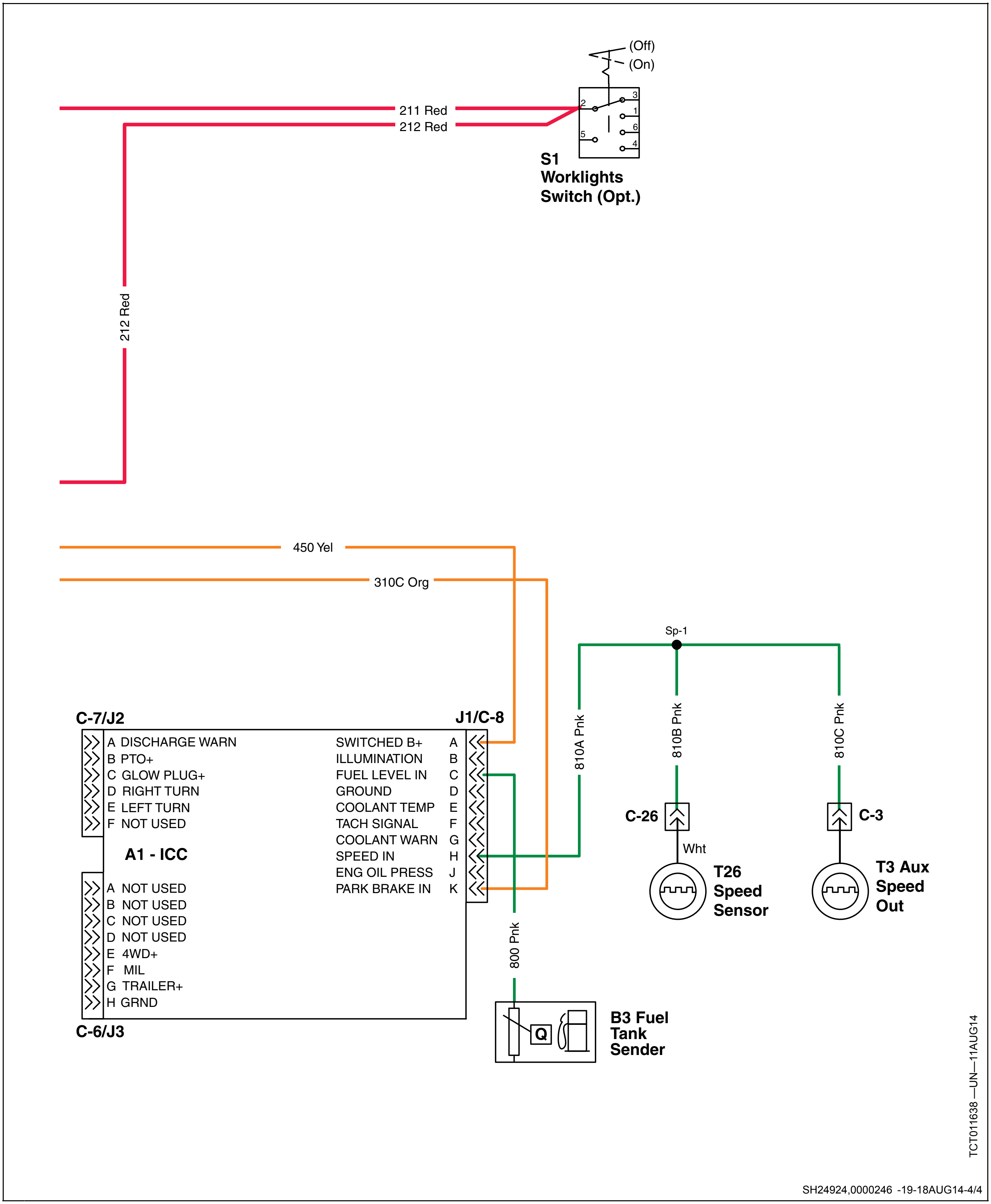
SH24924,0000246 -19-18AUG14-3/4



SH24924,0000246 -19-18AUG14-4/4

System: Power Circuit Diagnosis—Diesel Engine

RB14256,00009AF -19-12JUN14-1/25

Power Circuit Diagnosis—Diesel Engine

RB14256,00009AF -19-12JUN14-2/25

Step 1	• Key switch in OFF position. • Park brake LOCKED. • Meter negative (-) lead on battery negative (-) terminal or chassis ground. Starting Motor Solenoid - terminal B. Is battery voltage present?	**YES:** Go to next step. **NO:** Test red cable and connections.

RB14256,00009AF -19-12JUN14-3/25

Step 2	Alternator - terminal B. Is battery voltage present?	**YES:** Go to next step. **NO:** Test red cable and connections.

RB14256,00009AF -19-12JUN14-4/25

Step 3	Radiator Fan Relay - Pnk wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Test 200 series Red wires and fuse, Pnk wire and connections.

RB14256,00009AF -19-12JUN14-5/25

Step 4	Glow Plug Module - 400 series Red wires. Is battery voltage present?	**YES:** Go to next step. **NO:** Test 200 series Red wire and fuse and connections.

RB14256,00009AF -19-12JUN14-6/25

Step 5	Fuse - 204 Yel wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Test Fuse Yel wires, and connections.

RB14256,00009AF -19-12JUN14-7/25

Step 6	Brake Switch - 400 series Yel wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Test 400 series Yel wires and connections.

RB14256,00009AF -19-12JUN14-8/25

Step 7	Key Switch - 800 series Pnk wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Test 400 series Pnk wire, fuse and connections.

RB14256,00009AF -19-12JUN14-9/25

Step 8	Start Relay - 200 series Red wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Test 200 series Red wire, fuse and connections.

Continued on next page

RB14256,00009AF -19-12JUN14-10/25

Step 9	Key Switch - 400 series Yel wire. Place key switch in RUN position. Is battery voltage present.	**YES:** Go to next step. **NO:** Test key switch.

RB14256,00009AF -19-12JUN14-11/25

Step 10	Fuse - 400 series Yel wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Test 400 series Yel wire and connections.

RB14256,00009AF -19-12JUN14-12/25

Step 11	Brake Switch - 400 series Yel wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Test Fuse, 400 series Yel wire and connections.

RB14256,00009AF -19-12JUN14-13/25

Step 12	Auxiliary Power Connector - 405 Yel wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Test 405 Yel wire and connections.

RB14256,00009AF -19-12JUN14-14/25

Step 13	Alternator - 400 series Yel wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Test 400 series Yel wire and connections.

RB14256,00009AF -19-12JUN14-15/25

Step 14	Instrument Panel Connector - 450 Yel wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Test 400 series Yel wire and connections.

RB14256,00009AF -19-12JUN14-16/25

Step 15	Radiator Fan Relay - 421 Yel wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Test 421 Yel wire and connections.

RB14256,00009AF -19-12JUN14-17/25

Step 16	Fan/Over Temperature Switch - 400 series Yel wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Test 400 series Yel wire(s) and connections.

RB14256,00009AF -19-12JUN14-18/25

Step 17	Fuel Pump - 400 series Yel wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Test 400 series Yel wires and connections.

RB14256,00009AF -19-12JUN14-19/25

Step 18	Glow Plug Timer Module - 400 series Yel wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Test 400 series Yel wires and connections.

Continued on next page

RB14256,00009AF -19-12JUN14-20/25

Step 19	Park Brake Switch - 400 series Yel wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Test 400 series Yel wires and connections.

RB14256,00009AF -19-12JUN14-21/25

Step 20	Seat Switch - 400 series Yel wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Test 400 series Yel wires and connections.

RB14256,00009AF -19-12JUN14-22/25

Step 21	Seat Relay - 400 series Yel wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Test 400 series Yel wires and connections.

RB14256,00009AF -19-12JUN14-23/25

Step 22	Off Delay Module - 400 series Yel wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Test 400 series Yel wires and connections.

RB14256,00009AF -19-12JUN14-24/25

Step 23	4-Wheel Drive Switch - 400 series Yel wire. Is battery voltage present?	**NO:** Test 400 series Yel wires and connections.

RB14256,00009AF -19-12JUN14-25/25

Starting Circuit Operation - Gasoline Engine

Function

To energize the starting motor solenoid and engage the starting motor to crank the engine.

Operating Conditions

- Key switch in START position
- Transmission in NEUTRAL
- PTO DISENGAGED
- Operator ON the seat, or Brake Pedal Pressed, or Park Brake Engaged

Theory of Operation - Start Logic

The ECM determines if the starter is able to crank based on a power input to pin 50, and a zero engine rpm signal at pins 25 and 26.

One special condition is the when the foot pedal is fully depressed, the engine will crank but not start to clear an engine flooding condition.

ECM pin 72 has the crank enable signal (Starter). When this goes low the engine is allowed to crank. It will only go low if conditions are met.

Theory of Operation - Start Conditions

The neutral switch must be closed thereby supplying power through the closed PTO switch (PTO off) and through the closed key switch (switch in start position) and on to the start relay coil. This signal will pass through the coil to pin 72 (Starter) of the ECM.

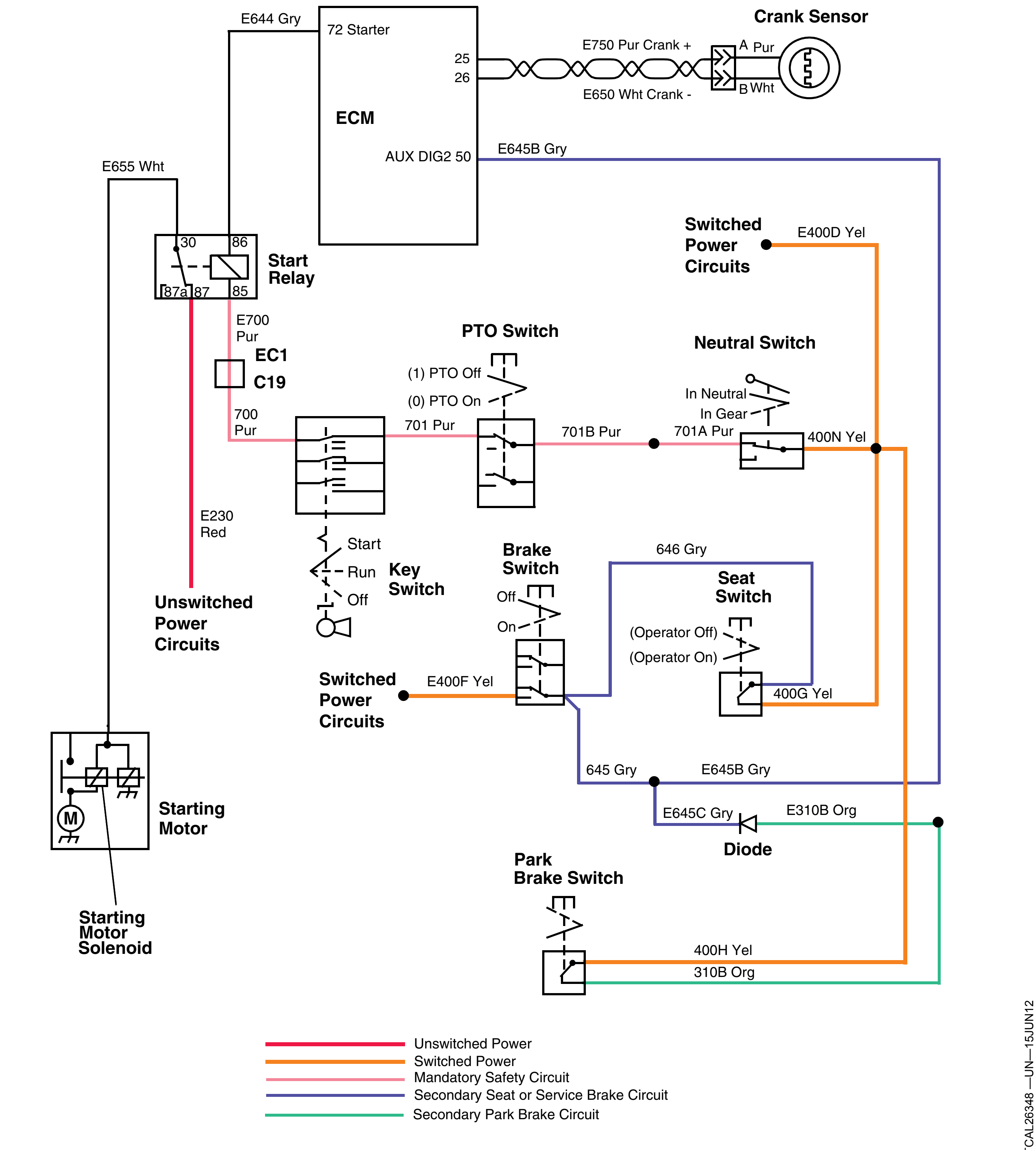
Power to pin 50 of the ECM is supplied by switched power through any of three circuits.

- Park brake ON
- Foot brake ON
- Seat switch ON

Once conditions are met, the ECM will pull this circuit low and cause the relay coil to energize and close the relay contacts. Unswitched power will then flow through the relay energizing the starter solenoid.

RB14256,00009B0 -19-18JUN12-1/1

Cranking Circuit Schematic - Gasoline EFI



RB14256,00009B1 -19-18JUN12-1/1

Starting and Fuel Shut-off Solenoid Circuit Operation - Diesel Engine

Function

To energize the starting motor solenoid and engage the starting motor to start the engine and engage the fuel shutoff solenoid to allow the engine to start and run.

Operating Conditions

- Key switch in START position (RUN position oncethe engine is running)
- Transmission in NEUTRAL
- PTO DISENGAGED
- and either:
- Park brake LOCKED
  or
- Operator ON the seat
  or
- Brake engaged

NOTE: The operator must be properly seated in the left seat to operate the vehicle with the brake disengaged and the park brake LOCKED.

Theory of Operation

To energize the starting motor solenoid Y36 and the starting motor M36, the start relay K1 must be energized. The start relay K1 receives voltage to the common terminal from the unswitched power circuit. When the start relay K1 coil is energized, the contacts close and connect the 222B Red wire to the 730 Pur wires. The 730 Pur wire supplies voltage to the starting motor solenoid Y36 causing it to energize. This supplies voltage to the starting motor M36, starting the engine while the 920 Wht wire supplies voltage to the fuel shutoff solenoid Y3 pull in coil. To energize the start relay K1, both the voltage input and the ground side are switched and must be activated.

Power to the start relay K1 for the starting process can be supplied by any one of three circuits:

- Brake switch S13
- Seat relay K4
- Park brake switch S15

Power is supplied to the fuse, 200 series Red wires, F2 fuse, S1 key switch over 841 Pnk wire Yel wire, F2 10 amp fuse, and 400 series wires.

From splice #3, power is supplied to the S17 seat switch through the 400 series Yel wires, the A3 off delay module through the 660 Gry wire, the K4 seat relay through the 400 Yel wire, and the S15 park brake switch through the 400 series Yel wires. Engaging either the park brake switch, brake switch or the seat switch will supply voltage to the start relay K1 as well as supplying voltage to hold in coil of the fuel shutoff solenoid Y30.

CAUTION: Avoid Injury! To avoid injury, ALWAYS lock park brake when starting the engine.

Park Brake Switch

If the operator has the park brake switch S15 engaged, then power is supplied to the 310 series Org wires. The 310C Org wire supplies power to the instrument panel to illuminate the park brake light while the 310A Org wire supplies power across the V1 diode to the 660 series Grn wires. The 660C Grn wire supplies power to the start relay K1, and the 660F wire to supply power across the C30 connector to the hold in coil of the Y30 fuel shutoff solenoid.

Seat Switch

Power is supplied via the 400 series Yel wires to the S17 seat switch. Output from the switch is then carried to the A34 delay module over the 660 Gry wire as an input. The 320 Org wire powers the K4 seat relay thereby closing the contacts and sending power out over the 660 series Grn wires. This will satisfy the A34 delay module and allow cranking or running functions.

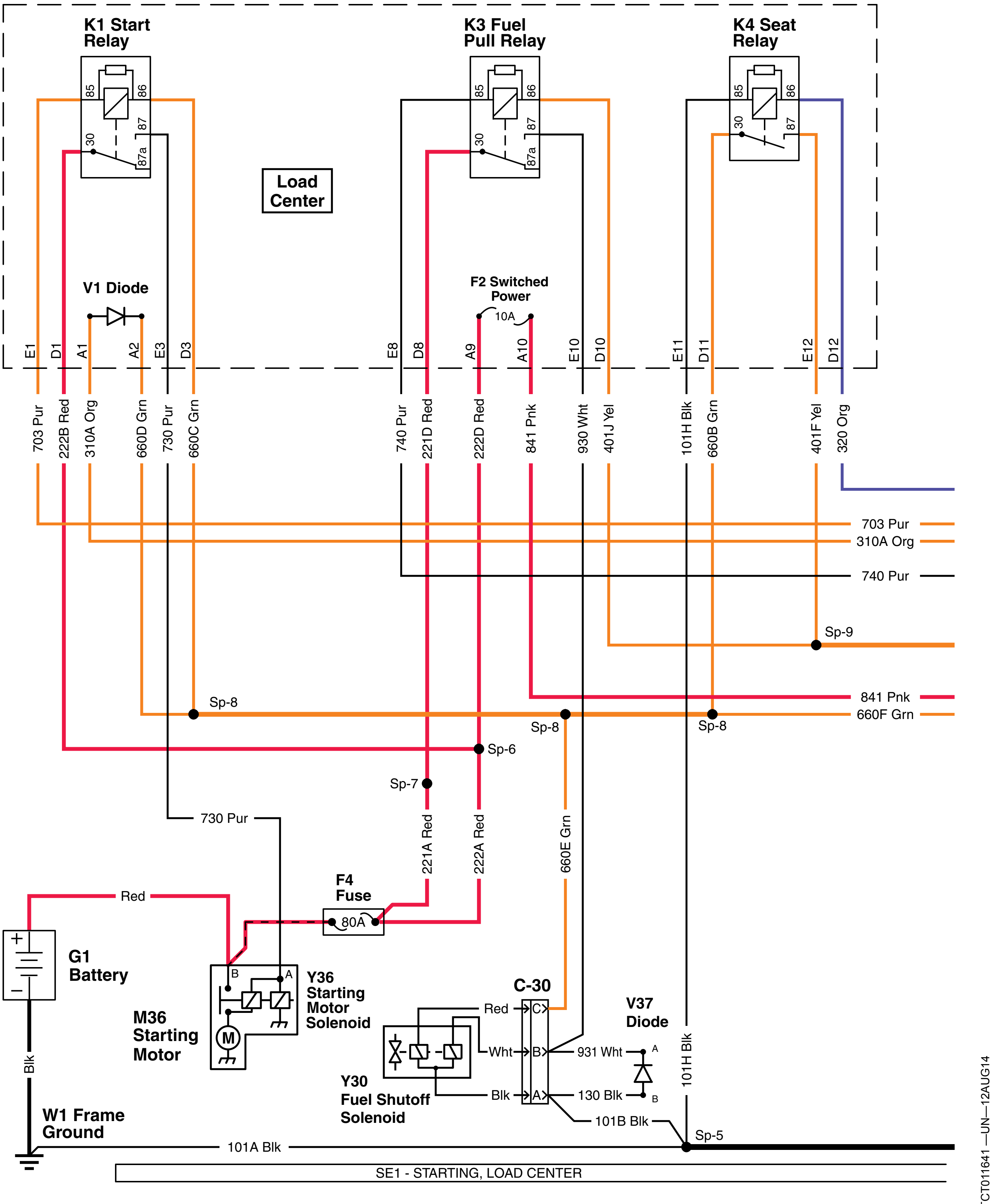
Brake Switch

If the operator has the brake switch S13 engaged, then power is supplied from the 400 series Yel wires. The 660 series Gry wires connect to supply power to the start relay K1 as well as the C30 connector to the hold in coil of the Y3 fuel shutoff solenoid.

Ground is provided, if operating conditions are met, via the 700 series Pur wires and 100 series Blk wires.

RB14256,00009B2 -19-18JUN12-1/1

Starting and Fuel Shutoff Solenoid Circuit Schematic - Diesel Engine (S.N. 080000)



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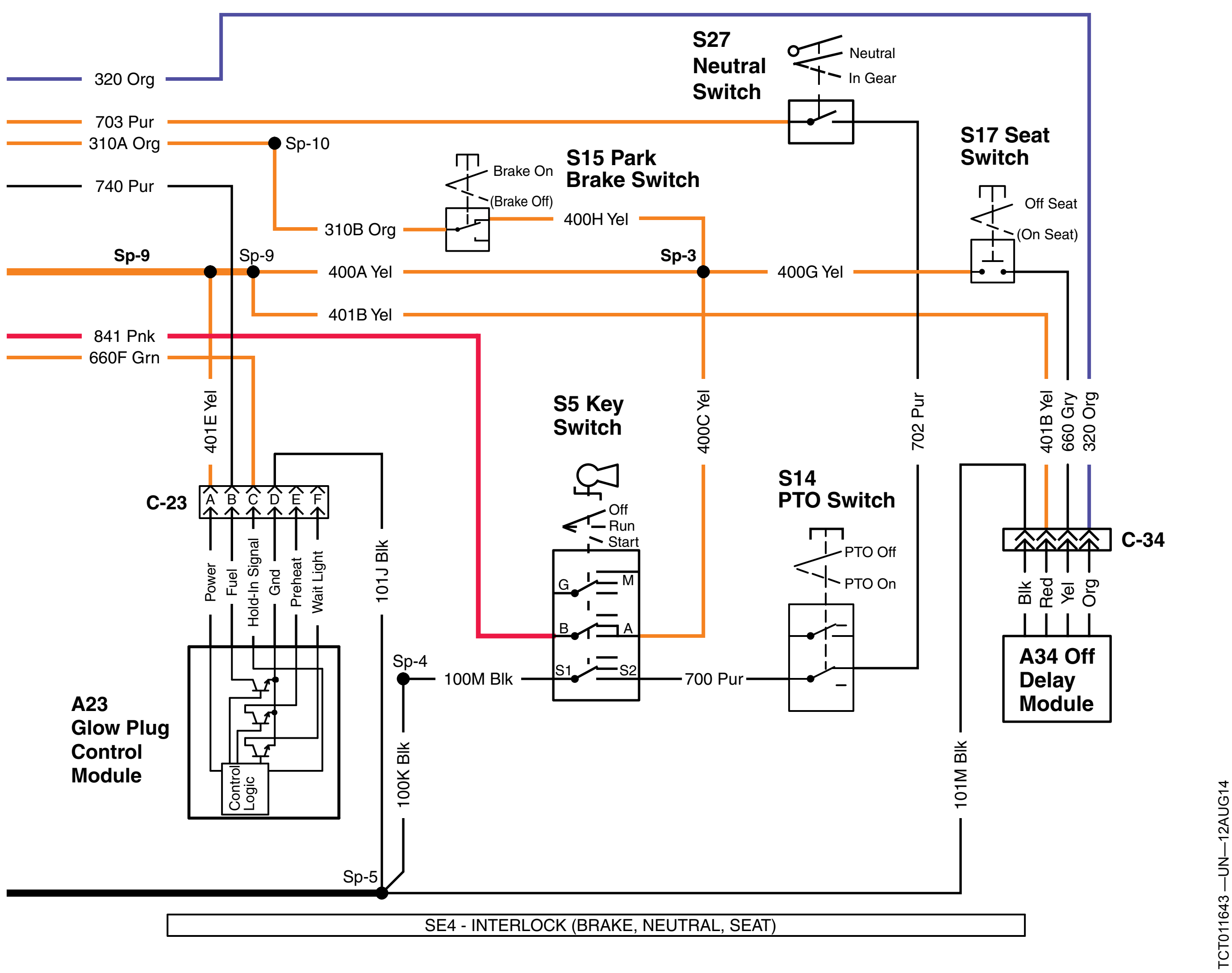
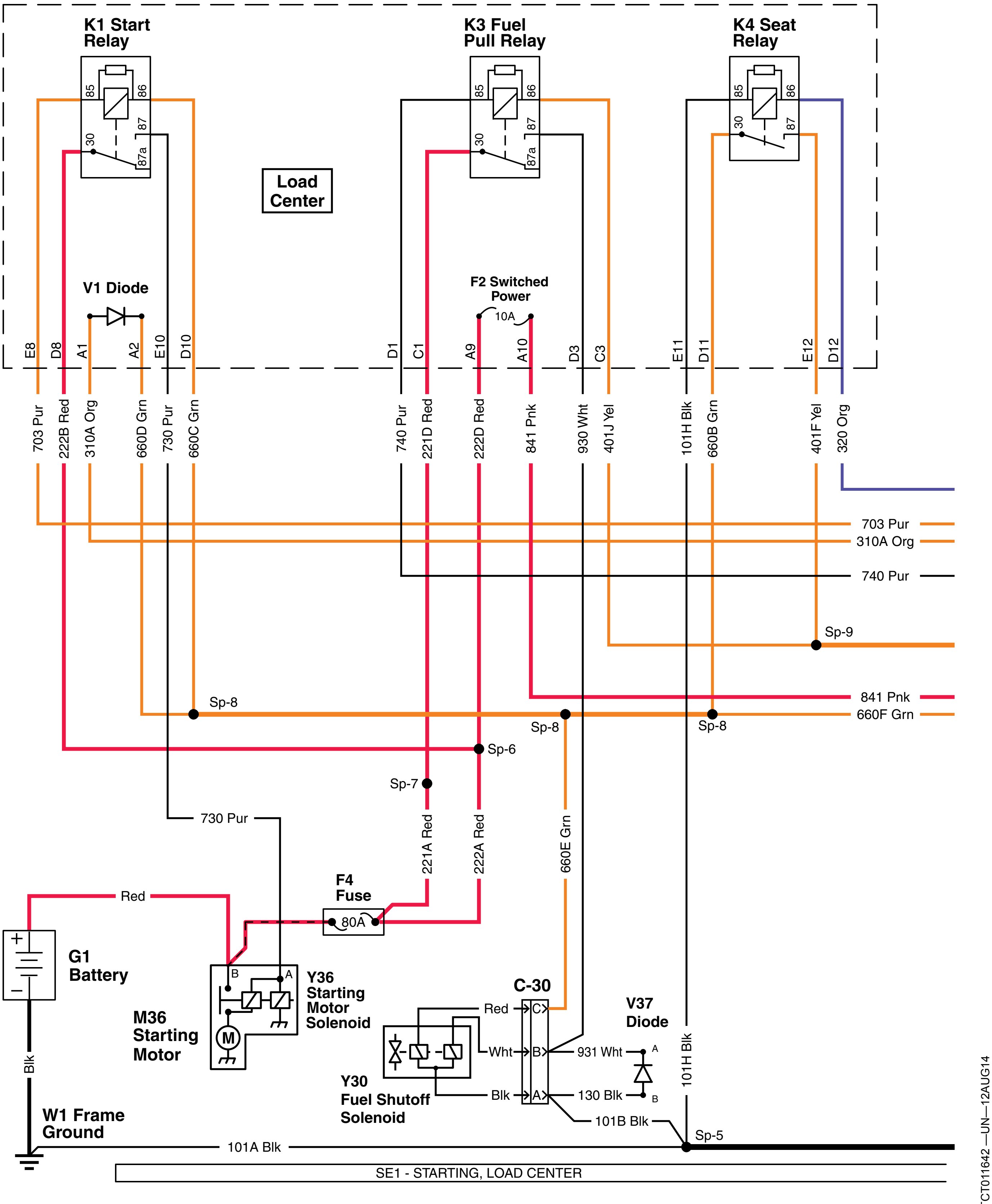
RB14256,00009B3 -19-18AUG14-1/2

Starting and Fuel Shutoff Solenoid Circuit Schematic - Diesel Engine (S.N. -080000) 2 of 2



RB14256,00009B3 -19-18AUG14-2/2

Starting and Fuel Shutoff Solenoid Circuit Schematic - Diesel Engine (S.N. 080001-)



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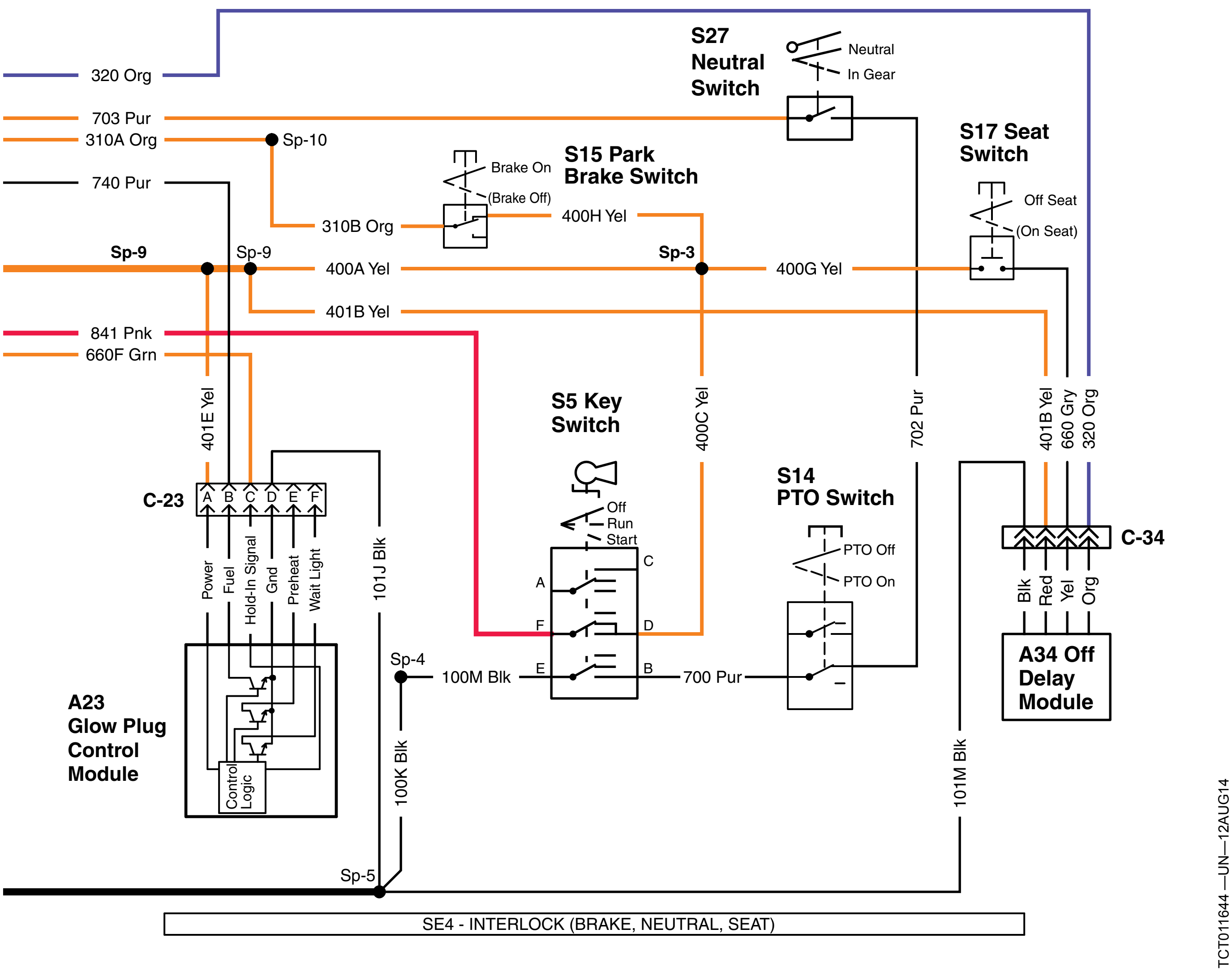
SH24924,0000247 -19-18AUG14-1/2

Starting and Fuel Shutoff Solenoid Circuit Schematic - Diesel Engine (S.N. 080001-) 2 of 2



SH24924,0000247 -19-18AUG14-2/2

System: Starting and Fuel Shutoff Solenoid Circuit (Operator OFF Seat) Diagnosis—Diesel Engine

RB14256,00009B4 -19-19JUN14-1/26

Starting and Fuel Shutoff Solenoid Circuit (Operator OFF Seat)—Diesel Engine

RB14256,00009B4 -19-19JUN14-2/26

Step 1	• Park brake LOCKED. • Key switch in START position. • Operator OFF the seat. • Transmission in NEUTRAL. • PTO DISENGAGED. • Fuel Shutoff Solenoid Connector (C30) disconnected. • Meter negative (-) lead on battery negative (-) terminal or chassis ground. Key Switch (S5) - 400C Yel wire. Is battery voltage present	**YES:** Go to next step. **NO:** Test key switch. Test 200 series Red wires to key switch.

RB14256,00009B4 -19-19JUN14-3/26

Step 2	Fuse (F2) - 841 Pnk wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Test 404 Yel wire and connections.

RB14256,00009B4 -19-19JUN14-4/26

Step 3	Fuse (F2) - 841 Pnk wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Test fuse (F2).

RB14256,00009B4 -19-19JUN14-5/26

Step 4	Fuel Pump Connector (C33) - 401C Yel wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Test 400 series Yel wires and connections.

RB14256,00009B4 -19-19JUN14-6/26

Step 5	Fuel Pump Connector (C33) - 101F Blk wire. Measure resistance to ground. Is there less than 0.1 ohm of resistance?	**YES:** Go to next step. **NO:** Test 101F Blk wire and connections. If ground circuit tests good, replace fuel pump.

RB14256,00009B4 -19-19JUN14-7/26

Step 6	Park Brake Switch (S15) - 400H Yel wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Test 400 series Yel wires and connections.

RB14256,00009B4 -19-19JUN14-8/26

Step 7	Park Brake Switch (S15) - 310B Org wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Replace park brake switch.

Continued on next page

RB14256,00009B4 -19-19JUN14-9/26

Step 8	Diode (V1) - 310A Org wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Test 310 series Org wires and connections.

RB14256,00009B4 -19-19JUN14-10/26

Step 9	Diode (V1) - 660D Grn wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Replace diode.

RB14256,00009B4 -19-19JUN14-11/26

Step 10	Start Relay (K1) - 660C Grn wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Test 660 Grn series Grn wires and connections.

RB14256,00009B4 -19-19JUN14-12/26

Step 11	Key Switch (S5) - 100M Blk wire. Measure resistance to ground. Is there less than 0.1 ohm of resistance?	**YES:** Go to next step. **NO:** Test 100 series Blk wires and connections.

RB14256,00009B4 -19-19JUN14-13/26

Step 12	Key Switch (S5) - 700 Pur wire. Measure resistance to ground. Is there less than 0.1 ohm of resistance?	**YES:** Go to next step. **NO:** Replace key switch.

RB14256,00009B4 -19-19JUN14-14/26

Step 13	PTO Switch (S14) - 700 Pur wire. Measure resistance to ground. Is there less than 0.1 ohm of resistance?	**YES:** Go to next step. **NO:** Test 700 Pur wire and connections.

RB14256,00009B4 -19-19JUN14-15/26

Step 14	PTO Switch (S14) - 702 Pur wire. Measure resistance to ground. Is there less than 0.1 ohm of resistance?	**YES:** Go to next step. **NO:** Replace PTO switch.

RB14256,00009B4 -19-19JUN14-16/26

Step 15	Neutral Switch (S27) - 702 Pur wire. Measure resistance to ground. Is there less than 0.1 ohm of resistance?	**YES:** Go to next step. **NO:** Test 703 Pur wire and connections.

RB14256,00009B4 -19-19JUN14-17/26

Step 16	Neutral Switch (S27) - 703 Pur wire. Measure resistance to ground. Is there less than 0.1 ohm of resistance?	**YES:** Go to next step. **NO:** Replace neutral switch.

RB14256,00009B4 -19-19JUN14-18/26

Step 17	Start Relay (K1) - 703 Pur wire. Measure resistance to ground. Is there less than 0.1 ohm of resistance?	**YES:** Go to next step. **NO:** Test 703 Pur wire and connections.

Continued on next page

RB14256,00009B4 -19-19JUN14-19/26

Step 18	Start Relay (K1). Cycle key switch between RUN and START positions. Does start relay click when switch is cycled?	**YES:** Go to next step. **NO:** Replace start relay.

RB14256,00009B4 -19-19JUN14-20/26

Step 19	Start Relay (K1) - 222B Red wire. Key switch in START position. Is battery voltage present?	**YES:** Go to next step. **NO:** Test 200 series Red wires, fuse and connections.

RB14256,00009B4 -19-19JUN14-21/26

Step 20	Start Relay (K1) - 730 Pur wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Replace start relay.

RB14256,00009B4 -19-19JUN14-22/26

Step 21	Starting motor solenoid - 730 Pur wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Test 700 series Pur wires and connections. Test starting motor solenoid. Test starting motor. (See Starting Motor Amperage Draw Test.)

RB14256,00009B4 -19-19JUN14-23/26

Step 22	Fuel Shutoff Solenoid Connector (C30) - 660E Yel wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Test 660 series Yel wires and connections.

RB14256,00009B4 -19-19JUN14-24/26

Step 23	Fuel Shutoff Solenoid Connector (C30) - 930 Wht wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Test 930 Wht wire and connections.

RB14256,00009B4 -19-19JUN14-25/26

Step 24	Fuel Shutoff Solenoid Connector (C30) - 101B Blk wire. Measure resistance to ground. Is there less than 0.1 ohm of resistance?	**NO:** Test 100 series Blk wires and connections.

RB14256,00009B4 -19-19JUN14-26/26

System: Starting and Fuel Shutoff Solenoid Circuit (Operator ON Seat) Diagnosis—Diesel Engine

RB14256,00009B5 -19-12JUN14-1/27

Starting and Fuel Shutoff Solenoid Circuit (Operator ON Seat)—Diesel Engine

Continued on next page

RB14256,00009B5 -19-12JUN14-2/27

Step 1	• Park brake DISENGAGED. • Key switch in START position. • Operator ON seat. • Transmission in NEUTRAL. • PTO DISENGAGED. • Fuel Shut-off Connector (C30) disconnected. • Meter negative (-) lead on battery negative (-) terminal or chassis ground. Key Switch (S5) -400C Yel wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Test key switch. Test 400 series wires.

RB14256,00009B5 -19-12JUN14-3/27

Step 2	Fuse (F2) - 404 yel wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Test 841 Pnk wire and connections.

RB14256,00009B5 -19-12JUN14-4/27

Step 3	Seat Switch (S17) - 400G Yel wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Test 400 series Yel wires and connections.

RB14256,00009B5 -19-12JUN14-5/27

Step 4	Seat Switch (S17) - 660 Gry wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Replace seat switch.

RB14256,00009B5 -19-12JUN14-6/27

Step 5	Off Delay Module (A34) - 401B Yel wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Test 4400 series wires and connections.

RB14256,00009B5 -19-12JUN14-7/27

Step 6	Off Delay Module (A34) - 101M Blk wire. Measure resistance to ground. Is there less than 0.1 ohm of resistance?	**YES:** Go to next step. **NO:** Test 100 series Blk wires and connections.

RB14256,00009B5 -19-12JUN14-8/27

Step 7	Off Delay Module (A34) - 320 Org wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Replace off delay module.

RB14256,00009B5 -19-12JUN14-9/27

Step 8	Seat Relay (K4) - 320 Org wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Test 320 Org wire and connections.

RB14256,00009B5 -19-12JUN14-10/27

Step 9	Seat Relay (K4) - 101H Blk wire. Measure resistance to ground. Is there less than 0.1 ohm of resistance?	**YES:** Go to next step. **NO:** Test 100 series Blk wires and connections.

Continued on next page

RB14256,00009B5 -19-12JUN14-11/27

Step 10	Seat Relay (K4) - 401F Yel wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Test 400 series Yel wires and connections.

RB14256,00009B5 -19-12JUN14-12/27

Step 11	Seat Relay (K4) - 660B Grn wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Replace seat relay.

RB14256,00009B5 -19-12JUN14-13/27

Step 12	Brake Switch (S13) - 400F Yel wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Test 400 series Yel wires and connections.

RB14256,00009B5 -19-12JUN14-14/27

Step 13	Diode (V1) - 660D Grn wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Test 4660 series wires and connections.

RB14256,00009B5 -19-12JUN14-15/27

Step 14	Start Relay (K1) - 703 Pur wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Test 703 wire and connections.

RB14256,00009B5 -19-12JUN14-16/27

Step 15	Key Switch (S5) - 100M Blk wire. Measure resistance to ground. Is there less than 0.1 ohm of resistance?	**YES:** Go to next step. **NO:** Test 100 series Blk wires and connections.

RB14256,00009B5 -19-12JUN14-17/27

Step 16	Key Switch (S5) - 700 Pur wire. Measure resistance to ground. Is there less than 0.1 ohm of resistance?	**YES:** Go to next step. **NO:** Replace key switch.

RB14256,00009B5 -19-12JUN14-18/27

Step 17	PTO Switch (S14) - 702 Pur wire. Measure resistance to ground. Is there less than 0.1 ohm of resistance?	**YES:** Go to next step. **NO:** Replace PTO switch.

RB14256,00009B5 -19-12JUN14-19/27

Step 18	Neutral Switch (S27) - 703 Pur wire. Measure resistance to ground. Is there less than 0.1 ohm of resistance?	**YES:** Go to next step. **NO:** Replace neutral switch.

RB14256,00009B5 -19-12JUN14-20/27

Step 19	Start Relay (K1) - 702 Pur wire. Measure resistance to ground. Is there less than 0.1 ohm of resistance?	**YES:** Go to next step. **NO:** Test 702 Pur wire and connections.

Continued on next page

RB14256,00009B5 -19-12JUN14-21/27

Step 20	Start Relay (K1). Cycle key switch between RUN and START positions. Does start relay click when the key switch is cycled?	**YES:** Go to next step. **NO:** Replace start relay.

RB14256,00009B5 -19-12JUN14-22/27

Step 21	Start Relay (K1) - 222B Red wire. Place key switch in START position. Is battery voltage present?	**YES:** Go to next step. **NO:** Test 200 series Red wires, fuse and connections.

RB14256,00009B5 -19-12JUN14-23/27

Step 22	Start Relay (K1) - 730 Pur wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Replace start relay.

RB14256,00009B5 -19-12JUN14-24/27

Step 23	Starting motor solenoid - 730 Pur wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Test 730 Pur wire and connections. Test starting motor solenoid. Test starting motor. See Starting Motor Amperage Draw Test.

RB14256,00009B5 -19-12JUN14-25/27

Step 24	Fuel Shutoff Solenoid Connector (C30) - 930 Wht wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Test 930 Wht wire and connections.

RB14256,00009B5 -19-12JUN14-26/27

Step 25	Fuel Shutoff Solenoid Connector (C30) - 101B Blk wire. Measure resistance to ground. Is there less than 0.1 ohm?	**NO:** Test 100 series Blk wires and connections.

RB14256,00009B5 -19-12JUN14-27/27

Charging Circuit Theory of Operation

Function

To maintain battery voltage between 12.4 and 14.2 volts.

Operating Conditions

- Key switch in RUN position
- Engine running

Theory of Operation

The charging system consists of the alternator with an integrated voltage regulator/rectifier. Charging output is controlled by a regulator/rectifier. The status of the charge rate is indicated by the discharge light on the display panel.

A rotating electro-magnet in the alternator induces AC current in the alternator controlled by the internal regulator.

The voltage regulator/rectifier converts AC current to DC current needed to charge the battery.

If battery voltage is low, the regulator/rectifier allows DC current to flow to the battery to charge it through the battery charging circuit (red wire). When the battery is fully charged, the voltage regulator/rectifier stops current flow to the battery.

Gas Engines: If battery voltage falls below a set point, and unlike a conventional charging system, the voltage regulator does not control the operation of the discharge light. The ECM has several voltage sensing inputs. Depending upon operating conditions, the ECM will illuminate the discharge light.

Diesel Engines: If battery voltage falls below a set point the alternator regulator turns on the discharge light.

RB14256,00009B6 -19-18JUN12-1/1

Tachometer Circuit Operation

Function

To indicate engine rpm to the operator.

Operating Conditions

- Key switch in RUN position
- Engine running

Theory of Operation

The display panel uses a pulsed signal from the ECM's injector #5 circuit as an engine timing reference to generate a visual display indicating actual engine rpm.

RB14256,00009B7 -19-18JUN12-1/1

Hour Meter Circuit Operation

Function

To indicate to the operator the number of hours the vehicle has been in use.

Operating Conditions

- Key switch in RUN or START position.

Theory of Operation

The hour meter operates when the key switch is in either the RUN or START position.

The hour meter is integrated into the control panel.

RB14256,00009B8 -19-18JUN12-1/1

Brake Light Circuit Operation

Function

To provide power from the brake switch to the tail lights to illuminate the brake light elements.

Operating Conditions

- Brake pedal depressed.

Theory of Operation

The brake switch is a double pole switch with one pole used in the ignition circuit and the other pole used to supply power to the brake lights.

The brake switch receives unswitched voltage to operate the brake lights from the 200 series Red wires. When the brake pedal is pressed, the contacts close and supply power to the 400 series Yel wires.

The ground path is provided by the 101 Blk wire series to the W1 frame ground.

RB14256,00009B9 -19-18JUN12-1/1

Park Brake Light Circuit Operation

Function

To provide power from the park brake switch to the instrument panel to illuminate the park brake light.

Operating Conditions

- Key switch in RUN position.
- Park brake LOCKED.

Theory of Operation

The park brake switch is activated by the park brake lever. When the park brake lever is disengaged, the park brake switch is held in the open position. When the park brake lever is engaged, the park brake switch is released and its contacts close allowing current to flow across it.

Switched voltage is supplied to the park brake switch common terminal from the 400 series Yel wires. With the park brake lever engaged, voltage is supplied to the 600 series wires. The 600 series wires supply voltage across the V1 diode to the ignition circuit, as well as voltage to the park brake light.

The ground path for the park brake light is provided by the 100 series Blk wires and the W1 frame ground.

RB14256,00009BA -19-18JUN12-1/1

Signal Light Circuit Operation (Optional)

Function

- To intermittently illuminate the signal lights on one side of the vehicle to indicate the intent to turn one direction or another.
- To intermittently illuminate all four signal lights to warn other people to use extra caution as they near the vehicle.

Operating Conditions

- Key switch in RUN position

Theory of Operation

The signal light switches have power available to them whenever a charged battery is properly connected to the electrical system and the key switch is in the RUN or START position.

Switched power is provided to the signal light circuit through 400 series Yel wires, 10 amp fuse, and flasher.

The flasher provides intermittent voltage to the signal light circuit when either the hazard switch or the turn signal switch is activated.

Turn Signal Switch Left Position

With the turn signal switch in the LEFT TURN position, intermittent voltage flows through the turn signal switch to 600 series wires. The 611 Org wire provides intermittent voltage to the left front turn signal. The 612 Red wire provides intermittent voltage to the left rear turn signal. The 617 Grn wire provides intermittent voltage to the left turn signal indicator light in the instrument panel.

Turn Signal Switch S9 Right Position

With the turn signal switch in the RIGHT TURN position, intermittent voltage flows through the turn signal switch to 600 series wires. The 615 Tan wire provides intermittent voltage to the right front turn signal. The 616 Red wire provides intermittent voltage to the right rear turn signal. The 619 Grn wire provides intermittent voltage to the right turn signal indicator light in the instrument panel.

Hazard Switch ON Position

With the hazard switch in the ON position, intermittent voltage flows through the hazard switch to both the left and right turn signal circuits.

The 600 series wires provide intermittent voltage to the left front turn signal. The 600 series wires provide intermittent voltage to the left rear turn signal. The 617 Grn wire provides intermittent voltage to the left turn signal indicator light in the instrument panel.

The 600 series wires provide intermittent voltage to the right front turn signal. The 600 series wires provide intermittent voltage to the right rear turn signal. The 619 Grn wire provides intermittent voltage to the right turn signal indicator light in the instrument panel.

The hazard switch will override the turn signals and cause all four signal lights to flash when it is in the ON position regardless of the position of the turn signal switch.

Each of the lights is also connected to the unswitched ground circuit to complete the electrical circuit.

RB14256,00009BB -19-18JUN12-1/1

Headlights Circuit Operation

Function

To provide voltage to the headlights, tail lights and instrument panel lights to illuminate them for added visibility.

Operating Conditions

- Headlight switch in ON position

Theory of Operation

The headlight switch receives voltage from the unswitched power circuit 200 Red wire. When the headlight switch is in the ON position, power is supplied to the 400 series Yel wires. See Power Circuit Operation - Gasoline Engine.

Each of the lights is connected to the unswitched ground circuit to complete the electrical circuit. See Power Circuit Operation - Gasoline Engine.

RB14256,00009BC -19-18JUN12-1/1

Work Lights Circuit Operation

Function

To provide voltage to the work lights to illuminate them for added visibility.

Operating Conditions

- Work light switch in ON position

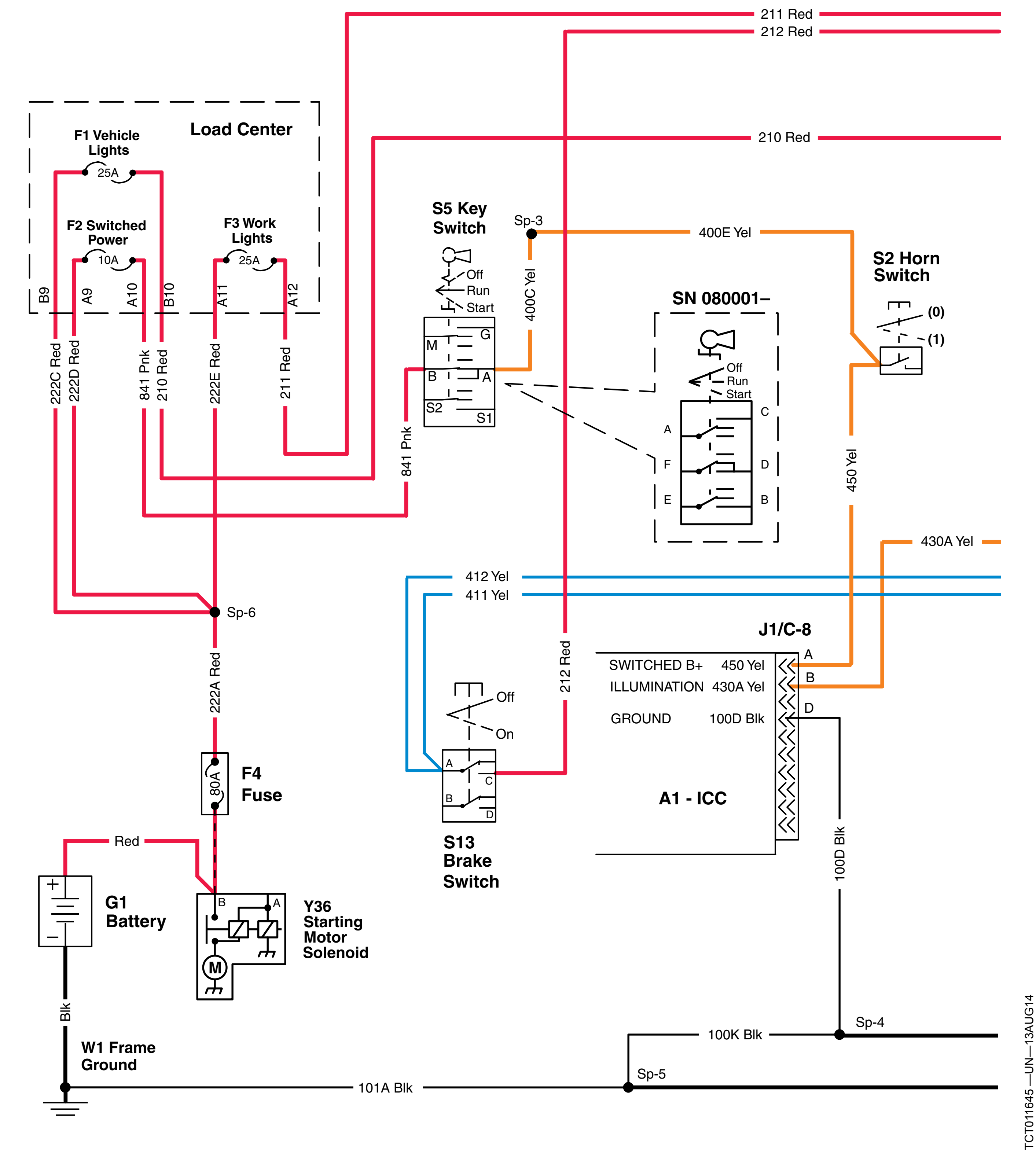
Theory of Operation

The work light switch receives voltage from the unswitched power circuit 200 series Red wires. When the work light switch is in the ON position, power is supplied to the 400 series wires to the 200 series Blk wires of the work lights wiring harness. See Power Circuit Operation - Gasoline Engine.

Ground is provided by the 100 series Blk wires of the work lights wiring harness and the connector back to the unswitched ground circuit of the W1 main wiring harness to complete the electrical circuit. See Power Circuit Operation - Gasoline Engine.

RB14256,00009BD -19-18JUN12-1/1

Lights Circuit Schematic



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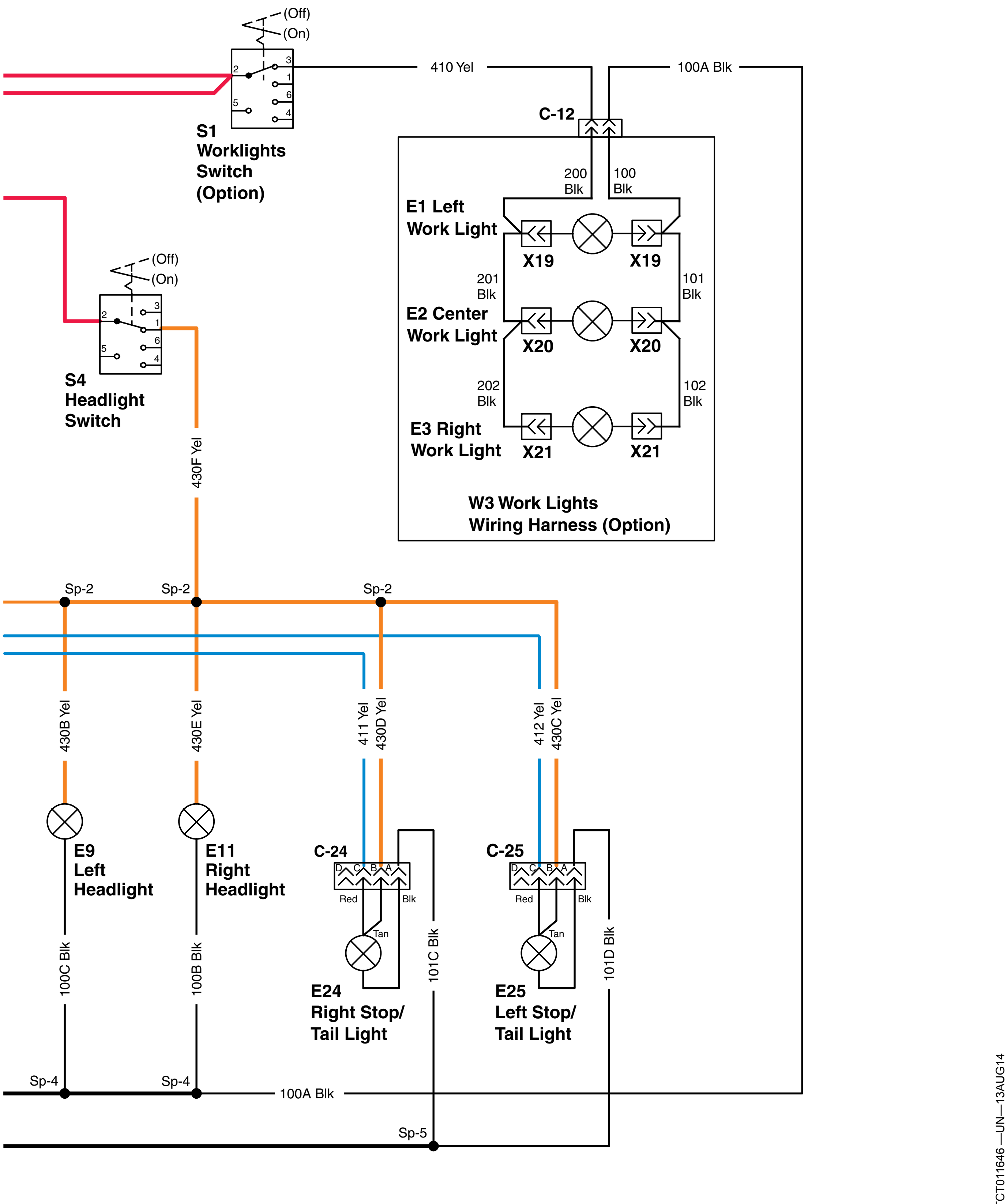
RB14256,00009BE -19-13AUG14-1/2



RB14256,00009BE -19-13AUG14-2/2

Radiator Fan Circuit Operation

Function

To energize the fan motor relay turning the fan motor on. This draws fresh air through the radiator to remove heat from the engine coolant. Should the coolant temperature exceed the normal operating range, an indicator light on the instrument panel will warn the operator.

Operating Conditions

- Key switch in RUN position
- Coolant temperature above 91°C (196°F) to turn on the radiator fan motor and above 110°C (230°F) to illuminate the coolant temperature warning light

Theory of Operation

The radiator fan circuit consists of five main components which are:

- Radiator fan relay
- Radiator fan motor
- Fan/over temperature switch
- Coolant temperature light
- Hydraulic oil temperature switch (if the auxiliary hydraulic kit is installed)

The fan/over temperature switch is a double pole temperature sensor that switches one set of contacts at approximately 91°C (196°F) and the other set of contacts at approximately 110°C (230°F). The lower temperature circuit is used to turn the radiator fan motor on and off as needed to draw air through the radiator to remove heat from the engine coolant. The higher temperature circuit is used to turn the coolant temperature light on if the coolant temperature continues to rise above the normal operating range of the engine.

The radiator fan and over temperature circuit is provided voltage from three sources.

The radiator fan relay has unswitched power supplied from the 200 series Red wires to the common (30) terminal, and switched power supplied to the relay coil (86) terminal. When the coolant temperature rises above approximately 91°C (196°F), the 100 series Blk wires connected to the other relay coil terminal (85) is connected to the unswitched ground circuit on the 100 series Blk wires by the fan/over temperature switch. The radiator fan relay then closes its contact and provides voltage from the 200 series Red wires (30 terminal) to the 400 series Yel wires (87 terminal) across the connector to the fan motor red wire. The fan motor black wire provides the path to ground through the connector, 100 series Blk wires to W1 frame ground.

If the coolant temperature rises above approximately 110°C (230°F), the fan/over temperature switch contacts close and provide a ground path for the 300 Org wire. This will illuminate the coolant temperature light.

If the hydraulic fluid temperature exceeds approximately 71°C (160°F), the hydraulic oil temperature switch closes. This provides a ground path for the 100 series Blk wires. The ground will allow the fan relay to be energized, turning on the radiator fan. When the oil cools to approximately 66°C (150°F), the temperature switch will open.

RB14256,00009BF -19-18JUN12-1/1

Engine Oil Pressure Light

Function

To alert operator of low engine oil pressure

Operating Condition

- Key switch must be in RUN or START position.

Theory of Operation

With the engine OFF and key switch in RUN position, engine oil pressure will be below 49 kPa (7.1 psi). The oil pressure switch will be in the normally closed position. The closed position completes a circuit path to ground and illuminates the engine oil pressure light. This informs the operator that the light is functional.

The light goes out when the engine oil pressure is at or above 49 kPa (7.1 psi), opens the engine oil pressure switch, and removes the ground circuit from the engine oil pressure light.

RB14256,00009C0 -19-18JUN12-1/1

Engine Coolant Temperature Gauge

Function

To inform the operator of the engine and coolant operating temperature.

Operating Condition

- Key switch must be in RUN or START position

Theory of Operation

The engine coolant temperature sensor is a variable resistor, providing a ground circuit path for the temperature gauge. As the engine coolant heats, the resistance increases. The temperature gauge circuit is part of the vehicle control panel. The engine coolant temperature sensor resistance is 46—481 ohms.

RB14256,00009C1 -19-18JUN12-1/1

Fuel Gauge

Function

Inform the operator of the approximate fuel level in the fuel tank.

Operating Condition

- Key switch must be in RUN or START position

Theory of Operation

The fuel level in the fuel tank is measured by the fuel gauge sensor. The sensor is a variable resistor. The resistance is set by movement of a mechanical linkage connected to a float in the fuel tank. The 5 to 95 ohm variable resistance creates a variable voltage difference across the fuel gauge. The voltage difference ranges from approximately 0.8 VDC (fuel tank FULL) to approximately 5.7 VDC (fuel tank EMPTY).

RB14256,00009C2 -19-18JUN12-1/1

PTO Indicator Light Circuit Operation

Function

To alert the operator that the PTO is engaged.

Operating Conditions

- Key switch in RUN position
- PTO engaged

Theory of Operation

Power for the PTO indicator light is provided from the fuse , 200 series Red wires, key switch, 400 series Yel wires, 10 amp fuse, 400 series Yel wires, to the instrument panel across the PTO indicator light to the 500 Blu wire.

The ground circuit for the PTO indicator light when the PTO is engaged is provided from the 100 series Blk wires to ground.

RB14256,00009C3 -19-18JUN12-1/1

System: PTO Indicator Light Circuit Diagnosis

RB14256,00009C4 -19-12JUN14-1/7

PTO Indicator Light Circuit Diagnosis

RB14256,00009C4 -19-12JUN14-2/7

Step 1	• Key switch in OFF position. • Park brake LOCKED. • PTO DISENGAGED. • Meter negative (-) lead on battery negative (-) terminal or chassis ground. PTO Switch 100F Blk wire. Measure resistance to ground. Is there less than 0.1 ohm of resistance?	**YES:** Go to next step. **NO:** Test 100 series Blk wires and connections.

RB14256,00009C4 -19-12JUN14-3/7

Step 2	Key Switch Yel wire. Place key switch in RUN position. Is battery voltage present?	**YES:** Go to next step. **NO:** Test key switch. (See Key Switch Test.)

RB14256,00009C4 -19-12JUN14-4/7

Step 3	Instrument Panel Connector Yel wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Check fuse. If fuse is good, test 400 series Yel wires and connections.

Continued on next page

RB14256,00009C4 -19-12JUN14-5/7

Step 4	Instrument Panel Connector - 500 Blu wire. Is battery voltage present?	**YES:** Go to next step. **NO:** Replace instrument panel.

RB14256,00009C4 -19-12JUN14-6/7

Step 5	PTO switch - 500 Blu wire. Is battery voltage present?	**NO:** Test 500 Blu wire and connections.

RB14256,00009C4 -19-12JUN14-7/7

4-Wheel Drive Indicator Light Circuit Operation

Function

To alert the operator that 4-wheel drive is engaged.

Operating Conditions

- Key switch in RUN position
- 4-wheel drive engaged

Theory of Operation

Power for the 4-wheel drive indicator light is provided from the fuse, 200 series Red wires, key switch, 400 series Yel wires, 10 amp fuse, 403 and 402 Yel wires, to the 4-wheel drive switch. When the 4-wheel drive switch is closed, power continues through Grn wire to the instrument panel.

The ground circuit for the 4-wheel drive indicator light is provided from the instrument panel through 100 series Blk wires to ground.

RB14256,00009C5 -19-18JUN12-1/1

Multi-Mode Throttle Operation

Function

There are three modes of operation:

- Normal Mode - Engine speed tracks foot pedal throttle position up to the maximum governed speed.
- Mobile Mode - Allows operator to set an alternate governed engine speed (less than the maximum). Engine speed will track the foot throttle up to this alternate speed and no higher, even if the foot pedal is pressed full stroke.
- PTO Mode - Engine controller ignores the foot pedal throttle and will hold engine speed at a constant value (idle up to 2500 rpm) based on the position of the rotary potentiometer. This mode requires transmission be in NEUTRAL and park brake to be ON.

Controls

A) Rotary Potentiometer - When in PTO Mode, rotating the knob clockwise increases the engine speed. Rotating the knob counterclockwise decreases engine speed.

B) Accel/Decel Switch - When operating in the Mobile Mode, pressing and holding the right hand side of the momentary switch will cause the governor set speed to increase at a linear rate until the switch is released. The Engine Control Unit (ECU) will remember this as the new maximum engine speed. Pressing and holding the left hand side of the momentary switch will clear the saved value, and the ECU will revert to the factory maximum governor speed.

To prevent unexpected engine acceleration, the ECU will not recognize the CLEAR input unless the foot throttle is at the idle position.

C) Mode Selection Switch - This switch tells the ECU which mode is desired.

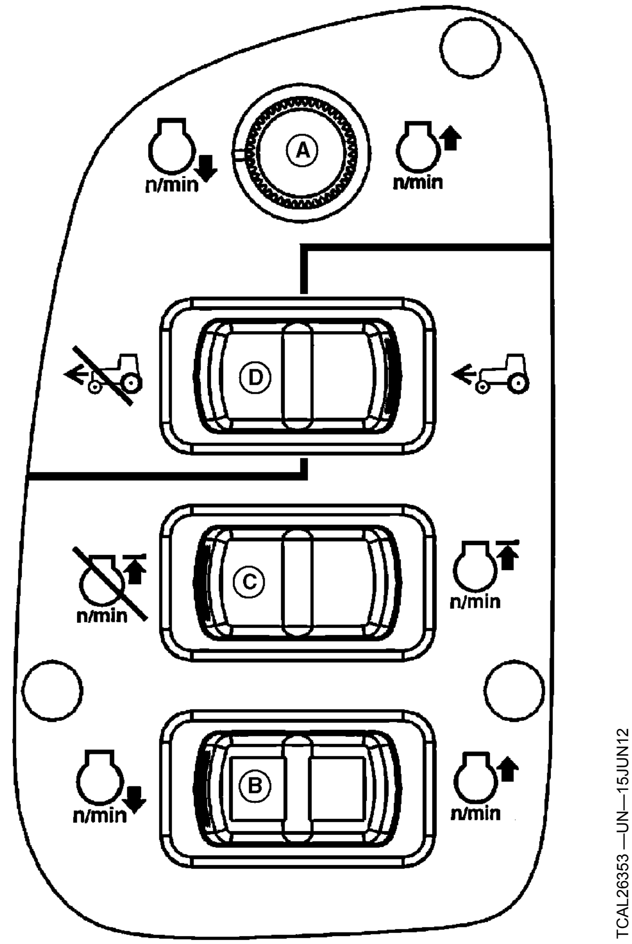
- Left - PTO (Stationary) Mode (illuminated)
- Middle - Normal Mode
- Right - Mobile Mode (illuminated)

Operation:

- Normal Mode
- Mode Select Switch - Middle position
- Mobile Mode
- Mode Select Switch - Right (MOBILE)
- While moving at desired maximum vehicle speed, move Set/Clear switch to SET
- Foot throttle can now be pushed to floor and set speed will be maintained
- PTO Mode
- Mode Select Switch - Left (PTO)
- Park Brake - ON
- Transmission - NEUTRAL
- Rotate potentiometer to desired engine speed

Operation

Mode Select:



A—PTO Mode Potentiometer
B—Accel/Decel Switch
C—Set/Clear Switch
D—Mode Select Switch

Before any multi-mode functions can be used, a mode of operation must be selected by depressing the desired mode of operation via S-4 mode switch.

Selecting either mobile or PTO mode will send a 12 Vdc or high signal via switched power to the ECU, latching that particular mode until manually released.

Accel/Decel Function:

Accel/Decel function is controlled by the S-3 momentary switch and the ECU is either sent a low or a high depending upon which operation is desired. The ECU will then maintain this speed until the mobile mode is de-selected.

This function may only be used in mobile mode and is controlled by the Set/Clear function.

Set/Clear Function:

Set/Clear function is controlled by the S-2 momentary switch and the ECU is sent either a high or a low depending upon which operation is desired. The ECU will either set or clear selected operation.

This function may be used in either PTO or mobile mode.

Continued on next page
RB14256,00009C6 -19-18JUN12-1/2

PTO Mode Potentiometer:

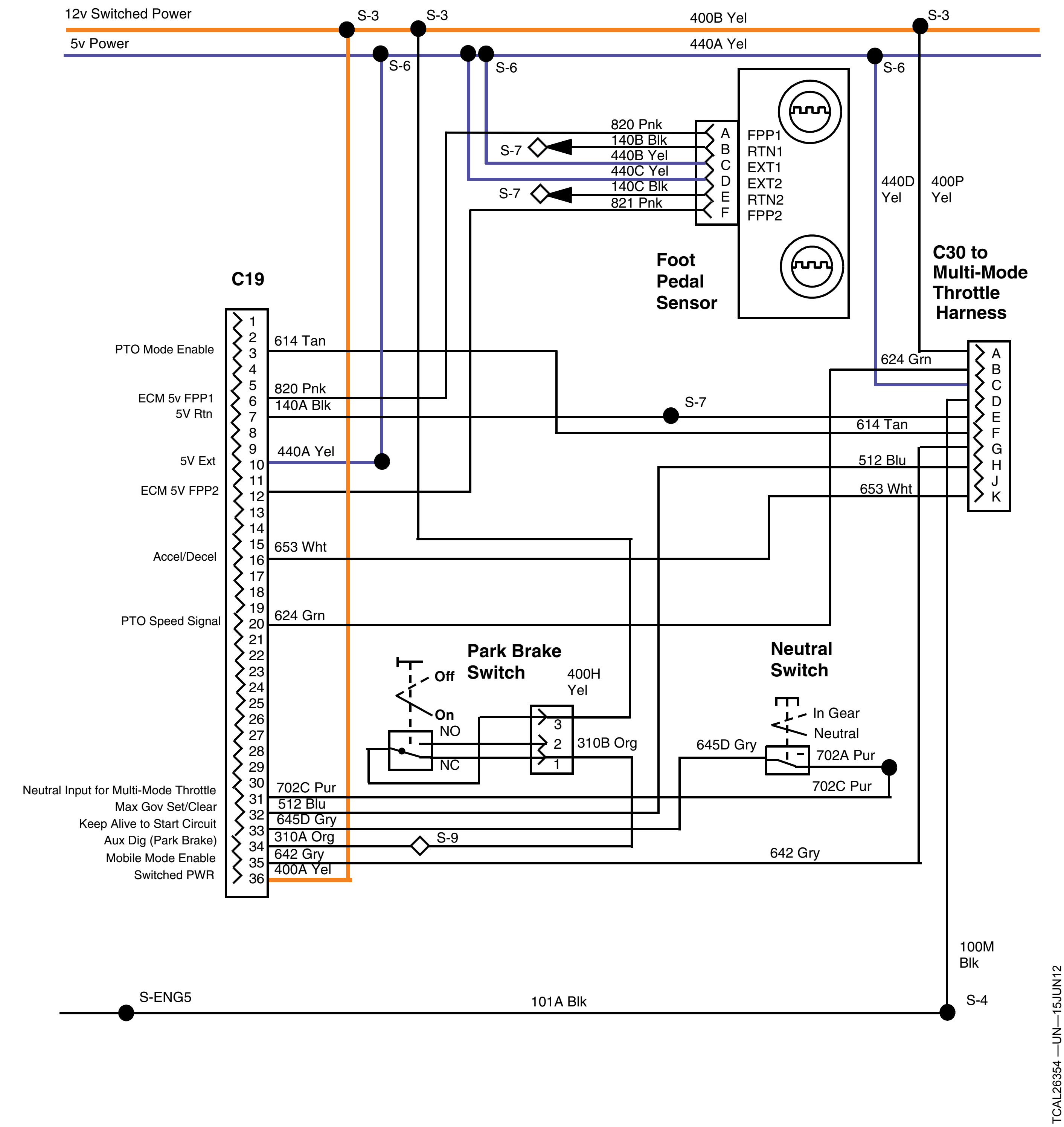
PTO engine speed potentiometer controls engine speed in PTO mode only. Maximum speed is 2500 RPM and minimum is low idle.

Potentiometer return voltage is 1.0 to 4.0 Vdc.

This function is controlled by Set/Clear function.

RB14256,00009C6 -19-18JUN12-2/2

Main Schematic to Multi-Mode Schematic



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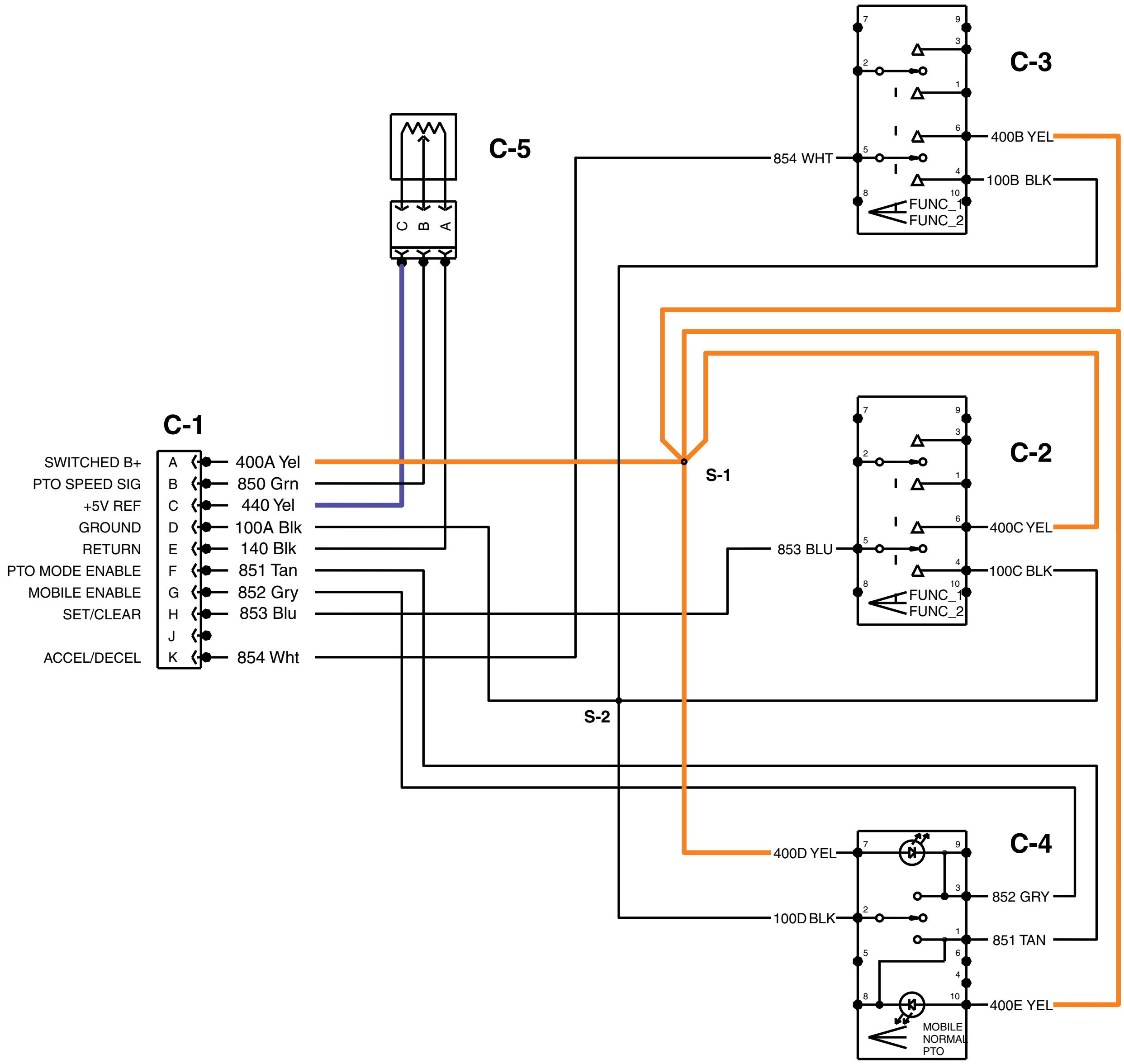
RB14256,00009C7 -19-18JUN12-1/2



TCAL26355 —UN—15JUN12

RB14256,00009C7 -19-18JUN12-2/2

Common Circuit Tests

Shorted or Grounded Circuit:

A shorted circuit on the ground side of a component (i.e. improper wire-to-wire or wire to ground contact) may result in improper component operation.

A shorted circuit on the power side of a component or contact of two power circuits (i.e. improper wire-to-wire or wire to ground contact) may result in blown fusible link and fuses.

To test for a shorted or improperly wired circuit:

1. Turn component switch on.
2. Start at the controlling switch of the component that should not be operating.
3. Follow the circuit and disconnect wires at connectors until components stop operating.
4. Shorted or improper connections will be the last two wires disconnected.

High Resistance or Open Circuit:

High resistance or open circuits usually result in slow, dim, or no component operation (i.e. poor, corroded, or severed connections). Voltage at the component will be low when the component is in operation.

To test for high resistance and open circuits:

1. Check all terminals and ground connections of the circuit for corrosion.
2. If terminals are not loose or corroded, the problem is in the component or wiring.

OUMX068,0000292 -19-04DEC12-1/1

Ground Circuit Test

Reason

To check for open circuits, loose terminal wire crimps, poor connections, or corrosion in the ground circuit.

NOTE: The voltmeter method checks ground connections under load.

Procedure - Ohmmeter Method

1. Park machine on level surface.
2. Turn all switches to the OFF position.
3. Make sure key switch is in the OFF position.
4. Raise engine cover.
5. Connect ohmmeter negative (black) lead to negative terminal of battery. Connect meter positive (red) lead to negative terminal of battery and record reading.
6. Connect ohmmeter red lead to ground terminal of circuit or component to be tested that is closest to the battery negative terminal. Resistance reading must be the same or very close to the battery negative terminal reading. Work backward from the battery frame ground on the ground side of the problem circuit until the resistance reading increases above 0.1 ohm. The problem is between the last two test points. If a problem is indicated, disconnect the wiring harness connector to isolate the wire or component and check resistance again. Maximum allowable resistance in the circuit is 0.1 ohm. Check both sides of the connectors closely, as disconnecting and connecting may temporarily solve problem.

Procedure - Voltmeter Method

1. Park machine on level surface.
2. Turn all switches to the OFF position.
3. Make sure key switch is in the RUN position.
4. Make sure the engine is not running.
5. Raise engine cover.
6. Connect voltmeter negative (black) lead to negative terminal of battery.
7. Connect voltmeter positive (red) lead to ground terminal of circuit (A) or component to be tested. Be sure that component circuit is activated (see appropriate circuit operation description) so that voltage will be present at the component. Record voltage. Voltage must be greater than 0, but less than 1.0 volt. Some components will have a very small voltage reading on the ground side and still be operating correctly.

Results

- If voltage is 0, the component is open.
- If voltage is greater than 1.0 volt, the ground circuit is bad. Check for open wiring, loose terminal wire crimps, poor connections, or corrosion in the ground circuit.

CB12260,000042C -19-20NOV15-1/1

Battery Voltage and Specific Gravity Tests

Reason:

To check voltage and determine condition of battery.

Procedure:

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

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

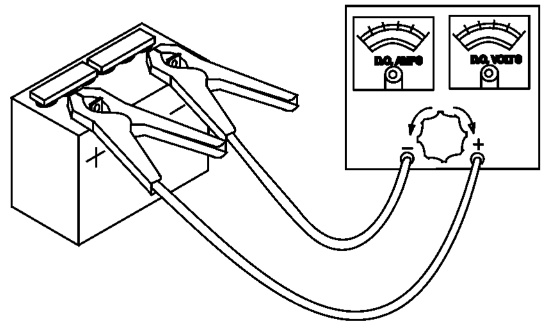
If you spill acid on yourself:

- **Flush your skin with water.**
- **Apply baking soda or lime to help neutralize the acid.**
- **Flush your eyes with water for 10—15 minutes. Get medical attention immediately.**

If acid is swallowed:

- **Drink large amounts of water or milk.**
- **Then drink milk of magnesia, beaten eggs, or vegetable oil.**
- **Get medical attention immediately.**

1. Clean battery terminals and top of battery. Inspect battery terminals and case for breakage or cracks.
2. Check electrolyte level in each battery cell. Add clean, soft water as needed. If water added, charge battery for 20 minutes at 10 amps.
3. Remove surface charge by placing a small load on the battery for 15 seconds.



MXT001931 —UN—22DEC11

4. Check battery voltage with voltmeter or JT05685 Battery Tester or equivalent.
5. Check specific gravity of each cell with a hydrometer.

Results:

- Battery voltage less than 12.4 VDC, charge battery to specification.

Specification

Battery (Minimum)—Voltage	12.4 VDC

- Battery voltage more than 12.4 VDC, test specific gravity to specification.

Specification

Battery (Minimum)—Electrolyte Specific Gravity	1.225 with less than 50 point variation

- All cells less than 1.175, charge battery at 10 A rate.
- All cells less than 1.225 with less than 50 point variation, charge battery at 10 A rate.
- All cells more than 1.225 with less than 50 point variation, load test battery.
- More than 50 point variation: replace battery.

OUMX068,000027A -19-11AUG14-1/1

Battery Charge

Reason:

To increase battery charge after battery has been discharged.

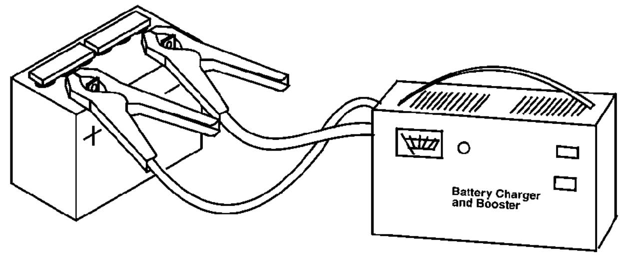
Procedure:

1. Connect variable rate charger to battery.

NOTE: Maximum charge time at boost setting is 10 minutes. Allow an additional 5 minutes for each 10 degrees below 21°C (70°F).

2. Start charger at slow rate. Increase charge rate one setting at a time. Check charger ammeter after 1 minute at each setting. Maintain 10 A charge rate. Use boost setting as necessary.
3. Check if battery is accepting a 10 A charge after 10 minutes at boost setting.
   - Battery will not accept 10 A charge after 10 minutes at boost setting: replace battery.
   - Battery is accepting 10 A charge after 10 minutes at boost setting, and battery did not need water: go to steps 6 and 7.
   - Battery is accepting 10 A charge after 10 minutes at boost setting, but battery did need water or all cells were below 1.175: go to steps 4 and 5.

IMPORTANT: Decrease charge rate if battery gases or bubbles excessively or becomes too warm to touch.



MXT001932 —UN—22DEC11

4. Set charger at 15—25 amps.

NOTE: If battery was discharged at slow or unknown rate, charge at 10—15 amps for 6—12 hours (Maintenance—free battery: 12—24 hours). If battery was discharged at fast rate, charge at 20—25 amps for 2—4 hours (Maintenance—free battery: 4—8 hours).

5. Check specific gravity after 30 minutes (60 minutes for maintenance—free battery).
   - More than 50 point variation between cells: replace battery.
   - Less than 50 point variation between cells: go to steps 6 and 7.
6. Continue charging battery until specific gravity is 1.230—1.265 points.
7. Load test battery. (See “Battery Load Test”.)

OUMX258,00002EA -19-11AUG14-1/1

Battery Load Test

Reason:

To check condition of battery under load.

NOTE: See “Battery Charge” before applying a load to battery.

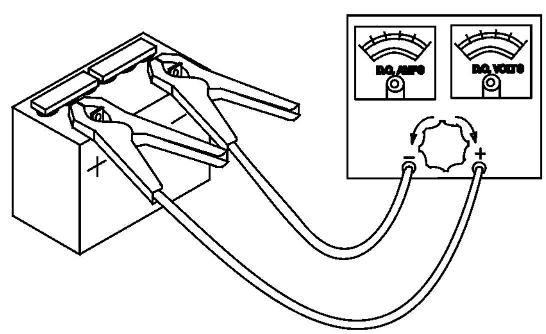
NOTE: Use the procedures given with the tester.

Procedure:

1. Turn load knob of JT05685 battery tester or equivalent clockwise until amperage reading is equal to:
   - One half (1/2) cold cranking amperage rating (use blue scale).

   OR

   - Three times ampere hour rating (use black scale).
2. Hold for 15 seconds and turn load knob of tester off.



MXT001931 —UN—22DEC11

JT05685 Battery Tester or Equivalent

3. Read battery voltage.

Results:

- If the battery does not indicate 9.6 V or more, replace battery.

OUMX068,000027C -19-03SEP15-1/1

Unregulated Voltage Output Test

Reason

To measure alternator output.

Special or Required Tools:

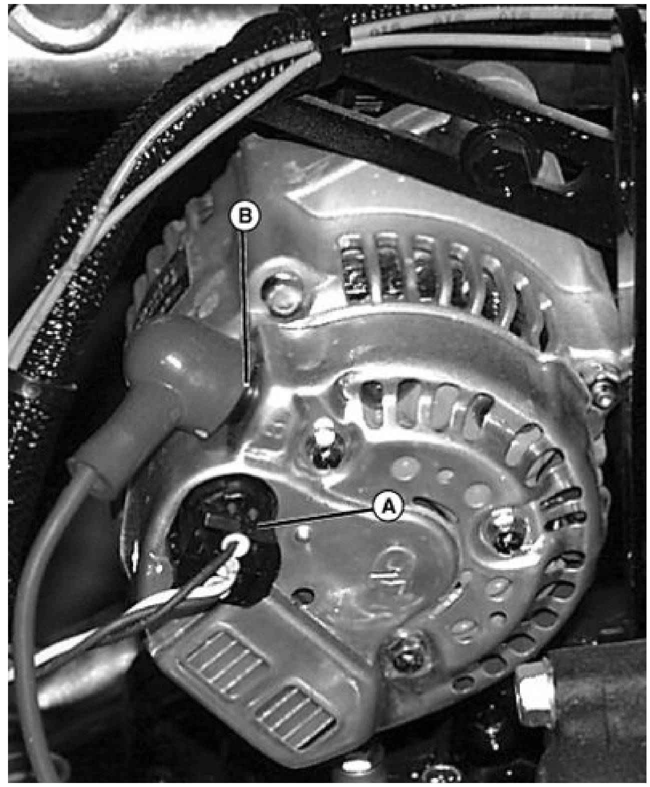
- Voltmeter

Procedure

1. Park machine on a level surface.
2. Turn all switches to the OFF position.
3. Lock park brake, place gear shift in neutral position, and disengage differential lock.
4. Raise cargo box or remove the optional component installed on the vehicle as needed to provide clearance.

CAUTION: Avoid Injury! Engine parts may be hot. Allow engine to cool before servicing.

5. Disconnect three-pin connector (A) from alternator.
6. Connect voltmeter, set to read AC voltage, to alternator outputs (B).
7. Start and run engine at fast idle. The meter should read a minimum of 50 volts AC at FAST idle.



TCAL26360 —UN—15JUN12

Specification

Alternator Slow Idle—Voltage	32 VAC
Alternator Fast Idle—Voltage	50 VAC

.

If reading is BELOW specification, test alternator.

RB14256,00009CC -19-30SEP16-1/1

Unregulated Amperage Test

Reason

To determine charging output of the alternator stator.

Special or Required Tools:

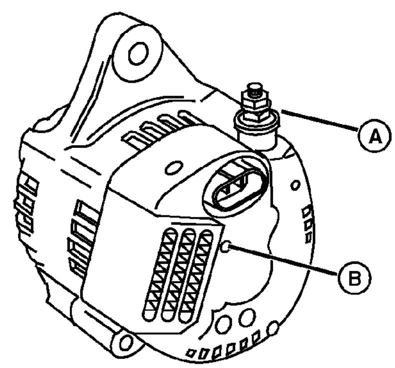
- Current Gun

Procedure

1. Put JT05712 Current Gun over red wire connected to the alternator output terminal (A). Set current gun for DC current.

IMPORTANT: Avoid Damage! Perform this test quickly to prevent damage to the battery. DO NOT apply full load to battery for more than 10 seconds.

2. Start and run engine at 3570 rpm.
3. Insert a small Phillips screwdriver through the hole (B) in rear cover of alternator to ground the regulator to the rear cover. Read amperage on current gun.



TCAL26361 —UN—15JUN12

Specification

Minimum Unregulated Amperage—Amperage	40 amps

Results

If reading does not meet specification, verify voltage at the alternator regulated terminal and good alternator ground. If voltage and ground are OK, replace the alternator.

RB14256,00009CD -19-18JUN12-1/1

Regulated Amperage and Voltage Tests

Reason

To determine the regulated voltage (charging) output of the regulator/rectifier.

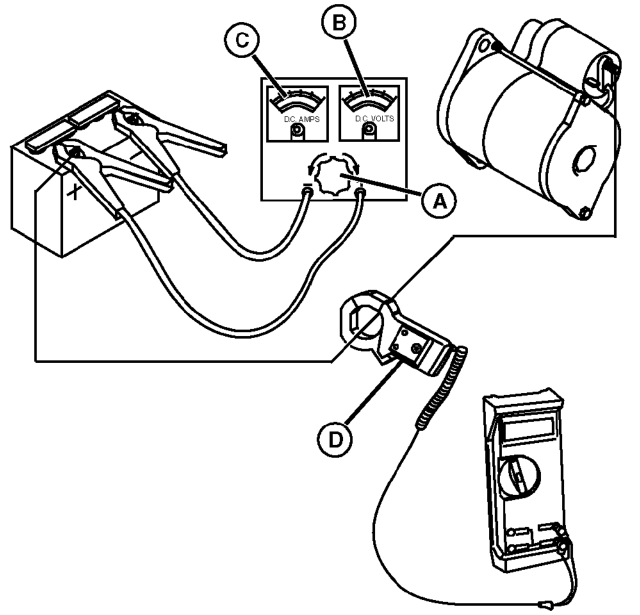
Special or Required Tools:

- Current Gun
- Battery Tester

Procedure

1. Park machine on a level surface.
2. Turn all switches to the OFF position.
3. Lock park brake, place gear shift in neutral position, and disengage differential lock.
4. Raise cargo box or remove the optional component installed on the vehicle as needed to provide clearance.
5. Disconnect three-pin connector from alternator.

NOTE: Battery must be in a good state of charge.



TCAL26362 —UN—15JUN12

6. Connect JT05712 Current Gun (D) to voltmeter and put around positive (red) battery cable going to starter. Set current gun for DC current.

IMPORTANT: Avoid Damage! Turn load knob (A) fully counterclockwise (out) into OFF position BEFORE making any test connections.

7. Connect battery tester to battery.

IMPORTANT: Avoid Damage! Perform this test quickly to prevent damage to the battery. DO NOT apply full load to battery for more than 5-10 seconds.

8. Turn load knob clockwise (in) until voltage on voltage tester scale reads 11 volts for 5 seconds only, to partially drain battery.
9. Quickly turn load knob completely counterclockwise (out) to OFF position.
10. Start and run engine at fast idle. Battery voltage should read between 12.2 and 14.7 volts DC.
11. Turn load knob clockwise (in) until voltage on tester voltage scale (B) reads 11 volts and look at current gun for a minimum reading of 13.5 amps.
12. Quickly turn load knob completely counterclockwise (out) to OFF position.
13. After load test, voltage scale (B) should return to a maximum of 14.7 volts DC.

Specification

Regulated Voltage
(Max)—Voltage..14.7 VDC

Results

- If current gun amp reading is BELOW specification, test for unregulated voltage output. If unregulated voltage output test meets specifications and you have verified voltage to ground to regulator/rectifier, replace regulator/rectifier.
- If at any time voltage increase exceeds 14.7 volts DC, replace regulator/rectifier.

RB14256,00009CE -19-30SEP16-1/1

Starting Motor Solenoid Test

Reason

To determine if starting motor is operating properly.

Special or Required Tools

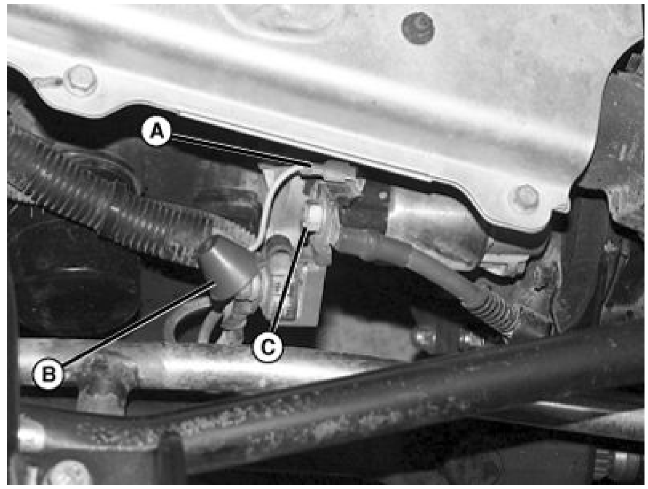
- Jumper Wire

Procedure

1. Park machine on level surface.
2. Turn all switches to the OFF position.
3. Lock park brake, place gear shift in neutral position, and disengage differential lock.
4. Raise cargo box or remove the optional component installed on the vehicle as needed to provide clearance.
5. Disconnect fuel shutoff solenoid wire connector.
6. Disconnect Pur wire from starting motor solenoid terminal (A).
7. Connect jumper wire to positive (+) battery terminal and briefly jump to starting motor solenoid terminal (A).

   Results

   - Starting motor runs - solenoid is good, test cranking circuit wiring.



TCAL26363 —UN—15JUN12

   - Starting motor DOES NOT run - go to next step.

8. Remove rubber boot from terminal (B).
9. Connect jumper wire between starting motor solenoid large terminals (B and C).

Results

- Starting motor runs - replace starter.
- Starting motor DOES NOT run - check battery cables, then replace starting motor.

RB14256,00009CF -19-19AUG14-1/1

Starting Motor Amperage Draw Test

Reason

To determine the amperage required to crank the engine and check starting motor operation under load.

Special or Required Tools:

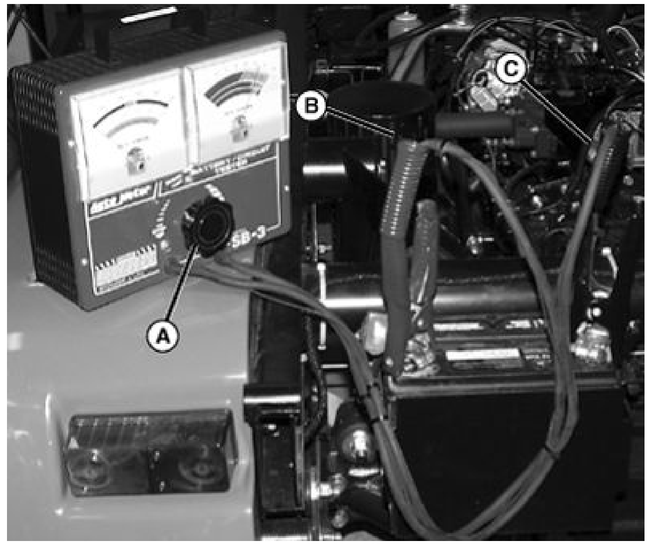
- Battery Tester

Procedure

1. Park machine on level surface.
2. Turn all switches to the OFF position.
3. Lock park brake, place gear shift in neutral position, and disengage differential lock.
4. Raise cargo box or remove the optional component installed on the vehicle as needed to provide clearance.
5. Test ground connections and battery.
6. Disconnect fuel shutoff solenoid connector.

IMPORTANT: Avoid Damage! Turn load knob (A) fully counterclockwise before making any test connections.

7. Connect JT05685 Battery Tester red lead (B) to battery positive (+) terminal.
8. Connect JT05685 Battery Tester black lead (C) to battery negative (-) terminal.
9. Crank engine and read voltage.
10. Turn key switch to the OFF position. Adjust load knob until battery voltage reads the same as when cranking.



TCAL26364 —UN—15JUN12

11. Read amperage on meter.

Specification

Starting Motor Current Drawwhile Cranking Engine—Amperage.. 150 amps

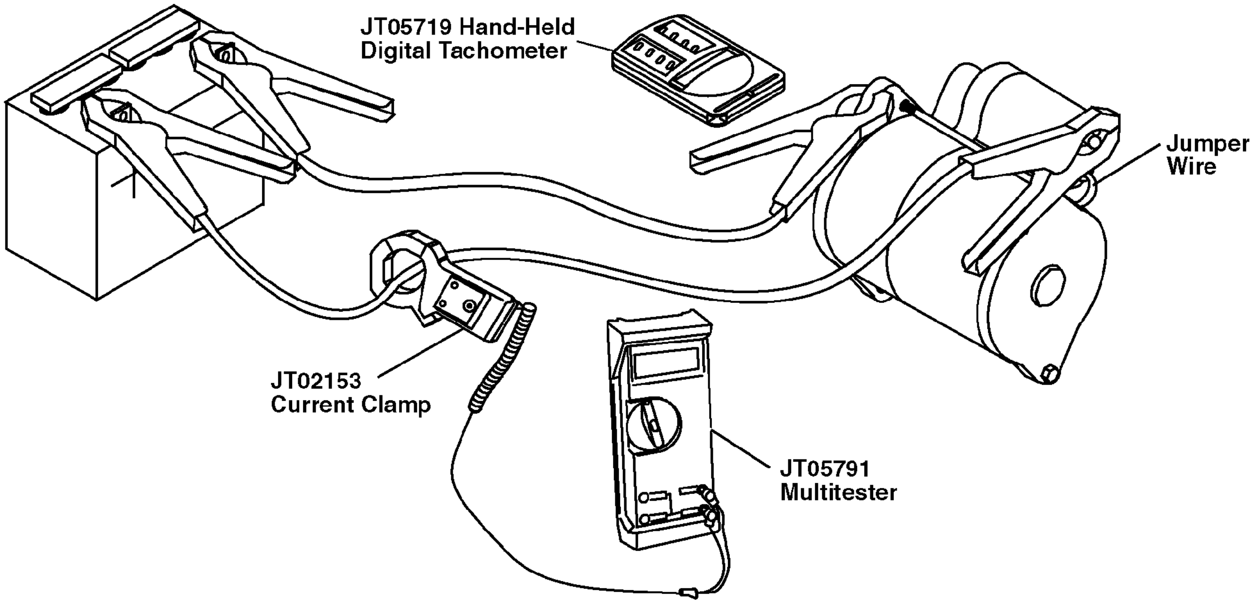
12. Turn load knob fully counterclockwise.

Results

- If amperage is greater than specification, test starting motor no-load rpm and amperage to determine if the starting motor is binding or damaged.
- If the starting motor is good, check internal engine components for binding or damage.

RB14256,00009D0 -19-18JUN12-1/1

Starting Motor Current Draw and RPM Tests



Reason

To determine if starter is binding or has excessive amperage draw under no load.

Special or Required Tools

- Current Clamp
- Multitester
- Tachometer

Procedure

NOTE: Check that battery is fully charged and of proper size to ensure accuracy of test.

1. Park machine on level surface.
2. Turn all switches to the OFF position.
3. Lock park brake, place gear shift in neutral position, and disengage differential lock.
4. Raise cargo box or remove the optional component installed on the vehicle as needed to provide clearance.
5. Remove starting motor assembly from vehicle and place starting motor in vice.
6. Connect jumper cables to a 12-volt battery.
7. Connect positive (+) cable to solenoid battery terminal on starting motor.
8. Connect negative (-) cable to starting motor body.
9. Attach current gun to positive (+) cable.

IMPORTANT: Avoid Damage! Complete this test in 20 seconds or less to prevent starting motor damage.

10. Use a jumper wire to briefly connect positive (+) starting motor terminal to solenoid terminal. Starting motor should engage and run.
11. Read and record starting motor amperage and rpm.
    - If solenoid “clicks” or chatters and starting motor does not turn, replace starting motor.
    - If pinion gear engages and starting motor doesn’t turn, replace starting motor.
    - If starting motor engages and runs, but amperage is more than 60 amps at 4300 rpm, repair or replace starting motor.

Specification

Starting Motor Current Draw (Max)(No Load @ 4300 rpm)—Amperage.......... 60 amps

- If free-running rpm is less than 4000 rpm, repair or replace starting motor.

Specification

Starting Motor rpm (Min at No Load)—Amperage.......... 4000 rpm

RB14256,00009D1 -19-19AUG14-1/1

Fan Relay Test

Reason

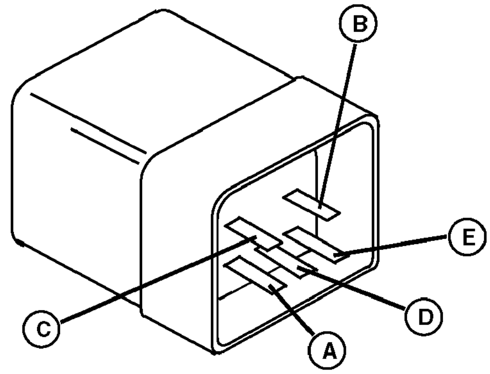
To check relay terminal continuity in the energized and de-energized condition.

Special or Required Tools:

- Ohmmeter or Continuity Tester
- 12-Volt Battery and Jumper Wires

Procedure

1. Park machine on level surface.
2. Turn all switches to the OFF position.
3. Lock park brake, place gear shift in neutral position, and disengage differential lock.
4. Slide under the vehicle behind the right front wheel and locate the relays mounted on the inside frame rail.
5. Disconnect relay connector from harness.
6. Check terminal continuity using an ohmmeter or continuity tester.
    - There should be continuity between terminals (A) and (B), and between terminals (C) and (D).



TCAL26366 —UN—15JUN12

- There should NOT be continuity between any other terminals.

7. Connect a jumper wire from battery positive (+) terminal to relay terminal (A). Connect a jumper wire from relay terminal (B) and ground (—).
    - There should be continuity between terminals (C) and (E).
    - If continuity is NOT correct, replace relay.

RB14256,00009D2 -19-19AUG14-1/1

Load Center Relay Test

Reason:

To check relay in both the powered and unpowered states.

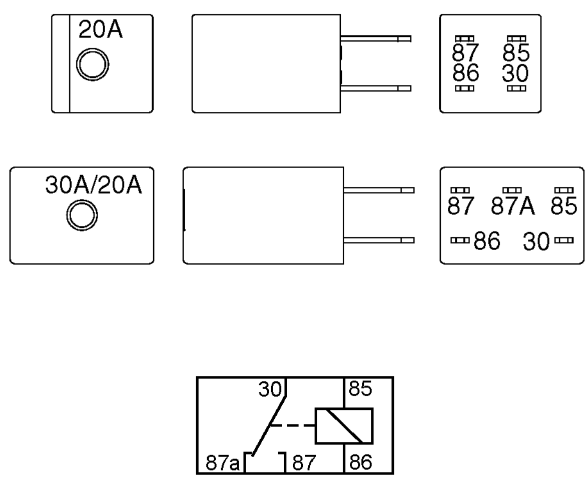
Equipment:

- Ohmmeter or continuity tester
- 12 Volt Power Source
- (2) Jumper wires

Procedure

NOTE: All relays function the same. The relay schematic below reflects the operation of the relays.

1. Unplug relay(s) from fuse block.
2. Check continuity using an ohmmeter or continuity tester.
    - Test for continuity across terminals (85)-(86) and across terminals (30)-(87a - if applicable).
    - Test for no continuity across terminals (30)-(87).
3. Connect a 12 VDC power source to terminals (85)-(86).
    - Now test for continuity across terminals (30)-(87).



TCAL26367 —UN—15JUN12

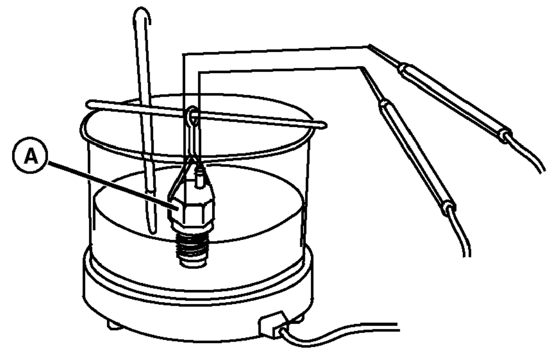
- Test for no continuity across terminals (30)-(87a - if applicable).

Results

If continuity is not correct, replace relay.

RB14256,00009D3 -19-19AUG14-1/1

Engine Coolant Temperature Sensor Test



Reason

To verify that engine coolant temperature sensor is functioning properly.

Special or Required Tools:

- Ohmmeter

Procedure

NOTE: Perform test with engine at room temperature.

1. Park machine on level surface.
2. Turn all switches to the OFF position.
3. Lock park brake, place gearshift in neutral position, and disengage differential lock.
4. Raise cargo box or remove the optional component installed on the vehicle as needed.
5. Disconnect 301 Org wire from engine coolant temperature sensor.
6. Measure resistance between terminal and sensor body.
7. If resistance does not meet specification, replace coolant temperature switch.
8. Drain engine coolant and remove coolant temperature sensor.
9. Place sensor (A) in water and coolant solution.
10. Bring solution to specified temperatures while measuring resistance of sensor. If resistance does not meet specification, replace coolant temperature sensor.

Specification

Resistance at 71°C (160°F)—Resistance	100 ohms
Resistance at 82°C (180°F)—Resistance	80 ohms
Resistance at 93°C (200°F)—Resistance	60 ohms
Resistance at 116°C (240°F)—Resistance	40 ohms

RB14256,00009D4 -19-19AUG14-1/1

Engine Oil Pressure Switch Test

Reason

To determine if engine oil pressure switch is functioning properly, to warn operator that oil pressure has dropped below minimum operating pressure.

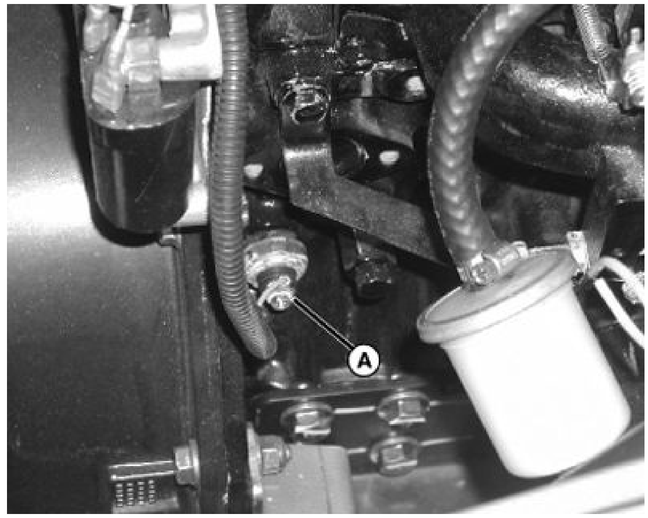
Procedure

NOTE: Perform test with engine at room temperature.

1. Park machine on level surface.
2. Turn all switches to the OFF position.
3. Lock park brake, place gear shift in neutral position, and disengage differential lock.
4. Raise cargo box or remove the optional component installed on the vehicle as needed to provide clearance.
5. Disconnect wire from oil pressure switch (A).
6. Connect black lead of ohmmeter to engine block and red lead of ohmmeter to terminal of switch.
7. Measure resistance between terminal and engine block.
   - There should be continuity between terminal and ground.

NOTE: Be sure to apply Pipe Sealant with TEFLON™ to threads of switch anytime it is installed.

   - If there is NO continuity between terminal and ground, replace the switch.



TCAL26369 —UN—15JUN12

8. Start and run engine.
9. Measure resistance between terminal and engine block.
   - There should be NO continuity between terminal and ground.
   - If the switch DOES have continuity to engine block (ground) with engine running, check oil pressure. See Test Engine Oil Pressure for gasoline engines, and Test Oil Pressure—Gasoline for diesel engines.
   - If oil pressure is to specification, replace the oil pressure switch.

RB14256,00009D5 -19-19JUN14-1/1

Glow Plug Test

Reason:

To test operation of glow plugs.

Equipment:

- Digital ohmmeter with a resolution no less than 100 milliohms.

1. Remove electrical connections from glow plug terminals; clean off any oil, dirt, or corrosion.
2. Locate a clean ground connection on the engine block or starter motor.
3. Measure resistance between glow plug terminal and engine ground. Repeat for all glow plugs.

NOTE: Subtract the residual test lead resistance (offset) from measurement for meters without a “zero ohms” function.

4. Record glow plug resistance values. Replace glow plugs as a set if defective or if values between plugs vary widely.

Specification

Glow Plug—Resistance..0.2—2.0 ohms

OUMX068,00002BC -19-11DEC15-1/1

Fuse Test

Reason:

To verify that the fuse has continuity.

Equipment:

- Ohmmeter or Continuity Tester

Procedure:

1. Park machine safely. (See the “Safety Section”.)
2. Remove fuse to be tested.
3. Check fuse visually for broken filament (A).
4. Connect ohmmeter or continuity tester to each end of fuse.
5. Check for continuity.

Results:

- If continuity is not indicated, replace fuse.

LVAL21827 —UN—17APR12

A—Broken Filament

OUMX068,00002B4 -19-05DEC12-1/1

Bulb Test

Reason

To verify that the bulb has continuity.

Special or Required Tools:

- Ohmmeter or Continuity Tester

Procedure

1. Remove bulb from socket.
2. Check visually for broken filament (A).
3. Connect ohmmeter or continuity tester to each terminal of bulb.
4. Check for continuity. If continuity is not indicated, replace bulb.

TCAL26372 —UN—15JUN12

RB14256,00009D8 -19-19AUG14-1/1

Key Switch Test

Reason

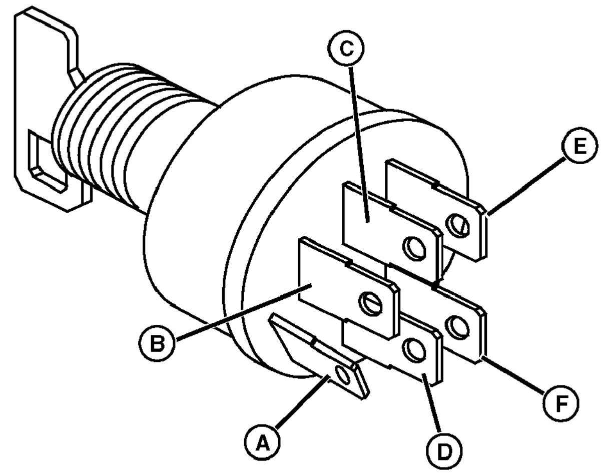
To verify key switch functions are operating properly.

Special or Required Tools:

- Ohmmeter or Continuity Teste

Procedure

1. Park machine on level surface.
2. Turn all switches to the OFF position.
3. Lock park brake, place gear shift in neutral position, and disengage differential lock.
4. Remove the grille from the front of the vehicle. Remove the entire hood if necessary. See Remove and Install Hood.
5. Disconnect key switch connector from harness.
6. Use an ohmmeter or continuity tester to test switch continuity in OFF, RUN, and START positions. If any continuity is NOT correct, replace the switch.



TCAL26373 —UN—15JUN12

Key Switch Continuity

Switch Position	Terminal Continuity
OFF	E and F
RUN	A and D
START	A and D; B and C

RB14256,00009D9 -19-19AUG14-1/1

Headlight and Work Light Switch Test

Reason

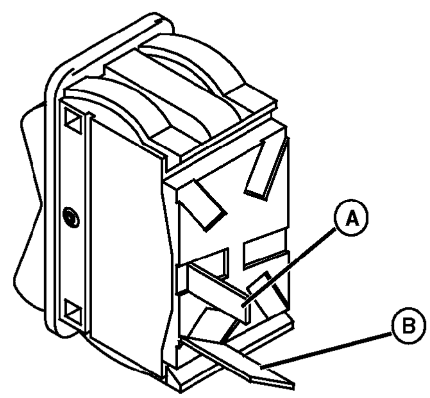
To make sure the headlight and work light switch terminals have continuity when the switch is ON.

Special or Required Tools:

- Ohmmeter or Continuity Tester

Procedure

1. Park machine on level surface.
2. Turn all switches to the OFF position.
3. Lock park brake, place gear shift in neutral position, and disengage differential lock.
4. Remove the grille from the front of the vehicle. Remove the entire hood if necessary. See Remove and Install Hood.
5. Disconnect light switch from harness.
6. Move light switch to the ON and then the OFF position. Check continuity between terminals (A and B).



TCAL26374 —UN—15JUN12

- Terminals should have continuity with switch ON.
- Terminals should NOT have continuity with switch OFF.
- If continuity is NOT correct, replace light switch.

RB14256,00009DA -19-19AUG14-1/1

Seat Switch Test

Reason

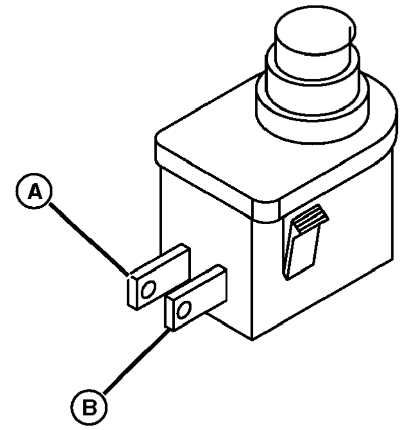
To verify seat switch functions are operating properly.

Special or Required Tools:

- Ohmmeter or Continuity Tester

Procedure

1. Park machine on level surface.
2. Turn all switches to the OFF position.
3. Lock park brake, place gear shift in neutral position, and disengage differential lock.
4. Disconnect the wiring harness from under the driver side seat switch.
5. Remove the seat(s). See Remove and Install Seat.
6. Check continuity across both switch terminals (A) and (B). There should be no continuity.



7. Depress seat switch plunger. Continuity should exist between terminals (A and B). If continuity is not correct, replace seat switch.

RB14256,00009DB -19-19AUG14-1/1

Off Delay Module Test

Reason

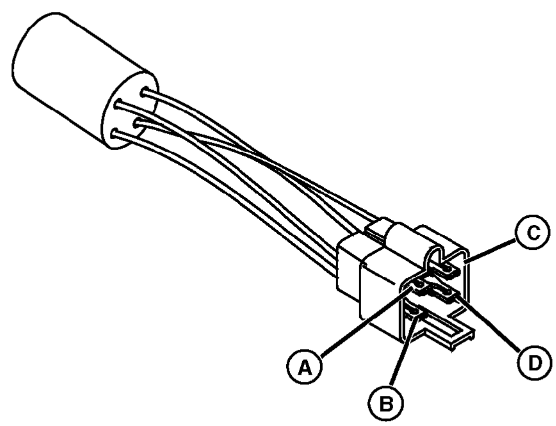
To verify the off delay module is functioning properly.

Special or Required Tools:

- Ohmmeter

Procedure

1. Park machine on level surface.
2. Turn all switches to the OFF position.
3. Lock park brake, place gear shift in neutral position, and disengage differential lock.
4. Slide under the vehicle between the fuel tank and the right front wheel, and locate the off delay module mounted on the inside frame rail.
5. Disconnect seat switch connector from harness.
6. Set the multimeter to measure ohms, and use the chart to sequentially test continuity across each terminal combination.
7. The red lead position of the meter is listed down the side and the black lead position of the meter is listed across the top of the chart.



Black Red	A	B	C	D
A		5.3 m	O.L.	1.7 m
B	O.L.		O.L.	O.L.
C	O.L.	2.43 m		O.L.
D	O.L.	2.69 m	O.L.	

If continuity is not correct, replace the off delay module.

RB14256,00009DC -19-19AUG14-1/1

Brake Switch Test

Reason

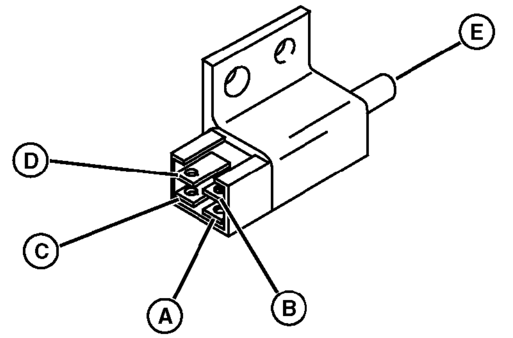
To determine proper operation of the brake switch.

Special or Required Tools:

- Ohmmeter

Procedure

1. Park machine on level surface.
2. Turn all switches to the OFF position.
3. Lock park brake, place gear shift in neutral position, and disengage differential lock.
4. Remove the grille from the front of the vehicle. Remove the entire hood if necessary. See Remove and Install Hood.
5. Remove connector from brake switch.
6. Connect meter leads to pairs of switch posts and compare to specifications.
7. Press and release plunger (E) of switch.



8. If brake switch does not pass all tests, replace switch.

Brake Switch Continuity

Switch Plunger Not Pressed	Continuity between posts A and B
Switch Plunger Not Pressed	Continuity between posts C and D
Switch Plunger Pressed	No continuity between posts A and B
Switch Plunger Pressed	No continuity between posts C and D

RB14256,00009DD -19-19AUG14-1/1

Park Brake Switch Test

Reason

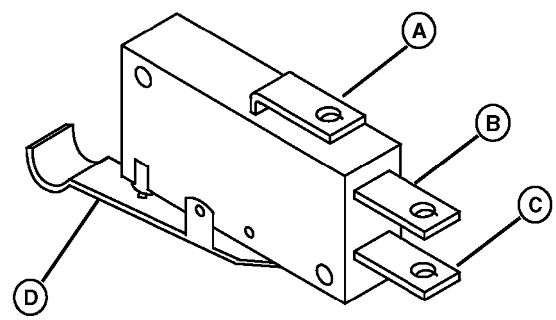
To determine proper operation of park brake switch.

Special or Required Tools:

- Ohmmeter

Procedure

1. Park machine on level surface.
2. Turn all switches to the OFF position.
3. Lock park brake, place gear shift in neutral position, and disengage differential lock.
4. Remove the control plate located between the seats. See Remove and Install Control Plate.
5. Remove connector from park brake switch.
6. Connect one lead of the meter to the COM terminal (A) of the switch.
7. Connect the other lead of the meter to terminal (B) and then (C) of the switch.
8. Press and release the switch lever (D) and note the results.



9. If the park brake switch does not pass both tests, replace switch.

Park Brake Switch Continuity

Switch Lever Not Pressed	Continuity between post A and B
Switch Lever Not Pressed	No continuity between post A and C
Switch Lever Pressed	No continuity between post A and B
Switch Lever Pressed	Continuity between post A and C

RB14256,00009DE -19-19AUG14-1/1

Horn Switch Test

Reason

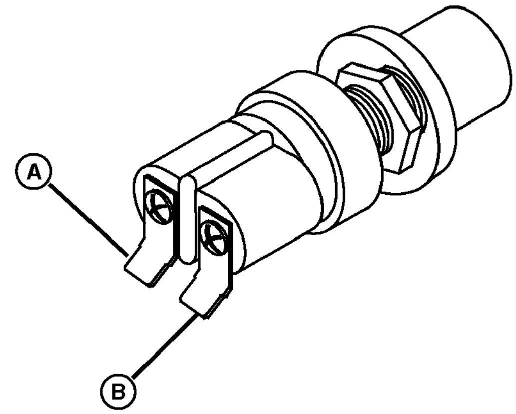
To verify the horn switch is operating properly.

Special or Required Tools:

- Ohmmeter or Continuity Tester

Procedure

1. Park machine on level surface.
2. Turn all switches to the OFF position.
3. Lock park brake, place gear shift in neutral position, and disengage differential lock.
4. Remove the grille from the front of the vehicle. Remove the entire hood if necessary. See Remove and Install Hood.
5. Disconnect the horn switch connectors from the switch.
6. With the button released, check continuity across both switch terminals (A) and (B). There should be no continuity.



TCAL26379 —UN—15JUN12

7. Depress the horn switch button. Continuity should exist between both terminals (A) and (B).
8. If continuity is not correct, replace horn switch.

RB14256,00009DF -19-19AUG14-1/1

Neutral Switch Test

Reason

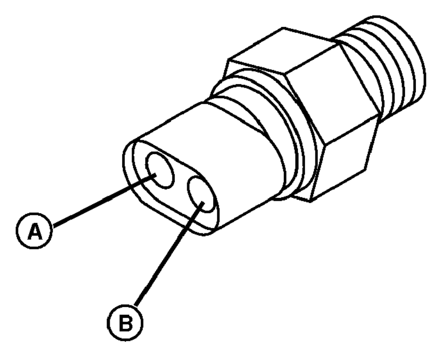
To verify transmission neutral switch is operating properly.

Special or Required Tools:

- Ohmmeter or Continuity Tester

Procedure

1. Park machine on level surface.
2. Turn all switches to the off position.
3. Lock park brake, place gear shift in neutral position and disengage differential lock.
4. Raise cargo box or remove the optional component installed on the vehicle as needed to provide clearance.
5. Disconnect transmission neutral switch from harness.
6. Check for continuity between terminals (A) and (B). If no continuity exists, ensure that transmission selector lever is in neutral. Replace transmission neutral switch.
7. With the transmission in neutral, check continuity across both switch terminals (A) and (B). There should be continuity.



TCAL26380 —UN—15JUN12

8. With the transmission shifted into any gear, check continuity across both switch terminals (A) and (B). There should be no continuity.
9. If continuity is not correct, replace transmission neutral switch.

RB14256,00009E0 -19-19AUG14-1/1

Fan-Over Temperature Switch Test

Reason

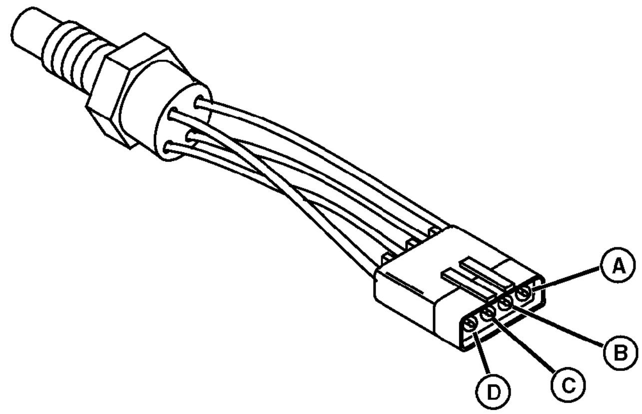
To verify the fan/over temperature switch is operating properly.

Special or Required Tools:

- Ohmmeter

Procedure

1. Park machine on level surface.
2. Turn all switches to the OFF position.
3. Lock park brake, place gear shift in neutral position and disengage differential lock.
4. Raise cargo box or remove the optional component installed on the vehicle as needed to provide clearance.
5. Disconnect the fan/over temperature switch connector from harness.
6. Check continuity across all switch terminals with the engine cold.



TCAL26381 —UN—15JUN12

7. Set the multimeter to measure ohms, and use the chart to sequentially test continuity across each terminal combination.

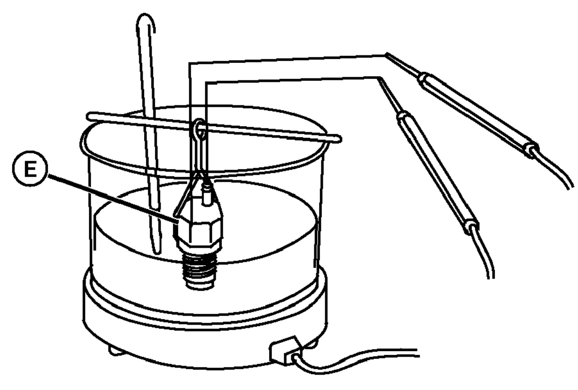
   The red lead position of the meter is listed down the side and the black lead position of the meter is listed across the top of the chart.

	A	B	C	D
A		4.62 m	4.62 m	1.36 m
B	O.L.		O.L.	O.L.
C	O.L.	O.L.		O.L.
D	O.L.	2.62 m	2.62 m	

8. If the continuity is not correct, remove switch and test in a heated solution of antifreeze as specified below.

RB14256,00009E1 -19-19AUG14-1/2

9. Drain engine coolant and remove fan/over temperature switch. Reconnect to main engine harness.
10. Disconnect engine fuel pump electrical connector.
11. Turn key switch to the RUN position and place switch (E) in antifreeze solution heated to approximately 91°C (196°F). Measure voltage between terminal (A) and ground. Battery voltage will be present until first switch activates. When switch activates, voltage should drop to 0 volts and the radiator fan should turn on.
    - Voltage should drop to 0 volts.
    - If the voltage is not correct, replace switch.

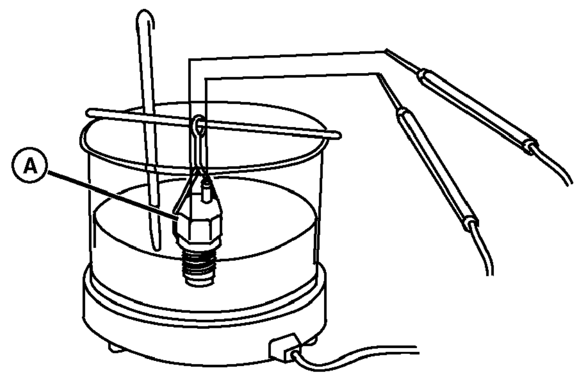


TCAL26382 —UN—15JUN12

12. Continue heating the switch (E) in antifreeze solution to approximately 110°C (230°F). Measure voltage between terminal (C) and ground while switch is heated above specification. Battery voltage will be present until second switch activates. Then voltage should drop to 0 volts and the over temperature light will illuminate.
    - Voltage should drop to 0 volts.
    - If voltage is not correct, replace switch.

RB14256,00009E1 -19-19AUG14-2/2

Hydraulic Oil Temperature Switch Test



Reason

To verify the hydraulic oil temperature switch is operating properly.

Special or Required Tools:

- Ohmmeter

Procedure

1. Park machine on level surface.
2. Turn all switches to the OFF position.
3. Lock park brake, place gear shift in neutral position, and disengage differential lock.
4. Raise cargo box or remove the optional component installed on the vehicle as needed to provide clearance.
5. Disconnect the fan/over temperature switch connector from harness.
6. Check continuity across all switch terminals with the engine cold.
7. Set the multimeter to measure ohms, and test continuity through switch.
8. If the continuity is not infinite, remove switch and test in a heated solution of antifreeze as specified below.
9. Drain oil and remove temperature switch.
10. Place switch in antifreeze solution heated to approximately 63°C (145°F). Measure resistance between end terminal and switch body.
11. Continue heating the switch in antifreeze solution to approximately 77°C (170°F). Measure resistance between end terminal and switch body while switch is heated above specification. The resistance should drop to 0 ohms when the switch closes.

Specification

Switch Closes (approximately)—Temperature ...... 71° C (160° F)

12. Allow antifreeze solution to cool. Measure resistance between end terminal and switch body while switch is cooled below specification. The resistance should increase to infinite ohms when the switch opens.

Specification

Switch Opens (approximately)—Temperature ...... 66° C (150° F)

RB14256,00009E2 -19-19AUG14-1/1

Turn Signal Switch Test

Reason

To verify turn signal switch functions are operating properly.

Special or Required Tools:

- Ohmmeter

Procedure

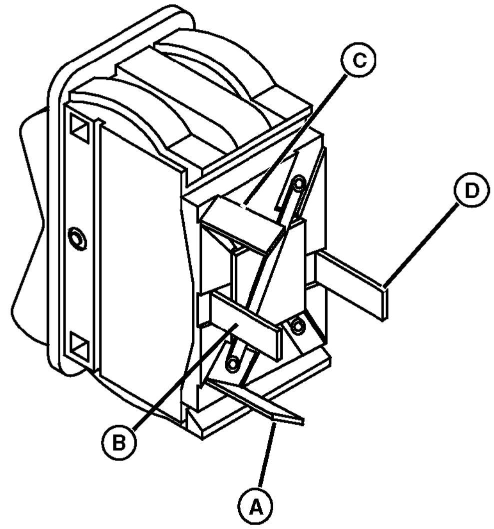
1. Park machine on level surface.
2. Turn all switches to the OFF position.
3. Lock park brake, place gear shift in neutral position, and disengage differential lock.
4. Remove the grille from the front of the vehicle. Remove the entire hood if necessary. See Remove and Install Hood.
5. Disconnect turn signal switch connector from harness.
6. Use an ohmmeter to test switch continuity in OFF, RIGHT, and LEFT positions.
7. Set the multimeter to measure ohms, and use the chart to sequentially test continuity across each terminal combination.

   The red lead position of the meter is listed down the side and the black lead position of the meter is listed across the top of the chart.

   OFF Position

Black Red	A	B	C	D
A		-	35.3	17.8
B	-		-	-
C	35.3	-		17.8
D	17.8	-	17.8	

   Right Turn Position



TCAL26384 —UN—15JUN12

Black Red	A	B	C	D
A		0.2	35.3	17.8
B	0.2		35.3	17.8
C	35.3	35.3		17.8
D	17.8	17.8	17.8	

   Left Turn Position

Black Red	A	B	C	D
A		35.3	35.3	17.8
B	35.3		0.2	17.8
C	35.3	0.2		17.8
D	17.8	17.8	17.8	

8. If any continuity is NOT correct, replace the turn signal switch.

RB14256,00009E3 -19-19AUG14-1/1

Hazard Lights Switch Test

Reason

To verify hazard switch functions are operating properly.

Special or Required Tools:

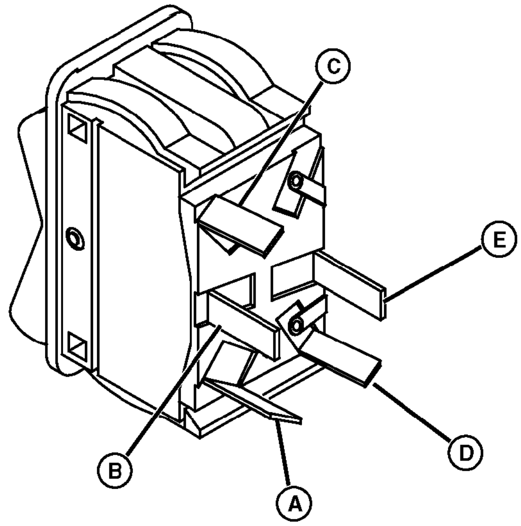
- Ohmmeter

Procedure

1. Park machine on level surface.
2. Turn all switches to the OFF position.
3. Lock park brake, place gear shift in neutral position, and disengage differential lock.
4. Remove the grille from the front of the vehicle. Remove the entire hood if necessary. See Remove and Install Hood.
5. Disconnect hazard light switch connector from harness.
6. Use an ohmmeter to test switch continuity in the OFF and ON positions.
7. Set the multimeter to measure ohms, and use the chart to sequentially test continuity across each terminal combination.

   The red lead position of the meter is listed down the side and the black lead position of the meter is listed across the top of the chart.

   OFF Position



Black Red	A	B	C	D	E
A		-	-	-	-
B	-		-	-	-
C	-	-		17.8	-
D	-	-	17.8		-
E	-	-	-	-	

ON Position

Black Red	A	B	C	D	E
A		0.2	-	-	-
B	0.2		-	-	-
C	-	-		17.8	17.8
D	-	-	17.8		0.2
E	-	-	17.8	0.2	

8. If any continuity is NOT correct, replace the hazard light switch.

RB14256,00009E4 -19-19AUG14-1/1

PTO Switch Test

Reason

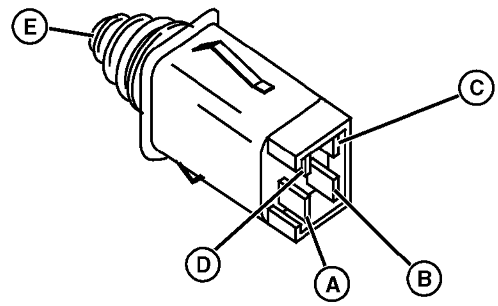
To verify PTO switch functions are operating properly.

Special or Required Tools:

- Ohmmeter or Continuity Tester

Procedure

1. Park machine on level surface.
2. Turn all switches to the OFF position.
3. Lock park brake, place gear shift in neutral position, and disengage differential lock.
4. Remove the control plate located between the seats. See Remove and Install Control Plate.
5. Disconnect PTO engaged sensor switch connector from harness.
6. Use an ohmmeter or continuity tester to test switch continuity.
7. Connect meter leads to pairs of switch posts and compare to specifications.
8. Press and release plunger (E) of switch.
9. If continuity is NOT correct, replace the switch.



Specifications—Specification

Switch Plunger Not Pressed—Temperature...................... Continuity between posts A and B
Switch Plunger Not Pressed—Temperature................. No continuity between posts C and D
Switch Plunger-Pressed—Temperature................. No continuity between posts A and B
Switch Plunger-Pressed—Temperature...................... Continuity between posts C and D

PTO Switch Continuity

Switch Plunger Not Pressed	Continuity between posts A and B
Switch Plunger Not Pressed	No continuity between posts C and D
Switch Plunger Pressed	No continuity between posts A and B
Switch Plunger Pressed	Continuity between posts C and D

RB14256,00009E5 -19-19AUG14-1/1

Fuel Gauge Sensor Test

Reason

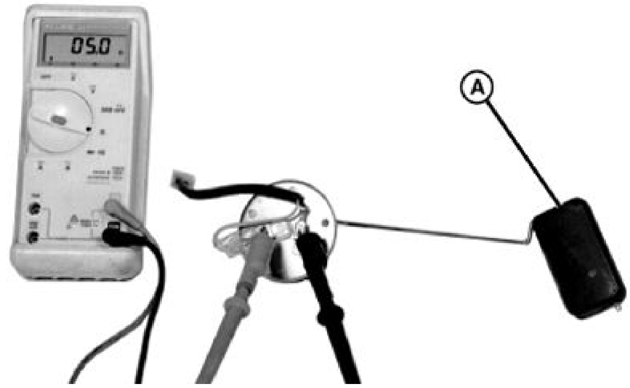
To verify that the fuel gauge sensor is operating properly.

Special or Required Tools:

- Ohmmeter or Continuity Tester

Procedure

1. Park machine on level surface.
2. Turn all switches to the OFF position.
3. Lock park brake, place gear shift in neutral position, and disengage differential lock.
4. Turn key switch to the ON position.
5. Disconnect red wire from fuel sensor and check fuel gauge. The fuel gauge must drop to EMPTY.
6. Short the red wire to the black wire connector on the fuel sensor. The gauge must rise to FULL. If not, test the fuel sensor ground circuit.
7. If the gauge does not correctly indicate fuel levels based on the two tests above, proceed to step 8.
8. Disconnect fuel gauge sensor wires.
9. Remove sensor from fuel tank.
10. Using an ohmmeter connected to fuel gauge sensor contacts, check if continuity exists between terminals.



TCAL26387 —UN—15JUN12

If continuity exists, measure resistance across terminals as float (A) and float arm are moved through full range of motion.

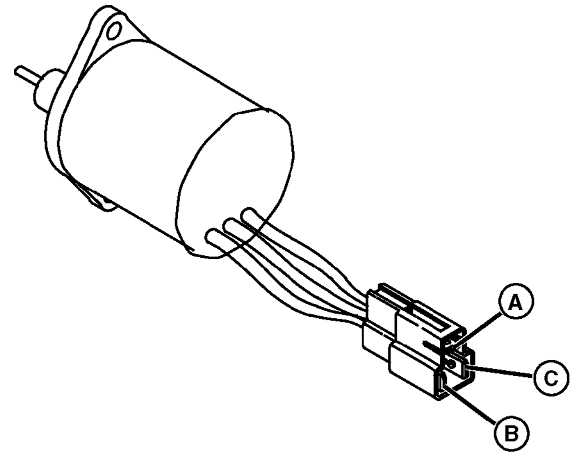
11. If resistance does not meet specifications, replace fuel gauge sensor.

Specification

Variable Resistance—Resistance..5—95 ohms

RB14256,00009E6 -19-19AUG14-1/1

Fuel Shutoff Solenoid Test—Diesel Engine



TCAL26388 —UN—15JUN12

Reason

To verify fuel shutoff solenoid is functioning properly.

Procedure

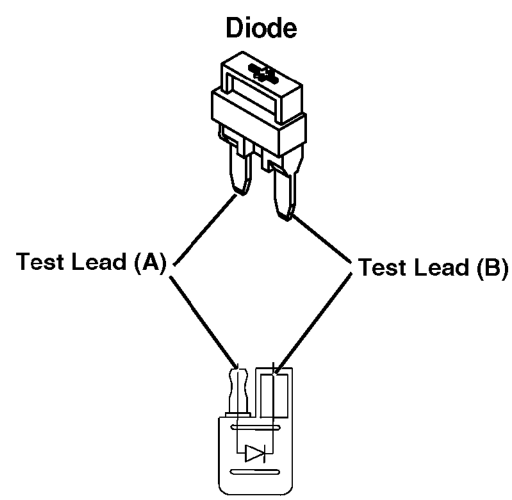
1. Park machine on level surface and turn start switch OFF.
2. Shift lever in NEUTRAL and park brake locked.
3. Cargo box raised and locked.
4. Disconnect fuel shutoff solenoid connector.
5. Measure and record the resistance across each combination of terminals as listed below.
6. The red lead position of the meter is listed down the side and the black lead position of the meter is listed across the top of the chart.

Black **Red**	**Blk Wire (A)**	**Red Wire (B)**	**Wht Wire (C)**
Blk Wire (A)		12	0.4
Red Wire (B)	12		12.4
Wht Wire (C)	0.4	12.4	

7. If continuity is NOT correct, replace fuel shutoff solenoid.

RB14256,00009E7 -19-19JUN14-1/1

Diode Test



TCAL26389 —UN—15JUN12

Both styes of diodes shown

Reason

To verify that diode has proper continuity.

Special or Required Tools:

- Ohmmeter or Continuity Tester

Procedure

1. Remove diode from connector.
2. Connect ohmmeter red (+) lead to pin (A) of diode. Connect ohmmeter black (-) lead to pin (B) of diode. Check for continuity.
3. Reverse test leads. Check for continuity.

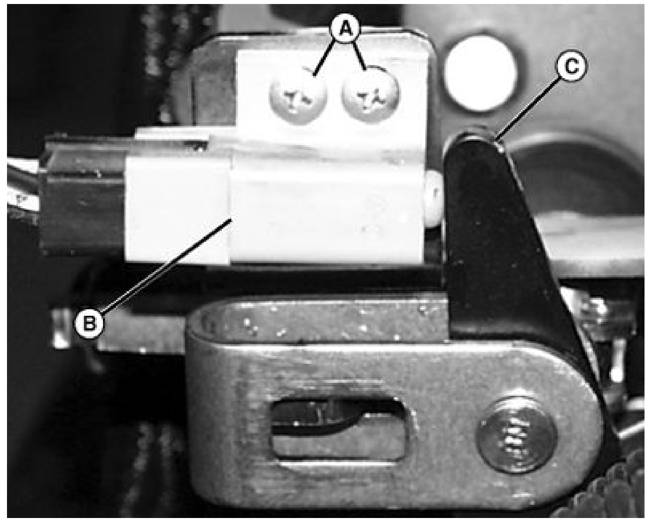
   Diode must have continuity in one direction only. Replace defective diode.

RB14256,00009E8 -19-19AUG14-1/1

Brake Switch Adjustment

Procedure

1. Park machine on level surface.
2. Turn all switches to the OFF position.
3. Lock park brake, place gear shift in neutral position, and disengage differential lock.
4. Remove the grille from the front of the vehicle. Remove the entire hood if necessary. See Remove and Install Hood.
5. Loosen the two screws (A) securing the brake switch (B) to the mounting bracket. Slide the switch away from (toward the front of the vehicle) the brake arm (C).
6. Hold the brake pedal in the released (up) position and slide the brake switch against the brake arm until the plunger is fully depressed.
7. Hold the switch in this position and tighten the two screws securely.



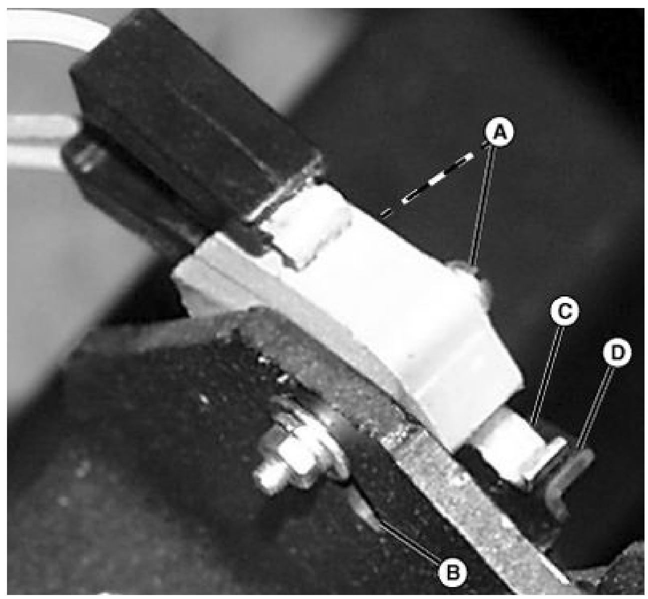
TCAL26390 —UN—15JUN12

RB14256,00009E9 -19-18JUN12-1/1

Park Brake Switch Adjustment

Procedure

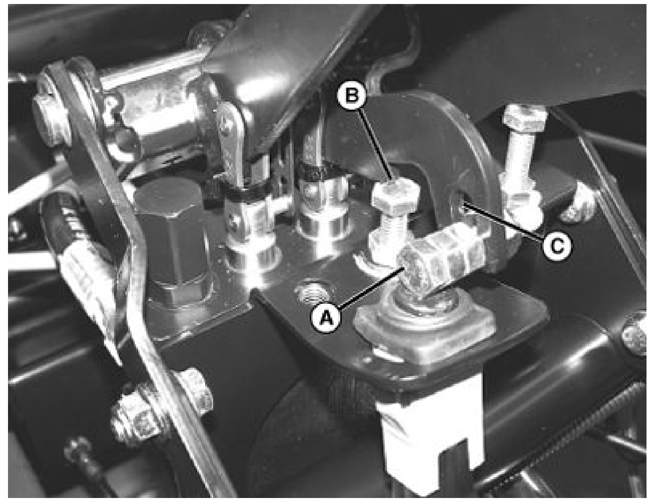
1. Park machine on level surface.
2. Turn all switches to the OFF position.
3. Lock park brake, place gear shift in neutral position, and disengage differential lock.
4. Remove the control plate located between the seats. See Remove and Install Control Plate.
5. Loosen the two mounting screws (A) enough to allow the park brake switch to pivot and slide in the adjustment slot (B).
6. Place park brake lever in the released position.
7. Pivot the switch down until the switch wand (C) contacts the park brake bracket (D) and is fully engaged.
8. Tighten the two mounting screws securely.



TCAL26391 —UN—15JUN12

RB14256,00009EA -19-18JUN12-1/1

PTO Switch Adjustment



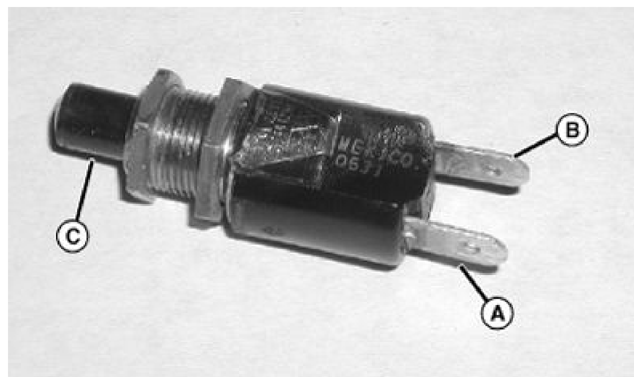
TCAL26392 —UN—15JUN12

Procedure

1. Park machine on level surface.
2. Turn all switches to the OFF position.
3. Lock park brake, place gear shift in neutral position, and disengage differential lock.
4. Remove the control plate located between the seats. See Remove and Install Control Plate.
5. Loosen the striker bolt (A) on the PTO lever bracket until it is free to slide in the adjustment slot (B).
6. Place the PTO control lever in its lowest position. The lever should rest firmly on the limit bolt (C).
7. Slide the striker bolt (A) until the switch plunger is fully depressed and tighten it securely.

RB14256,00009EB -19-18JUN12-1/1

4WD Switch Test



TCAL26393 —UN—15JUN12

Reason

To verify the 4WD switch is operating properly.

Special or Required Tools:

- Ohmmeter or Continuity Tester

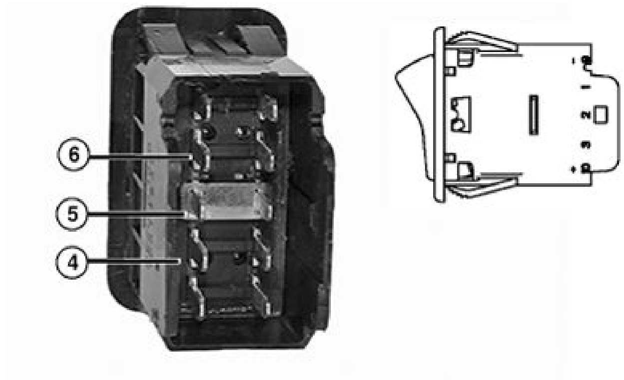
Procedure

1. Park machine on level surface.
2. Turn all switches to the OFF position.
3. Lock park brake, place gear shift in neutral position, and disengage differential lock.
4. Disconnect the 4WD switch connectors from the switch.
5. With the button released, check continuity across both switch terminals (A) and (B). There should be no continuity.
6. Depress the plunger (C). Continuity should exist between both terminals (A) and (B).

   If continuity is not correct, replace 4WD switch.

RB14256,00009EC -19-19AUG14-1/1

Multi-Mode Throttle Function and Mode Switches Test



Reason

To verify the cruise control switch functions properly.

Special or Required Tools:

- Ohmmeter or Continuity Tester

Procedure

1. Park machine safely on a level surface. (See “Park Machine Safely” in the Safety section.)
2. Disengage PTO.
3. Turn key switch to STOP position.
4. Park brake LOCKED.
5. Remove upper instrument cluster shroud and unplug harness from cruise control switch.
6. Check switch continuity as per table. Note orientation.

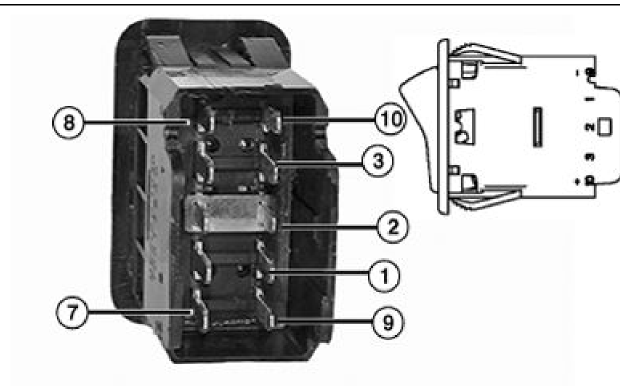
RB14256,00009ED -19-19AUG14-1/2

Accel/Decel and Set/Clear Switch

Switch Continuity	
Switch Position	**Terminal Continuity**
OFF	None
ON (momentary)	6 + 5
ON (momentary)	5 + 4

Mobile Enable or PTO Enable

Switch Continuity	
Switch Position	**Terminal Continuity**
OFF	8 + 1, 7(pos) + 9 (neg), 7 (pos) + 3 (neg), 10 (pos) + 8 (neg), 10 (pos) + 1 (neg)
Mobile ON	2 + 3, 2 + 9
PTO Mode Enable	2 + 1, 2 + 8



Results

If continuity is NOT correct or exists in any other combination than shown above, replace the switch.

RB14256,00009ED -19-19AUG14-2/2

Speed Sensor Test

Reason

To verify proper operation of speed sensor.

Special or Required Tools:

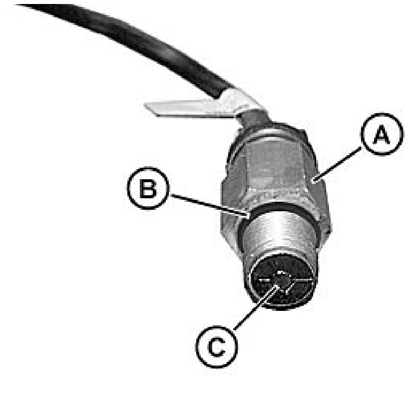
- Ohmmeter

Procedure:

1. Drain transaxle.
2. Unplug speed sensor connector and thread wire clear of harness.
3. Remove speed sensor from transmission.

Inspection:

1. Inspect speed sensor (A) for damage.
2. Remove and discard o-ring (B).
3. Test magnetic field of sensor pickup (C) with a ferrous metal object (such as a flat blade screwdriver). Objects within 6 mm (0.25 in.) should be attracted to sensor pickup.



MXT010525 —UN—27MAY14

A—Sensor Body
B—O-ring
C—Sensor Pickup

4. Check for continuity between sensor pickup (C) and sensor body (A). There should be no continuity present.

SH24924,000022B -19-19AUG14-1/2

5. Measure resistance between terminals of sensor connector (D). Resistance should be within specification.

Specification

Speed Sensor
Terminals—Resistance..265Ω ±10% @ 25°C (77°F)

6. Check for continuity between each terminal of connector (D) and sensor body (A). There should be no continuity present.
7. Check for continuity between each terminal of connector (D) and sensor pickup (C). There should be no continuity present

Installation:

1. Install new o-ring (B) on speed sensor body.
2. Wrap sensor body threads with thread sealing tape.
3. Install speed sensor to transaxle. Torque to specification.

Specification

Speed Sensor—Torque.. 34 N•m (25 lb-ft)

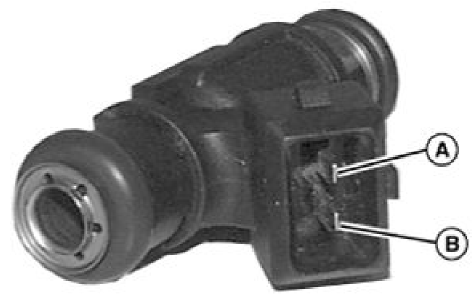
MXT010526 —UN—27MAY14

D—Sensor Connector

4. Reconnect speed sensor to wiring harness.
5. Refill transaxle and check for leaks.

SH24924,000022B -19-19AUG14-2/2

Fuel Injector Test



TCAL26396 —UN—15JUN12

Reason

To test condition of fuel injector coil.

NOTE: This test only checks the fuel injector coil.

Procedure

1. Allow engine to cool to room temperature.
2. Unplug harness from fuel injector.
3. Measure resistance across terminals (A-B).

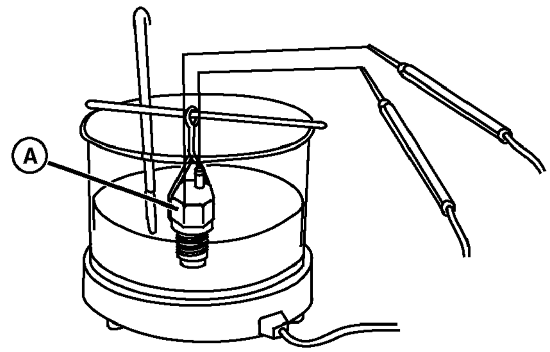
Specification	
Resistance (A-B) @20°C (68°F)—Resistance	10—14 ohms

Results

Replace fuel injector if coil resistance is not within specifications, or if the injector continues to have fuel delivery problems after being cleaned.

RB14256,00009EE -19-18JUN12-1/1

Engine Coolant Temperature Sensor Test—EFI



Reason

To verify engine coolant temperature sensor is functioning properly.

Procedure

NOTE: Perform test with engine at room temperature.

1. Park machine on level surface.
2. Turn all switches to the OFF position.
3. Lock park brake, place gear shift in neutral position, and disengage differential lock.
4. Raise cargo box or remove the optional component installed on the vehicle as needed to provide clearance.
5. Disconnect EC12 connector from engine coolant temperature sensor.
6. Measure resistance between terminal and sensor body.
7. If resistance does not meet specification, replace coolant temperature switch.
8. Drain engine coolant and remove coolant temperature sensor.
9. Place sensor (A) in water/coolant solution.
10. Bring solution to specified temperatures while measuring resistance of sensor. If resistance does not meet specification, replace coolant temperature sensor.

Specification

Resistance at -40°C (-40°F)—Resistance .... 100K ohms
Resistance at 1°C (33°F)—Resistance .... 9.5K ohms
Resistance at 14°C (57°F)—Resistance .... 4.1K ohms
Resistance at 26°C (78°F)—Resistance .... 3.0K ohms
Resistance at 38°C (100°F)—Resistance .... 1.8K ohms
Resistance at 49°C (120°F)—Resistance .... 1.4K ohms
Resistance at 62°C (143°F)—Resistance .... 840 ohms
Resistance at 73°C (163°F)—Resistance .... 430 ohms
Resistance at 86°C (186°F)—Resistance .... 300 ohms
Resistance at 99°C (210°F)—Resistance .... 190 ohms
Resistance at 112°C (234°F)—Resistance .... 60 ohms

RB14256,00009EF -19-19JUN14-1/1

Speed Sensor Test

Reason

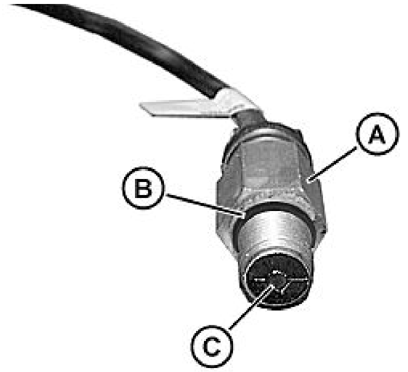
To verify proper operation of speed sensor.

Procedure:

1. Drain transaxle.
2. Unplug speed sensor connector and thread wire clear of harness.
3. Remove speed sensor from transmission.

Inspection:

1. Inspect speed sensor (A) for damage.
2. Remove and discard o-ring (B).
3. Test magnetic field of sensor pickup (C) with a ferrous metal object (such as a flat blade screwdriver). Objects within 6 mm (0.25 in.) should be attracted to sensor pickup.



A—Sensor Body **B—O-ring** **C—Sensor Pickup**

4. Check for continuity between sensor pickup (C) and sensor body (A). There should be no continuity present.

SH24924,0000245 -19-05AUG14-1/2

5. Measure resistance between terminals of sensor connector (D). Resistance should be within specification.

Specification

Speed Sensor Terminals—Resistance............265Ω ±10% @ 25°C (77°F)

6. Check for continuity between each terminal of connector (D) and sensor body (A). There should be no continuity present.
7. Check for continuity between each terminal of connector (D) and sensor pickup (C). There should be no continuity present

Installation:

1. Install new o-ring (B) on speed sensor body.
2. Wrap sensor body threads with thread sealing tape.
3. Install speed sensor to transaxle. Torque to specification.

Specification

Speed Sensor—Torque............34 N•m (25 lb-ft)

D—Sensor Connector

4. Reconnect speed sensor to wiring harness.
5. Refill transaxle and check for leaks.

SH24924,0000245 -19-05AUG14-2/2

Engine Oil Pressure Switch Test

Reason

To determine if engine oil pressure switch is functioning properly, to warn operator that oil pressure has dropped below minimum operating pressure.

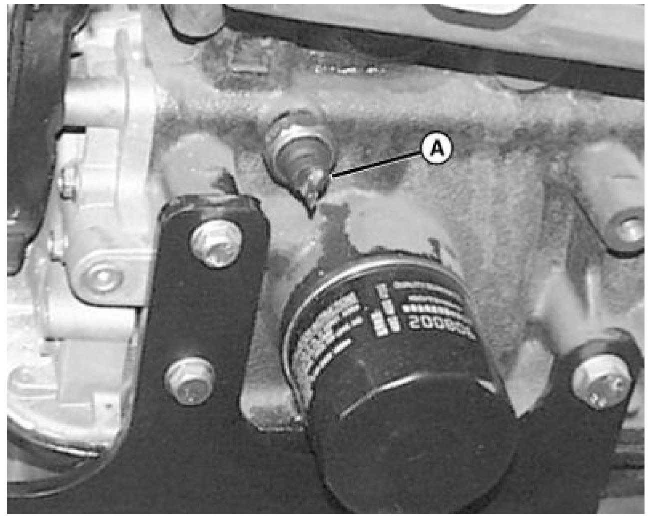
Procedure

NOTE: Perform test with engine at room temperature.

1. Park machine on level surface.
2. Turn all switches to the OFF position.
3. Lock park brake, place gear shift in neutral position, and disengage differential lock.
4. Raise cargo box or remove the optional component installed on the vehicle as needed to provide clearance.
5. Disconnect wire from oil pressure switch (A).
6. Connect black lead of ohmmeter to engine block and red lead of ohmmeter to terminal of switch.
7. Measure resistance between terminal and engine block.
   - There should be continuity between terminal and ground.

NOTE: Be sure to apply Pipe Sealant with TEFLON™ to threads of switch anytime it is installed.

   - If there is NO continuity between terminal and ground, replace the switch.



TCAL26404 —UN—15JUN12

8. Start and run engine.
9. Measure resistance between terminal and engine block.
   - There should be NO continuity between terminal and ground.
   - If the switch DOES have continuity to engine block (ground) with engine running, check oil pressure. See Test Oil Pressure—Gasoline.
   - If oil pressure is to specification, replace the oil pressure switch.

RB14256,00009F2 -19-19JUN14-1/1

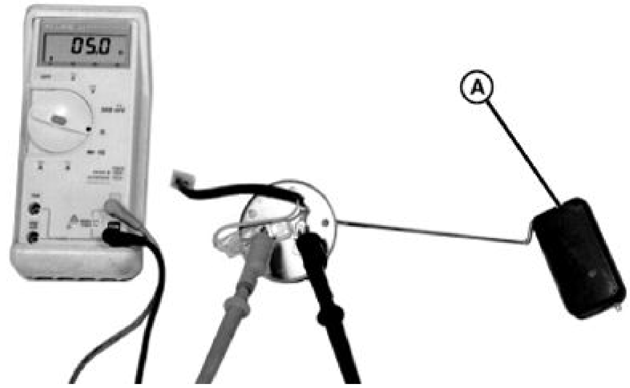
Fuel Gauge Sensor Test

Reason

To verify that the fuel gauge sensor is operating properly.

Procedure

1. Park machine on level surface.
2. Turn all switches to the OFF position.
3. Lock park brake, place gear shift in neutral position, and disengage differential lock.
4. Turn key switch to the ON position.
5. Disconnect pink wire from fuel sensor and check fuel gauge. The fuel gauge must drop to EMPTY.
6. Short the pink wire to the black wire connector on the fuel sensor. The gauge must rise to FULL. If not, test the fuel sensor ground circuit.
7. If the gauge does not correctly indicate fuel levels based on the two tests above, proceed to step 8.
8. Disconnect fuel gauge sensor wires.
9. Remove sensor from fuel tank.
10. Using an ohmmeter connected to fuel gauge sensor contacts, check if continuity exists between terminals.



TCAL26405 —UN—15JUN12

If continuity exists, measure resistance across terminals as float (A) and float arm are moved through full range of motion.

Specification

Fuel Gauge Sensor Full Position—Resistance.. 34 ohms
Fuel Gauge Sensor Empty Position—Resistance.. 240 ohms

11. If resistance does not meet specifications, replace fuel gauge sensor.

RB14256,00009F3 -19-18JUN12-1/1

Oxygen Sensor Heater Element Test

Reason

To determine if oxygen sensor (EGOH) heater element is functioning properly.

Procedure

NOTE: Perform test with oxygen sensor at room temperature.

1. Park machine on level surface.
2. Turn all switches to the OFF position.
3. Lock park brake, place gear shift in neutral position, and disengage differential lock.
4. Raise cargo box or remove the optional component installed on the vehicle as needed to provide clearance.
5. Disconnect EC9 connector from heated oxygen sensor (A).
6. Connect black lead of ohmmeter to (pin) and red lead of ohmmeter to (pin).
7. Check if continuity exists between terminals. If continuity does not exist replace oxygen sensor.

RB14256,00009F4 -19-18JUN12-1/1

Throttle Position Sensor 1 and 2 Test

Reason

To determine if throttle position circuits 1 and 2 are functioning properly on the sensor.

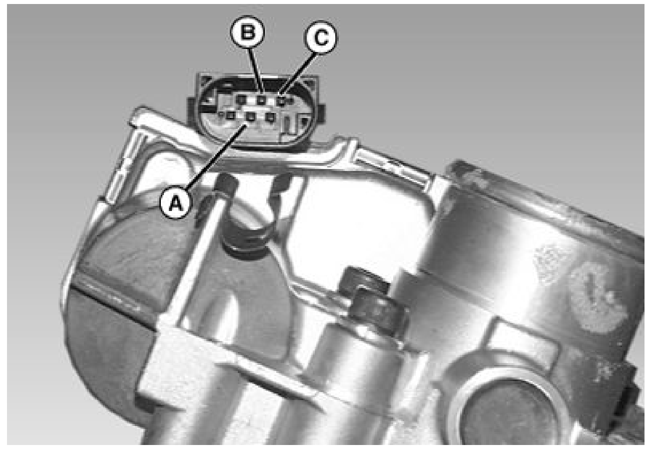
Procedure

NOTE: Perform test with engine at room temperature.

1. Park machine on level surface.
2. Turn all switches to the OFF position.
3. Lock park brake, place gear shift in neutral position, and disengage differential lock.
4. Raise cargo box or remove the optional component installed on the vehicle as needed to provide clearance.
5. Disconnect EC4 connector from electronic throttle body.
6. Connect black lead of ohmmeter to ground pin 2 (A) and red lead of ohmmeter to TPS2 pin 5 (B) and measure resistance while throttle is closed.

Specification

TPS2 closed throttle@20°C (68°F)—Resistance....................1120 ± 10% ohms
TPS2 open throttle @20°C (68°F)—Resistance....................380 ± 10% ohms



TCAL26406 —UN—15JUN12

7. With black lead of ohmmeter still connected to ground pin 2 (A) connect red lead of ohmmeter to TPS1 pin 6 (C) and measure resistance while throttle is closed.

Specification

TPS1 closed throttle@20°C (68°F)—Resistance....................660 ± 10% ohms
TPS1 open throttle @20°C (68°F)—Resistance....................1215 ± 10% ohms

8. If resistance of TPS1 and TPS2 are out of specification replace electronic throttle body.

RB14256,00009F5 -19-18JUN12-1/1

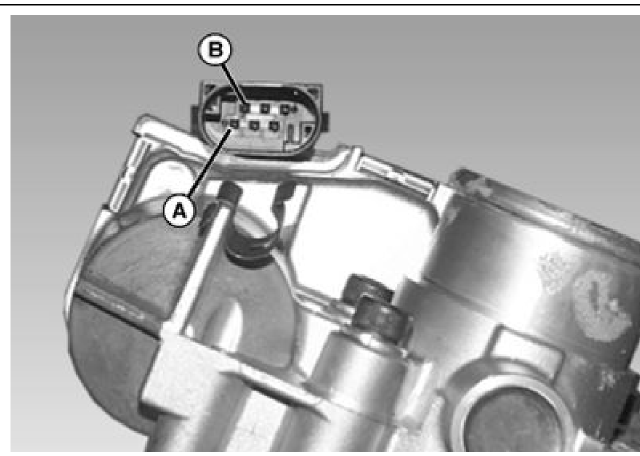
Electronic Throttle Motor Control Test

Reason

To determine if electronic throttle motor control is functioning properly.

Procedure

1. Park machine on level surface.
2. Turn all switches to the OFF position.
3. Lock park brake, place gear shift in neutral position, and disengage differential lock.
4. Raise cargo box or remove the optional component installed on the vehicle as needed to provide clearance.
5. Disconnect EC4 connector from electronic throttle body.
6. With a (XX) volt power source connect black lead to motor ground pin 1(A) and red lead to positive motor pin 4(B).

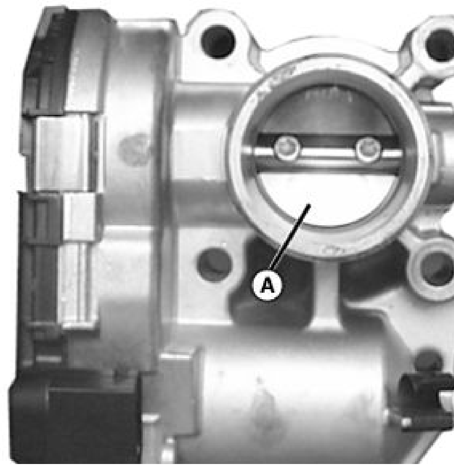


TCAL26407 —UN—15JUN12

Continued on next page

RB14256,00009F6 -19-18JUN12-1/2

7. Disconnect EC4 connector from electronic throttle body.
8. If throttle body plate (A) is wide open with leads connected electronic motor is in working condition. If throttle plate opens partially or not at all (shown), replace electronic throttle body.



TCAL26408 —UN—15JUN12

RB14256,00009F6 -19-18JUN12-2/2

TMAP Air Temperature And Pressure Circuit Test

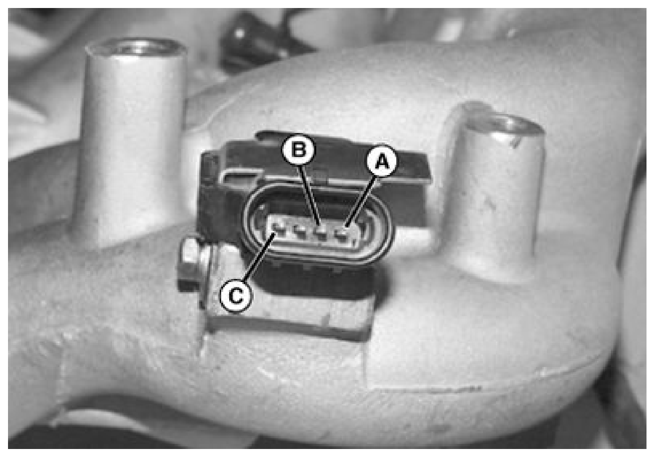
Reason

To determine if TMAP air and pressure circuits are functioning properly on the sensor.

Procedure

NOTE: Perform test with engine at room temperature.

1. Park machine on level surface.
2. Turn all switches to the OFF position.
3. Lock park brake, place gear shift in neutral position, and disengage differential lock.
4. Raise cargo box or remove the optional component installed on the vehicle as needed to provide clearance.
5. Disconnect EC13 connector from TMAP sensor.
6. Connect black lead of ohmmeter to ground pin (A) and red lead of ohmmeter to manifold air temperature pin (B) and measure resistance.



TCAL26409 —UN—15JUN12

Specification

MAT @20°C
(68°F)—Resistance.. 2050 ± 10% ohms

Continued on next page

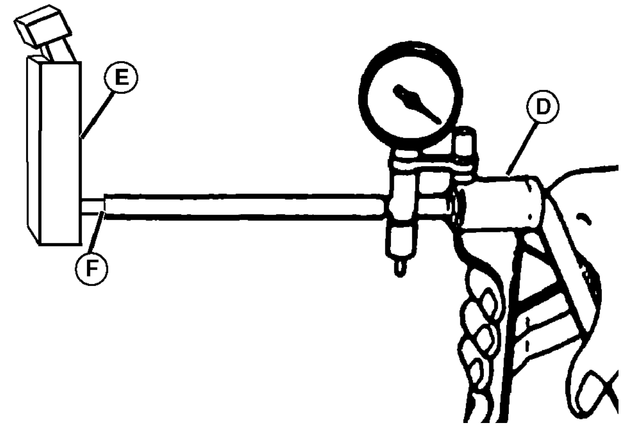
RB14256,00009F7 -19-18JUN12-1/2

7. Connect TMAP (E) sensor outlet (F) to a hand held vacuum pump (D). Create a vacuum of (XX) to simulate manifold conditions.
8. Connect black lead of ohmmeter to ground pin (A) and red lead of ohmmeter to manifold air pressure pin (C) and measure resistance.

Specification

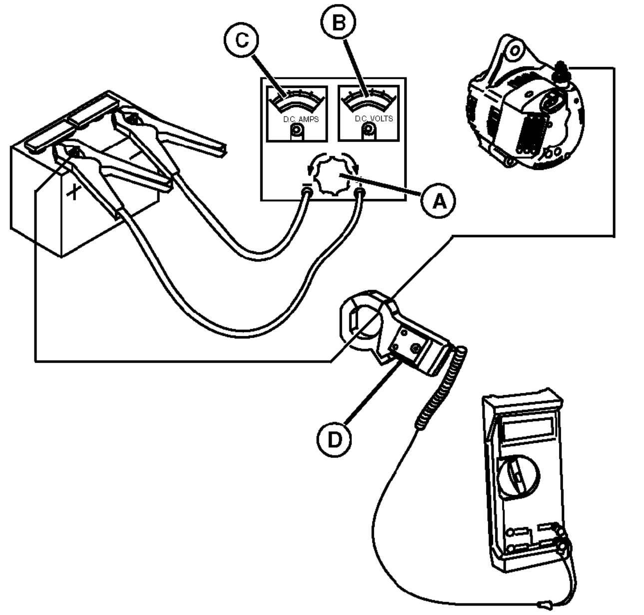
MAP XX lbs/in @20°C (68°F)—Resistance.. 93 ± 10% ohms

9. If resistance of MAT and MAP are out of specification replace the TMAP sensor.



RB14256,00009F7 -19-18JUN12-2/2

Regulated Amperage and Voltage Tests



Reason

To determine the regulated voltage (charging) output of the regulator/rectifier.

Special or Required Tools:

- Current Gun
- Battery Tester

NOTE: Not recommended testing unregulated voltage on EFI engine.

Procedure

1. Park machine on level surface.
2. Turn all switches to the OFF position.
3. Lock park brake, place gear shift in neutral position, and disengage differential lock.
4. Raise cargo box or remove the optional component installed on the vehicle as needed to provide clearance.

NOTE: Battery must be in a good state of charge.

5. Connect JT05712 Current Gun (D) to voltmeter and put around positive (red) battery cable going to alternator. Set current gun for DC current.

IMPORTANT: Avoid Damage! Turn load knob (A) fully counterclockwise (out) into OFF position BEFORE making any test connections.

6. Connect battery tester to battery.

IMPORTANT: Avoid Damage! Perform this test quickly to prevent damage to the battery. DO NOT apply full load to battery for more than 5-10 seconds.

7. Turn load knob clockwise (in) until voltage on voltage tester scale reads 11 volts for 5 seconds only, to partially drain battery.
8. Quickly turn load knob completely counterclockwise (out) to OFF position.
9. Start and run engine at fast idle . Battery voltage should read between 12.2 and 14.7 volts DC.

Specification

Regulated Voltage
(Max)—Voltage...14.7 VDC

10. Turn load knob clockwise (in) until voltage on tester voltage scale (B) reads 11 volts and look at current gun for a minimum reading of 60-65 amps.
11. Quickly turn load knob completely counterclockwise (out) to OFF position.
12. After load test, voltage scale (B) should return to a maximum of 14.7 volts DC.

Results

- If at any time voltage increase exceeds 14.7 volts DC, replace alternator.

RB14256,00009F8 -19-30SEP16-1/1

ECM and General Sensor Circuit Operation

Function:

Sensors provide the inputs to the ECM, which in turn provides the proper output to the injectors and ignition coils.

The malfunction indicator light (MIL) displays a code to provide a visual indication of sensor/component circuit integrity. These fault codes (as viewed through Service ADVISOR) will aid in the diagnosis of operational problems that may occur.

Operating Conditions:

- Key in run or start position,
- Engine running.

Theory of Operation:

Power is supplied to the engine electronic control unit (ECM) when the key is in the run or start positions and the main engine control relay has been energized.

When the operating conditions have been met, the ECM sensors provide inputs to the ECM so that the ECM will provide the ground path (low side switched) for the injectors at the correct time and duration.

The ECM also has a self diagnostic mode that will display a code through Service ADVISOR and illuminate the onboard warning light if any of the input sensors, injectors, or ignition coils are not operating properly. When the circuit is operating normally, this light will remain off.

The engine sensors are all components that change their signal outputs to the ECM. The fault codes for these components are based on the ECM reading an out of range voltage, or either an open or a shorted circuit. This means that the ECM is receiving either greater than 5 VDC or less than 1.0 VDC from the sensors.

The malfunction indicator light (MIL) will continue to be illuminated as long as the key switch is in the run position if a qualifying error is present. When the key switch is turned to the off position the fault is stored in memory.

MIL Circuit Function:

During normal startup the MIL will illuminate until the engine is running. The MIL will illuminate when the input from any one or more sensors is not operating properly. If more than one fault exists, each fault will be displayed using Service ADVISOR in the order that they occurred.

The ECM also has many different fault codes available to assist with diagnostics. If a malfunction is displayed, this means that the ECM is receiving an erroneous voltage signal, no voltage, an open or closed circuit, or a trigger voltage from a sensor or component.

Once a code has been read through Service ADVISOR, it can be matched to the fault code chart to assist in diagnosis.

Limp Home Mode - Gas Only:

When the ECM detects a malfunction that may cause engine damage, it shuts off fuel and the ground for the rear cylinder ignition coil. This allows the engine to run, in a reduced capacity, to prevent engine damage and to allow the machine to be driven to a safe location.

RB14256,00009F9 -19-18JUN12-1/1

Troubleshooting Electronic Controllers

NOTE: This reference is a guideline for troubleshooting problems that still exist after standard diagnostics have been performed. These problems are typically due to specific operating conditions, intermittent failures or, in rare cases, control unit failures. Depending on the situation, some or all of the following may be important.

Problems Due to Specific Operating Conditions:

Review all recorded codes and consult with operator to determine operating and vehicle conditions when the problem occurs. Record details.

- Does code/problem occur at the same time as other problems?
- Does code/problem occur when vehicle is warm or cold?
- Does code/problem occur during field or transport operation?
- Does code/problem occur while performing a specific action such as shifting, turning, braking, operating certain hydraulics?
- When did code/problem first appear? Was there any maintenance performed recently? (If yes, inspect areas of maintenance for inadvertent damage or improper installations).

Attempt to recreate code/problem based on conditions. If possible, repeat operational, system, electrical, hydraulic or mechanical checks under these conditions.

Problems Due to Intermittent Electrical Failures:

NOTE: **Electrical intermittent failures are usually caused by harness, terminal or connector problems.**

- Inspect all connectors and terminals of related circuits.
- Inspect mechanical linkages for interference with harnesses or connectors.
- Inspect harnesses for missing or improperly installed clamps or bands. Loose harnesses that are allowed to move too freely or harnesses that are banded too tightly may result in worn or damaged wires.
- Inspect mechanical linkages for proper operating condition.

Problems Due to Control Unit Failures:

NOTE: Before replacing control unit, review all tests. Control units are the least likely cause of failure!

- If all checks have been made with no problems identified, check power and ground circuits. Power inputs must be within 1 V of battery voltage and ground circuits must be less than 1.0 ohm to the vehicle single point ground.
- Do not confuse low side driver (LSD) or dedicated sensor/control grounds with frame ground. These grounds or LSDs are often at a higher potential than frame ground.
- Inspect all connectors and terminals of associated control units.

RB14256,00009FA -19-18JUN12-1/1

ECM Sensor and Diagnostic Circuit Diagnosis

Test Procedure:

The sensors used to operate and control the engine are not easily tested in the system. If a fault is displayed or it is believed that a fault exists, it is easiest to test each component separate from the circuit. Remove the component from the machine and follow the test procedure for that component in the Tests and Adjustments section.

RB14256,00009FB -19-18JUN12-1/1

TMAP Faults

SPN	FMI	MIL	Fault Conditions	Description
106	16	108	MAP >17 psia TPS < 8% RPM > 800 Unlatch < 10 psia	MAP High Pressure
106	4	107	MAP Voltage < 0.05VDC TPS > 2% RPM < 3000 Unlatch > 0.5VDC	MAP Low Voltage

RB14256,00009FC -19-18JUN12-1/1

ECT Faults

SPN	FMI	MIL	Fault Conditions	Description
110	3	118	ECT Voltage > 4.95VDC	ECT High Voltage
110	4	117	ECT Voltage <0.05VDC	ECT Low Voltage
110	15	116	ECT >220°F RPM >600	ECT Higher than Expected 1
110	0	217	ECT >230°F RPM >600	ECT Higher than Expected 2

RB14256,00009FD -19-18JUN12-1/1

IAT Faults

SPN	FMI	MIL	Fault Conditions	Description
105	3	113	IAT Voltage >4.95VDC	IAT High Voltage
105	4	112	IAT Voltage <0.05VDC	IAT Low Voltage
105	15	111	IAT >200°F RPM >600	IAT Higher than Expected 1
105	0	127	IAT >210°F RPM >600	IAT Higher than Expected 2

RB14256,00009FE -19-18JUN12-1/1

Barometric Pressure (BP) Faults

SPN	FMI	MIL	Fault Condition	Description
108	0	2229	BP >16 psia	BP High Pressure
108	1	129	BP <8.3 psia	BP Low Pressure

RB14256,00009FF -19-18JUN12-1/1

Battery Voltage Faults

SPN	FMI	MIL	Fault Condition	Description
168	15	563	Voltage >16VDC	Battery Voltage High
168	17	562	Voltage <12VDC RPM >950	Battery Voltage Low

RB14256,0000A00 -19-18JUN12-1/1

5V External Faults

SPN	FMI	MIL	Fault Condition	Description
1079	3	643	5VE1 >5.4VDC	5VE1 High Voltage
1079	4	642	5VE1 <4.6VDC	5VE1 Low Voltage
1080	3	653	5VE2 >5.4VDC	5VE2 High Voltage
520206	1	652	5VE2 <1.5VDC	5VE2 Low Voltage
1079	31	1611	Same as Above	5VE1/2 Simultaneous Out of Range

RB14256,0000A01 -19-18JUN12-1/1

TPS Faults

SPN	FMI	MIL	Fault Condition	Description
51	3	123	TPS1 >4.8VDC	TPS1 High Voltage
51	4	122	TPS1 <0.2VDC	TPS1 Low Voltage
520251	3	223	TPS2 >4.8VDC	TPS2 High Voltage
520251	4	222	TPS2 <0.2VDC	TPS2 Low Voltage
51	0	221	(TPS1% - TPS2%) >20%	TPS1 Higher than TPS2
51	1	121	(TPS1% - TPS2%) < -20%	TPS1 lower than TPS2
51	7	2112	(Target TPS - Actual TPS) >20%	Unable to reach higher TPS Persistently longer than 200ms Battery Voltage >9VDC Battery Voltage <16VDC
51	7	2111	(Target TPS - Actual TPS) <-20%	Unable to reach lower TPS Persistently longer than 200ms Battery Voltage >9VDC Battery Voltage <16VDC
51	31	2135	TPS1/2 Simultaneous Voltages out of Range	Uses same parameters as individual TPS1/2 fault detection above

RB14256,0000A02 -19-18JUN12-1/1

FPP Faults

SPN	FMI	MIL	Fault Condition	Description
91	3	2122	FPP1 Voltage >4.8VDC	FPP1 High Voltage
91	4	2123	FPP1 Voltage <0.1VDC	FFP1 Low Voltage
29	3	2128	FPP2 Voltage >4.8VDC	FPP2 High Voltage
29	4	2127	FPP2 Voltage <0.1VDC	FFP2 Low Voltage
91	16	2126	FFP1 Higher than FFP2	(FFP1% - FFP2%) >20%
91	18	2121	FFP1 Lower than FFP2	(FFP1% - FFP2%) <-20%

RB14256,0000A03 -19-18JUN12-1/1

Auxiliary Analog Input Fault

SPN	FMI	MIL	Fault Condition	Description
520223	4	1554	AUX DIG2 <5VDC	AUX DIG2 Low

RB14256,0000A04 -19-18JUN12-1/1

Engine Speed Faults

SPN	FMI	MIL	Fault Condition	Description
515	15	219	rpm > 4500	Max govern speed override
515	16	1111	rpm >4500	Fuel rev Limit
515	0	1112	rpm >4500	Spark rev Limit

RB14256,0000A05 -19-18JUN12-1/1

Oil Pressure Fault

SPN	FMI	MIL	Fault Condition	Description
100	1	524	Oil Pressure Pulled Up Input <2.5VDC	Oil Pressure Low (switch)

RB14256,0000A06 -19-18JUN12-1/1

Adaptive Learn Faults

SPN	FMI	MIL	Fault Condition	Description
520200	0	171	AL_BM >30%	AL High Gasoline Bank1
520200	1	172	AL_BM <-30%	AL Low Gasoline Bank1

RB14256,0000A07 -19-18JUN12-1/1

Closed Loop Faults

SPN	FMI	MIL	Fault Condition	Description
520204	0	1155	CL_BM >35%	CL High Gasoline Bank1
520204	1	1156	CL_BM <-35%	CL Low Gasoline Bank1

RB14256,0000A08 -19-18JUN12-1/1

EGO Sensor Fault

SPN	FMI	MIL	Fault Condition	Description
724	10	134	EGO Cold Persistently for 120 seconds	EGO Open / Lazy pre-cat1

RB14256,0000A09 -19-18JUN12-1/1

Fuel Pump Relay Control / Coil Faults

SPN	FMI	MIL	Fault Condition	Description
1348	4	628	5 Samples	F Pump Relay Control Ground Short
1348	5	627	5 Samples	F Pump Relay Coil Open
1347	6	629	5 Samples	F Pump Relay Coil Short to Power

RB14256,0000A0A -19-18JUN12-1/1

Power Relay Control / Coil Faults

SPN	FMI	MIL	Fault Condition	Description
1485	4	686	5 Samples	Relay Control Ground Short
1485	5	685	5 Samples	Relay Coil Open
1485	3	687	5 Samples	Relay Coil Short to Power

RB14256,0000A0B -19-18JUN12-1/1

MIL Control Faults

SPN	FMI	MIL	Fault Condition	Description
1213	4	1644	5 Samples	MIL Control Ground Short
1213	5	650	5 Samples	MIL Open
1213	3	1645	5 Samples	MIL Control Short to Power

RB14256,0000A0C -19-18JUN12-1/1

Cam / Crank Sensors Faults

SPN	FMI	MIL	Fault Condition	Description
636	4	337	Cam Pulses without Crank Activity >6 Cam Pulses	Crank Loss
636	2	336	Number of Invalid Crank Re-syncs within a Time Window <=800ms	Crank Sync Noise
636	8	16	Cranking Revs without Sync > 4 revs RPM >90	Never Crank Synced at Start

RB14256,0000A0D -19-18JUN12-1/1

Internal Processor Diagnostics Faults

SPN	FMI	MIL	Fault Condition	Description
629	31	606		COP Failure
629	31	1612		RTI 1 Loss
629	31	1613		RTI 2 Loss
629	31	1614		RTI 3 Loss
629	31	1615		A/D Loss
629	31	1616		Invalid Interrupt
628	13	601		Flash Checksum Invalid
630	12	604		RAM Failure

RB14256,0000A0E -19-18JUN12-1/1

Electronic Throttle Control Device (ETC)

Engine speed is controlled by the ECM and the ETC.The ECM controls engine speed using signals from a foot pedal position sensor. This sensor will send a 0 - 5VDC signal to the ECM, which will in turn send a signal to the ETC motor. This will increase or decrease the throttle plate angle, thereby changing the air/fuel mixture to the engine. Two throttle position sensors (TPS) are contained within the ETC. These will provide output signals back to the ECM as to the location of the throttle shaft and plate. The TPS information is used by the ECM to correct for speed and load control as well as emissions.

The ETC consists of two redundant sensors. The output of the primary will generally be twice the output of the secondary and maintain this ratio within a certain tolerance.

RB14256,0000A0F -19-18JUN12-1/1

Three Way Catalytic Converter

The catalytic converter is a component of the emissions system which is designed to meet Tier 3 emissions requirements.

The exhaust gasses pass through a honeycomb catalyst which is coated with a mixture of precious metals to oxidize and reduce CO, HC, and NOX emission gasses.

RB14256,0000A10 -19-18JUN12-1/1

Engine Control Module (ECM)

The ECM is a 32 bit controller which receives input data from sensors mounted on the engine and fuel system and then outputs various signals to control engine operation.One function of the controller is to maintain closed loop fuel control using the heated oxygen (O2) sensor. The O2 sensor is mounted on the exhaust system and sends a voltage signal to the ECM to change the amount of fuel being delivered to the engine.

The ECM also performs diagnostic functions on the fuel system and notifies the operator of engine malfunctions by turning on the malfunction indicator light (MIL) mounted on the dash. In addition to turning on the MIL, the controller also stores the information about the malfunction in its memory. Service ADVISOR can then be used to retrieve the stored diagnostic codes to determine the cause of the malfunction. The MIL can also be used to retrieve codes to activate a blink feature to determine the diagnostic code number.

RB14256,0000A11 -19-18JUN12-1/1

Heated Exhaust Gas Oxygen Sensor (O2)

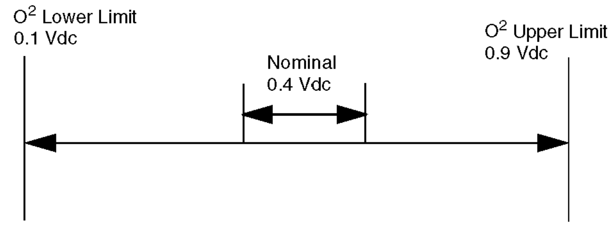
The O2 sensor is mounted in the exhaust system before the catalytic converter.

The O2 sensor is used to measure the amount of oxygen present in the exhaust stream to determine whether the air-fuel ratio is too rich or too lean. It then sends this information to the ECM.

The heating element allows the sensor to become active earlier on a cold engine, thereby reducing emissions.

Code Caused By: This code can be triggered in two ways:

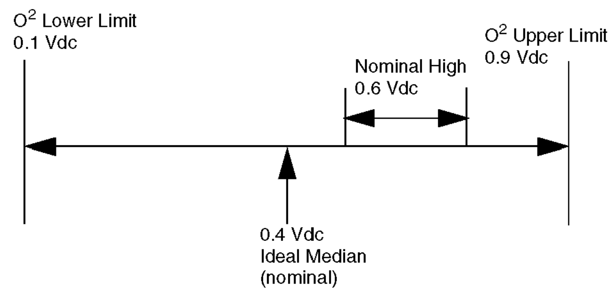
- O2 sensor ‘s output does not deviate from its approximate nominal voltage.



TCAL26412 —UN—15JUN12

RB14256,0000A12 -19-18JUN12-1/3

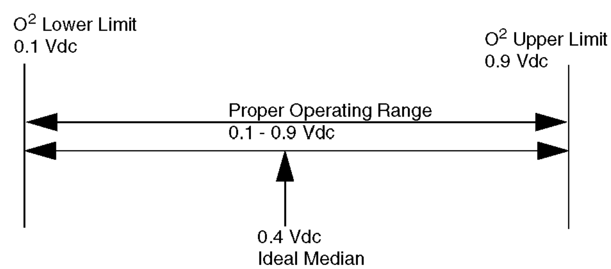
- O2 sensor’s output does not deviate from a point above or below its nominal voltage.



TCAL26413 —UN—15JUN12

Example shows sensor consistently nominal high

RB14256,0000A12 -19-18JUN12-2/3



TCAL26414 —UN—15JUN12

Proper O2 sensor operation

RB14256,0000A12 -19-18JUN12-3/3

TMAP Sensor

The temperature manifold absolute pressure sensor is a variable resistor used to monitor the difference in pressure between the intake manifold and outside atmospheric pressure and temperature. The ECM monitors the resistance of the sensor to determine engine load. When the engine is under load, the ECM my alter the air-fuel mixture to improve performance and emissions, The temperature is monitored to improve cold start performance.

RB14256,0000A13 -19-18JUN12-1/1

Coolant Temperature Sensor

The coolant temperature sensor is a variable resistance thermistor that changes resistance as the engine temperature change.The sensors output is measured by the ECM to determine a cold start condition and regulate various fuel and emission control functions for closed loop operation.

RB14256,0000A14 -19-18JUN12-1/1

Oil Pressure Sensor

This sensor is designed to ensure proper engine lubrication. It provides the ECM with pressure data.

RB14256,0000A15 -19-18JUN12-1/1

Fuel Pump

The fuel pump is a 12V electric motor that is controlled by the ECM. When the key is first turned on, the ECM will prime the pump for 2 seconds prior to starting the engine.

RB14256,0000A16 -19-18JUN12-1/1

Fuel Injector

The injector is fed a pulse signal from the ECM. The ECM will control the opening and duration of the injector. The engine must be calibrated to deliver the precise amount of fuel for optimum performance and emission control.

RB14256,0000A17 -19-18JUN12-1/1

Malfunction Indicator Light (MIL) Operation

Function:

To indicate the presence of an engine related malfunction to the operator.

NOTE: This light is not used for reading diagnostic codes.

Operating Conditions:

Not running - self test

Engine running - will illuminate only if a DTC is active

Theory of Operation:

The display panel MIL is controlled by the ECM. All the display panel does is supply constant power to the MIL via switched power.

A MIL DTC is caused by one of three things:

- ECM detects an excessively high voltage from MIL circuit when the ECM calls MIL to turn on. Short circuit on ECM low side driver - LSD.
- ECM detects an excessively low voltage from MIL circuit when ECM calls for MIL to be turned off. Open circuit.
- ECM detects no voltage when MIL is in called to be in any state. Short to ground.

When the MIL is in its on state, the ECM will pull voltage low (approximately 1.2Vdc). This will cause a great enough difference in potential to illuminate the bulb. This low side driver is NOT at ground potential.

The ECM can detect these voltage changes if they are not correct and record a DTC.

In addition to indicating a system fault, the ECM can be manually placed into a diagnostic blink code mode.

RB14256,0000A18 -19-18JUN12-1/1

On Board Diagnostics

Diagnostic Trouble Codes (DTC s):

The ECM is capable of recording current or stored DTC s to its memory. If a malfunction exists, ti will turn on the malfunction indicator light (MIL). This light will only indicate that a problems exists, not display what the specific problem is. In order to display the specific DTC (s), Service ADVISOR must be connected to the machine.

An industry standard ISO 9141-2 serial communication protocol is used for DTC retrieval.

Description of Code Structure:

Sample Code: P0031

Code digit position - 1 2 3 4 5

1st Digit:

P = Powertrain

B = Body

C = Chassis

U = Unspecified

2nd Digit:

0 = Standard

1 = Manufacturer Specific

3rd Digit:

1 = Emission Management

2 = Injector Circuit

3 = Ignition

4 = Auxiliary Emission

5 = Vehicle Speed & Idle Control

6 = Computer and Output Circuit

7 = Transmission

The remaining digits describe the specific malfunction which may or may not be industry standards.

RB14256,0000A19 -19-18JUN12-1/1

Data Bus Systems

The ECU controller electronic control unit is connected via a data bus system (CAN BUS [CAN = CONTROLLER AREA NETWORK]).

The data BUS system forms a communication network for data-sharing and diagnostics.

The lines that link up the elements of a data BUS system are known as communication lines.

RB14256,0000A1A -19-18JUN12-1/1

CAN Bus Theory of Operation

The Controller Area Network (CAN-BUS) is used to allow communication to the control unit.

The CAN bus has terminating resistors in the bus or the controller. The terminating resistors are required to reduce faults in the communication lines

The control unit can send and receive digital messages via the CAN-BUS.

In order to regulate the information being transmitted, the electronic control unit has an interface controller built in. While the electronic control unit is fully occupied performing its own tasks, the interface controller manages the information on the CAN-BUS and passes required information onto the bus.

Diagnostic Trouble Codes (DTCs) are based on the CAN ISO and J1939 SAE Standards. These are worldwide standards for automotive and off-highway machines and are controlled by an ISO industry committee.

RB14256,0000A1B -19-18JUN12-1/1

CAN Network Voltage Checks

NOTE: These procedures should be followed in sequence until the problem is resolved.

Reason:

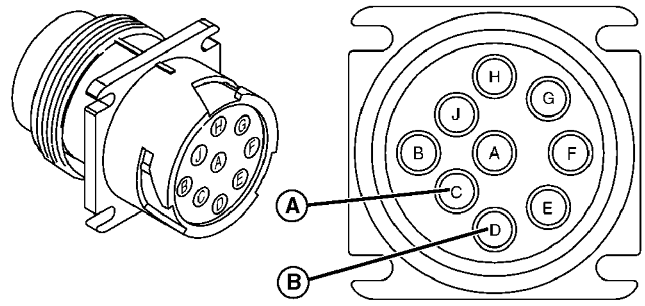
To check the CAN Hi(+) and CAN Lo(-) signals for proper voltage.

Equipment:

- A separate 12 volt wall outlet supply is needed to power the Service ADVISOR™ EDL (electronic data link). The EDL is required to connect a computer to the machine.

Check for proper voltage:

1. Park machine safely.
2. Connect a ground lead to the engine ground (located on the front of the engine) and route it close to the CAN diagnostic connector.
3. Start the engine.
4. Use a multimeter to measure CAN Hi (A) and CAN Lo (B) voltages at the Service ADVISOR diagnostic connector.



5. Correct readings (desired):
   - CAN Hi (A to ground): 2.50 - 3.50 V
   - CAN Lo (B to ground): 1.50 - 2.49 V
6. Incorrect readings:
   - One or both voltages above 5 V.
   - One or both voltages below 1 V.
   - CAN Hi and CAN Lo voltages are equal.
   - Voltages out of specification but between 1 - 5 V.

Continued on next page RB14256,0000A1C -19-20AUG14-1/2

Check for Short Circuits to CAN Hi and CAN Lo:

1. This check should only be performed if the previous checks of CAN Hi and CAN Lo indicated:
   - Voltage at or near battery voltage.
   - Voltage above 5 volts.
   - Voltage below 1 volt.
   - Voltages of CAN Hi and CAN Lo were stable and equal.
2. Verify all connectors and terminators are connected.
3. Start the engine.
4. Use a multimeter to measure CAN Hi (A) and CAN Lo (B) voltages at the Service ADVISOR diagnostic connector, from machine engine ground to CAN Hi and CAN Lo. Record values.
5. Remove one of the two CAN passive terminators.
6. Check for a change in voltage on CAN Hi and CAN Lo from value recorded. If voltage changed, terminator is bad, replace passive terminator.

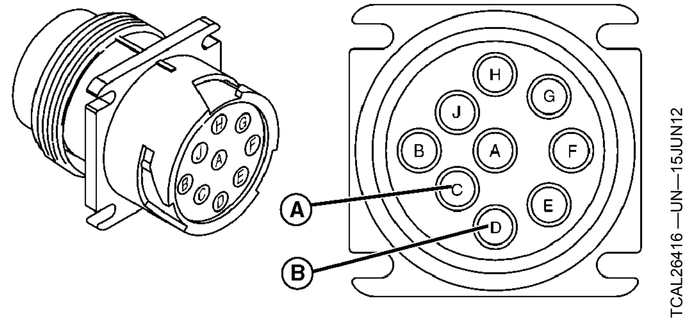
NOTE: **Voltage higher than 5 V on either CAN Hi or CAN Lo indicates a short to high voltage. Voltage lower than 1 V indicates a short to ground. If CAN Hi and CAN Lo are equal, they could be shorted together.**

7. Repeat procedure for the other terminator.

Compare CAN Hi and CAN Lo Voltages:

NOTE: **The CAN bias voltage is 2.5 V on the CAN Hi and Lo. To evaluate the CAN Hi and CAN Lo circuits, the voltage recorded for each must be calculated in reference to this bias.**

1. To calculate CAN voltage bias differential where A=CAN Hi voltage and where B=CAN Lo voltage and:
   - CAN Hi: Recorded voltage minus 2.5V=A
   - CAN Lo: 2.5V minus Recorded voltage=B
2. Compare results from CAN Hi and CAN Lo calculations. Values must be within 35% of each other. Use the following table to evaluate:



CAN Hi Result (A)	CAN Lo Result (B)
0.1V	0.06 - 0.14
0.2V	0.13 - 0.27
0.3V	0.21 - 0.4
0.4V	0.26 - 0.54
0.5V	0.33 - 0.67
0.6V	0.39 - 0.81
0.7V	0.46 - 0.94
0.8V	0.52 - 1.0
0.9V	0.59 - 1.0
1.0V	0.65 - 1.0

3. If results are within acceptable limits according to table:

   a. CAN differential voltage is OK.

4. If results are not within acceptable limits according to table:
   - CAN Hi result approximately 2X CAN Lo result. Loss of CAN Lo between controller and passive terminator.
   - CAN Lo result approximately 2X CAN Hi result. Loss of CAN Hi between controller and passive terminator.

Voltages Within Range but Out of Specification:

Perform the following until voltages are within specification:

1. Replace or test passive terminators if installed.
2. With engine off and terminators (if installed) removed, perform continuity checks on all CAN bus circuits. See CAN Bus Topology diagrams for machine's configuration.

RB14256,0000A1C -19-20AUG14-2/2

Troubleshooting Electronic Controllers

NOTE: This reference is a guideline for troubleshooting problems that still exist after standard diagnostics have been performed. These problems are typically due to specific operating conditions, intermittent failures or, in rare cases, control unit failures. Depending on the situation, some or all of the following may be important.

Problems Due to Specific Operating Conditions:

Review all recorded codes and consult with operator to determine operating and machine conditions when the problem occurs. Record details.

- Does code/problem occur at the same time as other problems?
- Does code/problem occur when machine is warm or cold?
- Does code/problem occur during field or transport operation?
- Does code/problem occur while performing a specific action?
- When did code/problem first appear? Was there any maintenance performed recently? (If yes, inspect areas of maintenance for inadvertent damage or improper installations.)

Attempt to recreate code/problem based on conditions. If possible, repeat operational, system, electrical or mechanical checks under these conditions.

Problems Due to Intermittent Electrical Failures:

NOTE: **Electrical intermittent failures are usually caused by harness, terminal or connector problems.**

- Inspect all connectors and terminals of related circuits.
- Inspect mechanical linkages for interference with harnesses or connectors.
- Inspect harnesses for missing or improperly installed clamps or bands. Loose harnesses that are allowed to move too freely or harnesses that are banded too tightly may result in worn or damaged wires.
- Inspect mechanical linkages for proper operating condition.

Problems Due to Control Unit Failures:

NOTE: Before replacing control unit, review all tests. Control units are the least likely cause of failure!

- If all checks have been made with no problems identified, check power and ground circuits.
- Inspect all connectors and terminals of associated control units.

RB14256,0000A1D -19-18JUN12-1/1

Accessing Addresses and Diagnostic Trouble Codes

The control unit monitors electrical circuits. The unit then stores the relevant diagnostic trouble code if there is a malfunction (error). However, not all of the diagnostic trouble codes indicate a current problem, since most of the circuits are monitored only at the actual moment of activation or when they are actually activated (switched on). To make sure that the diagnostic trouble code you are troubleshooting is ”active”, you should proceed as follows:

1. General procedure for dealing with diagnostic trouble codes:
   - Start the machine and check for diagnostic codes.
   - Carry out an operational test (activate the circuit affected) or test operation of the machine.
   - If it is not possible to (re-)produce a relevant diagnostic fault code by means of a functional check and the problem is still present in the circuit, deal with the codes you noted earlier.
2. Procedure for dealing with diagnostic trouble codes using Service ADVISOR:
   - Access diagnostic trouble codes via the ”Diagnostic” tab
   - ”Active” diagnostic trouble codes take priority
   - If no "ACTIVE" diagnostic trouble codes are present:

   □ Delete diagnostic trouble code(s)
   □ Carry out an operational test (activate the circuit affected) or test operation of the machine
   □ Shut off engine and turn restart it after five seconds (re-initiate the control units)
   □ If no active diagnostic trouble codes are present, deal with the ”SAVED” codes
   □ If it is not possible to (re-)produce a relevant diagnostic trouble code by means of a functional check or operational test, and the circuit problem persists, the cleared diagnostic trouble codes must be checked; if the codes are associated with the problem on the machine, they must be processed.

NOTE: Cleared diagnostic trouble codes should only be dealt with if it is not possible to (re-)produce the problem on the machine (no active or saved codes are present after a functional test has been carried out) and when the description of diagnostic trouble code can be associated with the machine problem.

3. Processing cleared diagnostic trouble codes using Service ADVISOR:
   - Every time a diagnostic trouble code is accessed, it is saved in Service ADVISOR in the ”Readings Logs” of the job that is being processed. Before it is cleared, the diagnostic trouble code status of the machine can be accessed via the ”Sessions” menu or ”Logs”.
4. Status of diagnostic trouble codes in Service ADVISOR:
   - Status: ”ACTIVE” (priority I):

   □ Diagnostic trouble code cannot be cleared.
   □ Current problem with the machine.

   - Status: ”SAVED” (priority 2):

   □ Diagnostic trouble code can be cleared
   □ At present the problem is not recognized by the control unit (example: faulty switch or circuit not activated at the moment).

RB14256,0000A1E -19-18JUN12-1/1

Approved Software for Control Unit

IMPORTANT: Avoid Damage! When reprogramming electronic control units, always comply with the relevant instructions (e.g. installation instructions, DTAC or PIP).

Do NOT reprogram the control unit if the version numbers of the new and current software are identical, or if the control unit is already programmed with a newer software version.

NOTE: New software always includes the properties that were newly introduced with the previous software. However, not all software versions can be used on every machine.

NOTE: The software for reprogramming is either supplied with the Service ADVISOR data DVD, or else it must be downloaded from John Deere's Intranet (John Deere Custom Performance (Software Delivery System)).

For the current summary of software, see PATHWAYS or DTAC.

All identical controllers on the machine should be running the same software version.

RB14256,0000A1F -19-18JUN12-1/1

Reading Codes

Reading Name	Reading Description	Units	Attributes	Discrete Values
Accelerator Pedal 1 Low Idle Switch				
Accelerator Pedal Position 1	FPP1 Sensor Position	Percent	Numeric	
Accelerator Pedal Position 2	FPP2 Sensor Position	Percent	Numeric	
Actual Engine - Percent Torque	Engine Torque Percentage	Percent	No Decimal, Numeric	
Active Trouble Codes	Diagnostic Trouble Codes (DTC)			
Arbitrary Address Capable			Numeric	0-1
Barometric Pressure	Barometric Pressure	psi/kPa	Decimal, Numeric	
Battery Potential (voltage)/Power Input	Battery Voltage	Volts	Decimal, Numeric	
Control Byte				
Current Data Link				
ECM Instance				
ECM Location	ECM Location		Alphanumeric	
ECM Manufacturer	ECM Manufacturer		Alphanumeric	
ECM Type	ECM Type		Alphanumeric	
ECM Part Number	ECM Part Number		Alphanumeric	
ECM Serial Number	ECM Serial Number		Alphanumeric	
Engine Air Inlet Pressure	Intake Pressure/Vacuum	psi/kPa	No Decimal, Numeric	
Engine Air Inlet Temperature	Intake Temperature	Degrees	No Decimal, Numeric	
Engine Intake Manifold Pressure/Vacuum	Intake Pressure/Vacuum	psi/kPa	No Decimal, Numeric	
Engine Intake Manifold Temperature	Intake Temperature	Degrees	No Decimal, Numeric	
Engine Coolant Temperature	Engine Coolant Temperature	Degrees	No Decimal, Numeric	
Engine Desired Operating Speed	Engines Desired Operating Speed	RPM	Decimal, Numeric	0-8031.875
Engine Exhaust Gas Oxygen Sensor Closed Loop Operation	ECM is using the Oxygen Sensor to Maintain a Stoichiometric Ratio			
Fuel Rate	Fuel Delivery Rate	L/H	Decimal, Numeric	
Engine Maximum Momentary Over-ride Speed, Point 7		RPM	No Decimal, Numeric	
Engine Maximum Momentary Over-ride Time Limit		Seconds	Numeric	
Engine Oil Pressure	Engine Oil Pressure	psi/kPa	Numeric	
Engine Override Control Mode				
Engine Load at Current Speed		Percent	Numeric	
Engine Torque at Idle. Point 1		Percent	Numeric	
Engine Torque at Point 2		Percent	Numeric	
Engine Torque at Point 3		Percent	Numeric	
Engine Torque at Point 4		Percent	Numeric	
Engine Torque at Point 5		Percent	Numeric	
Engine Protection System has Shutdown Engine				
Engine Rated Power		kW	Decimal, Numeric	
Engine Rated Speed		RPM	Decimal, Numeric	0-8031.875

Continued on next page RB14256,0000A20 -19-18JUN12-1/3

Reading Name	Reading Description	Units	Attributes	Discrete Values
Engine Reference Engine Torque		lbs/ft-nm	Numeric	
Engine Request Speed/Speed Limit		RPM	Numeric	
Engine Request Speed Control Range Lower Limit		RPM	Numeric	
Engine Request Speed Control Range Upper Limit		RPM	Numeric	
Engine Request Torque/Torque Limit		Percent	Numeric	
Engine Request Torque Control Range Lower Limit		Percent	Numeric	
Engine Request Torque Control Range Upper Limit		Percent	Numeric	
Engine Speed	Engine Revolution Speed	RPM	Decimal, Numeric	0-8031.875
Engine Speed at Idle. Point 1		RPM	Numeric	
Engine Speed at Point 2		RPM	Numeric	
Engine Speed at Point 3		RPM	Numeric	
Engine Speed at Point 4		RPM	Numeric	
Engine Speed at Point 5		RPM	Numeric	
Engine Speed at High Idle. Point 6		RPM	Numeric	
Engine Throttle Actuator 1 Control Command		Percent	Decimal, Numeric	
Engine Throttle Position	Throttle Body Plate Position	Percent	Decimal, Numeric	0-100
Engine Total Hours of Operation	Engine Hours of Operation	Hours	Decimal, Numeric	0-210554060.8
Engine Total Revolutions	Total Engine Revolutions	Revolution	Numeric	0-4.21E+12
Failure Mode Identifier (FMI)	Type of Failure Detected		Numeric	0-31
Freeze Frame Length	Length of Time Engine Conditions are Recorded			
Function Instance				0-31
Function				0-255
Group Function Value	Used for Special Function Groups, Network Management, and Multi Packet Transport Functions			
Hold Signal				
Identity Number				
Industry Group				
Key Switch Battery Potential	Battery voltage at key-on position	Volts	Numeric	
Short Term Fuel Trim	Short term deviation from normal operating range of the oxygen sensor.	Percent	Decimal, Numeric	
Long Term Fuel Trim	Long term deviation from normal operating range of the oxygen sensor.	Percent	Decimal, Numeric	
Make	Machine Make		Alphanumeric	
Model	Machine Model		Alphanumeric	
Manufacturer Code				
Multifunction Indicator Lamp				
Number of Software Identification Fields		Step		
Occurrence Count				
Parameter Group Number (ACK)		Count	Numeric	

Continued on next page RB14256,0000A20 -19-18JUN12-2/3

Reading Name	Reading Description	Units	Attributes	Discrete Values
Parameter Group Number (RQST)		Count	Numeric	
Previously Active Trouble Codes			Numeric	
SPN Conversion Method				
Serial Number	Machine Serial Number		Alphanumeric	
Software Identification			Alphanumeric	
Suspect Parameter Number	Identifies the Item for which Diagnostics are being Reported		Numeric	
Unit Power (Power Unit)			Alphanumeric	
Vehicle Identification Number	Vehicle Identification Number			
Vehicle System	Vehicle System			
Vehicle System Instance				0-15

RB14256,0000A20 -19-18JUN12-3/3

End of Diagnostic Procedure

1. Remove all test equipment except the Service ADVISOR.
2. Connect any disconnected components, fuses, ect.
3. Using the Service ADVISOR clear the DTC information from the ECM.
4. Turn the ignition OFF and wait 30 seconds.
5. Start the engine and operate the vehicle to full operating temperature.
6. Observe the MIL.
7. Observe engine performance and drivability.
8. After operating the engine within the test parameters, check for any stored codes.

RB14256,0000A21 -19-18JUN12-1/1

106.16 (DTC 108) - TMAP High Pressure — System: TMAP

Code Caused By:

- MAP pressure greater than 17 psia.
- TPS less than 8%.
- Engine speed greater than 800 rpm.

Alarm Level:

- Mil light on.

Control Unit Response:

- Adaptive learning disabled.
- Unlatch under 10 psia.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Visually ensure that TMAP sensor wiring is not compromised. If other power related codes are present, troubleshoot all codes as other conditions may be a factor.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller’s address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A22 -19-18JUN12-1/8

Procedure A:

RB14256,0000A22 -19-18JUN12-2/8

Step 1	Key ON, engine running at operating temperature, Service ADVISOR connected. Is there a MAP pressure of 17 psia or greater with the engine running above 800 rpm with a TPS value less than 8% observed?	**YES:** Go to next step. **NO:** Intermittent problem.

RB14256,0000A22 -19-18JUN12-3/8

Step 2	Key OFF, disconnect MAP sensor connector, key ON. Is a MAP pressure of 0.05 psia observed.	**YES:** Go to next step. **NO:** Go to procedure B.

Continued on next page RB14256,0000A22 -19-18JUN12-4/8

Step 3	Probe MAP connector EC13 ground pin D with a test light connected to battery voltage. Does the test light come on?	**YES:** Go to next step. **NO:** Go to procedure F.

RB14256,0000A22 -19-18JUN12-5/8

Step 4	Check MAP mechanical vacuum connection for correct mounting or possible damage causing leakage. Is the MAP sensor mechanical connection ok?	**YES:** Go to procedure B. **NO:** Go to procedure E.

RB14256,0000A22 -19-18JUN12-6/8

Step 5	Reinstall ECM payload and verify that the problem has been corrected. Does the code return?	**YES:** Go to procedure G. **NO:** End of test.

RB14256,0000A22 -19-18JUN12-7/8

Procedure B:

- Key OFF, disconnect ECM connector and inspect terminals for damage, corrosion, or contamination. If there is no problem with the connection go to procedure C. If there is a problem go to procedure D.

Procedure C:

- Replace MAP sensor. After this procedure (See End of Diagnostic Procedure.)

Procedure D:

- Repair the circuit as necessary. After this procedure (See End of Diagnostic Procedure.)

Procedure E:

- Replace o-rings and correct MAP mechanical connection. After this procedure (See End of Diagnostic Procedure.)

Procedure F:

- Disconnect ECM connector EC3 and check for continuity between MAP sensor connector EC13 ground pin D and ECM sensor ground pin 20. If there is continuity go to procedure G. If there is no continuity go to procedure D.

Procedure G:

- Replace ECM. After this step (See End of Diagnostic Procedure.)

RB14256,0000A22 -19-18JUN12-8/8

106.04 (DTC 107) - TMAP Low Voltage — System: TMAP

Code Caused By:

- MAP Voltage less than 0.05 VDC.
- TPS greater than 2%.
- Engine speed less than 3000 rpm.

Alarm Level:

- Mil light on.

Control Unit Response:

- Adaptive learning disabled.
- Unlatch over 0.5 VDC.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Visually ensure that TMAP sensor wiring is not compromised. If other power related codes are present, troubleshoot all codes as other conditions may be a factor.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller’s address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A23 -19-18JUN12-1/14

Procedure A:

RB14256,0000A23 -19-18JUN12-2/14

Step 1	Key ON, engine running at operating temperature. Service ADVISOR connected. Is there a MAP voltage of 0.05 VDC or less with the engine running below 3000 rpm with a TPS value greater than 2% observed?	**YES:** Go to next step. **NO:** Intermittent problem.

RB14256,0000A23 -19-18JUN12-3/14

Step 2	Key OFF, disconnect MAP sensor connector EC13. Jump the 5-volt reference pin B and MAP signal circuit pin A together. Key ON, Is there a voltage of 4.5 VDC or greater from the MAP sensor observed?	**YES:** Go to next step. **NO:** Go to procedure B.

RB14256,0000A23 -19-18JUN12-4/14

Step 3	Inspect MAP connector and pins for corrosion, contamination, or mechanical damage. Are there any problems?	**YES:** Go to procedure D. **NO:** Go to next step.

RB14256,0000A23 -19-18JUN12-5/14

Step 4	Key OFF, disconnect ECM connector EC3. Check continuity between MAP sensor signal pin A and ECM MAP signal pin 23. Is there continuity?	**YES:** Go to next step. **NO:** Go to procedure D.

Continued on next page RB14256,0000A23 -19-18JUN12-6/14

Step 5	Check for continuity between the MAP sensor connector EC13 5-volt supply supply pin B and ECM 5 volt supply pin 19? Is there continuity?	**YES:** Go to next step. **NO:** Go to procedure D.

RB14256,0000A23 -19-18JUN12-7/14

Step 6	Check for continuity between MAP sensor connector EC13 ground pin D and ECM connector EC3 sensor ground pin 20. Is there continuity?	**YES:** Go to procedure E. **NO:** Go to Procedure D.

RB14256,0000A23 -19-18JUN12-8/14

Step 7	Key OFF, disconnect ECM connector EC3. Check for continuity between MAP sensor connector EC13 5-volt reference pin B and ECM connector 5-volt pin 19. Is there continuity?	**YES:** Go to next step. **NO:** Go to procedure D.

RB14256,0000A23 -19-18JUN12-9/14

Step 8	Check for continuity between MAP sensor connector EC13 5-volt reference pin B and engine ground. Is there continuity?	**YES:** Go to procedure D. **NO:** Go to next step

RB14256,0000A23 -19-18JUN12-10/14

Step 9	Inspect ECM and MAP wire harness connector and terminals for corrosion, contamination, or mechanical damage. Are there any problems?	**YES:** Go to procedure D. **NO:** Go to procedure F.

RB14256,0000A23 -19-18JUN12-11/14

Step 10	Check for continuity between MAP sensor connector EC13 signal pin A and engine ground. Is there continuity?	**YES:** Go to procedure D. **NO:** Go to next step.

RB14256,0000A23 -19-18JUN12-12/14

Step 11	Inspect ECM connector and wire harness connector terminals for corrosion, contamination, or mechanical damage. Are there any problems?	**YES:** Go to procedure D. **NO:** Go to procedure F.

RB14256,0000A23 -19-18JUN12-13/14

Procedure B:

- Probe MAP connector EC13 signal circuit pin A with a test light connected to battery voltage. If there is a voltage of 4.0 VDC or greater continue with step 7. If voltage does not reach 4.0 VDC go to procedure C.

Procedure C:

- Disconnect the ECM connector EC3 and check for continuity between MAP connector EC13 sensor signal circuit pin A and ECM signal pin 23. If continuity does not exist, go to procedure D. If continuity is present continue with step 10.

Procedure D:

- Repair the circuit as necessary. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

Procedure E:

- Replace MAP sensor. After this procedure (See End of Diagnostic Procedure.)

Procedure F:

- Replace ECM. After this procedure (See End of Diagnostic Procedure.)

RB14256,0000A23 -19-18JUN12-14/14

110.03 (DTC 118) - ECT High Voltage — System: ECT/CHT

Code Caused By:

- ECT sensor voltage exceeds 4.95 volts.

Alarm Level:

- Mil light on.

Control Unit Response:

- Adaptive learning disabled.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Visually ensure that engine coolant temperature sensor wiring is not compromised. If other related malfunction codes are present, troubleshoot other codes first as these conditions may be a driving factor in this DTC.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller's address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A24 -19-18JUN12-1/10

Procedure A:

RB14256,0000A24 -19-18JUN12-2/10

Step 1	Key ON, Service ADVISOR connected. Does the display show an ECT voltage of 4.95 VDC?	**YES:** Go to next step. **NO:** Intermittent problem.

RB14256,0000A24 -19-18JUN12-3/10

Step 2	Key OFF, disconnect the ECT sensor connector EC12 and jump terminals A and B together. Key ON. Is the display showing an ECT voltage of 0.05 VDC or less?	**YES:** Go to next step. **NO:** Go to procedure B.

RB14256,0000A24 -19-18JUN12-4/10

Step 3	Using a DVOM check the resistance between the two terminals of the ECT sensor and compare the resistance reading to the chart. Is the resistance value correct?	**YES:** Go to next step. **NO:** Go to procedure C.

RB14256,0000A24 -19-18JUN12-5/10

Step 4	Inspect the ECT wire harness connector EC12 terminals A and B for damage, corrosion or contamination. Is there a problem?	**YES:** Go to procedure D. **NO:** Go to next step.

RB14256,0000A24 -19-18JUN12-6/10

Step 5	Key OFF, disconnect ECM wire harness connector EC3. Inspect ECM connector pins 20 and 37 for damage corrosion or contamination. Is there a problem?	**YES:** Go to procedure D. **NO:** Intermittent problem.

Continued on next page RB14256,0000A24 -19-18JUN12-7/10

Step 6	Key OFF, disconnect ECM wire harness connector EC3. Using a DVOM check for continuity between ECT connector EC12 sensor ground pin B and ECM connector pin 20. Is there continuity between them?	**YES:** Go to next step. **NO:** Go to Procedure D.

RB14256,0000A24 -19-18JUN12-8/10

Step 7	Inspect ECM connector EC3 pins 20 and 37 for damage, corrosion, or contamination. Is there a problem?	**YES:** Go to procedure D. **NO:** Go to procedure G.

RB14256,0000A24 -19-18JUN12-9/10

Procedure B:

- Jump the ECT signal pin A at the ECT connector to engine ground. If voltage is 0.05 VDC or less continue with step 6. If voltage is not 0.05 VDC or less go to procedure E.

Procedure C:

- Replace ECT sensor. After this procedure (See End of Diagnostic Procedure.)

Procedure D:

- Repair the circuit as necessary. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

Procedure E:

- Key OFF, disconnect ECM wire harness connector EC-3. Using a DVOM check for continuity between ECT connector EC12 signal pin A and ECM connector terminal 37. If there is continuity go to procedure F. If there is no continuity go to procedure D.

Procedure F:

- Inspect ECM connector EC3 pins 20 and 37 for damage, corrosion, and contamination. If there is a problem go to procedure D. If no problem is detected go to procedure G.

Procedure G:

- Replace ECM. After this procedure (See End of Diagnostic Procedure.)

RB14256,0000A24 -19-18JUN12-10/10

110.04 (DTC 117) - ECT Low Voltage — System: ECT/CHT

Code Caused By:

- ECT sensor voltage less than 0.05 VDC.

Alarm Level:

- Mil light on.

Control Unit Response:

- Adaptive learning disabled.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Visually ensure that engine coolant temperature sensor wiring is not compromised. If other related malfunction codes are present, troubleshoot other codes first as these conditions may be a driving factor in this DTC.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller's address.

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Continued on next page

RB14256,0000A25 -19-18JUN12-1/7

Procedure A:

RB14256,0000A25 -19-18JUN12-2/7

Step 1	Key ON, Service ADVISOR connected. Does the display show an ECT voltage of 0.05 VDC?	**YES:** Go to next step. **NO:** Intermittent problem.

RB14256,0000A25 -19-18JUN12-3/7

Step 2	Key OFF, disconnect the ECT wire harness connector EC12. Key ON. Is the display showing an ECT voltage of 4.90 VDC or greater?	**YES:** Go to procedure B. **NO:** Go to next step.

RB14256,0000A25 -19-18JUN12-4/7

Step 3	Key OFF, disconnect ECM wire harness connector EC3. Check for continuity between ECT sensor connector EC12 signal pin A and ECT sensor ground pin B. Is there continuity between them?	**YES:** Go to procedure C. **NO:** Go to next step.

RB14256,0000A25 -19-18JUN12-5/7

Step 4	Check for continuity between ECT sensor connector EC12 signal circuit pin A and engine ground. Is there continuity between them?	**YES:** Go to procedure C. **NO:** Go to procedure D.

RB14256,0000A25 -19-18JUN12-6/7

Procedure B:

- Replace ECT sensor. After this procedure (See End of Diagnostic Procedure.)

Procedure C:

- Repair the circuit as necessary. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

Procedure D:

- Replace ECM. After this procedure (See End of Diagnostic Procedure.)

RB14256,0000A25 -19-18JUN12-7/7

110.15 (DTC 116) - ECT Higher Than Expected 1 — System: ECT/CHT

Code Caused By:

- ECT sensor reading greater than 220 degrees F for greater than 10 seconds.
- Engine speed greater than 600 rpm.

Alarm Level:

- Mil light on.

Control Unit Response:

- Adaptive learning disabled.
- Power derate level 1.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Check coolant level. Visually ensure that engine coolant temperature sensor wiring is not compromised. If other related malfunction codes are present, troubleshoot other codes first as these conditions may be a driving factor in this DTC.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller's address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A26 -19-18JUN12-1/5

Procedure A:

RB14256,0000A26 -19-18JUN12-2/5

Step 1	Key ON, Service ADVISOR connected. Warm engine to normal operating temperature and run the engine above 1200 rpm for at least 60 seconds. Does the display show an ECT temperature of 220 degrees F or greater?	**YES:** Go to next step. **NO:** Intermittent problem.

RB14256,0000A26 -19-18JUN12-3/5

Step 2	Verify with a temperature gauge that the engine coolant is over 220 degrees F. Does the temperature gauge indicate the coolant over 220 degrees F?	**YES:** Repair coolant system. (See Symptom: Engine Overheats.) **NO:** Go to next step.

RB14256,0000A26 -19-18JUN12-4/5

Step 3	Verify the ECT/CHT circuit is working properly. Is the system functioning properly?	**YES:** Clear codes with Service ADVISOR and (See End of Diagnostic Procedure.) **NO:** Correct ECT/CHT system.

RB14256,0000A26 -19-18JUN12-5/5

110.00 (DTC 217) - ECT Higher Than Expected 2 — System: ECT/CHT

Code Caused By:

- ECT sensor reading greater than 230 degrees F for greater than 1 seconds.
- Engine RPM greater than 600.

Alarm Level:

- Mil light on.

Control Unit Response:

- Adaptive learning disabled.
- Power derate level 1.
- Low rev limit.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Check coolant level. Visually ensure that engine coolant temperature sensor wiring is not compromised. If other related malfunction codes are present, troubleshoot other codes first as these conditions may be a driving factor in this DTC.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the "Diagnostics" tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller's address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A27 -19-18JUN12-1/5

Procedure A:

RB14256,0000A27 -19-18JUN12-2/5

Step 1	Key ON, Service ADVISOR connected. Warm engine to normal operating temperature and run the engine above 1200 rpm for at least 60 seconds. Does the display show an ECT temperature of 230 degrees F or greater?	**YES:** Go to next step. **NO:** Intermittent problem.

RB14256,0000A27 -19-18JUN12-3/5

Step 2	Verify with a temperature gauge that the engine coolant is over 230 degrees F. Does the temperature gauge indicate the coolant over 230 degrees F?	**YES:** Repair coolant system. (See Symptom: Engine Overheats.) **NO:** Go to next step.

RB14256,0000A27 -19-18JUN12-4/5

Step 3	Verify the ECT/CHT circuit is working properly. Is the system functioning properly?	**YES:** Clear codes with Service ADVISOR and (See End of Diagnostic Procedure.) **NO:** Correct ECT/CHT system.

RB14256,0000A27 -19-18JUN12-5/5

105.03 (DTC 113) - IAT High Voltage — System: IAT

Code Caused By:

- IAT sensor voltage greater than 4.95 VDC for 1 second or longer.

Alarm Level:

- Mil light on.

Control Unit Response:

- Adaptive learning disabled.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Visually ensure that TMAP sensor wiring is not compromised. If other power related codes are present, troubleshoot all codes as other conditions may be a factor.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the "Diagnostics" tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller's address.

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RB14256,0000A28 -19-18JUN12-1/7

Procedure A:

RB14256,0000A28 -19-18JUN12-2/7

Step 1	Key ON, Service ADVISOR connected. Does the display read an IAT voltage of 4.95 VDC or greater?	**YES:** Go to next step. **NO:** Intermittent problem.

RB14256,0000A28 -19-18JUN12-3/7

Step 2	Key OFF, disconnect the TMAP sensor connector EC13 and jump pins D and C together. Key ON. Does the display read IAT voltage of 0.1 volts or less?	**YES:** Go to procedure B. **NO:** Go to next step.

RB14256,0000A28 -19-18JUN12-4/7

Step 3	Key OFF, jump TMAP sensor connector EC13 signal pin C to engine ground. Key ON. Does the display read IAT voltage of 0.1 volts or less?	**YES:** Go to procedure C. **NO:** Go to next step

RB14256,0000A28 -19-18JUN12-5/7

Step 4	Key OFF, disconnect the ECM wire harness connector. Check for continuity between TMAP sensor connector signal pin C and ECM IAT signal pin 24.	**YES:** Go to procedure E. **NO:** Go to procedure B.

Continued on next page

RB14256,0000A28 -19-18JUN12-6/7

Procedure B:

- Check wire harness and TMAP sensor connector EC13 for damage, corrosion, or contamination. If problems are found go to procedure B. If none are found go to procedure C.

Procedure C:

- Check for continuity between TMAP sensor connector ground pin D and ECM sensor ground circuit pin 3. If there is continuity go to procedure F. If there is no continuity go to procedure D.

Procedure D:

- Repair the circuit as necessary. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

Procedure E:

- Replace the TMAP sensor. After this procedure (See End of Diagnostic Procedure.)

Procedure F:

- Re-Check wire harness and TMAP sensor connectors for damage corrosion or contamination. If there are problems go to procedure D. If no problems are detected go to procedure G.

Procedure G:

- Replace ECM. After this procedure (See End of Diagnostic Procedure.)

RB14256,0000A28 -19-18JUN12-7/7

105.04 (DTC 112) - IAT Low Voltage — System: IAT

Code Caused By:

- IAT sensor voltage less than 0.05 VDC for 1 second or longer.

Alarm Level:

- Mil light on.

Control Unit Response:

- Adaptive learning disabled.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Visually ensure that TMAP sensor wiring is not compromised. If other power related codes are present, troubleshoot all codes as other conditions may be a factor.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller's address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A29 -19-18JUN12-1/7

Procedure A:

RB14256,0000A29 -19-18JUN12-2/7

Step 1	Key ON, Service ADVISOR connected. Does the display read an IAT voltage of 0.05 VDC or less?	**YES:** Go to next step. **NO:** Intermittent problem.

Continued on next page RB14256,0000A29 -19-18JUN12-3/7

Step 2	Key OFF, disconnect the TMAP sensor connector EC13. Key ON. Does the display read IAT voltage of 4.90 VDC or greater?	**YES:** Go to procedure C. **NO:** Go to next step.

RB14256,0000A29 -19-18JUN12-4/7

Step 3	Key OFF, disconnect ECM wire harness connector. Check for continuity between TMAP sensor connector EC13 ground pin D and TMAP sensor connector signal pin C. Is there continuity between them?	**YES:** Go to procedure B. **NO:** Go to next step

RB14256,0000A29 -19-18JUN12-5/7

Step 4	Check for continuity between TMAP sensor connector EC13 signal circuit pin C and engine ground. Is there is continuity between them?	**YES:** Go to procedure B. **NO:** Go to procedure D.

RB14256,0000A29 -19-18JUN12-6/7

Procedure B:

- Repair the circuit as necessary. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

Procedure C:

- Replace the TMAP sensor. After this procedure (See End of Diagnostic Procedure.)

Procedure D:

- Replace the ECM. After this procedure (See End of Diagnostic Procedure.)

RB14256,0000A29 -19-18JUN12-7/7

105.15 (DTC 111) - IAT Higher Than Expected 1 — System: IAT

Code Caused By:

- IAT sensor reads greater than 200 degrees F for minimum of 60 seconds.
- Engine rpm greater than 600.

Alarm Level:

- Mil light on.

Control Unit Response:

- Adaptive learning disabled.
- Forced idle.
- Power derate level 1.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Check for obstruction, modified, or damaged air inlet.
- Inspect air inlet system for cracks or breaks that may allow unwanted under hood air in the system.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller’s address.

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RB14256,0000A2A -19-18JUN12-1/7

Procedure A:

RB14256,0000A2A -19-18JUN12-2/7

Step 1	Key ON, Service ADVISOR connected. Does the display read an IAT voltage of 0.05 VDC or less?	**YES:** Go to next step. **NO:** Intermittent problem.

RB14256,0000A2A -19-18JUN12-3/7

Step 2	Key OFF, disconnect the TMAP sensor connector EC13. Key ON. Does the display read IAT voltage of 4.90 VDC or greater?	**YES:** Go to procedure C. **NO:** Go to next step.

RB14256,0000A2A -19-18JUN12-4/7

Step 3	Key OFF, disconnect ECM wire harness connector. Check for continuity between TMAP sensor connector EC13 ground pin D and TMAP sensor connector signal pin C. Is there continuity between them?	**YES:** Go to procedure B. **NO:** Go to next step

RB14256,0000A2A -19-18JUN12-5/7

Step 4	Check for continuity between TMAP sensor connector EC13 signal circuit pin C and engine ground. Is there is continuity between them?	**YES:** Go to procedure B. **NO:** Go to procedure D.

RB14256,0000A2A -19-18JUN12-6/7

Procedure B:

- Repair the circuit as necessary. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

Procedure C:

- Replace the TMAP sensor. After this procedure (See End of Diagnostic Procedure.)

Procedure D:

- Replace the ECM. After this step (See End of Diagnostic Procedure.)

RB14256,0000A2A -19-18JUN12-7/7

105.00 (DTC 127) - IAT Higher Than Expected 2 — System: IAT

Code Caused By:

- IAT sensor reads greater than 210 degrees F for longer than 1 second.
- Engine rpm greater than 600.

Alarm Level:

- Mil light on.

Control Unit Response:

- Adaptive learning disabled.
- Forced engine shut down.

Required Tools:

- Multimeter or;
- Service ADVISOR

Preliminary Checks:

- Check for obstruction, modified, or damaged air inlet.
- Inspect air inlet system for cracks or breaks that may allow unwanted under hood air in the system.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller's address.

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RB14256,0000A2B -19-18JUN12-1/7

Procedure A:

RB14256,0000A2B -19-18JUN12-2/7

Step 1	Key ON, Service ADVISOR connected. Does the display read an IAT voltage of 0.05 VDC or less?	**YES:** Go to next step. **NO:** Intermittent problem.

RB14256,0000A2B -19-18JUN12-3/7

Step 2	Key OFF, disconnect the TMAP sensor connector. Key ON. Does the display read IAT voltage of 4.90 VDC or greater?	**YES:** Go to procedure C. **NO:** Go to next step.

RB14256,0000A2B -19-18JUN12-4/7

Step 3	Key OFF, disconnect ECM wire harness connector. Check for continuity between TMAP sensor connector EC13 ground pin D and TMAP sensor connector signal pin C. Is there continuity between them?	**YES:** Go to procedure B. **NO:** Go to next step

RB14256,0000A2B -19-18JUN12-5/7

Step 4	Check for continuity between TMAP sensor connector EC13 signal circuit pin C and engine ground. Is there is continuity between them?	**YES:** Go to procedure B. **NO:** Go to procedure D.

Continued on next page RB14256,0000A2B -19-18JUN12-6/7

Procedure B:

- Repair the circuit as necessary. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

Procedure C:

- Replace the TMAP sensor. After this procedure (See End of Diagnostic Procedure.)

Procedure D:

- Replace the ECM. After this step (See End of Diagnostic Procedure.)

RB14256,0000A2B -19-18JUN12-7/7

108.00 (DTC 2229) - Barometric High Pressure — System: Barometric Pressure

Code Caused By:

- Barometric Pressure greater than 16 psia.

Alarm Level:

- Mil light on.

Control Unit Response:

- Adaptive learning disabled.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- If other related codes are present, troubleshoot all codes as other conditions may be a factor.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller’s address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A2C -19-18JUN12-1/5

Procedure A:

RB14256,0000A2C -19-18JUN12-2/5

Step 1	Key ON, Service ADVISOR connected. Does the display read a MAP pressure of 16 psia or greater?	**YES:** Clear codes with Service ADVISOR. Go to next step. **NO:** Intermittent problem.

RB14256,0000A2C -19-18JUN12-3/5

Step 2	Bring engine to normal operating temperature. Key OFF. If barometric pressure code still exists replace TMAP sensor. (See End of Diagnostic Procedure.)	**YES:** Go to procedure B. **NO:** End test.

RB14256,0000A2C -19-18JUN12-4/5

Procedure B:

- Replace ECM. After this procedure (See End of Diagnostic Procedure.)

RB14256,0000A2C -19-18JUN12-5/5

108.01 (DTC 129) - Barometric Low Pressure — System: Barometric Pressure

Code Caused By:

- Barometric Pressure less than 8.3 psia.

Alarm Level:

- Mil light on.

Control Unit Response:

- Adaptive learning disabled.

Required Tools:

- Multimeter or;
- Service ADVISOR

Preliminary Checks:

- If other related codes are present, troubleshoot all codes as other conditions may be a factor.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the "Diagnostics" tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller's address.

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RB14256,0000A2D -19-18JUN12-1/14

Procedure A:

RB14256,0000A2D -19-18JUN12-2/14

Step 1	Key ON, Service ADVISOR connected. Does the display read a barometric pressure of 8.3 psia or less?	**YES:** Go to next step. **NO:** Intermittent problem.

RB14256,0000A2D -19-18JUN12-3/14

Step 2	Key OFF, disconnect the TMAP sensor connector EC13. Jump the 5-volt reference pin B and TMAP signal pin A together. Key ON. Does the display show a barometric pressure of 16.0 psia	**YES:** Go to next step. **NO:** Go to procedure B.

RB14256,0000A2D -19-18JUN12-4/14

Step 3	Inspect TMAP connector and wire harness connector terminals for corrosion, contamination, or mechanical damage. Are there problems?	**YES:** Go to procedure C. **NO:** Go to next step.

RB14256,0000A2D -19-18JUN12-5/14

Step 4	Key OFF, disconnect ECM connector. Check continuity between TMAP sensor connector EC13 pin A and ECM connector pin 23. Is there continuity between them?	**YES:** Go to next step. **NO:** Go to procedure C.

RB14256,0000A2D -19-18JUN12-6/14

Step 5	Check for continuity between TMAP sensor connector EC13 5-volt supply pin B and ECM connector pin 19. Is there continuity between them?	**YES:** Go to next step. **NO:** Go to procedure C.

Continued on next page

RB14256,0000A2D -19-18JUN12-7/14

Step 6	Check for continuity between TMAP sensor connector EC13 ground pin D and ECM connector pin 20. Is there continuity between them?	**YES:** Go to procedure D. **NO:** Go to procedure C.

RB14256,0000A2D -19-18JUN12-8/14

Step 7	Key OFF, disconnect ECM connector. Check for continuity between TMAP sensor connector EC13 pin B and ECM connector pin 19. Is there continuity between them?	**YES:** Go to next step. **NO:** Go to procedure C.

RB14256,0000A2D -19-18JUN12-9/14

Step 8	Check for continuity between TMAP sensor connector EC13 5-volt reference pin B and engine ground. Is there continuity?	**YES:** Go to procedure G. **NO:** Go to next step.

RB14256,0000A2D -19-18JUN12-10/14

Step 9	Inspect TMAP and ECM connector pins for corrosion, contamination, or mechanical damage. Is there a problem?	**YES:** Go to procedure C. **NO:** Go to procedure E.

RB14256,0000A2D -19-18JUN12-11/14

Step 10	Check for continuity between TMAP sensor connector EC13 pin A and engine ground. Is there continuity?	**YES:** Go to procedure G. **NO:** Go to next step.

RB14256,0000A2D -19-18JUN12-12/14

Step 11	Inspect ECM connector and wire harness connector pins for corrosion, contamination, or mechanical damage. Is there a problem?	**YES:** Go to procedure C. **NO:** Go to procedure E.

RB14256,0000A2D -19-18JUN12-13/14

Procedure B:

1. Remove the jumper that was installed during step 3. Probe TMAP connector EC13 signal circuit pin A with a test light connected to battery voltage. If the display shows a barometric pressure of 16 psia or greater go to step 7. If the pressure does not reach 16 psia go to procedure F.

Procedure C:

1. Repair the circuit as necessary. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

Procedure D:

1. Replace the TMAP. After this procedure (See End of Diagnostic Procedure.)

Procedure E:

1. Replace the ECM. After this procedure (See End of Diagnostic Procedure.)

Procedure F:

1. Disconnect ECM connector, check continuity between TMP sensor connector EC13 pin A and ECM pin 23. If there is no continuity between them go to procedure C. If there is continuity go to step 10.

Procedure G:

1. Repair the open ground circuit as necessary. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

RB14256,0000A2D -19-18JUN12-14/14

168.15 (DTC 563) - Battery Voltage High — System: Battery

Code Caused By:

- System battery voltage at ECM is greater than 16 VDC.

Alarm Level:

- Mil light on.

Control Unit Response:

- Adaptive learning disabled.

Required Tools:

- Multimeter or;
- Service ADVISOR

Preliminary Checks:

- Visually ensure that wiring harness is not compromised. If related codes are present, troubleshoot all codes as other conditions may be a factor.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller's address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A2E -19-18JUN12-1/5

Procedure A:

RB14256,0000A2E -19-18JUN12-2/5

Step 1	Key ON, Service ADVISOR connected. Does the display show a voltage greater than 16 VDC?	**YES:** Go to next step. **NO:** Intermittent problem.

RB14256,0000A2E -19-18JUN12-3/5

Step 2	Check voltage at battery terminals with DVOM with engine speed greater than 1500 rpm. Is it showing voltage greater than 16 VDC.	**YES:** Repair the charging system. After repair (See End of Diagnostic Procedure.) **NO:** Key OFF, engine stopped. Key ON, clear all codes with Service ADVISOR. If system voltage high returns to code list go to procedure B.

RB14256,0000A2E -19-18JUN12-4/5

Procedure B:

- Replace the ECM. After this procedure (See End of Diagnostic Procedure.)

RB14256,0000A2E -19-18JUN12-5/5

168.17 (DTC 562) - Battery Voltage Low — System: Battery

Code Caused By:

- System battery voltage at ECM is less than 12 VDC.
- Engine speed greater than 950 rpm.

Alarm Level:

- Mil light on.

Control Unit Response:

- Adaptive learning disabled.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Check alternator belt. Visually ensure that wiring harness is not compromised. If related codes are present, troubleshoot all codes as other conditions may be a factor.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™ : This procedure can be performed by making a connection to the vehicle and using the "Diagnostics" tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller's address.

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RB14256,0000A2F -19-18JUN12-1/9

Procedure A:

RB14256,0000A2F -19-18JUN12-2/9

Step 1	Key ON, Service ADVISOR connected. Engine running greater than 950 rpm. Does the display show a voltage less than 12VDC?	**YES:** Go to next step. **NO:** Intermittent problem.

RB14256,0000A2F -19-18JUN12-3/9

Step 2	Check battery condition with a DVOM. Is it maintaining normal voltage?	**YES:** Go to next step. **NO:** Replace battery.

RB14256,0000A2F -19-18JUN12-4/9

Step 3	Check the charging system. Is it charging at normal voltage?	**YES:** Go to next step. **NO:** Repair charging system.

RB14256,0000A2F -19-18JUN12-5/9

Step 4	Key OFF, disconnect the ECM connector. With a DVOM check the voltage between ECM connector EC3 pin 79 and engine ground. Is the voltage greater than 12 VDC?	**YES:** Repair ECM ground circuit. **NO:** Go to next step.

RB14256,0000A2F -19-18JUN12-6/9

Step 5	Using a DVOM check the voltage at ECM connector pin 4, 69, 81, and battery positive. Is the voltage greater than 12 VDC?	**YES:** Repair ECM power circuit **NO:** Go to next step.

Continued on next page RB14256,0000A2F -19-18JUN12-7/9

Step 6	Key OFF, Key ON. Clear codes with Service ADVISOR. Start engine, run at 950 rpm. Does system low voltage code return?	**YES:** Go to procedure B. **NO:** End test.

RB14256,0000A2F -19-18JUN12-8/9

Procedure B:

- Replace the ECM. After this procedure (See End of Diagnostic Procedure.)

RB14256,0000A2F -19-18JUN12-9/9

1079.03 (DTC 643) - 5v External High Voltage Reference 1 — System: 5v External Faults

Code Caused By:

- 5 volt reference higher than 5.4 VDC.

Alarm Level:

- Mil light on.

Control Unit Response:

- Adaptive learning disabled.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Visually ensure that wiring harness is not compromised. If related codes are present, troubleshoot all codes as other conditions may be a factor.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller’s address.

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RB14256,0000A30 -19-18JUN12-1/7

Procedure A:

RB14256,0000A30 -19-18JUN12-2/7

Step 1	Key ON, engine running, Service ADVISOR connected. Does the display show DTC 643?	**YES:** Go to next step. **NO:** Intermittent problem.

RB14256,0000A30 -19-18JUN12-3/7

Step 2	Check all ECM ground connections. Are all ground connections ok?	**YES:** Go to next step. **NO:** Go to procedure B.

RB14256,0000A30 -19-18JUN12-4/7

Step 3	Key OFF, disconnect ECM connector EC3. Key ON, using a DVOM check for voltage between ECM harness wire pin 19 and engine ground. Is there voltage?	**YES:** Go to procedure B. **NO:** Go to next step.

Continued on next page RB14256,0000A30 -19-18JUN12-5/7

Step 4	Reconnect all connections. Key OFF, clear all codes with Service ADVISOR. Key ON, does the DTC 643 code still remain?	**YES:** Go to procedure C. **NO:** End test.

RB14256,0000A30 -19-18JUN12-6/7

Procedure B:

- Repair the circuit as necessary. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

Procedure C:

- Replace ECM. After this procedure (See End of Diagnostic Procedure.)

RB14256,0000A30 -19-18JUN12-7/7

1079.04 (DTC 642) - 5v External Low Voltage Reference 1 — System: 5v External Faults

Code Caused By:

- 5 volt reference lower than 4.6 VDC.

Alarm Level:

- Mil light on.

Control Unit Response:

- Adaptive learning disabled.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Visually ensure that wiring harness is not compromised. If related codes are present, troubleshoot all codes as other conditions may be a factor.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller’s address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A31 -19-18JUN12-1/6

Procedure A:

RB14256,0000A31 -19-18JUN12-2/6

Step 1	Key ON, engine running, Service ADVISOR connected. Does the display show DTC 642?	**YES:** Go to next step. **NO:** Intermittent problem.

RB14256,0000A31 -19-18JUN12-3/6

Step 2	Key OFF, disconnect ECM connector. Using a DVOM check for continuity between ECM 5 volt reference pin 19 and engine ground. Is there continuity?	**YES:** Go to next step. **NO:** Go to procedure B.

Continued on next page RB14256,0000A31 -19-18JUN12-4/6

Step 3	While monitoring DVOM for continuity between ECM 5 volt reference and engine ground, disconnect each sensor listed in procedure C, one at a time to find the shorted 5 volt reference. When continuity to ground is lost the last sensor disconnected is the area of suspicion. Inspect the 5 volt reference supply wire leads for a short before replacing the sensor. While disconnecting each sensor one at a time, did you loose continuity?	**YES:** Go to procedure D. **NO:** Go to procedure E.

RB14256,0000A31 -19-18JUN12-5/6

Procedure B:

- Replace ECM. After this procedure (See End of Diagnostic Procedure.)

Procedure C:

- Check the following sensors:
- TMAP
- Electronic Throttle
- FPP
- Crankshaft Sensor
- Camshaft Sensor

Procedure D:

- Replace the last disconnected sensor. After this procedure (See End of Diagnostic Procedure.)

Procedure E:

- Repair shorted wire harness. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

RB14256,0000A31 -19-18JUN12-6/6

1080.03 (DTC 653) - 5v External High Voltage Reference 2 — System: 5v External Faults

Code Caused By:

- 5 volt reference higher than 5.4 VDC.

Alarm Level:

- Mil light on.

Control Unit Response:

- Adaptive learning disabled.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Visually ensure that wiring harness is not compromised. If related codes are present, troubleshoot all codes as other conditions may be a factor.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the "Diagnostics" tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller's address.

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RB14256,0000A32 -19-18JUN12-1/7

Procedure A:

RB14256,0000A32 -19-18JUN12-2/7

Step 1	Key ON, engine running, Service ADVISOR connected. Does the display show DTC 653?	**YES:** Go to next step. **NO:** Intermittent problem.

Continued on next page RB14256,0000A32 -19-18JUN12-3/7

Step 2	Check all ECM ground connections. Are all ground connections ok?	**YES:** Go to next step. **NO:** Go to procedure B.

RB14256,0000A32 -19-18JUN12-4/7

Step 3	Key OFF, disconnect ECM connector. Key ON, using a DVOM check for voltage between ECM harness wire pin 19 and engine ground. Is there voltage?	**YES:** Go to procedure B. **NO:** Go to next step.

RB14256,0000A32 -19-18JUN12-5/7

Step 4	Reconnect all connections. Key OFF, clear all codes with Service ADVISOR. Key ON, does the DTC 653 code still remain?	**YES:** Go to procedure C. **NO:** End test.

RB14256,0000A32 -19-18JUN12-6/7

Procedure B:

- Repair the circuit as necessary. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

Procedure C:

- Replace ECM. After this procedure (See End of Diagnostic Procedure.)

RB14256,0000A32 -19-18JUN12-7/7

1080.04 (DTC 652) - 5v External Low Voltage Reference 2 — System: 5v External Faults

Code Caused By:

- 5 volt reference lower than 1.50 VDC.

Alarm Level:

- Mil light on.

Control Unit Response:

- Adaptive learning disabled.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Visually ensure that wiring harness is not compromised. If related codes are present, troubleshoot all codes as other conditions may be a factor.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller’s address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A33 -19-18JUN12-1/6

Procedure A:

RB14256,0000A33 -19-18JUN12-2/6

Step 1	Key ON, engine running, Service ADVISOR connected. Does the display show DTC 652?	**YES:** Go to next step. **NO:** Intermittent problem.

Continued on next page RB14256,0000A33 -19-18JUN12-3/6

Step 2	Key OFF, disconnect ECM connector. Using a DVOM check for continuity between ECM 5 volt reference pin 19 and engine ground. Is there continuity?	**YES:** Go to next step. **NO:** Go to procedure B.

RB14256,0000A33 -19-18JUN12-4/6

Step 3	While monitoring DVOM for continuity between ECM 5 volt reference and engine ground, disconnect each sensor listed in procedure C, one at a time to find the shorted 5 volt reference. when continuity to ground is lost the last sensor disconnected is the area of suspicion. Inspect the 5 volt reference supply wire leads for short before replacing the sensor. While disconnecting each sensor one at a time, did you loose continuity?	**YES:** Go to procedure D. **NO:** Go to procedure E.

RB14256,0000A33 -19-18JUN12-5/6

Procedure B:

- Replace ECM. After this procedure (See End of Diagnostic Procedure.)

Procedure C:

- Check the following sensors:
- TMAP
- Electronic Throttle
- FPP
- Crankshaft Sensor
- Camshaft Sensor

Procedure D:

- Replace the last disconnected sensor. After this procedure (See End of Diagnostic Procedure.)

Procedure D:

- Repair shorted wire harness. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

RB14256,0000A33 -19-18JUN12-6/6

1079.31 (DTC 1611) - 5v External Simultaneous Out of Range — System: 5v External Faults

Code Caused By:

- 5v external low and high voltage references are simultaneously faulted.

Alarm Level:

- Mil light on.

Control Unit Response:

- Adaptive learning disabled.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Visually ensure that wiring harness is not compromised. If related codes are present, troubleshoot all codes as other conditions may be a factor.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller’s address.

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RB14256,0000A34 -19-18JUN12-1/9

Procedure A:

Continued on next page

RB14256,0000A34 -19-18JUN12-2/9

Step 1	Key ON, engine running, Service ADVISOR connected. Does the display show DTC 642?	**YES:** Go to next step. **NO:** Intermittent problem.

RB14256,0000A34 -19-18JUN12-3/9

Step 2	Key OFF, disconnect ECM connector. Using a DVOM check for continuity between ECM 5 volt reference pin 14 and engine ground. Is there continuity?	**YES:** Go to next step. **NO:** Go to procedure B.

RB14256,0000A34 -19-18JUN12-4/9

Step 3	While monitoring DVOM for continuity between ECM 5 volt reference and engine ground, disconnect each sensor listed in procedure C, one at a time to find the shorted 5 volt reference. When continuity to ground is lost the last sensor disconnected is the area of suspicion. Inspect the 5 volt reference supply wire leads for a short before replacing the sensor. While disconnecting each sensor one at a time, did you loose continuity?	**YES:** Go to procedure D. **NO:** Go to procedure E.

RB14256,0000A34 -19-18JUN12-5/9

Step 4	Check all ECM ground connections. Are all ground connections ok?	**YES:** Go to next step. **NO:** Go to procedure F.

RB14256,0000A34 -19-18JUN12-6/9

Step 5	Key OFF, disconnect ECM connector EC3. Key ON, using a DVOM check for voltage between ECM harness wire pin 19 and engine ground. Is there voltage?	**YES:** Go to procedure F. **NO:** Go to next step.

RB14256,0000A34 -19-18JUN12-7/9

Step 6	Reconnect all connections. Key OFF, clear all codes with Service ADVISOR. Key ON, does the DTC 643 code still remain?	**YES:** Go to procedure B. **NO:** End test.

RB14256,0000A34 -19-18JUN12-8/9

Procedure B:

- Replace ECM. After this procedure (See End of Diagnostic Procedure.)

Procedure C:

- Check the following sensors:
- TMAP
- Electronic Throttle
- FPP
- Crankshaft Sensor
- Camshaft Sensor

Procedure D:

- Replace the last disconnected sensor. After this procedure (See End of Diagnostic Procedure.)

Procedure E:

- Repair shorted wire harness. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

Procedure F:

- Repair the circuit as necessary. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

RB14256,0000A34 -19-18JUN12-9/9

51.03 (DTC 123) - Throttle Position Sensor 1 High Voltage — System: Throttle Position Sensor 1

Code Caused By:

- TPS sensor voltage is greater than 4.8 VDC

Alarm Level:

- Mil light on.

Control Unit Response:

- Engine shut down.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Visually ensure that throttle position sensor (TPS) sensor wiring is not compromised. If other power related codes are present, troubleshoot all codes as other conditions may be a factor. Look for any physical damage to TPS or throttle assembly and linkage.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller’s address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A35 -19-18JUN12-1/7

Procedure A:

RB14256,0000A35 -19-18JUN12-2/7

Step 1	Key ON, engine OFF, Service ADVISOR connected. Does the display show the TPS 1 voltage greater than 4.8 VDC with the throttle closed?	**YES:** Go to next step. **NO:** Go to procedure B.

RB14256,0000A35 -19-18JUN12-3/7

Step 2	Key OFF, disconnect electronic throttle connector. Key ON, does the display show a TPS 1 voltage less than 0.2 volts?	**YES:** Go to next step. **NO:** Go to procedure C.

RB14256,0000A35 -19-18JUN12-4/7

Step 3	Back probe sensor ground circuit at the ECM side of the harness pin 20 with a test light connected to battery voltage. Does the test light turn on?	**YES:** Go to next step. **NO:** Go to procedure F.

RB14256,0000A35 -19-18JUN12-5/7

Step 4	Inspect the electronic throttle connector terminals for damage, corrosion, or contamination. Is there a problem?	**YES:** Go to procedure D. **NO:** Go to procedure G.

Continued on next page

RB14256,0000A35 -19-18JUN12-6/7

Procedure B:

- Slowly depress foot pedal while observing TPS 1 voltage. If the voltage exceeds 4.8 VDC continue to step 2. If the voltage does exceed 4.8 VDC there is an intermittent problem.

Procedure C:

- Key OFF, disconnect ECM wire harness connector. Key ON, using a DVOM check for voltage between TPS 1 signal at the ECM connector pin 47 and engine ground. If there is voltage go to procedure D. If there is no voltage go to procedure E.

Procedure D:

- Repair the circuit as necessary. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

Procedure E:

- Replace ECM. After this procedure (See End of Diagnostic Procedure.)

Procedure F:

- Key OFF, disconnect ECM. Using a DVOM check for continuity between the electronic throttle connector sensor ground pin 2 and ECM connector TPS 1 sensor ground pin 3. If there is continuity between them go to procedure E. If no continuity exists go to procedure D.

Procedure G:

- Replace the Electronic Throttle. After this procedure (See End of Diagnostic Procedure.)

RB14256,0000A35 -19-18JUN12-7/7

51.04 (DTC 122) - Throttle Position Sensor 1 Low Voltage — System: Throttle Position Sensor 1

Code Caused By:

- TPS sensor voltage is less than 0.2 VDC

Alarm Level:

- Mil light on.

Control Unit Response:

- Engine shut down.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Visually ensure that throttle position sensor (TPS) sensor wiring is not compromised. If other power related codes are present, troubleshoot all codes as other conditions may be a factor. Look for any physical damage to TPS or throttle assembly and linkage.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller’s address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A36 -19-18JUN12-1/6

Procedure A:

RB14256,0000A36 -19-18JUN12-2/6

Step 1	Key ON, engine OFF, Service ADVISOR connected. Does the display show the TPS 1 voltage less than 0.2 VDC with the throttle closed?	**YES:** Go to next step. **NO:** Go to procedure B.

Continued on next page

RB14256,0000A36 -19-18JUN12-3/6

Step 2	Key OFF, disconnect the electronic throttle connector EC4. Jump the 5 volt reference circuit pin 3 and TPS 1 signal circuit pin 6 together at the throttle connector. Key ON. Does the display show a TPS 1 voltage of 4 VDC or greater?	**YES:** Go to next step. **NO:** Go to procedure C.

RB14256,0000A36 -19-18JUN12-4/6

Step 3	Inspect the electronic throttle connector terminals for damage, corrosion, or contamination. Is there a problem?	**YES:** Go to procedure D. **NO:** Go to procedure F.

RB14256,0000A36 -19-18JUN12-5/6

Procedure B:

- Slowly depress foot pedal while observing TPS 1 voltage. If the voltage falls below 0.2 VDC continue to step 2. If the voltage does not fall below 0.2 VDC there is an intermittent problem.

Procedure C:

- Key OFF, disconnect ECM wire harness connector. Using a DVOM check continuity between the electronic throttle connector EC4 signal pin 6 and ECM throttle connector EC3 TPS 1 signal pin 47. If there is continuity between them go to procedure E. If there is no continuity then go to procedure D.

Procedure D:

- Repair the circuit as necessary. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

Procedure E:

- Replace ECM. After this procedure (See End of Diagnostic Procedure.)

Procedure F:

- Replace the Electronic Throttle. After this procedure (See End of Diagnostic Procedure.)

RB14256,0000A36 -19-18JUN12-6/6

520251.03 (DTC 223) - Throttle Position Sensor 2 High Voltage — System: Throttle Position Sensor 2

Code Caused By:

- TPS sensor voltage is greater than 4.8 VDC

Alarm Level:

- Mil light on.

Control Unit Response:

- Engine shut down.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Visually ensure that throttle position sensor (TPS) sensor wiring is not compromised. If other power related codes are present, troubleshoot all codes as other conditions may be a factor. Look for any physical damage to TPS or throttle assembly and linkage.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the "Diagnostics" tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller's address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A37 -19-18JUN12-1/7

Procedure A:

Continued on next page

RB14256,0000A37 -19-18JUN12-2/7

Step 1	Key ON, engine OFF, Service ADVISOR connected. Does the display show the TPS 2 voltage greater than 4.8 VDC with the throttle closed?	**YES:** Go to next step. **NO:** Go to procedure B.

RB14256,0000A37 -19-18JUN12-3/7

Step 2	Key OFF, disconnect electronic throttle connector. Key ON, does the display show a TPS 2 voltage less than 0.2 volts?	**YES:** Go to next step. **NO:** Go to procedure C.

RB14256,0000A37 -19-18JUN12-4/7

Step 3	Back probe sensor ground circuit at the ECM side of the harness pin 20 with a test light connected to battery voltage. Does the test light turn on?	**YES:** Go to next step. **NO:** Go to procedure F.

RB14256,0000A37 -19-18JUN12-5/7

Step 4	Inspect the electronic throttle connector terminals for damage, corrosion, or contamination. Is there a problem?	**YES:** Go to procedure D. **NO:** Go to procedure G.

RB14256,0000A37 -19-18JUN12-6/7

Procedure B:

- Slowly depress foot pedal while observing TPS 2 voltage. If the voltage exceeds 4.8 VDC continue to step 2. If the voltage does exceed 4.8 VDC there is an intermittent problem.

Procedure C:

- Key OFF, disconnect ECM wire harness connector. Key ON, using a DVOM check for voltage between electronic throttle connector EC4 TPS 2 signal pin 5 and engine ground. If there is voltage go to procedure D. If there is no voltage go to procedure E.

Procedure D:

- Repair the circuit as necessary. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

Procedure E:

- Replace ECM. After this procedure (See End of Diagnostic Procedure.)

Procedure F:

- Key OFF, disconnect ECM. Using a DVOM check for continuity between the electronic throttle connector EC4 sensor ground pin 2 and ECM connector sensor ground pin 20. If there is continuity between them go to procedure E. If no continuity exists go to procedure D.

Procedure G:

- Replace the Electronic Throttle. After this procedure (See End of Diagnostic Procedure.)

RB14256,0000A37 -19-18JUN12-7/7

520251.04 (DTC 222) - Throttle Position Sensor 2 Low Voltage — System: Throttle Position Sensor 2

Code Caused By:

- TPS sensor voltage is less than .20 VDC

Alarm Level:

- Mil light on.

Control Unit Response:

- Engine shut down.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Visually ensure that throttle position sensor (TPS) sensor wiring is not compromised. If other power related codes are present, troubleshoot all codes as other conditions may be a factor. Look for any physical damage to TPS or throttle assembly and linkage.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller's address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A38 -19-18JUN12-1/6

Procedure A:

RB14256,0000A38 -19-18JUN12-2/6

Step 1	Key ON, engine OFF, Service ADVISOR connected. Does the display show the TPS 2 voltage less than .20 VDC with the throttle closed?	**YES:** Go to next step. **NO:** Go to procedure B.

RB14256,0000A38 -19-18JUN12-3/6

Step 2	Key OFF, disconnect the electronic throttle connector EC4. Jump the 5 volt reference circuit pin 3 and TPS 2 signal circuit pin 5 together at the throttle connector. Key ON. Does the display show a TPS 2 voltage of 4 VDC or greater?	**YES:** Go to next step. **NO:** Go to procedure C.

RB14256,0000A38 -19-18JUN12-4/6

Step 3	Inspect the electronic throttle connector terminals for damage, corrosion, or contamination. Is there a problem?	**YES:** Go to procedure D. **NO:** Go to procedure F.

Continued on next page RB14256,0000A38 -19-18JUN12-5/6

Procedure B:

- Slowly depress foot pedal while observing TPS 2 voltage. If the voltage falls below .20 VDC continue to step 2. If the voltage does not fall below .20 VDC there is an intermittent problem.

Procedure C:

- Key OFF, disconnect ECM wire harness connector. Using a DVOM check continuity between the electronic TPS 2 connector EC4 signal pin 5 and ECM connector TPS 2 signal pin 48. If there is continuity between them go to procedure E. If there is no continuity then go to procedure D.

Procedure D:

- Repair the circuit as necessary. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

Procedure E:

- Replace ECM. After this procedure (See End of Diagnostic Procedure.)

Procedure F:

- Replace the Electronic Throttle. After this procedure (See End of Diagnostic Procedure.)

RB14256,0000A38 -19-18JUN12-6/6

51.00 (DTC 221) - Throttle Position Sensor 1 Higher Than Throttle Position Sensor 2 — System: Throttle Position Sensor

Code Caused By:

- TPS 1 is 20% higher than TPS 2.

Alarm Level:

- Mil light turns on for remainder of key cycle.

Control Unit Response:

- Engine shut down.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Visually ensure that throttle position sensor (TPS) sensor wiring is not compromised. If other power related codes are present, troubleshoot all codes as other conditions may be a factor. Look for any physical damage to TPS or throttle assembly and linkage.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller’s address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A39 -19-18JUN12-1/12

Procedure A:

RB14256,0000A39 -19-18JUN12-2/12

Step 1	Key ON, engine OFF. Service ADVISOR connected. Does the display show more than 20% difference in voltage between TPS 1 and TPS 2?	**YES:** Go to next step. **NO:** Intermittent problem.

RB14256,0000A39 -19-18JUN12-3/12

Step 2	Key OFF, disconnect electronic throttle connector. Does the display show a voltage for TPS 1 less than 0.1 VDC.	**YES:** Go to procedure B. **NO:** Go next step.

Continued on next page

RB14256,0000A39 -19-18JUN12-4/12

Step 3	Key OFF, disconnect ECM wiring harness connector. Key ON, using a DVOM check for voltage between ECM connector TPS 1 signal pin 6 and engine ground. Is there voltage?	**YES:** Go to procedure C. **NO:** Go next step.

RB14256,0000A39 -19-18JUN12-5/12

Step 4	Using a DVOM check for continuity between throttle connector EC4 ground pin 2 and ECM connector ground pin 20. Is there continuity between them?	**YES:** Go to next step. **NO:** Go to procedure D.

RB14256,0000A39 -19-18JUN12-6/12

Step 5	Inspect ECM connector terminals for damage, corrosion, or contamination. Is there a problem?	**YES:** Go to procedure G. **NO:** Go to procedure E.

RB14256,0000A39 -19-18JUN12-7/12

Step 6	Inspect wire terminals at throttle connector for damage, corrosion, or contamination. Is there any problems?	**YES:** Go to procedure G. **NO:** Go to procedure F.

RB14256,0000A39 -19-18JUN12-8/12

Step 7	Key OFF, disconnect wire harness connector. Using a DVOM check for continuity between throttle connector TPS 1 signal pin 6 and ECM connector TPS 1 signal pin 47. Is there continuity between them?	**YES:** Go to next step. **NO:** Go to procedure D.

RB14256,0000A39 -19-18JUN12-9/12

Step 8	Using a DVOM check for continuity between throttle connector signal ground pin 2 and ECM connector ground pin 20. Is there continuity between them?	**YES:** Go to next step. **NO:** Go to procedure D.

RB14256,0000A39 -19-18JUN12-10/12

Step 9	Inspect ECM connector terminals for damage, corrosion, or contamination. Is there a problem?	**YES:** Go to procedure G. **NO:** Go to procedure E.

RB14256,0000A39 -19-18JUN12-11/12

Procedure B:

- Jump TPS 1 signal pin 6 to the 5 volt reference pin 3 at connector. If the display shows a TPS 1 voltage over 4.9 VDC, continue with step 6. If it shows a voltage less than 4.9 VDC continue with step 7.

Procedure C:

- Repair the TPS 1 circuit short as necessary. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

Procedure D:

- Repair the open circuit as necessary. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

Procedure E:

- Replace ECM. After this procedure (See End of Diagnostic Procedure.)

Procedure F:

- Replace the Electronic Throttle. After this procedure (See End of Diagnostic Procedure.)

Procedure G:

- Repair the circuit as necessary. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

RB14256,0000A39 -19-18JUN12-12/12

51.01 (DTC 121) - Throttle Position Sensor 1 Lower Than Throttle Position Sensor 2 — System: Throttle Position Sensor

Code Caused By:

- TPS 1 is 20% lower than TPS 2.

Alarm Level:

- Mil light turns on for remainder of key cycle.

Control Unit Response:

- Engine shut down.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Visually ensure that throttle position sensor (TPS) sensor wiring is not compromised. If other power related codes are present, troubleshoot all codes as other conditions may be a factor. Look for any physical damage to TPS or throttle assembly and linkage.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller’s address.

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RB14256,0000A3A -19-18JUN12-1/12

Procedure A:

RB14256,0000A3A -19-18JUN12-2/12

Step 1	Key ON, engine OFF. Service ADVISOR connected. Does the display show more than 20% difference in voltage between TPS 1 and TPS 2?	**YES:** Go to next step. **NO:** Intermittent problem.

RB14256,0000A3A -19-18JUN12-3/12

Step 2	Key OFF, disconnect electronic throttle connector. Does the display show a voltage for TPS 1 less than 0.1 VDC.	**YES:** Go to procedure B. **NO:** Go next step.

RB14256,0000A3A -19-18JUN12-4/12

Step 3	Key OFF, disconnect ECM wiring harness connector. Key ON, using a DVOM check for voltage between ECM connector TPS 1 signal pin 6 and engine ground. Is there voltage?	**YES:** Go to procedure C. **NO:** Go next step.

RB14256,0000A3A -19-18JUN12-5/12

Step 4	Using a DVOM check for continuity between throttle connector EC4 ground pin 2 and ECM connector ground pin 20. Is there continuity between them?	**YES:** Go to next step. **NO:** Go to procedure D.

RB14256,0000A3A -19-18JUN12-6/12

Step 5	Inspect ECM connector terminals for damage, corrosion, or contamination. Is there a problem?	**YES:** Go to procedure G. **NO:** Go to procedure E.

Continued on next page RB14256,0000A3A -19-18JUN12-7/12

Step 6	Inspect wire terminals at throttle connector for damage, corrosion, or contamination. Is there any problems?	**YES:** Go to procedure G. **NO:** Go to procedure F.

RB14256,0000A3A -19-18JUN12-8/12

Step 7	Key OFF, disconnect wire harness connector. Using a DVOM check for continuity between throttle connector TPS 1 signal pin 6 and ECM connector TPS 1 signal pin 47. Is there continuity between them?	**YES:** Go to next step. **NO:** Go to procedure D.

RB14256,0000A3A -19-18JUN12-9/12

Step 8	Using a DVOM check for continuity between throttle connector signal ground pin 2 and ECM connector ground pin 20. Is there continuity between them?	**YES:** Go to next step. **NO:** Go to procedure D.

RB14256,0000A3A -19-18JUN12-10/12

Step 9	Inspect ECM connector terminals for damage, corrosion, or contamination. Is there a problem?	**YES:** Go to procedure G. **NO:** Go to procedure E.

RB14256,0000A3A -19-18JUN12-11/12

Procedure B:

- Jump TPS 1 signal pin 6 to the 5 volt reference pin 3 at connector. If the display shows a TPS 1 voltage over 4.9 VDC, continue with step 6. If it shows a voltage less than 4.9 VDC continue with step 7.

Procedure C:

- Repair the TPS 1 circuit short as necessary. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

Procedure D:

- Repair the open circuit as necessary. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

Procedure E:

- Replace ECM. After this procedure (See End of Diagnostic Procedure.)

Procedure F:

- Replace the Electronic Throttle. After this procedure (See End of Diagnostic Procedure.)

Procedure G:

- Repair the circuit as necessary. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

RB14256,0000A3A -19-18JUN12-12/12

51.07 (DTC 2112) - Unable to Reach Higher Throttle Position — System: Throttle Position Sensor

Code Caused By:

- Actual throttle position is 20% more than the throttle command.
- Battery voltage greater than 9 VDC and less than 16 VDC.
- Persistently longer than 200ms.

Alarm Level:

- Mil light on.

Control Unit Response:

- Engine shut down.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Check for foreign objects in the throttle bore.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller’s address.

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RB14256,0000A3B -19-18JUN12-1/8

Procedure A:

RB14256,0000A3B -19-18JUN12-2/8

Step 1	Key ON, engine OFF, Service ADVISOR connected. Depress foot pedal until the throttle command is 63-68% Is the TPS voltage less than 2.0 VDC?	**YES:** Go to next step. **NO:** Intermittent problem.

RB14256,0000A3B -19-18JUN12-3/8

Step 2	Key OFF, disconnect electronic throttle connector. Probe TPS 1 signal circuit pin 6 with a test light connected to battery voltage. Key ON. Does the display show a TPS voltage of 4.0 VDC or greater?	**YES:** Go to next step. **NO:** Go to procedure B.

RB14256,0000A3B -19-18JUN12-4/8

Step 3	Check throttle bore for foreign object. Is there an object in the bore?	**YES:** Go to procedure D. **NO:** Go to next step.

RB14256,0000A3B -19-18JUN12-5/8

Step 4	Check the electronic throttle connector terminals for damage, corrosion, or contamination. Is there a problem?	**YES:** Go to procedure C. **NO:** Go to procedure E.

RB14256,0000A3B -19-18JUN12-6/8

Step 5	Using a DVOM check for continuity between throttle connector TPS 1 signal pin 6 and engine ground. Is there continuity between them?	**YES:** Go to procedure G. **NO:** Go to procedure F.

Continued on next page

RB14256,0000A3B -19-18JUN12-7/8

Procedure B:

- Key OFF, disconnect ECM wire harness connector. Using a DVOM check for continuity between throttle connector TPS 1 signal pin 6 and ECM TPS 1 signal pin 47. If there is continuity between them continue with step 5. If there is no continuity go to procedure C.

Procedure C:

- Repair the circuit as necessary. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

Procedure D:

- Remove foreign object. After this procedure (See End of Diagnostic Procedure.)

Procedure E:

- .Replace the Throttle. After this procedure (See End of Diagnostic Procedure.)

Procedure F:

- Replace ECM. After this procedure (See End of Diagnostic Procedure.)

Procedure G:

- Repair short in the circuit as necessary. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

RB14256,0000A3B -19-18JUN12-8/8

51.07 (DTC 2111) - Unable to Reach Lower Throttle Position — System: Throttle Position Sensor

Code Caused By:

- Actual throttle position is 20% less than the throttle command.
- Battery voltage greater than 9 VDC and less than 16 VDC.
- Persistently longer than 200ms.

Alarm Level:

- Mil light on.

Control Unit Response:

- Engine shut down.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Check for foreign objects in the throttle bore.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller’s address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A3C -19-18JUN12-1/9

Procedure A:

RB14256,0000A3C -19-18JUN12-2/9

Step 1	Key ON, engine OFF, Service ADVISOR connected. Depress foot pedal until the throttle command is 63-68% Is the TPS voltage greater than 2.0 VDC?	**YES:** Go to next step. **NO:** Intermittent problem.

Continued on next page

RB14256,0000A3C -19-18JUN12-3/9

Step 2	Key OFF, disconnect electronic throttle connector. Probe TPS 1 signal circuit pin 6 with a test light connected to battery voltage. Key ON. Does the display show a voltage of 0.2 VDC or less?	**YES:** Go to procedure B. **NO:** Go to next step.

RB14256,0000A3C -19-18JUN12-4/9

Step 3	Key OFF, disconnect ECM wire harness connector. Key ON, using a DVOM check for voltage between throttle connector TPS 1 signal pin 6 and engine ground. Is there voltage?	**YES:** Go to procedure C. **NO:** Go to procedure F.

RB14256,0000A3C -19-18JUN12-5/9

Step 4	Key OFF, disconnect ECM wire harness connector. Using a DVOM check for continuity between throttle connector signal ground pin 2 and ECM signal ground circuit pin 20. Is there continuity between them?	**YES:** Go to procedure F. **NO:** Go to procedure C.

RB14256,0000A3C -19-18JUN12-6/9

Step 5	Check throttle for foreign objects in bore. Are there any foreign objects in bore?	**YES:** Go to procedure D. **NO:** Go to next step.

RB14256,0000A3C -19-18JUN12-7/9

Step 6	Inspect the throttle wire harness connector terminals for damage, corrosion, or contamination. Is there a problem?	**YES:** Go to procedure C. **NO:** Go to procedure E.

RB14256,0000A3C -19-18JUN12-8/9

Procedure B:

- Probe sensor ground circuit at ECM connector with a test light connected to battery voltage. If the light turns on continue to step 5. If the light does not turn on go to procedure C.

Procedure C:

- Repair the circuit as necessary. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

Procedure D:

- Remove foreign object. After this procedure (See End of Diagnostic Procedure.)

Procedure E:

- .Replace the Throttle. After this procedure (See End of Diagnostic Procedure.)

Procedure F:

- Replace ECM. After this procedure (See End of Diagnostic Procedure.)

RB14256,0000A3C -19-18JUN12-9/9

51.31 (DTC 2135) - Simultaneous Voltages Out of Range TPS 1 and 2 — System: Throttle Position Sensor 1 and 2

Code Caused By:

- TPS 1 is 20% (or more) higher than TPS 2.
- Battery voltage greater than 9 VDC and less than 16 VDC.
- Persistently longer than 200ms.

Alarm Level:

- Mil light on.

Control Unit Response:

- Engine shut down.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Visually ensure that throttle position sensor (TPS) sensor wiring is not compromised. If other power related codes are present, troubleshoot all codes as other conditions may be a factor. Look for any physical damage to TPS or throttle assembly and linkage.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the "Diagnostics" tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller's address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A3D -19-18JUN12-1/12

Procedure A:

RB14256,0000A3D -19-18JUN12-2/12

Step 1	Key ON, engine OFF, Service ADVISOR connected. Does the display show 20% or more difference between TPS 1 and TPS 2?	**YES:** Go to next step. **NO:** Intermittent problem.

RB14256,0000A3D -19-18JUN12-3/12

Step 2	Key OFF, disconnect electronic throttle connector. Key ON, does the display show a voltage for TPS 1 less than 0.1 VDC?	**YES:** Go to procedure B. **NO:** Go to next step.

RB14256,0000A3D -19-18JUN12-4/12

Step 3	Key OFF, disconnect ECM wiring harness connector. Key ON. Using a DVOM check for voltage between ECM connector TPS 1 signal pin 5 and engine ground. Is there voltage?	**YES:** Go to procedure D. **NO:** Go to next step.

RB14256,0000A3D -19-18JUN12-5/12

Step 4	Using a DVOM check for continuity between throttle connector EC4 signal ground pin 2 and ECM connector signal ground pin 20. Is there continuity between them?	**YES:** Go to next step. **NO:** Go to procedure G.

Continued on next page RB14256,0000A3D -19-18JUN12-6/12

Step 5	Inspect ECM connector terminals for damage, corrosion, or contamination. Is there a problem?	**YES:** Go to procedure C. **NO:** Go to procedure F.

RB14256,0000A3D -19-18JUN12-7/12

Step 6	Inspect wire terminals at throttle connector for damage, corrosion, and contamination. Is there a problem?	**YES:** Go to procedure C. **NO:** Go to procedure E.

RB14256,0000A3D -19-18JUN12-8/12

Step 7	Key OFF, disconnect ECM wire harness connector. Using a DVOM check for continuity between throttle connector EC4 TPS 1 signal pin 6 and ECM connector TPS 1 signal pin 47. Is there continuity between them?	**YES:** Go to next step. **NO:** Go to procedure G.

RB14256,0000A3D -19-18JUN12-9/12

Step 8	Using a DVOM check for continuity between throttle connector EC4 signal ground pin 2 and ECM connector signal ground pin 20. Is there continuity between them?	**YES:** Go to next step. **NO:** Go to procedure G.

RB14256,0000A3D -19-18JUN12-10/12

Step 9	Inspect ECM connector terminals for damage, corrosion, or contamination. Is there a problem?	**YES:** Go to procedure C. **NO:** Go to procedure F.

RB14256,0000A3D -19-18JUN12-11/12

Procedure B:

- Jump TPS 1 signal pin 6 to the 5 volt reference pin 3 at connector. If the Service ADVISOR displays a TPS 1 voltage over 4.9 VDC continue with step 6. If it does not display over 4.9 VDC skip to step 7.

Procedure C:

- Repair the circuit as necessary. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

Procedure D:

- Repair the short in the circuit. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

Procedure E:

- .Replace the Throttle. After this procedure (See End of Diagnostic Procedure.)

Procedure F:

- Replace ECM. After this procedure (See End of Diagnostic Procedure.)

Procedure G:

- Repair open circuit as necessary. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

RB14256,0000A3D -19-18JUN12-12/12

91.03 (DTC 2122) - Foot Pedal Position Sensor 1 High Voltage — System: Foot Pedal Position Sensor 1.

Code Caused By:

- FPP1 voltage is higher than 4.8 VDC.

Alarm Level:

- Mil light on.

Control Unit Response:

- Power derate level 1.
- Forced idle.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Visually ensure there is no damage to wiring harness or connectors. Troubleshoot all codes as other conditions may be a factor. Look for any physical damage to foot pedal position sensor.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller’s address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A3E -19-18JUN12-1/6

Procedure A:

RB14256,0000A3E -19-18JUN12-2/6

Step 1	Key ON, engine OFF, Service ADVISOR connected. Does the display show a FPP voltage of 4.8 VDC or greater?	**YES:** Go to next step. **NO:** Go to procedure B.

RB14256,0000A3E -19-18JUN12-3/6

Step 2	Key OFF, disconnect FPP sensor from harness. Key ON. Does the display show FPP voltage less than 0.2 VDC?	**YES:** Go to next step. **NO:** Go to procedure D.

RB14256,0000A3E -19-18JUN12-4/6

Step 3	Probe sensor connector C28 ground circuit pin B with test light connected to battery voltage. Does the test light turn on?	**YES:** Go to procedure E. **NO:** Go to procedure F.

Continued on next page RB14256,0000A3E -19-18JUN12-5/6

Procedure B:

- Slowly increase foot pedal while observing FPP voltage. If the voltage exceeds 4.8 VDC go to procedure C. If the voltage does not exceed 4.8 VDC there is an intermittent problem.

Procedure C:

- Check ground circuits and connector pins on ECM connector and sensor connector for damage, corrosion, or contamination. If there is a problem with the circuits repair as necessary. See Electrical Repair section. After this step (See End of Diagnostic Procedure.)

Procedure D:

- Repair FPP shorted signal circuit to voltage as necessary. See Electrical Repair section. After this step (See End of Diagnostic Procedure.)

Procedure E:

- Replace the FPP sensor. After this step (See End of Diagnostic Procedure.)

Procedure F:

- Replace ECM. After this step (See End of Diagnostic Procedure.)

RB14256,0000A3E -19-18JUN12-6/6

91.04 (DTC 2123) - Foot Pedal Position Sensor 1 Low Voltage — System: Foot Pedal Position Sensor 1.

Code Caused By:

- FPP1 voltage is lower than 0.1 VDC.

Alarm Level:

- Mil light on.

Control Unit Response:

- Power derate level 1.
- Forced idle.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Visually ensure there is no damage to wiring harness or connectors. Troubleshoot all codes as other conditions may be a factor. Look for any physical damage to foot pedal position sensor.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller’s address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A3F -19-18JUN12-1/6

Procedure A:

RB14256,0000A3F -19-18JUN12-2/6

Step 1	Key ON, engine OFF, Service ADVISOR connected. Does the display show a voltage of 0.1 VDC or less with the pedal in idle position?	**YES:** Go to next step. **NO:** Go to procedure B.

RB14256,0000A3F -19-18JUN12-3/6

Step 2	Key OFF, disconnect FPP sensor connector C28 from the harness. Jump 5 volt reference circuit pin C and FPP signal circuit pin A together. Key ON. Does the display show a FPP voltage of 4.8 VDC or greater?	**YES:** Go to procedure D. **NO:** Go to next step.

Continued on next page

RB14256,0000A3F -19-18JUN12-4/6

Step 3	Probe FPP signal circuit pin A with test light connected to battery ground. Does the display show a FPP voltage 4.8 volts or greater?	**YES:** Go to procedure E. **NO:** Go to procedure F.

RB14256,0000A3F -19-18JUN12-5/6

Procedure B:

- Slowly depress foot pedal while observing FPP voltage. If the voltage drops below 0.1 VDC go to procedure C. If the voltage does not drop below 0.1 VDC there is an intermittent problem.

Procedure C:

- Check circuits and connector pins on ECM connector and sensor connector for damage, corrosion, or contamination. Check 5 volt supply for open or shorted circuit. If there is a problem with the circuits repair as necessary. See Electrical Repair section. After this step (See End of Diagnostic Procedure.)

Procedure D:

- Replace the FPP sensor. After this step (See End of Diagnostic Procedure.)

Procedure E:

- Check 5 volt supply for open or shorted circuit. If there is a problem with the circuits repair as necessary. See Electrical Repair section. After this step (See End of Diagnostic Procedure.)

Procedure F:

- Check FPP signal for open or shorted circuit. If there is a problem with the circuits repair as necessary. See Electrical Repair section. After this step (See End of Diagnostic Procedure.)

Procedure G:

- Replace the ECM. After this step (See End of Diagnostic Procedure.)

RB14256,0000A3F -19-18JUN12-6/6

29.03 (DTC 2128) - Foot Pedal Position Sensor 2 High Voltage — System: Foot Pedal Position Sensor 2.

Code Caused By:

- FPP1 voltage is higher than 4.8 VDC.

Alarm Level:

- Mil light on.

Control Unit Response:

- Power derate level 1.
- Forced idle.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Visually ensure there is no damage to wiring harness or connectors. Troubleshoot all codes as other conditions may be a factor. Look for any physical damage to foot pedal position sensor.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller’s address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A40 -19-18JUN12-1/6

Procedure A:

Continued on next page

RB14256,0000A40 -19-18JUN12-2/6

Step 1	Key ON, engine OFF, Service ADVISOR connected. Does the display show a FPP voltage of 4.8 VDC or greater?	**YES:** Go to next step. **NO:** Go to procedure B.

RB14256,0000A40 -19-18JUN12-3/6

Step 2	Key OFF, disconnect FPP sensor from harness. Key ON. Does the display show FPP voltage less than 0.2 VDC?	**YES:** Go to next step. **NO:** Go to procedure D.

RB14256,0000A40 -19-18JUN12-4/6

Step 3	Probe sensor connector C28 ground circuit pin B with test light connected to battery voltage. Does the test light turn on?	**YES:** Go to procedure E. **NO:** Go to procedure F.

RB14256,0000A40 -19-18JUN12-5/6

Procedure B:

- Slowly increase foot pedal while observing FPP voltage. If the voltage exceeds 4.8 VDC go to procedure C. If the voltage does not exceed 4.8 VDC there is an intermittent problem.

Procedure C:

- Check ground circuits and connector pins on ECM connector and sensor connector for damage, corrosion, or contamination. If there is a problem with the circuits repair as necessary. See Electrical Repair section. After this step (See End of Diagnostic Procedure.)

Procedure D:

- Repair FPP shorted signal circuit to voltage as necessary. See Electrical Repair section. After this step (See End of Diagnostic Procedure.)

Procedure E:

- Replace the FPP sensor. After this step (See End of Diagnostic Procedure.)

Procedure F:

- Replace ECM. After this step (See End of Diagnostic Procedure.)

RB14256,0000A40 -19-18JUN12-6/6

29.04 (DTC 2127) - Foot Pedal Position Sensor 2 Low Voltage — System: Foot Pedal Position Sensor 2.

Code Caused By:

- FPP1 voltage is lower than 0.1 VDC.

Alarm Level:

- Mil light on.

Control Unit Response:

- Power derate level 1.
- Forced idle.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Visually ensure there is no damage to wiring harness or connectors. Troubleshoot all codes as other conditions may be a factor. Look for any physical damage to foot pedal position sensor.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller’s address.

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RB14256,0000A41 -19-18JUN12-1/6

Procedure A:

RB14256,0000A41 -19-18JUN12-2/6

Step 1	Key ON, engine OFF, Service ADVISOR connected. Does the display show a voltage of 0.1 VDC or less with the pedal in idle position?	**YES:** Go to next step. **NO:** Go to procedure B.

RB14256,0000A41 -19-18JUN12-3/6

Step 2	Key OFF, disconnect FPP sensor connector C28 from the harness. Jump 5 volt reference circuit pin C and FPP signal circuit pin A together. Key ON. Does the display show a FPP voltage of 4.8 VDC or greater?	**YES:** Go to procedure D. **NO:** Go to next step.

RB14256,0000A41 -19-18JUN12-4/6

Step 3	Probe FPP signal circuit pin A with test light connected to battery ground. Does the display show a FPP voltage 4.8 volts or greater?	**YES:** Go to procedure E. **NO:** Go to procedure F.

Continued on next page RB14256,0000A41 -19-18JUN12-5/6

Procedure B:

- Slowly depress foot pedal while observing FPP voltage. If the voltage drops below 0.1 VDC go to procedure C. If the voltage does not drop below 0.1 VDC there is an intermittent problem.

Procedure C:

- Check circuits and connector pins on ECM connector and sensor connector for damage, corrosion, or contamination. Check 5 volt supply for open or shorted circuit. If there is a problem with the circuits repair as necessary. See Electrical Repair section. After this step (See End of Diagnostic Procedure.)

Procedure D:

- Replace the FPP sensor. After this step (See End of Diagnostic Procedure.)

Procedure E:

- Check 5 volt supply for open or shorted circuit. If there is a problem with the circuits repair as necessary. See Electrical Repair section. After this step (See End of Diagnostic Procedure.)

Procedure F:

- Check FPP signal for open or shorted circuit. If there is a problem with the circuits repair as necessary. See Electrical Repair section. After this step (See End of Diagnostic Procedure.)

Procedure G:

- Replace the ECM. After this step (See End of Diagnostic Procedure.)

RB14256,0000A41 -19-18JUN12-6/6

91.16 (DTC 2126) - FPP Sensor 1 Higher than FPP 2 (IVS) — System: Foot Pedal Position Sensor.

Code Caused By:

- FPP 1 is higher than FPP 2 by at least 20%.

Alarm Level:

- Mil light on.

Control Unit Response:

- Power derate level 1.
- Low rev limit.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Visually ensure there is no damage to wiring harness or connectors. Troubleshoot all codes as other conditions may be a factor. Look for any physical damage to foot pedal position sensor.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller’s address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A42 -19-18JUN12-1/5

Procedure A:

RB14256,0000A42 -19-18JUN12-2/5

Step 1	Key ON, engine OFF, Service ADVISOR connected. Does the display show IVS idle with foot fully depressed?	**YES:** Go to procedure B. **NO:** Go to next step.

Continued on next page RB14256,0000A42 -19-18JUN12-3/5

Step 2	Depress foot pedal until FPP is between 1.1 and 1.3 VDC. Does the display show IVS at idle?	**YES:** Go to procedure C. **NO:** Intermittent problem.

RB14256,0000A42 -19-18JUN12-4/5

Procedure B:

- Key OFF, disconnect foot pedal from harness. Key ON. If the display shows the IVS at idle go to procedure C. If the IVS is not displaying at idle go to procedure D.

Procedure C:

- Replace faulty foot pedal assembly. After this step (See End of Diagnostic Procedure.)

Procedure D:

- Repair IVS signal short to ground. After this step (See End of Diagnostic Procedure.)

Procedure E:

- Replace faulty ECM. After this step (See End of Diagnostic Procedure.)

RB14256,0000A42 -19-18JUN12-5/5

91.18 (DTC 2121) - FPP Sensor 1 Lower than FPP 2 (IVS) — System: Foot Pedal Position Sensor.

Code Caused By:

- FPP 1 is lower than FPP 2 by at least 20%.

Alarm Level:

- Mil light on.

Control Unit Response:

- Power derate level 1.
- Low rev limit.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Visually ensure there is no damage to wiring harness or connectors. Troubleshoot all codes as other conditions may be a factor. Look for any physical damage to foot pedal position sensor.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller’s address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A43 -19-18JUN12-1/5

Procedure A:

RB14256,0000A43 -19-18JUN12-2/5

Step 1	Key ON, engine OFF, Service ADVISOR connected. Does the display show the IVS off idle with the pedal in idle position?	**YES:** Go to next step. **NO:** Intermittent problem.

RB14256,0000A43 -19-18JUN12-3/5

Step 2	Key OFF, jump IVS signal and IVS ground together on harness connector. Key ON. Does the display show the IVS on?	**YES:** Go to procedure B. **NO:** Go to procedure C.

Continued on next page

RB14256,0000A43 -19-18JUN12-4/5

Procedure B:

- Replace faulty foot pedal assembly. After this step (See End of Diagnostic Procedure.)

Procedure C:

- Repair IVS signal short to ground. After this step (See End of Diagnostic Procedure.)

Procedure D:

- Replace faulty ECM. After this step (See End of Diagnostic Procedure.)

RB14256,0000A43 -19-18JUN12-5/5

515.16 (DTC 1111) - Fuel Rev Limit — System: Engine Speed Fault

Code Caused By:

- Engine speed greater than 4500 rpm for 0.5 seconds or more.

Alarm Level:

- Mil light on.

Control Unit Response:

- Fuel injectors disabled.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Check for obstruction in the throttle body bore.
- Check for stuck accelerator pedal.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller’s address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A44 -19-18JUN12-1/8

Procedure A:

RB14256,0000A44 -19-18JUN12-2/8

Step 1	Key ON, Does the Service ADVISOR connected. Are any DTC codes present with code 1111?	**YES:** Go to procedure B. **NO:** Go to next step.

RB14256,0000A44 -19-18JUN12-3/8

Step 2	Check the mechanical operation of the throttle. Is it functioning properly?	**YES:** Go to next step. **NO:** Go to procedure C.

RB14256,0000A44 -19-18JUN12-4/8

Step 3	Check mechanical operation of accelerator pedal and wire harness associated with the connection. Is there a problem?	**YES:** Go to procedure D. **NO:** Go to next step.

Continued on next page RB14256,0000A44 -19-18JUN12-5/8

Step 4	Inspect throttle body and intake manifold for possible air leaks. Are there any air leaks?	**YES:** Go to procedure E. **NO:** Go to next step.

RB14256,0000A44 -19-18JUN12-6/8

Step 5	If DTC remains active reinstall ECM payload and verify that the problem has been corrected. Does the code return?	**YES:** Go to procedure F. **NO:** End test.

RB14256,0000A44 -19-18JUN12-7/8

Procedure B:

- Diagnose and repair any other DTC s stored before proceeding with these diagnostic steps.

Procedure C:

- Repair mechanical operation of throttle assembly. If throttle assembly is damaged or beyond mechanical repair, replace as necessary. After this procedure (See End of Diagnostic Procedure.)

Procedure D:

- Repair mechanical operation of accelerator pedal assembly or wire harnesses associated with the connection. If assembly is damaged beyond mechanical repair, replace as necessary. After this procedure (See End of Diagnostic Procedure.)

Procedure E:

- Repair any leaks around throttle body or replace any gaskets that may be causing air leakage behind throttle body including intake manifold. After this procedure (See End of Diagnostic Procedure.)

Procedure F:

- Replace ECM. After this procedure (See End of Diagnostic Procedure.)

RB14256,0000A44 -19-18JUN12-8/8

515.00 (DTC 1112) - Spark Rev Limit — System: Engine Speed Fault

Code Caused By:

- Engine speed greater than 4500 rpm for 0.5 seconds or more.

Alarm Level:

- Mil light on.

Control Unit Response:

- Spark disabled.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Check for obstruction in the throttle body bore.
- Check for stuck accelerator pedal.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller’s address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A45 -19-18JUN12-1/8

Procedure A:

Continued on next page RB14256,0000A45 -19-18JUN12-2/8

Step 1	Key ON, Does the Service ADVISOR connected. Are any DTC codes present with code 1111?	**YES:** Go to procedure B. **NO:** Go to next step.

RB14256,0000A45 -19-18JUN12-3/8

Step 2	Check the mechanical operation of the throttle. Is it functioning properly?	**YES:** Go to next step. **NO:** Go to procedure C.

RB14256,0000A45 -19-18JUN12-4/8

Step 3	Check mechanical operation of accelerator pedal and wire harness associated with the connection. Is there a problem?	**YES:** Go to procedure D. **NO:** Go to next step.

RB14256,0000A45 -19-18JUN12-5/8

Step 4	Inspect throttle body and intake manifold for possible air leaks. Are there any air leaks?	**YES:** Go to procedure E. **NO:** End test.

RB14256,0000A45 -19-18JUN12-6/8

Step 5	If DTC remains active reinstall ECM payload and verify that the problem has been corrected. Does the code return?	**YES:** Go to procedure F. **NO:** End test.

RB14256,0000A45 -19-18JUN12-7/8

Procedure B:

- Diagnose and repair any other DTC s stored before proceeding with these diagnostic steps.

Procedure C:

- Repair mechanical operation of throttle assembly. If throttle assembly is damaged or beyond mechanical repair, replace as necessary. After this procedure (See End of Diagnostic Procedure.)

Procedure D:

- Repair mechanical operation of accelerator pedal assembly or wire harnesses associated with the connection. If assembly is damaged beyond mechanical repair, replace as necessary. After this procedure (See End of Diagnostic Procedure.)

Procedure E:

- Repair any leaks around throttle body or replace any gaskets that may be causing air leakage behind throttle body including intake manifold. After this procedure (See End of Diagnostic Procedure.)

Procedure F:

- Replace ECM. After this procedure (See End of Diagnostic Procedure.)

RB14256,0000A45 -19-18JUN12-8/8

524.01 (DTC 524) - Oil Pressure Low — System: Oil Pressure Fault

Code Caused By:

- Oil pressure closed circuit voltage less than 2.5 VDC.

Alarm Level:

- Mil light on.

Control Unit Response:

- Engine shut down.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Check oil level.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the "Diagnostics" tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller's address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A46 -19-18JUN12-1/8

Procedure A:

RB14256,0000A46 -19-18JUN12-2/8

Step 1	Verify that the engine has oil pressure using a mechanical oil pressure gauge before proceeding with these steps. Does the engine have oil pressure above 2 psi?	**YES:** Go to next step. **NO:** Repair faulty oiling system.

RB14256,0000A46 -19-18JUN12-3/8

Step 2	Key ON, engine running with Service ADVISOR connected. Clear DTC 524. Warm engine by idling until the ECT temperature is above 160 degrees F and has been running for at least 20 seconds or more. Increase engine speed above 600 RPM. Does the DTC 524 code reset and cause the engine to shut down?	**YES:** Go to next step. **NO:** Intermittent problem.

RB14256,0000A46 -19-18JUN12-4/8

Step 3	Key OFF, disconnect the oil pressure switch harness connector. Clear the DTC 524. Start engine, let idle for at least one minute with ECT over 160 degrees F. Increase engine speed above 600 RPM. Does the DTC 524 reset?	**YES:** Go to next step. **NO:** Go to procedure B.

RB14256,0000A46 -19-18JUN12-5/8

Step 4	Key Off, disconnect ECM harness connector. Using a DVOM check for continuity between oil pressure switch connector wire and engine ground. Is there continuity between them?	**YES:** Go to procedure C. **NO:** Go to next step.

Continued on next page

RB14256,0000A46 -19-18JUN12-6/8

Step 5	Inspect ECM connector pin 35 for damage, corrosion, or contamination. Is there a problem?	**YES:** Go to procedure C. **NO:** Go to procedure D.

RB14256,0000A46 -19-18JUN12-7/8

Procedure B:

- Replace oil pressure switch. If there is a 5-volt reference coming out of the ECM (See End of Diagnostic Procedure.)

Procedure C:

- Repair the circuit as necessary. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

Procedure D:

- Replace ECM. After this procedure (See End of Diagnostic Procedure.)

RB14256,0000A46 -19-18JUN12-8/8

520200.00 (DTC 171) - Adaptive Learn High Gasoline — System: EGO (oxygen sensor)

Code Caused By:

- Adaptive multiplier out of range by greater than 30%

Alarm Level:

- Mil light on.

Control Unit Response:

- N/A

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Make sure Oxygen sensor wires are not contacting the exhaust manifold.
- Check for vacuum and crankcase leaks.
- Check fuel system pressure.
- Check Exhaust leaks
- Check ECM grounds to be clean, tight, and in proper location.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller’s address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A47 -19-18JUN12-1/9

Procedure A:

RB14256,0000A47 -19-18JUN12-2/9

Step 1	Key ON, Service ADVISOR connected, are there any other DTC s present?	**YES:** Go to procedure B. **NO:** Go to next step.

Continued on next page

RB14256,0000A47 -19-18JUN12-3/9

Step 2	Visually and physically check the following items: After the check, was a repair made? • The air intake duct for being collapsed or restricted. • The air filter for being plugged. • The EGO 1 sensor installed securely and the wire leads are not contacting the exhaust manifold or ignition wires. • ECM grounds must be clean and tight. • System power fuses are good and in the proper location. • Fuel system diagnostics.	**YES:** (See End of Diagnostic Procedure.) **NO:** Go to next step.

RB14256,0000A47 -19-18JUN12-4/9

Step 3	Disconnect EGO 1 connector. Using a DVOM check for voltage between EGO 1 connector EC9 pin B and engine ground. Key ON, check must be made within 30 seconds or before power relay shuts down. Is there voltage?	**YES:** Go to next step. **NO:** Go to procedure C.

RB14256,0000A47 -19-18JUN12-5/9

Step 4	Key OFF, disconnect EGO 1 sensor wire harness connector. Disconnect ECM wire harness connector. Key ON, using a high impedance DVOM check for continuity between EGO 1 connector EC9 signal pin A and engine ground. Is there continuity?	**YES:** Go to procedure D. **NO:** Go to next step.

RB14256,0000A47 -19-18JUN12-6/9

Step 5	Using a high impedance DVOM check for continuity between EGO 1 connector signal pin C and EGO 1 signal pin A. Is there continuity?	**YES:** Go to procedure D. **NO:** Go to next step.

RB14256,0000A47 -19-18JUN12-7/9

Step 6	Using a high impedance DVOM check for continuity between EGO 1 heater pin D and ECM pin 62. Is there continuity?	**YES:** Go to procedure E. **NO:** Go to procedure F.

RB14256,0000A47 -19-18JUN12-8/9

Procedure B:

- Diagnose any other DTC codes before proceeding with these steps. Always repair existing codes starting with the lowest numerical code set first. If any codes have been detected, diagnosed, and repaired (See End of Diagnostic Procedure.)

Procedure C:

- Repair the open EGO power circuit as necessary. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

Procedure D:

- Repair short in the circuit as necessary. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

Procedure E:

- Replace EGO 1 sensor. After this procedure (See End of Diagnostic Procedure.)

Procedure F:

- Repair the open EGO heater ground. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

RB14256,0000A47 -19-18JUN12-9/9

520200.01 (DTC 172) - Adaptive Learn Low Gasoline — System: EGO (oxygen sensor)

Code Caused By:

- Adaptive multiplier out of range by greater than -30%

Alarm Level:

- Mil light on.

Control Unit Response:

- N/A

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Check for plugged or damaged air filter.
- Check fuel injector leakage.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller’s address.

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RB14256,0000A48 -19-18JUN12-1/6

Procedure A:

RB14256,0000A48 -19-18JUN12-2/6

Step 1	Key ON, Service ADVISOR connected, are there any other DTC s present?	**YES:** Go to procedure B. **NO:** Go to next step.

RB14256,0000A48 -19-18JUN12-3/6

Step 2	Visually and physically check the following items: After the check, was a repair made? • The air intake duct for being collapsed or restricted. • The air filter for being plugged. • The EGO 1 sensor installed securely and the wire leads are not contacting the exhaust manifold or ignition wires. • ECM grounds must be clean and tight. • Fuel system diagnostics.	**YES:** (See End of Diagnostic Procedure.) **NO:** Go to next step.

RB14256,0000A48 -19-18JUN12-4/6

Step 3	Key OFF, disconnect EGO 1 sensor wire harness connector EC9. Disconnect ECM wire harness connector. Key ON, using a high impedance DVOM check for continuity between EGO 1 connector signal pin A and engine ground. Is there continuity?	**YES:** Go to procedure C. **NO:** Go to procedure D.

Continued on next page RB14256,0000A48 -19-18JUN12-5/6

Procedure B:

- Diagnose any other DTC codes before proceeding with these steps. Always repair existing codes starting with the lowest numerical code set first. If any codes have been detected, diagnosed, and repaired (See End of Diagnostic Procedure.)

Procedure C:

- Repair circuit as necessary. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

Procedure D:

- Replace EGO 1 sensor. After this procedure (See End of Diagnostic Procedure.)

RB14256,0000A48 -19-18JUN12-6/6

520204.00 (DTC 1155) - Closed Loop Multiplier High Gasoline — System: EGO (oxygen sensor)

Code Caused By:

- Closed loop multiplier out of range by greater than 35%

Alarm Level:

- Mil light on.

Control Unit Response:

- Adaptive learn disabled.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Make sure Oxygen sensor wires are not contacting the exhaust manifold.
- Check for vacuum and crankcase leaks.
- Check fuel system pressure.
- Check Fuel pressure regulator.
- Check Exhaust leaks.
- Check ECM grounds to be clean, tight, and in proper location.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller’s address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A49 -19-18JUN12-1/9

Procedure A:

RB14256,0000A49 -19-18JUN12-2/9

Step 1	Key ON, Service ADVISOR connected, are there any other DTC s present?	**YES:** Go to procedure B. **NO:** Go to next step.

Continued on next page

RB14256,0000A49 -19-18JUN12-3/9

Step 2	Visually and physically check the following items: After the check, was a repair made? • The air intake duct for being collapsed or restricted. • The air filter for being plugged. • The EGO 1 sensor installed securely and the wire leads are not contacting the exhaust manifold or ignition wires. • ECM grounds must be clean and tight. • System power fuses are good and in the proper location. • Fuel system diagnostics.	**YES:** (See End of Diagnostic Procedure.) **NO:** Go to next step.

RB14256,0000A49 -19-18JUN12-4/9

Step 3	Disconnect EGO 1 connector EC9. Using a DVOM check for voltage between EGO 1 connector pin B and engine ground. Key ON, check must be made within 30 seconds or before power relay shuts down. Is there voltage?	**YES:** Go to next step. **NO:** Go to procedure C.

RB14256,0000A49 -19-18JUN12-5/9

Step 4	Key OFF, disconnect EGO 1 sensor wire harness connector EC9. Disconnect ECM wire harness connector. Key ON, using a high impedance DVOM check for continuity between EGO 1 connector signal pin A and engine ground. Is there continuity?	**YES:** Go to procedure D. **NO:** Go to next step.

RB14256,0000A49 -19-18JUN12-6/9

Step 5	Using a high impedance DVOM check for continuity between EGO 1 connector signal pin C and EGO 1 signal pin A. Is there continuity?	**YES:** Go to procedure D. **NO:** Go to next step.

RB14256,0000A49 -19-18JUN12-7/9

Step 6	Using a high impedance DVOM check for continuity between EGO 1 heater pin D and ECM pin 62. Is there continuity?	**YES:** Go to procedure E. **NO:** Go to procedure F.

RB14256,0000A49 -19-18JUN12-8/9

Procedure B:

- Diagnose any other DTC codes before proceeding with these steps. Always repair existing codes starting with the lowest numerical code set first. If any codes have been detected, diagnosed, and repaired (See End of Diagnostic Procedure.)

Procedure C:

- Repair the open EGO power circuit as necessary. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

Procedure D:

- Repair short in the circuit as necessary. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

Procedure E:

- Replace EGO 1 sensor. After this procedure (See End of Diagnostic Procedure.)

Procedure F:

- Repair the open EGO heater ground. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

RB14256,0000A49 -19-18JUN12-9/9

520204.01 (DTC 1156) - Closed Loop Multiplier Low Gasoline — System: EGO (oxygen sensor)

Code Caused By:

- Adaptive multiplier out of range by greater than -35%

Alarm Level:

- Mil light on.

Control Unit Response:

- Adaptive learning disabled

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Check for plugged or damaged air filter.
- Check fuel injector leakage.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the "Diagnostics" tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller's address.

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RB14256,0000A4A -19-18JUN12-1/6

Procedure A:

RB14256,0000A4A -19-18JUN12-2/6

Step 1	Key ON, Service ADVISOR connected, are there any other DTC s present?	**YES:** Go to procedure B. **NO:** Go to next step.

RB14256,0000A4A -19-18JUN12-3/6

Step 2	Visually and physically check the following items: After the check, was a repair made? • The air intake duct for being collapsed or restricted. • The air filter for being plugged. • The EGO 1 sensor installed securely and the wire leads are not contacting the exhaust manifold or ignition wires. • ECM grounds must be clean and tight. • Fuel system diagnostics.	**YES:** (See End of Diagnostic Procedure.) **NO:** Go to next step.

RB14256,0000A4A -19-18JUN12-4/6

Step 3	Key OFF, disconnect EGO 1 sensor wire harness connector EC9. Disconnect ECM wire harness connector. Key ON, using a high impedance DVOM check for continuity between EGO 1 connector signal pin A and engine ground. Is there continuity?	**YES:** Go to procedure C. **NO:** Go to procedure D.

Continued on next page

RB14256,0000A4A -19-18JUN12-5/6

Procedure B:

- Diagnose any other DTC codes before proceeding with these steps. Always repair existing codes starting with the lowest numerical code set first. If any codes have been detected, diagnosed, and repaired (See End of Diagnostic Procedure.)

Procedure C:

- Repair circuit as necessary. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

Procedure D:

- Replace EGO 1 sensor. After this procedure (See End of Diagnostic Procedure.)

RB14256,0000A4A -19-18JUN12-6/6

724.10 (DTC 134) - EGO 1 Pre Cat Open/Lazy — System: EGO (oxygen sensor)

Code Caused By:

- EGO 1 pre catalyst persistently cold for more then 120 seconds.

Alarm Level:

- Mil light on.

Control Unit Response:

- Adaptive learning disabled
- Closed Loop disabled

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Visually ensure that O2 sensor wiring is not compromised (open or short). If other power related codes are present, troubleshoot those first as other conditions may be a factor.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller’s address.

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RB14256,0000A4B -19-18JUN12-1/9

Procedure A:

RB14256,0000A4B -19-18JUN12-2/9

Step 1	Key ON, engine running, Service ADVISOR connected. Run engine to full operating temperature and then idle for a minimum of 2 minutes. Does the display show EGO 1 voltage fixed between 0.4 and 0.5 VDC after at least 2 minutes of idle run time?	**YES:** Go to next step. **NO:** Intermittent problem.

RB14256,0000A4B -19-18JUN12-3/9

Step 2	Key OFF, disconnect EGO 1 connector. Key ON, using a DVOM check for voltage between EGO 1 connector EC9 pins C and D. Check must be made within 30 seconds or before power relay shuts down. Is there voltage?	**YES:** Go to procedure B. **NO:** Go to next step.

Continued on next page

RB14256,0000A4B -19-18JUN12-4/9

Step 3	Key OFF, disconnect EGO 1 connector EC9. Using a DVOM check for voltage between EGO 1 connector pin C and engine ground. Key ON, check must be made within 30 seconds or before power relay shuts down. Is there voltage?	**YES:** Go to next step. **NO:** Go to procedure C.

RB14256,0000A4B -19-18JUN12-5/9

Step 4	Disconnect ECM connector. Using a DVOM check for continuity between EGO 1 connector pin D and ECM connector pin 62. Is there continuity?	**YES:** Go to next step. **NO:** Go to procedure D.

RB14256,0000A4B -19-18JUN12-6/9

Step 5	Inspect wire harness connector pins B and D and connector pins 21 and 62 for damage, corrosion, or contamination.	**YES:** Go to procedure E. **NO:** Go to procedure F.

RB14256,0000A4B -19-18JUN12-7/9

Step 6	Using a DVOM check for continuity between EGO 1 pin A and ECM connector pin 20. Is there continuity?	**YES:** Go to procedure H. **NO:** Repair open EGO 1 signal ground. See Electrical Repair section. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

RB14256,0000A4B -19-18JUN12-8/9

Procedure B:

- Key OFF, disconnect ECM wire harness connector. Using a DVOM check for continuity between EGO 1 pin B and ECM connector pin 21. If there is continuity between them continue to step 6. If there is no continuity go to procedure G.

Procedure C:

- Repair system power relay open circuit. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

Procedure D:

- Repair open heater ground circuit. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

Procedure E:

- Repair circuit as necessary. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

Procedure F:

- Replace ECM. After this procedure (See End of Diagnostic Procedure.)

Procedure G:

- Repair open EGO 1 circuit. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

Procedure H:

- Replace EGO 1 sensor. After this procedure (See End of Diagnostic Procedure.)

RB14256,0000A4B -19-18JUN12-9/9

1348.04 (DTC 628) - Fuel Pump Relay Control Ground Short — System: Fuel

Code Caused By:

- Relay control shorted to ground.

Alarm Level:

- Mil light on.

Control Unit Response:

- N/A

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Ensure that no other codes are present when troubleshooting this DTC. This circuit relies on proper operation of ECM to properly diagnose. Ensure there is no damage to wiring harness and connectors.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller’s address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A4C -19-18JUN12-1/6

Procedure A:

RB14256,0000A4C -19-18JUN12-2/6

Step 1	Key ON, Service ADVISOR connected. Clear the DTC 628 then start the engine. Does the DTC 628 re-set?	**YES:** Go to next step. **NO:** Intermittent problem.

RB14256,0000A4C -19-18JUN12-3/6

Step 2	Disconnect ECM connector. Using a DVOM check the resistance value between ECM pin 78 and engine ground. Be sure to check resistance between 20 and 100 degrees F. Is the resistance less than 60 ohms?	**YES:** Go to next step. **NO:** Go to procedure B.

RB14256,0000A4C -19-18JUN12-4/6

Step 3	Remove the fuel pump relay from the fuse block. Using a DVOM check the resistance value again between ECM pin 78 and engine ground. Be sure to check resistance between 20 and 100 degrees F. Is the resistance less than 60 ohms?	**YES:** Go to procedure C. **NO:** Go to procedure D.

Continued on next page RB14256,0000A4C -19-18JUN12-5/6

Procedure B:

- Replace ECM. After this step (See End of Diagnostic Procedure.)

Procedure C:

- Repair the shorted ground relay control circuit as necessary. See Electrical Repair section. After this step (See End of Diagnostic Procedure.)

Procedure D:

- Replace the fuel pump relay. After this step (See End of Diagnostic Procedure.)

RB14256,0000A4C -19-18JUN12-6/6

1348.05 (DTC 627) - Fuel Pump Relay Coil Open — System: Fuel

Code Caused By:

- ECM detects an open circuit on the relay control output.

Alarm Level:

- Mil light on.

Control Unit Response:

- N/A

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Visually ensure that fuel pump wiring is not compromised. If other fuel related codes are present, troubleshoot all codes as other conditions may be a factor. Look for any physical damage to fuel pump and relay coil.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller’s address.

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RB14256,0000A4D -19-18JUN12-1/8

Procedure A:

RB14256,0000A4D -19-18JUN12-2/8

Step 1	Key OFF, Service ADVISOR connected. Remove the power relay from the fuse block. Using a DVOM check the resistance of the relay coil between terminals 1 and 2. Be sure to check resistance between 20 and 100 degrees F. Is the resistance value less than 100 ohms?	**YES:** Go to next step. **NO:** Go to procedure B.

RB14256,0000A4D -19-18JUN12-3/8

Step 2	Check fuse F3. Is the fuse open?	**YES:** Replace fuse. **NO:** Go to next step.

RB14256,0000A4D -19-18JUN12-4/8

Step 3	Disconnect ECM connector. Using a DVOM check for continuity between ECM pin 78 and fuse block cavity for relay terminal 2. Is there continuity?	**YES:** Go to next step. **NO:** Go to procedure C.

Continued on next page RB14256,0000A4D -19-18JUN12-5/8

Step 4	Remove fuse F3. Using a DVOM check for continuity between fuse block cavity for relay terminal 1 and the power out of the F3 fuse holder. Is there continuity?	**YES:** Go to next step. **NO:** Go to procedure C.

RB14256,0000A4D -19-18JUN12-6/8

Step 5	Check all system fuses. Check all relay placement positions in the fuse block. Run complete pin to pin checks on chassis wiring to fuel system harness. Is there a problem?	**YES:** Go to procedure C. **NO:** Go to procedure D.

RB14256,0000A4D -19-18JUN12-7/8

Procedure B:

- Replace the fuel pump relay. After this step (See End of Diagnostic Procedure.)

Procedure C:

- Repair open circuit as necessary. See Electrical Repair section. After this step (See End of Diagnostic Procedure.)

Procedure D:

- Replace the ECM. After this step (See End of Diagnostic Procedure.)

RB14256,0000A4D -19-18JUN12-8/8

1347.06 (DTC 629) - Fuel Pump Relay Coil Short to Power — System: Fuel

Code Caused By:

- ECM detects an open circuit on the relay control output.
- Relay coil shorted to power.

Alarm Level:

- Mil light on.

Control Unit Response:

- N/A

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Visually ensure that fuel pump wiring is not compromised. If other fuel related codes are present, troubleshoot all codes as other conditions may be a factor. Look for any physical damage to fuel pump and relay coil.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller’s address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A4E -19-18JUN12-1/6

Procedure A:

Continued on next page

RB14256,0000A4E -19-18JUN12-2/6

Step 1	Key OFF, Service ADVISOR connected. Remove the power relay from the fuse block. Using a DVOM check the resistance of the relay coil between terminals 1 and 2. Be sure to check resistance between 20 and 100 degrees F. Is the resistance value less than 100 ohms?	**YES:** Go to procedure B. **NO:** Go to next step.

RB14256,0000A4E -19-18JUN12-3/6

Step 2	Using a DVOM check for continuity between relay terminals 2 and 3. Is there continuity between them?	**YES:** Go to procedure B. **NO:** Go to next step.

RB14256,0000A4E -19-18JUN12-4/6

Step 3	Key OFF, disconnect ECM wire harness connector. Using a DVOM check for power between ECM pin 78 and engine ground with the KEY ON. Is there power?	**YES:** Go to procedure C. **NO:** Go to procedure B. After this procedure (See End of Diagnostic Procedure.)

RB14256,0000A4E -19-18JUN12-5/6

Procedure B:

- Replace the power relay. After this step (See End of Diagnostic Procedure.)

Procedure C:

- Repair short to power as necessary. See Electrical Repair section. After this step (See End of Diagnostic Procedure.)

Procedure D:

- Replace the ECM. After this step (See End of Diagnostic Procedure.)

RB14256,0000A4E -19-18JUN12-6/6

1485.04 (DTC 686) - Relay Control Ground Short — System: Power Relay Control

Code Caused By:

- ECM detects a short to ground on the relay control output.
- Relay control shorted to ground.

Alarm Level:

- Mil light on.

Control Unit Response:

- N/A

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Ensure that no other codes are present when troubleshooting this DTC. This circuit relies on proper operation of ECM and circuitry to properly diagnose. Ensure there is no damage to wiring harness and connectors.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the "Diagnostics" tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller's address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A4F -19-18JUN12-1/6

Procedure A:

RB14256,0000A4F -19-18JUN12-2/6

Step 1	Key ON, Service ADVISOR connected. Clear the DTC 686. Start the engine. Does the code re-set?	**YES:** Go to next step. **NO:** Intermittent problem.

RB14256,0000A4F -19-18JUN12-3/6

Step 2	Disconnect ECM connector. Using a DVOM check the resistance value between ECM pin 73 and engine ground. Be sure to check resistance between 20 and 100 degrees F. Is the resistance less than 60 ohms?	**YES:** Go to next step. **NO:** Go to procedure D.

RB14256,0000A4F -19-18JUN12-4/6

Step 3	Remove the power relay from the fuse block. Using a DVOM check the resistance value again between ECM pin 73 and engine ground. Be sure to check resistance between 20 and 100 degrees F. Is the resistance less than 60 ohms?	**YES:** Go to procedure C. **NO:** Go to procedure D.

Continued on next page

RB14256,0000A4F -19-18JUN12-5/6

Procedure B:

- Replace the power relay. After this step (See End of Diagnostic Procedure.)

Procedure C:

- Repair short to power as necessary. See Electrical Repair section. After this step (See End of Diagnostic Procedure.)

Procedure D:

- Replace the ECM. After this step (See End of Diagnostic Procedure.)

RB14256,0000A4F -19-18JUN12-6/6

1485.05 (DTC 685) - Relay Coil Open — System: Power Relay Control

Code Caused By:

- ECM detects an open circuit on the relay control output.
- Relay coil open.

Alarm Level:

- Mil light on.

Control Unit Response:

- N/A

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Ensure that no other codes are present when troubleshooting this DTC. This circuit relies on proper operation of ECM and circuitry to properly diagnose. Ensure there is no damage to wiring harness and connectors.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller’s address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A50 -19-18JUN12-1/8

Procedure A:

RB14256,0000A50 -19-18JUN12-2/8

Step 1	Key OFF, Service ADVISOR connected. Remove the power relay from the fuse block. Using a DVOM check the resistance of the relay coil between terminals 1 and 2. Be sure to check resistance between 20 and 100 degrees F. Is the resistance value less than 100 ohms?	**YES:** Go to next step. **NO:** Go to procedure B.

RB14256,0000A50 -19-18JUN12-3/8

Step 2	Check fuse F2. Is the fuse open?	**YES:** Replace fuse F2. **NO:** Go to next step.

Continued on next page

RB14256,0000A50 -19-18JUN12-4/8

Step 3	Disconnect ECM connector. Using a DVOM check for continuity between ECM pin 73 and fuse block cavity for relay terminal 2. Is there continuity between them?	**YES:** Go to next step. **NO:** Go to procedure C.

RB14256,0000A50 -19-18JUN12-5/8

Step 4	Remove fuse F2. Using a DVOM check for continuity between fuse block cavity for relay terminal 1 and the power out of the F2 fuse holder. Is there continuity between them?	**YES:** Go to next step. **NO:** Go to procedure C.

RB14256,0000A50 -19-18JUN12-6/8

Step 5	Check all system fuses. Check relay placement positions in fuse block. Run complete pin to pin checks on chassis wiring fuel system harness.	**YES:** Go to procedure C. **NO:** Go to procedure D.

RB14256,0000A50 -19-18JUN12-7/8

Procedure B:

- Replace the power relay. After this step (See End of Diagnostic Procedure.)

Procedure C:

- Repair open circuit as necessary. See Electrical Repair section. After this step (See End of Diagnostic Procedure.)

Procedure D:

- Replace the ECM. After this step (See End of Diagnostic Procedure.)

RB14256,0000A50 -19-18JUN12-8/8

1485.03 (DTC 687) - Relay Coil Short to Power — System: Power Relay Control

Code Caused By:

- ECM detects a short to ground on the relay control output.
- Relay coil shorted to power.

Alarm Level:

- Mil light on.

Control Unit Response:

- N/A

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Ensure that no other codes are present when troubleshooting this DTC. This circuit relies on proper operation of ECM and circuitry to properly diagnose. Ensure there is no damage to wiring harness and connectors.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller’s address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A51 -19-18JUN12-1/6

Procedure A:

Continued on next page RB14256,0000A51 -19-18JUN12-2/6

Step 1	Key OFF, Service ADVISOR connected. Remove power relay from the fuse block. Using a DVOM check the resistance of the relay coil between terminals 1 and 2. Be sure to check resistance between 20 and 100 degrees F. Is the resistance value less than 60 ohms?	**YES:** Go to procedure B. **NO:** Go to next step.

RB14256,0000A51 -19-18JUN12-3/6

Step 2	Using a DVOM check for continuity between relay terminals 2 and 3. Is there continuity between them?	**YES:** Go to procedure B. **NO:** Go to next step.

RB14256,0000A51 -19-18JUN12-4/6

Step 3	Key OFF, disconnect ECM wire harness connector. Using a DVOM check for power between ECM pin 73 and engine ground with the key ON. Is there power?	**YES:** Go to procedure C. **NO:** Go to procedure B. After this procedure (See End of Diagnostic Procedure.)

RB14256,0000A51 -19-18JUN12-5/6

Procedure B:

- Replace the power relay. After this step (See End of Diagnostic Procedure.)

Procedure C:

- Repair short to power as necessary. See Electrical Repair section. After this step (See End of Diagnostic Procedure.)

Procedure D:

- Replace the ECM. After this step (See End of Diagnostic Procedure.)

RB14256,0000A51 -19-18JUN12-6/6

1213.04 (DTC 1644) - MIL Control Ground Short — System: MIL Control

Code Caused By:

- ECM MIL output shorted to ground.

Alarm Level:

- Mil light on.

Control Unit Response:

- N/A

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- This code may be accompanied by other malfunctions or DTC s. If any other malfunctions are present, they may aid in diagnosing problem before proceeding further.
- Visually ensure that ECM and display panel wiring is not compromised. If other codes are present, troubleshoot all codes as other conditions may be a factor. Look for any physical damage to ECM and display panel connectors.
- If any other indicator lights fail to illuminate, do not proceed. Troubleshoot display panel power and ground circuits.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller’s address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A52 -19-18JUN12-1/6

Procedure A:

RB14256,0000A52 -19-18JUN12-2/6

Step 1	Key ON, engine running, Service ADVISOR connected. Clear system fault code. Key OFF, Key ON. Does the DTC 1644 re-set?	**YES:** Go to next step. **NO:** Intermittent problem.

RB14256,0000A52 -19-18JUN12-3/6

Step 2	Key OFF, disconnect the ECM wire harness connector. Using a DVOM check for continuity between ECM connector pin 74 and engine ground. Is there continuity between them?	**YES:** Go to next step. **NO:** Intermittent problem.

RB14256,0000A52 -19-18JUN12-4/6

Step 3	Disconnect vehicle interface connector. Using a DVOM check for continuity between ECM connector pin 74 and engine ground. Is there continuity between them?	**YES:** Go to procedure B. **NO:** Go to procedure C.

Continued on next page RB14256,0000A52 -19-18JUN12-5/6

Procedure B:

- Repair the short to ground circuit between the ECM connector and engine ground as necessary. See Electrical Repair section. After this step (See End of Diagnostic Procedure.)

Procedure C:

- Repair the MIL control wire short to ground between the vehicle interface connector and vehicle chassis. See Electrical Repair section. After this step (See End of Diagnostic Procedure.)

Procedure D:

- Replace the ECM. After this step (See End of Diagnostic Procedure.)

RB14256,0000A52 -19-18JUN12-6/6

1213.05 (DTC 650) - MIL Open — System: MIL Control

Code Caused By:

- ECM MIL circuit open.

Alarm Level:

- Mil light on.

Control Unit Response:

- N/A

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- This code may be accompanied by other malfunctions or DTC s. If any other malfunctions are present, they may aid in diagnosing problem before proceeding further.
- Visually ensure that ECM and display panel wiring is not compromised. If other codes are present, troubleshoot all codes as other conditions may be a factor. Look for any physical damage to ECM and display panel connectors.
- If any other indicator lights fail to illuminate, do not proceed. Troubleshoot display panel power and ground circuits.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the "Diagnostics" tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller's address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A53 -19-18JUN12-1/8

Procedure A:

RB14256,0000A53 -19-18JUN12-2/8

Step 1	Key ON, engine running, Service ADVISOR connected. Clear system fault code. Key OFF, Key ON. Does the DTC 650 re-set?	**YES:** Go to next step. **NO:** Intermittent problem.

RB14256,0000A53 -19-18JUN12-3/8

Step 2	Remove the MIL bulb or driver circuit. Using a DVOM check for continuity through the bulb or driver device. Is there continuity between them?	**YES:** Go to next step. **NO:** Go to procedure B.

Continued on next page

RB14256,0000A53 -19-18JUN12-4/8

Step 3	Key OFF, re-install bulb or driver device. Disconnect vehicle interface connector. Using a DVOM check for continuity between vehicle interface connector EC1 pin 28 and battery positive. Key ON. Is there continuity between them?	**YES:** Go to next step. **NO:** Go to procedure C.

RB14256,0000A53 -19-18JUN12-5/8

Step 4	Disconnect ECM wire harness connector. Using a DVOM check for continuity between ECM harness connector pin 74 and vehicle interface connector pin 28.	**YES:** Go to next step. **NO:** Go to procedure C.

RB14256,0000A53 -19-18JUN12-6/8

Step 5	Inspect ECM wire harness connector pin 74 and vehicle interface connector pin 28 for damage, corrosion, or contamination. Is there a problem?	**YES:** Go to procedure D. **NO:** (See End of Diagnostic Procedure.)

RB14256,0000A53 -19-18JUN12-7/8

Procedure B:

- Replace the open bulb or driver device. After this step (See End of Diagnostic Procedure.)

Procedure C:

- Repair the open circuit as necessary. See Electrical Repair section. After this step (See End of Diagnostic Procedure.)

Procedure D:

- Correct the problem as necessary. After this step (See End of Diagnostic Procedure.)

RB14256,0000A53 -19-18JUN12-8/8

1213.03 (DTC 1645) - MIL Control Short to Power — System: MIL Control

Code Caused By:

- ECM MIL output shorted to power.

Alarm Level:

- Mil light on.

Control Unit Response:

- N/A

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- This code may be accompanied by other malfunctions or DTC s. If any other malfunctions are present, they may aid in diagnosing problem before proceeding further.
- Visually ensure that ECM and display panel wiring is not compromised. If other codes are present, troubleshoot all codes as other conditions may be a factor. Look for any physical damage to ECM and display panel connectors.
- If any other indicator lights fail to illuminate, do not proceed. Troubleshoot display panel power and ground circuits.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the "Diagnostics" tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller's address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A54 -19-18JUN12-1/6

Procedure A:

RB14256,0000A54 -19-18JUN12-2/6

Step 1	Key ON, engine running, Service ADVISOR connected. Clear system fault code. Key OFF, Key ON. Does the DTC 1645 re-set?	**YES:** Go to next step. **NO:** Intermittent problem.

RB14256,0000A54 -19-18JUN12-3/6

Step 2	Key OFF, disconnect the ECM wire harness connector. Using a DVOM check for voltage between ECM connector pin 74 and engine ground. Is there voltage between them?	**YES:** Go to next step. **NO:** Intermittent problem.

RB14256,0000A54 -19-18JUN12-4/6

Step 3	Disconnect vehicle interface connector. Using a DVOM check for voltage between ECM connector pin 74 and engine ground. Is there voltage between them?	**YES:** Go to procedure B. **NO:** Go to procedure C.

Continued on next page

RB14256,0000A54 -19-18JUN12-5/6

Procedure B:

- Repair the short to power circuit between the ECM connector and engine ground as necessary. See Electrical Repair section. After this step (See End of Diagnostic Procedure.)

Procedure C:

- Repair the MIL control wire short to power between the vehicle interface connector and vehicle chassis. See Electrical Repair section. After this step (See End of Diagnostic Procedure.)

Procedure D:

- Replace the ECM. After this step (See End of Diagnostic Procedure.)

RB14256,0000A54 -19-18JUN12-6/6

636.04 (DTC 337) - Crank Loss — System: Crankshaft Position Sensor

Code Caused By:

- 6 cam pulses with out crankshaft activity.

Alarm Level:

- Mil light on.

Control Unit Response:

- Adaptive learning disabled.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Inspect sensor and crank pulley for any contamination or debris. Visually ensure that wiring is not compromised. If other timing related codes are present, troubleshoot all codes as other conditions may be a factor. Look for any physical damage to connector.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™ : This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller’s address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A55 -19-18JUN12-1/10

Procedure A:

RB14256,0000A55 -19-18JUN12-2/10

Step 1	Check the ECM ground terminals are to be sure they clean and tight. Are they clean and tight?	**YES:** Go to next step. **NO:** Go to procedure B.

RB14256,0000A55 -19-18JUN12-3/10

Step 2	Disconnect the crank sensor connector. Using a DVOM check for voltage output directly from the crank sensor while cranking the engine. Is there voltage output greater than 0.5 VDC?	**YES:** Go to next step. **NO:** Go to procedure C.

Continued on next page

RB14256,0000A55 -19-18JUN12-4/10

Step 3	Key OFF, disconnect ECM connector. Using a DVOM check for continuity between crank sensor connector EC14 pin A and ECM connector pin 25. Is there continuity between them.	**YES:** Go to next step. **NO:** Go to procedure B.

RB14256,0000A55 -19-18JUN12-5/10

Step 4	Using a DVOM check for continuity between crank sensor pin B and ECM connector pin 26. Is there continuity between them?	**YES:** Go to next step. **NO:** Go to procedure B.

RB14256,0000A55 -19-18JUN12-6/10

Step 5	Inspect the crank sensor connector EC14 pins for damage, corrosion, or contamination. Is there a problem?	**YES:** Go to procedure B. **NO:** Go to next step.

RB14256,0000A55 -19-18JUN12-7/10

Step 6	Inspect the ECM connector pins 25 and 26 for damage, corrosion, or contamination. Is there a problem?	**YES:** Go to procedure B. **NO:** Go to next step.

RB14256,0000A55 -19-18JUN12-8/10

Step 7	Using a DVOM check for continuity between ECM connector pins 25 and 26 to engine ground. Is there continuity between them?	**YES:** Go to procedure E. **NO:** Go to procedure F.

RB14256,0000A55 -19-18JUN12-9/10

Procedure B:

- Repair the circuit as necessary. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

Procedure C:

- Key OFF, inspect the pulse wheel and crank sensor for mechanical damage, corrosion, or contamination. If there is a problem repair as necessary. If no problem has been detected go to procedure D.

Procedure D:

- Replace crank sensor. After this procedure (See End of Diagnostic Procedure.)

Procedure E:

- Repair the short in the circuit as necessary. After this procedure (See End of Diagnostic Procedure.)

Procedure F:

- Replace the ECM. After this procedure (See End of Diagnostic Procedure.)

RB14256,0000A55 -19-18JUN12-10/10

636.02 (DTC 336) - Crank Sync Noise — System: Crankshaft Position Sensor

Code Caused By:

- 1 invalid crank re-sync in less than 800 ms.

Alarm Level:

- Mil light on.

Control Unit Response:

- Adaptive learning disabled.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Inspect sensor and crank pulley for any contamination or debris. Visually ensure that wiring is not compromised. If other timing related codes are present, troubleshoot all codes as other conditions may be a factor. Look for any physical damage to connector.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller’s address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A56 -19-18JUN12-1/10

Procedure A:

RB14256,0000A56 -19-18JUN12-2/10

Step 1	Check the ECM ground terminals are to be sure they clean and tight. Are they clean and tight?	**YES:** Go to next step. **NO:** Go to procedure B.

RB14256,0000A56 -19-18JUN12-3/10

Step 2	Disconnect the crank sensor connector EC14. Using a DVOM check for voltage output directly from the crank sensor while cranking the engine. Is there voltage output greater than 0.5 VDC?	**YES:** Go to next step. **NO:** Go to procedure C.

RB14256,0000A56 -19-18JUN12-4/10

Step 3	Key OFF, disconnect ECM connector. Using a DVOM check for continuity between crank sensor connector pin A and ECM connector pin 25. Is there continuity between them.	**YES:** Go to next step. **NO:** Go to procedure B.

RB14256,0000A56 -19-18JUN12-5/10

Step 4	Using a DVOM check for continuity between crank sensor pin B and ECM connector pin 26. Is there continuity between them?	**YES:** Go to next step. **NO:** Go to procedure B.

RB14256,0000A56 -19-18JUN12-6/10

Step 5	Inspect the crank sensor connector pins for damage, corrosion, or contamination. Is there a problem?	**YES:** Go to procedure B. **NO:** Go to next step.

Continued on next page RB14256,0000A56 -19-18JUN12-7/10

Step 6	Inspect the ECM connector pins 25 and 26 for damage, corrosion, or contamination. Is there a problem?	**YES:** Go to procedure B. **NO:** Go to next step.

RB14256,0000A56 -19-18JUN12-8/10

Step 7	Using a DVOM check for continuity between ECM connector pins 25 and 26 to engine ground. Is there continuity between them?	**YES:** Go to procedure E. **NO:** Go to procedure F.

RB14256,0000A56 -19-18JUN12-9/10

Procedure B:

- Repair the circuit as necessary. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

Procedure C:

- Key OFF, inspect the pulse wheel and crank sensor for mechanical damage, corrosion, or contamination. If there is a problem repair as necessary. If no problem has been detected go to procedure D.

Procedure D:

- Replace crank sensor. After this procedure (See End of Diagnostic Procedure.)

Procedure E:

- Repair the short in the circuit as necessary. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

Procedure F:

- Replace the ECM. After this procedure (See End of Diagnostic Procedure.)

RB14256,0000A56 -19-18JUN12-10/10

636.08 (DTC 16) - Crank Never Synced at Start — System: Crankshaft Position Sensor

Code Caused By:

- Cranking speed above 90 rpm and more than 4 cranking revolutions without sync.

Alarm Level:

- Mil light on.

Control Unit Response:

- Adaptive learning disabled.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- Inspect sensor and crank pulley for any contamination or debris. Visually ensure that wiring is not compromised. If other timing related codes are present, troubleshoot all codes as other conditions may be a factor. Look for any physical damage to connector.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™: This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller's address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A57 -19-18JUN12-1/10

Procedure A:

Continued on next page RB14256,0000A57 -19-18JUN12-2/10

Step 1	Check the ECM ground terminals are to be sure they clean and tight. Are they clean and tight?	**YES:** Go to next step. **NO:** Go to procedure B.

RB14256,0000A57 -19-18JUN12-3/10

Step 2	Disconnect the crank sensor connector EC14. Using a DVOM check for voltage output directly from the crank sensor while cranking the engine. Is there voltage output greater than 0.5 VDC?	**YES:** Go to next step. **NO:** Go to procedure C.

RB14256,0000A57 -19-18JUN12-4/10

Step 3	Key OFF, disconnect ECM connector. Using a DVOM check for continuity between crank sensor connector pin A and ECM connector pin 25. Is there continuity between them.	**YES:** Go to next step. **NO:** Go to procedure B.

RB14256,0000A57 -19-18JUN12-5/10

Step 4	Using a DVOM check for continuity between crank sensor pin B and ECM connector pin 26. Is there continuity between them?	**YES:** Go to next step. **NO:** Go to procedure B.

RB14256,0000A57 -19-18JUN12-6/10

Step 5	Inspect the crank sensor connector pins for damage, corrosion, or contamination. Is there a problem?	**YES:** Go to procedure B. **NO:** Go to next step.

RB14256,0000A57 -19-18JUN12-7/10

Step 6	Inspect the ECM connector pins 25 and 26 for damage, corrosion, or contamination. Is there a problem?	**YES:** Go to procedure B. **NO:** Go to next step.

RB14256,0000A57 -19-18JUN12-8/10

Step 7	Using a DVOM check for continuity between ECM connector pins 25 and 26 to engine ground. Is there continuity between them?	**YES:** Go to procedure E. **NO:** Go to procedure F.

RB14256,0000A57 -19-18JUN12-9/10

Procedure B:

- Repair the circuit as necessary. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

Procedure C:

- Key OFF, inspect the pulse wheel and crank sensor for mechanical damage, corrosion, or contamination. If there is a problem repair as necessary. If no problem has been detected go to procedure D.

Procedure D:

- Replace crank sensor. After this procedure (See End of Diagnostic Procedure.)

Procedure E:

- Repair the short in the circuit as necessary. See Electrical Repair section. After this procedure (See End of Diagnostic Procedure.)

Procedure F:

- Replace the ECM. After this procedure (See End of Diagnostic Procedure.)

RB14256,0000A57 -19-18JUN12-10/10

629.31 (DTC 606) - COP Failure — System: ECM

Code Caused By:

- Internal microprocessor error.

Alarm Level:

- Mil light on.

Control Unit Response:

- Engine shut down.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- This code may be accompanied by other malfunctions or DTC s. If any other malfunctions are present, they may aid in diagnosing problem before proceeding further.
- Visually ensure that ECM wiring is not compromised. If other ECM related codes are present, troubleshoot all codes as other conditions may be a factor. Look for any physical damage to ECM connector.

NOTE: Ensure that correct payload and/or ECM is installed on machine.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™ : This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller’s address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A58 -19-18JUN12-1/5

Procedure A:

RB14256,0000A58 -19-18JUN12-2/5

Step 1	Key ON, engine running, Service ADVISOR connected. Clear system fault code. Key OFF, Key ON. Does the DTC 606 re-set?	**YES:** Go to next step. **NO:** Intermittent problem.

RB14256,0000A58 -19-18JUN12-3/5

Step 2	Check the ECM power and ground circuits. Are the circuits in good condition?	**YES:** Go to procedure C. **NO:** Go to procedure B.

RB14256,0000A58 -19-18JUN12-4/5

Procedure B:

- Repair the circuit as necessary. See Electrical Repair section. After this step (See End of Diagnostic Procedure.)

Procedure C:

- Replace the ECM. After this step (See End of Diagnostic Procedure.)

RB14256,0000A58 -19-18JUN12-5/5

629.31 (DTC 1612) - RTI 1 Loss — System: ECM

Code Caused By:

- Internal microprocessor error.

Alarm Level:

- Mil light on.

Control Unit Response:

- Adaptive learning disabled for the remainder of the key cycle.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- This code may be accompanied by other malfunctions or DTC s. If any other malfunctions are present, they may aid in diagnosing problem before proceeding further.
- Visually ensure that ECM wiring is not compromised. If other ECM related codes are present, troubleshoot all codes as other conditions may be a factor. Look for any physical damage to ECM connector.

NOTE: Ensure that correct payload and/or ECM is installed on machine.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™ : This procedure can be performed by making a connection to the vehicle and using the "Diagnostics" tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller's address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A59 -19-18JUN12-1/5

Procedure A:

RB14256,0000A59 -19-18JUN12-2/5

Step 1	Key ON, engine running, Service ADVISOR connected. Clear system fault code. Key OFF, Key ON. Does the DTC 1612 re-set with the engine idling?	**YES:** Go to next step. **NO:** Intermittent problem.

RB14256,0000A59 -19-18JUN12-3/5

Step 2	Check the ECM power and ground circuits. Are the circuits in good condition?	**YES:** Go to procedure C. **NO:** Go to procedure B.

RB14256,0000A59 -19-18JUN12-4/5

Procedure B:

- Repair the circuit as necessary. See Electrical Repair section. After this step (See End of Diagnostic Procedure.)

Procedure C:

- Replace the ECM. After this step (See End of Diagnostic Procedure.)

RB14256,0000A59 -19-18JUN12-5/5

629.31 (DTC 1613) - RTI 2 Loss — System: ECM

Code Caused By:

- Internal microprocessor error.

Alarm Level:

- Mil light on.

Control Unit Response:

- Adaptive learning disabled for the remainder of the key cycle.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- This code may be accompanied by other malfunctions or DTC s. If any other malfunctions are present, they may aid in diagnosing problem before proceeding further.
- Visually ensure that ECM wiring is not compromised. If other ECM related codes are present, troubleshoot all codes as other conditions may be a factor. Look for any physical damage to ECM connector.

NOTE: Ensure that correct payload and/or ECM is installed on machine.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™ : This procedure can be performed by making a connection to the vehicle and using the "Diagnostics" tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller's address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A5A -19-18JUN12-1/5

Procedure A:

RB14256,0000A5A -19-18JUN12-2/5

Step 1	Key ON, engine running, Service ADVISOR connected. Clear system fault code. Key OFF, Key ON. Does the DTC 1613 re-set with the engine idling?	**YES:** Go to next step. **NO:** Intermittent problem.

RB14256,0000A5A -19-18JUN12-3/5

Step 2	Check the ECM power and ground circuits. Are the circuits in good condition?	**YES:** Go to procedure C. **NO:** Go to procedure B.

RB14256,0000A5A -19-18JUN12-4/5

Procedure B:

- Repair the circuit as necessary. See Electrical Repair section. After this step (See End of Diagnostic Procedure.)

Procedure C:

- Replace the ECM. After this step (See End of Diagnostic Procedure.)

RB14256,0000A5A -19-18JUN12-5/5

629.31 (DTC 1614) - RTI 3 Loss — System: ECM

Code Caused By:

- Internal microprocessor error.

Alarm Level:

- Mil light on.

Control Unit Response:

- Adaptive learning disabled for the remainder of the key cycle.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- This code may be accompanied by other malfunctions or DTC s. If any other malfunctions are present, they may aid in diagnosing problem before proceeding further.
- Visually ensure that ECM wiring is not compromised. If other ECM related codes are present, troubleshoot all codes as other conditions may be a factor. Look for any physical damage to ECM connector.

NOTE: Ensure that correct payload and/or ECM is installed on machine.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™ : This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller’s address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A5B -19-18JUN12-1/5

Procedure A:

RB14256,0000A5B -19-18JUN12-2/5

Step 1	Key ON, engine running, Service ADVISOR connected. Clear system fault code. Key OFF, Key ON. Does the DTC 1614 re-set with the engine idling?	**YES:** Go to next step. **NO:** Intermittent problem.

RB14256,0000A5B -19-18JUN12-3/5

Step 2	Check the ECM power and ground circuits. Are the circuits in good condition?	**YES:** Go to procedure C. **NO:** Go to procedure B.

RB14256,0000A5B -19-18JUN12-4/5

Procedure B:

- Repair the circuit as necessary. See Electrical Repair section. After this step (See End of Diagnostic Procedure.)

Procedure C:

- Replace the ECM. After this step (See End of Diagnostic Procedure.)

RB14256,0000A5B -19-18JUN12-5/5

629.31 (DTC 1615) - A/D Loss — System: ECM

Code Caused By:

- Internal microprocessor error.

Alarm Level:

- Mil light on.

Control Unit Response:

- Adaptive learning disabled for the remainder of the key cycle.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- This code may be accompanied by other malfunctions or DTC s. If any other malfunctions are present, they may aid in diagnosing problem before proceeding further.
- Visually ensure that ECM wiring is not compromised. If other ECM related codes are present, troubleshoot all codes as other conditions may be a factor. Look for any physical damage to ECM connector.

NOTE: Ensure that correct payload and/or ECM is installed on machine.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™ : This procedure can be performed by making a connection to the vehicle and using the "Diagnostics" tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller's address.

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RB14256,0000A5C -19-18JUN12-1/5

Procedure A:

RB14256,0000A5C -19-18JUN12-2/5

Step 1	Key ON, engine running, Service ADVISOR connected. Clear system fault code. Key OFF, Key ON. Does the DTC 1615 re-set with the engine idling?	**YES:** Go to next step. **NO:** Intermittent problem.

RB14256,0000A5C -19-18JUN12-3/5

Step 2	Check the ECM power and ground circuits. Are the circuits in good condition?	**YES:** Go to procedure C. **NO:** Go to procedure B.

RB14256,0000A5C -19-18JUN12-4/5

Procedure B:

- Repair the circuit as necessary. See Electrical Repair section. After this step (See <u>End of Diagnostic Procedure</u>.)

Procedure C:

- Replace the ECM. After this step (See <u>End of Diagnostic Procedure</u>.)

RB14256,0000A5C -19-18JUN12-5/5

629.31 (DTC 1616) - Invalid Interrupt — System: ECM

Code Caused By:

- Internal microprocessor error.

Alarm Level:

- Mil light on.

Control Unit Response:

- Adaptive learning disabled for the remainder of the key cycle.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- This code may be accompanied by other malfunctions or DTC s. If any other malfunctions are present, they may aid in diagnosing problem before proceeding further.
- Visually ensure that ECM wiring is not compromised. If other ECM related codes are present, troubleshoot all codes as other conditions may be a factor. Look for any physical damage to ECM connector.

NOTE: Ensure that correct payload and/or ECM is installed on machine.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™ : This procedure can be performed by making a connection to the vehicle and using the "Diagnostics" tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller's address.

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RB14256,0000A5D -19-18JUN12-1/5

Procedure A:

RB14256,0000A5D -19-18JUN12-2/5

Step 1	Key ON, engine running, Service ADVISOR connected. Clear system fault code. Key OFF, Key ON. Does the DTC 1616 re-set with the engine idling?	**YES:** Go to next step. **NO:** Intermittent problem.

RB14256,0000A5D -19-18JUN12-3/5

Step 2	Check the ECM power and ground circuits. Are the circuits in good condition?	**YES:** Go to procedure C. **NO:** Go to procedure B.

RB14256,0000A5D -19-18JUN12-4/5

Procedure B:

- Repair the circuit as necessary. See Electrical Repair section. After this step (See End of Diagnostic Procedure.)

Procedure C:

- Replace the ECM. After this step (See End of Diagnostic Procedure.)

RB14256,0000A5D -19-18JUN12-5/5

628.13 (DTC 601) - Flash Checksum Invalid — System: ECM

Code Caused By:

- Internal microprocessor error.

Alarm Level:

- Mil light on.

Control Unit Response:

- Engine shut down.

Required Tools:

- Multimeter or;
- Service ADVISOR.

Preliminary Checks:

- This code may be accompanied by other malfunctions or DTC s. If any other malfunctions are present, they may aid in diagnosing problem before proceeding further.
- Visually ensure that ECM wiring is not compromised. If other ECM related codes are present, troubleshoot all codes as other conditions may be a factor. Look for any physical damage to ECM connector.

NOTE: Ensure that correct payload and/or ECM is installed on machine.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™ : This procedure can be performed by making a connection to the vehicle and using the "Diagnostics" tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller's address.

The list of observable data points is too large to list here. It is just a matter of looking up the related CAN bus traffic in Service ADVISOR for the controller in question and observing the data in real time to assist with diagnostics.

RB14256,0000A5E -19-18JUN12-1/5

Procedure A:

RB14256,0000A5E -19-18JUN12-2/5

Step 1	Key ON, engine running, Service ADVISOR connected. Clear system fault code. Key OFF, Key ON. Does the DTC 601 re-set?	**YES:** Go to next step. **NO:** Intermittent problem.

RB14256,0000A5E -19-18JUN12-3/5

Step 2	Check the ECM power and ground circuits. Are the circuits in good condition?	**YES:** Go to procedure C. **NO:** Go to procedure B.

RB14256,0000A5E -19-18JUN12-4/5

Procedure B:

- Repair the circuit as necessary. See Electrical Repair section. After this step (See End of Diagnostic Procedure.)

Procedure C:

- Replace the ECM. After this step (See End of Diagnostic Procedure.)

RB14256,0000A5E -19-18JUN12-5/5

628.12 (DTC 604) - RAM Failure — System: ECM

Code Caused By:

- Internal microprocessor error.

Alarm Level:

- Mil light on.

Control Unit Response:

- Engine shut down.

Required Tools:

- Multimeter
  or;
- Service ADVISOR.

Preliminary Checks:

- This code may be accompanied by other malfunctions or DTC s. If any other malfunctions are present, they may aid in diagnosing problem before proceeding further.
- Visually ensure that ECM wiring is not compromised. If other ECM related codes are present, troubleshoot all codes as other conditions may be a factor. Look for any physical damage to ECM connector.

NOTE: Ensure that correct payload and/or ECM is installed on machine.

Diagnosis

- Recall, record, and clear codes.
- If using Service ADVISOR™ : This procedure can be performed by making a connection to the vehicle and using the ”Diagnostics” tab to view and clear codes.
- If not using Service ADVISOR™ or if unable to make a connection: (insert anchor here) for the on-board display procedure.
- Recreate operating conditions that caused code.
- Recall codes again and check for return of this code.
- End of tests if code does not return.

NOTE: Using Service ADVISOR, all CAN bus traffic can be monitored in real time. This can be a useful tool to assist in diagnosing DTC s. There are many more data points that can be monitored than by looking at data through the ICC display. These data points exceed information and parameters than can be accessed by calling up an individual controller’s address.

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RB14256,0000A5F -19-18JUN12-1/5

Procedure A:

RB14256,0000A5F -19-18JUN12-2/5

Step 1	Key ON, engine running, Service ADVISOR connected. Clear system fault code. Key OFF, Key ON. Does the DTC 604 re-set?	**YES:** Go to next step. **NO:** Intermittent problem.

RB14256,0000A5F -19-18JUN12-3/5

Step 2	Check the ECM power and ground circuits. Are the circuits in good condition?	**YES:** Go to procedure C. **NO:** Go to procedure B.

RB14256,0000A5F -19-18JUN12-4/5

Procedure B:

- Repair the circuit as necessary. See Electrical Repair section. After this step (See End of Diagnostic Procedure.)

Procedure C:

- Replace the ECM. After this step (See End of Diagnostic Procedure.)

RB14256,0000A5F -19-18JUN12-5/5

Section 60
Power Train

Contents

Specifications

Item	Measurement	Specification
Input Shaft OD		
#1 F.W. Pilot Bearing		11.942-11.968 mm (0.4702-0.4712 in.)
#2 Clutch Sleeve CMP		19.948-20.000 mm (0.7854-0.7874 in.)
#3 Bearing #6205		24.9935-25.0065 mm (0.9840-0.9845 in.)
#4 F4:33 & F5:36 Gear, Bearing #222617		21.979-22.000 mm (0.8653-0.8661 in.)
#5 Bearing #6304U		20.002-20.015 mm (0.7875-0.7880 in.)
Input Shaft Assembly Bore ID		
#1 C/H Case Bore, Bearing #6205		52.000-52.046 mm (2.0472-2.0491 in.)
#2 F4:33 & F5:36 Gear, Case Bore, Bearing #222617		26.020-26.033 mm (1.0244-1.0249 in.)
#3 T/A Case Bore, Bearing #6304U		26.020-26.033 mm (1.0244-1.0249 in.)
Reduction Shaft OD		
#1 Bearing #6305		25.002-25.015 mm (0.9843-0.9848 in.)
#2 R, F1, F2, F3 Gears (39T, 50T, 44T, 37T)		29.987-30.000 mm (1.1806-1.1811 in.)
#3 Bearing #6205U		25.002-25.015 mm (0.9843-0.9848 in.)
Reduction Shaft Assembly Bore ID		
#1 C/H Bore, Bearing #6305		62.000-62.030 mm (2.4409-2.4421 in.)
#2 R, F1, F2, F3 (39T, 50T, 44T, 37T) Case Bore		35.009-35.034 mm (1.3783-1.3793 in.)
#3 T/A Case Bore, Bearing #6205U		52.000-52.030 mm (2.0472-2.0484 in.)
Countershaft OD		
#1 T.R. Bearing #30306		30.002-30.015 mm (1.1812-1.1817 in.)
#2 T.R. Bearing #32208		40.002-40.018 mm (1.5749-1.5755 in.)
Countershaft Assembly Bore ID		
#1 C/H Bore T.R. Bearing #30306		72.000-72.030 mm (2.8346-2.8358 in.)
#2 T/A Case Bore T.R. Bearing #32208		80.000-80.030 mm (3.1496-3.1508 in.)
Reverse Shaft OD		
#1 Shaft (29T)		19.987-20.000 mm (0.7869-0.7874 in.)
Reverse Shaft Assembly Bore ID		
#1 C/H Bore (Reverse Shaft)		20.000-20.013 mm (0.7874-0.7879 in.)
#2 Gear Bore (29T) (Needle Bearing Part)		24.007-24.028 mm (0.9452-0.9460 in.)
Axle Shaft OD		
#1 Bearing #6208		39.992-40.008 mm (1.5745-1.5751 in.)
#2 Bearing #2208		39.992-40.008 mm (1.5745-1.5751 in.)

Continued on next page RB14256,00007F6 -19-18JUN12-1/4

Item	Measurement	Specification
#3 Flange		79.900-80.000 mm (3.1457-3.1496 in.)
Axle Shaft Assembly Bore ID		
#1 Axle Housing Bore, Bearing #6208		80.000-80.030 mm (3.1457-3.1508 in.)
#2 Axle Housing Bore, Bearing #2208		80.000-80.030 mm (3.1457-3.1508 in.)
Clutch Shaft OD		
#1 Shaft		14.957-15.000 mm (0.5889-0.5906 in.)
Clutch Shaft Bore ID		
#1 C/H Bore		15.050-15.100 mm (0.5925-0.5945 in.)
#2 C/H Fork Bore		15.016-15.043 mm (0.5912-0.5922 in.)
Clutch Fork		
Pin Thickness		19.200-20.200 mm (0.7559-0.7953 in.)
Fork R-1, 2-3, 4-5, Thickness		6.700-6.900 mm (0.2638-0.2717 in.)
Clutch Fork Shaft OD		
R-1, 2-3, 4-5		14.957-15.000 mm (0.5889-0.5906 in.)
Clutch Fork Shaft Bore ID		
#1 C/H Bore.		15.100-15.150 mm (0.5945-0.5965 in.)
#2 T/A Case Bore		15.100-15.200 mm (0.5945-0.5984 in.)
Clutch Sleeve Groove Width		
Clutch Fork Pin		20.500-21.000 mm (0.8071-0.8268 in.)
Selector Arm Pin		
Selector Arm Pin Diameter		11.800-11.900 mm (0.4646-0.4658 in.)
Selector Arm Fork Groove Width		
Pin Part		12.100-12.300 mm (0.4764-0.4843 in.)
Selector Shaft OD		
#1 Cover A and B		14.900-14.950 mm (0.5866-0.5886 in.)
#2 Switch and Selector Arm		14.957-15.000 mm (0.5889-0.5906 in.)
#3 Control Arm		14.900-14.950 mm (0.5866-0.5886 in.)
Selector Shaft Assembly Bore ID		
#1 Cover A and B Bore		15.016-15.043 mm (0.5912-0.5922 in.)
#2 Selector Arm Bore		15.016-15.043 mm (0.5912-0.5922 in.)
#3 Switch Arm		15.000-15.027 mm (0.5906-0.5916 in.)
#4 Switch Arm Bore		15.000-15.027 mm (0.5906-0.5916 in.)
Differential Lock Shaft Assembly Bore ID		
#1 T/A Case Bore		20.100-20.200 mm (0.7913-0.7953 in.)
#2 Differential Lock Fork Bore		20.050-20.100 mm (0.7894-0.7913 in.)
#3 Axle Housing L Bore		20.020-20.053 mm (0.7882-0.7895 in.)
#4 Differential Lock Arm Bore		20.000-20.052 mm (0.7874-0.7894 in.)

Continued on next page

RB14256,00007F6 -19-18JUN12-2/4

Item	Measurement	Specification
Differential Lock Shifter		
Pin OD		11.018-11.029 mm (0.4338-0.4342 in.)
Pin Hole Bore ID		11.400-11.600 mm (0.4488-0.4567 in.)
Differential Pinion Shaft OD		
Shaft OD		21.967-21.980 mm (0.8648-0.8654 in.)
Differential Pinion Shaft Bore ID		
#1 Differential Case Bore		22.000-22.021 mm (0.8661-0.8670 in.)
#2 Differential Pinion Gear Bore		22.040-22.061 mm (0.8677-0.8685 in.)
Differential Case OD		
#1 Bearing #6212		60.002-60.021 mm (2.3623-2.3630 in.)
#2 Bearing #6210		50.002-50.018 mm (1.9686-1.9692 in.)
Differential Assembly Bore ID		
#1 Axle Housing L Bore, Bearing #6212		110.000-110.035 mm (4.3307-4.3321 in.)
#2 Transaxle Case Bore, Bearing #6210		90.000-90.035 mm (3.5433-3.5447 in.)
Axle Housing Collar OD		
Brake Assembly Component		81.910-81.990 mm (3.2248-3.2280 in.)
Input Shaft Assembly		
F4 Gear Side (33T) 22 x 33 x 2		1.90-2.10 mm (0.0748-0.0827 in.)
F5 Gear Side (36T) 22 x 34 x 2		1.90-2.10 mm (0.0748-0.0827 in.)
Reduction Shaft Assembly		
R Gear Side (39T) 26 x 41 x 3		2.90-3.10 mm (0.1142-0.1220 in.)
F1 Gear Side (50T) 30 x 43 x 3(2)		1.90-2.10 mm (0.0748-0.0827 in.)
F2 Gear Side (44T) 30 x 42 x 2		1.90-2.10 mm (0.0748-0.0827 in.)
F3 Gear Side (37T) 30 x 42 x 3.2		3.10-3.30 mm (0.1220-0.1299 in.)
Reverse Shaft Assembly		
R Gear Both Sides (29T) 20 x 34 x 2.5		2.40-2.50 mm (0.0945-0.0984 in.)
Countershaft Assembly		
MFWD Gear Side (40T) 30 x 38 x 4 Collar		3.90-4.10 mm (0.1535-0.1614 in.)
Spiral Pinion Side 40 x 50 x 9 Collar		8.90-9.10 mm (0.3504-0.3583 in.)
Differential		
Gear Washer		0.95-1.05 mm (0.0374-0.0413 in.)
Axle Shaft Assembly		
6208 Bearing Side 40 x 52 x 2.3 Collar		2.17-2.43 mm (0.0854-0.0957 in.)
2208 Bearing Side 41 x 51 x 6 Collar		5.90-6.00 mm (0.2323-0.2362 in.)

Continued on next page

RB14256,00007F6 -19-18JUN12-3/4

Item	Measurement	Specification
Differential Lock Assembly		
Transaxle Case Side 19.5 x 1.6 Washer		1.50-1.70 mm (0.0591-0.0669 in.)
Axle Housing Left Side 20 x 32 x 3.2 Spacer		3.05-3.35 mm (0.1201-0.1319 in.)
Selector Shaft Assembly		
Liner 4 Pieces		1.90-2.10 mm (0.0748-0.0827 in.)
Synchronizer Assembly		
Synchro Key Thickness		4.90-5.10 mm (0.1929-0.2008 in.)
F4, F5 Synchro Ring Key Groove Width		8.30-8.50 mm (0.3268-0.3346 in.)
R, F1-F3 Synchro Ring Key Groove Width		9.00-9.20 mm (0.3543-0.3622 in.)
Specifications		
Base System Capacity		12.5 L (3.3 gal)
Base with Auxiliary System Capacity		14.4 L (3.8 gal)
Transaxle Capacity		7.0-7.8 L (1.85-2.06 gal)
Clutch disengagement travel	Distance	12.5-18.5 mm (0.5-0.73 in.)
Specifications		
Backlash		0.17-0.23 mm (0.007-0.009 in.)
Clutch Housing Cap Screws	Torque	23-29 N•m (17-22 lb-ft)
Leaf Spring U-Bolt Nut	Torque	129 N•m (95 lb-ft)
Spring Shackle Cap Screws	Torque	102 N•m (75 lb-ft)
Ring Gear Cap Screw Torque	Torque	30-39 N·m (22-28 lb-ft)
Pinion Cone End to Case front Distance	Distance	2.1 ± 0.05 mm (0.083 ± 0.002 in.)
Differential Ring Gear Backlash	Backlash	0.17-0.23 mm (0.007-0.009 in.)
Synchronizer Wear Limit	Distance	0.1 mm (0.004 in.)
38T Gear Locknut Torque	Torque	166 N·m (123 lb-ft)
Reverse Idler Shaft Nut	Torque	44-59 N•m (33-43 lb-ft)
Transaxle Housing Cap Screw	Torque	23-29 N•m (17-21 lb-ft)
Ring Gear Retaining Cap Screws	Torque	78-98 N·m (58-72 lb-ft)
Axle Housing Cap Screw	Torque	23-29 N•m (17-22 lb-ft)
Axle Housing Cap Screw	Torque	44-59 N•m (33-43 lb-ft)
Specifications		
Axle Housing Cap Screw Torque (Left Side)		23-29 N·m (17-22 lb-ft)
Axle Housing Cap Screw Torque (Right Side)		44-59 N·m (33-43 lb-ft)

RB14256,00007F6 -19-18JUN12-4/4

Service Equipment and Tools

NOTE: Order tools according to information given in the SERVICEGARD™ Catalog. Some tools may be available from a local supplier.

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RB14256,00007F7 -19-18JUN12-1/2

Clutch Alignment Tool.. JDG1331

For use in Aligning Clutch to Flywheel and Flex Plate.

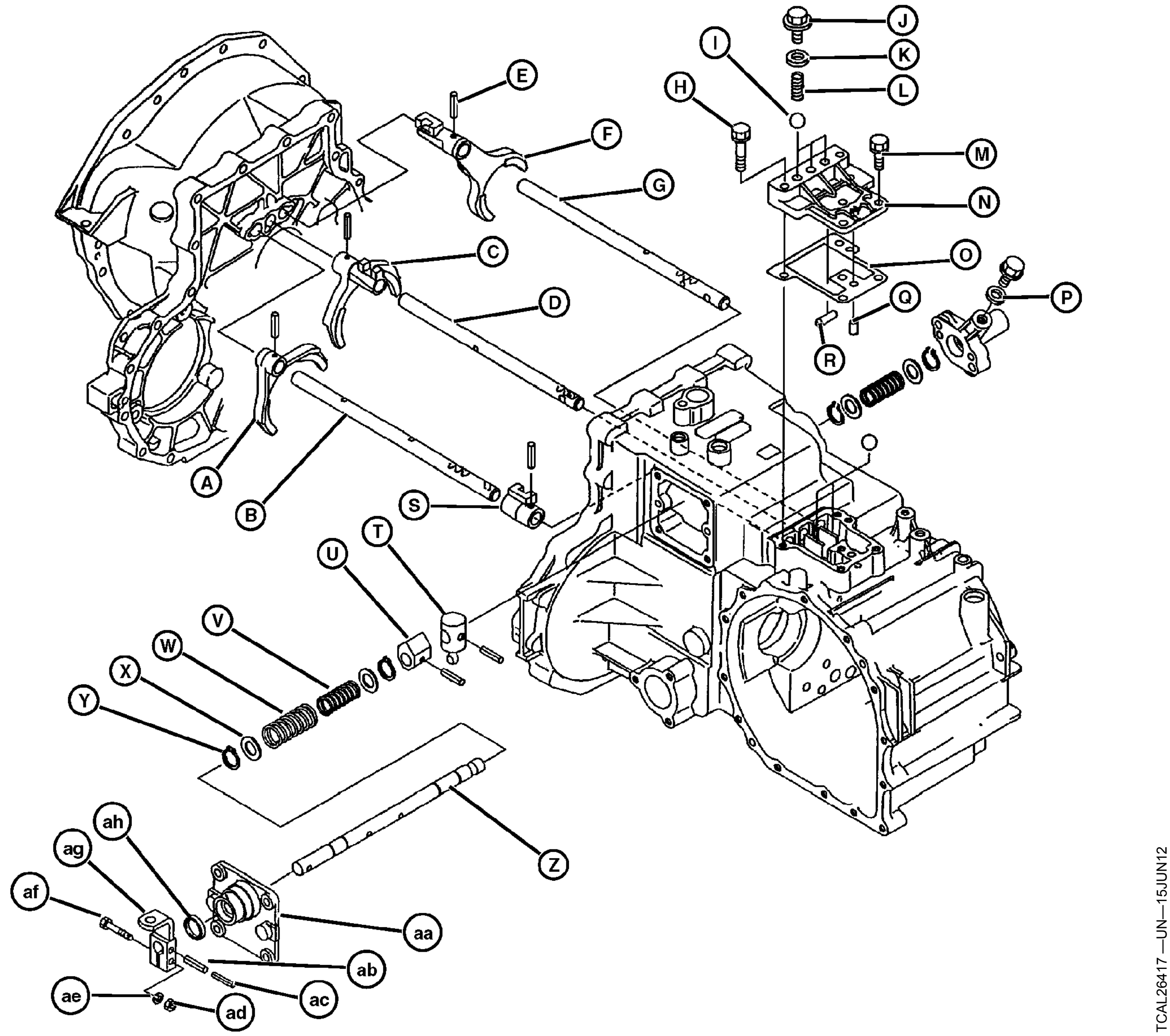
RB14256,00007F7 -19-18JUN12-2/2

Other Material

Number	Name	Use
Dot 3 (U.S.)	Brake Fluid	Used in brake systems to create pressure when brakes are applied.
TY24344 (U.S.) (U.S.)	Form-in-Place Gasket	Applied to covers before installation.
TY24344 (U.S.)	John Deere Form-in-Place Gasket	Used to create gaskets between two surfaces.
TY24344 (U.S.) (U.S.)	Form-in-Place Gasket	Applied to front cover mating surface before installation.
TY24344 (U.S.)	John Deere Form-in-Place Gasket	Used in creating Gaskets between two surfaces
PM37477 (U.S.) PM38622 (Canada) (U.S.)	Thread Lock and Sealer (Medium Strength)	Applied to threads of ring gear retaining cap screws.
PM37477 (U.S.)	John Deere Medium Strength Thread Lock and Sealer	Used to lock items together once torqued to specification.
TY24344 (U.S.) (U.S.)	Form-in-Place Gasket	Applied to axle housing mating surface before installation.
TY15130 (U.S.)	John Deere Form-in-Place Gasket	Apply to axle housing mating surfaces.

RB14256,00007F8 -19-18JUN12-1/1

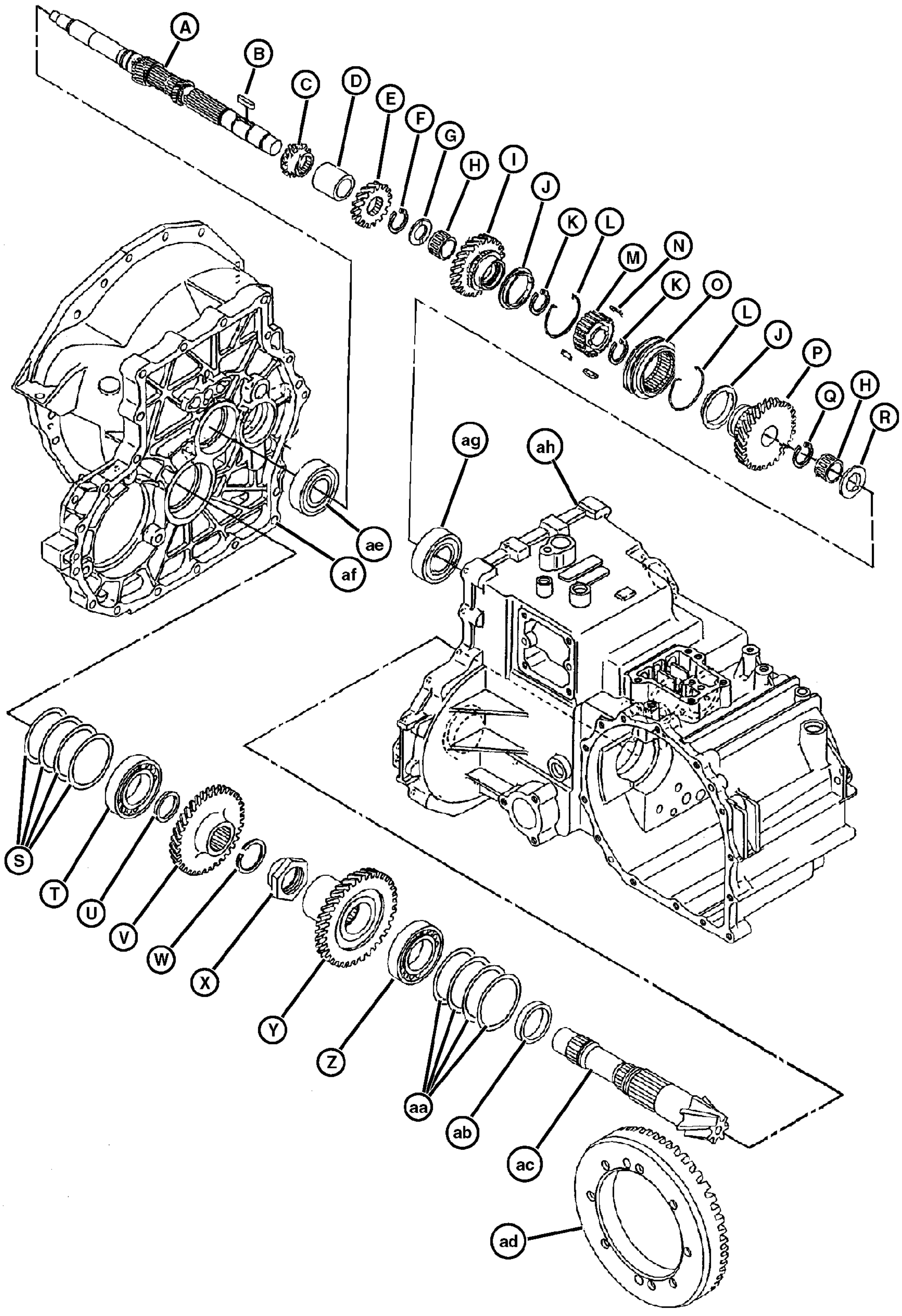
Shifter Shafts Component Location



A—Shifter Fork (R-1)
B—Shifter Shaft (R-1)
C—Shifter Fork (2-3)
D—Shifter Shaft (2-3)
E—Spring Pin (6 used)
F—Shifter Fork (4-5)
G—Shifter Shaft (4-5)
H—Cap Screw with Washer (2 used)
I— Detent Ball (5 used)
J— Bolt (4 used)
K—Seal (4 used)
L—Spring (3 used)
M—Cap Screw with Washer (3 used)
N—Cover
O—Gasket
P—Seal
Q—Pin (2 used)
R—Pin
S—Shift Collar (R-1)
T—Shift Fork
U—Shift Arm
V—Spring (2 used)
W—Spring
X—Spacer (4 used)
Y—Snap Ring (4 used)
Z—Selector Shaft
AA—Cover
AB—Spring Pin
AC—Spring Pin
AD—Nut
AE—Washer
AF—Bolt
AG—Control Arm
AH—Seal

RB14256,00007F9 -19-18JUN12-1/1

Input Shaft and Pinion Component Location



TCAL26418 —UN—15JUN12

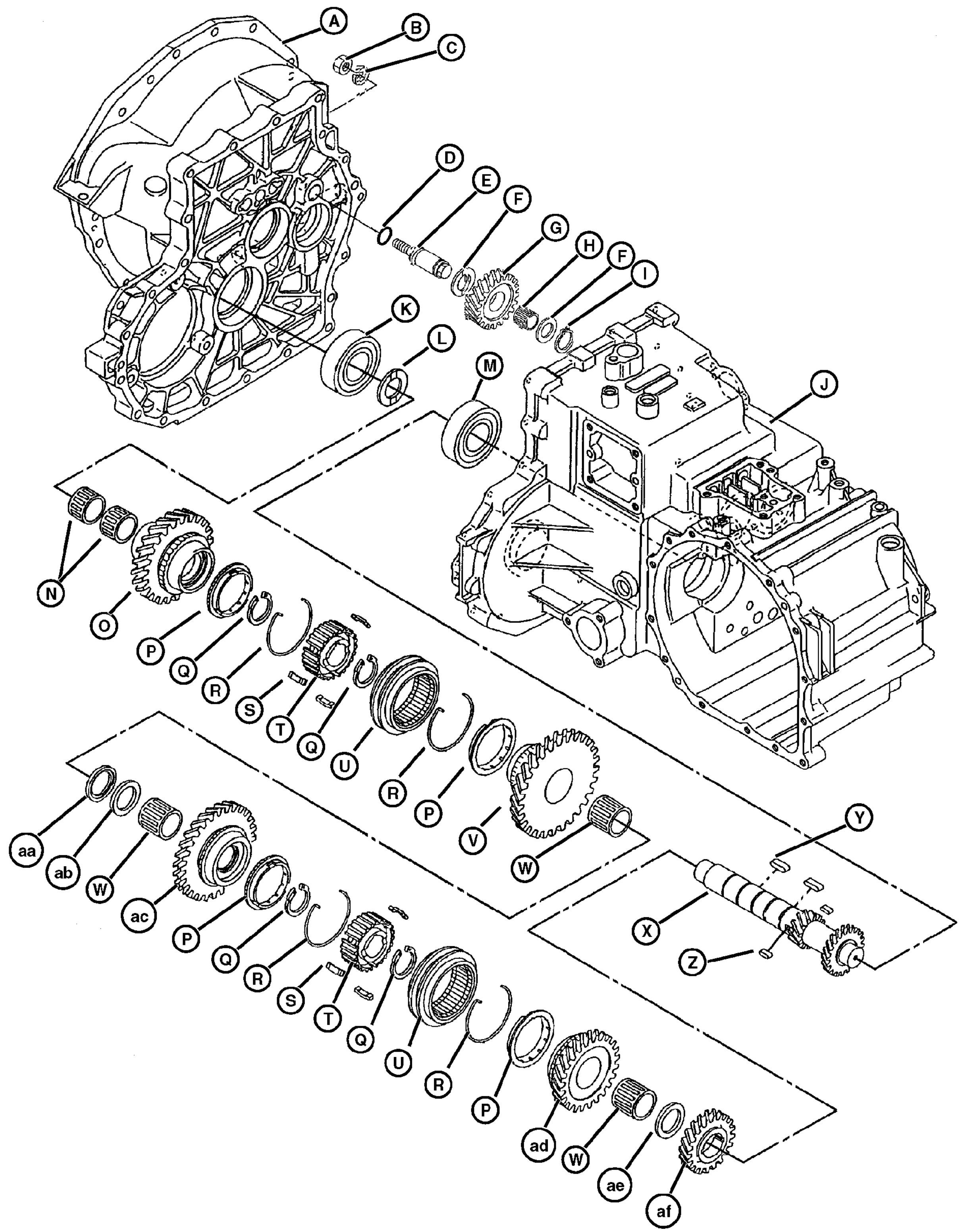
Continued on next page

RB14256,00007FA -19-18JUN12-1/2

A—Input Shaft
B—Shaft Key
C—Gear (16T)
D—Bushing
E—Gear (23T)
F—Snap Ring
G—Washer
H—Needle Bearing (2 used)
I— Gear (33T)
J—Synchronizer Ring (2 used)
K—Snap Ring (2 used)
L—Retaining Ring (2 used)
M—Hub
N—Key (3 used)
O—Shift Collar
P—Gear (36T)
Q—Snap Ring
R—Washer
S—Shim (as required)
T—Bearing
U—Bushing
V—Gear (40T) (4WD)
W—Snap Ring
X—Locknut
Y—Gear (36T)
Z—Bearing
AA—Shim (as required - cone point dimension adjustment)
AB—Bushing
AC—Pinion
AD—Ring Gear
AE—Ball Bearing
AF—Clutch Housing
AG—Ball Bearing
AH—Transaxle Case

RB14256,00007FA -19-18JUN12-2/2

Reverse and Reduction Shaft Component Location



TCAL26419 —UN—15JUN12

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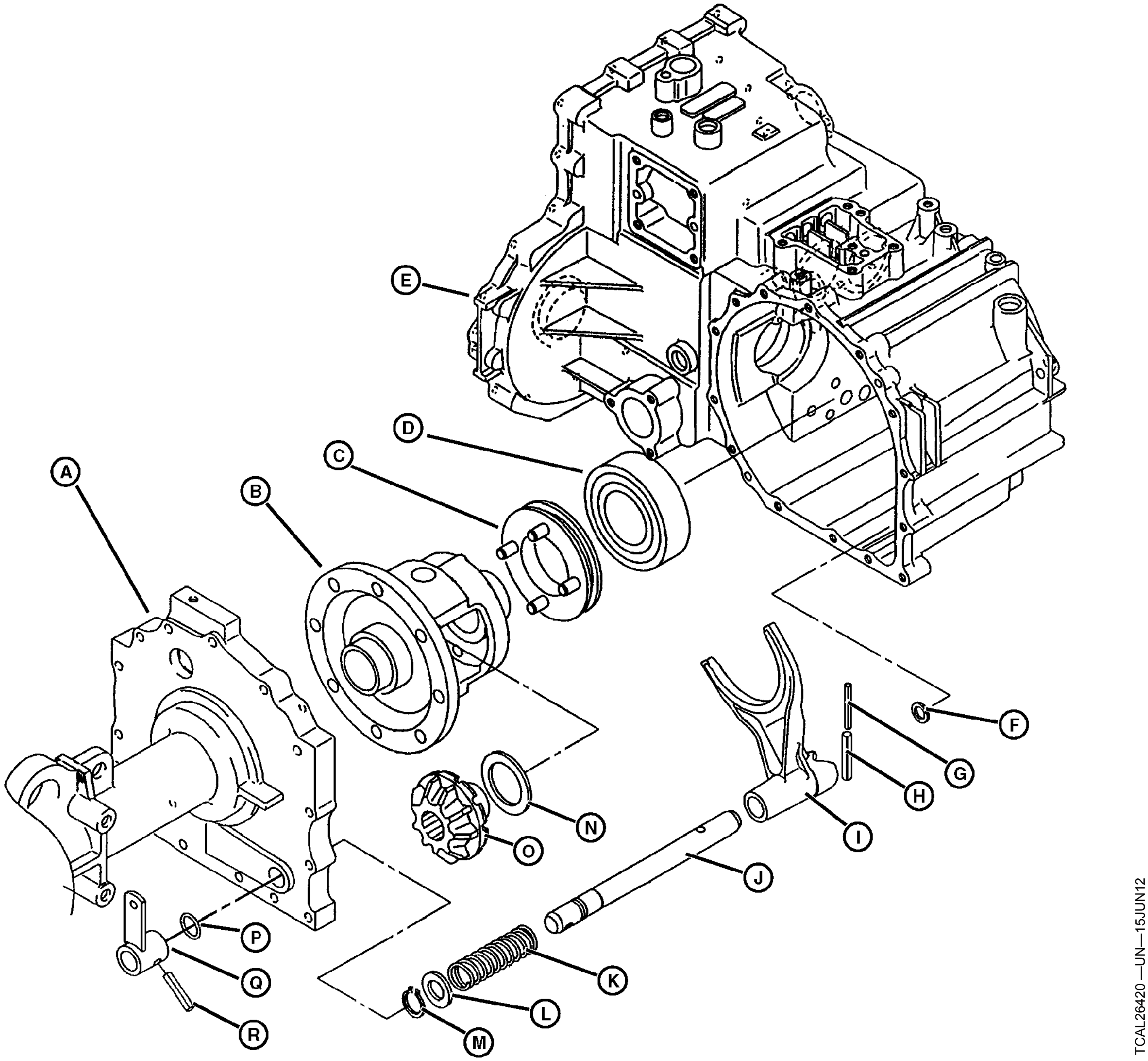
RB14256,00007FB -19-18JUN12-1/2

A—Clutch Housing
B—Nut
C—Seal
D—Side Lock Gear
E—Reverse Shaft
F—Washer (2 used)
G—Reverse Gear (29T)
H—Needle Bearing
I— Snap Ring
J—Transaxle Case
K—Ball Bearing
L—Washer
M—Ball Bearing
N—Needle Bearing (2 used)
O—Reduction Gear (39T)
P—Ring (4 used)
Q—Snap Ring (5 used)
R—Spring (4 used)
S—Key (6 used)
T—Hub (2 used)
U—Shift Collar (2 used)
V—Reduction Gear (50T)
W—Needle Bearing (3 used)
X—Reduction Shaft
Y—Key (2 used)
Z—Key (2 used)
AA—Washer
AB—Washer
AC—Reduction Gear (44T)
AD—Reduction Gear (37T)
AE—Washer
AF—Reduction Gear (28T)

RB14256,00007FB -19-18JUN12-2/2

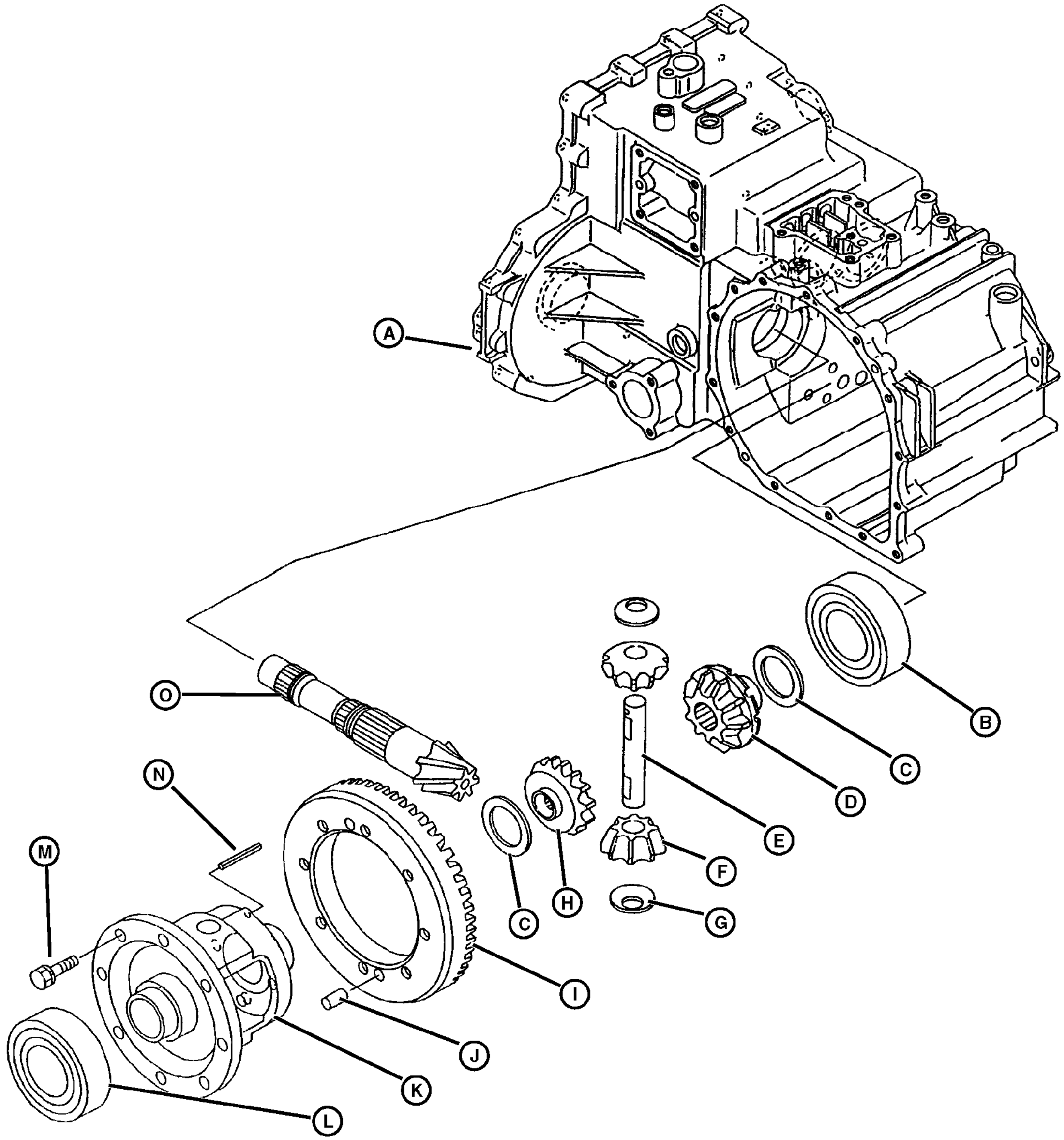
Differential Lock Component Location



A—Housing
B—Differential Case
C—Lock Collar
D—Bearing
E—Transaxle Case
F—Washer
G—Spring Pin
H—Spring Pin
I— Lock Fork
J—Shaft
K—Spring
L—Washer
M—Snap Ring
N—Washer (2 used)
O—Side Lock Gear
P—Seal
Q—Lock Arm
R—Spring Pin

RB14256,00007FC -19-18JUN12-1/1

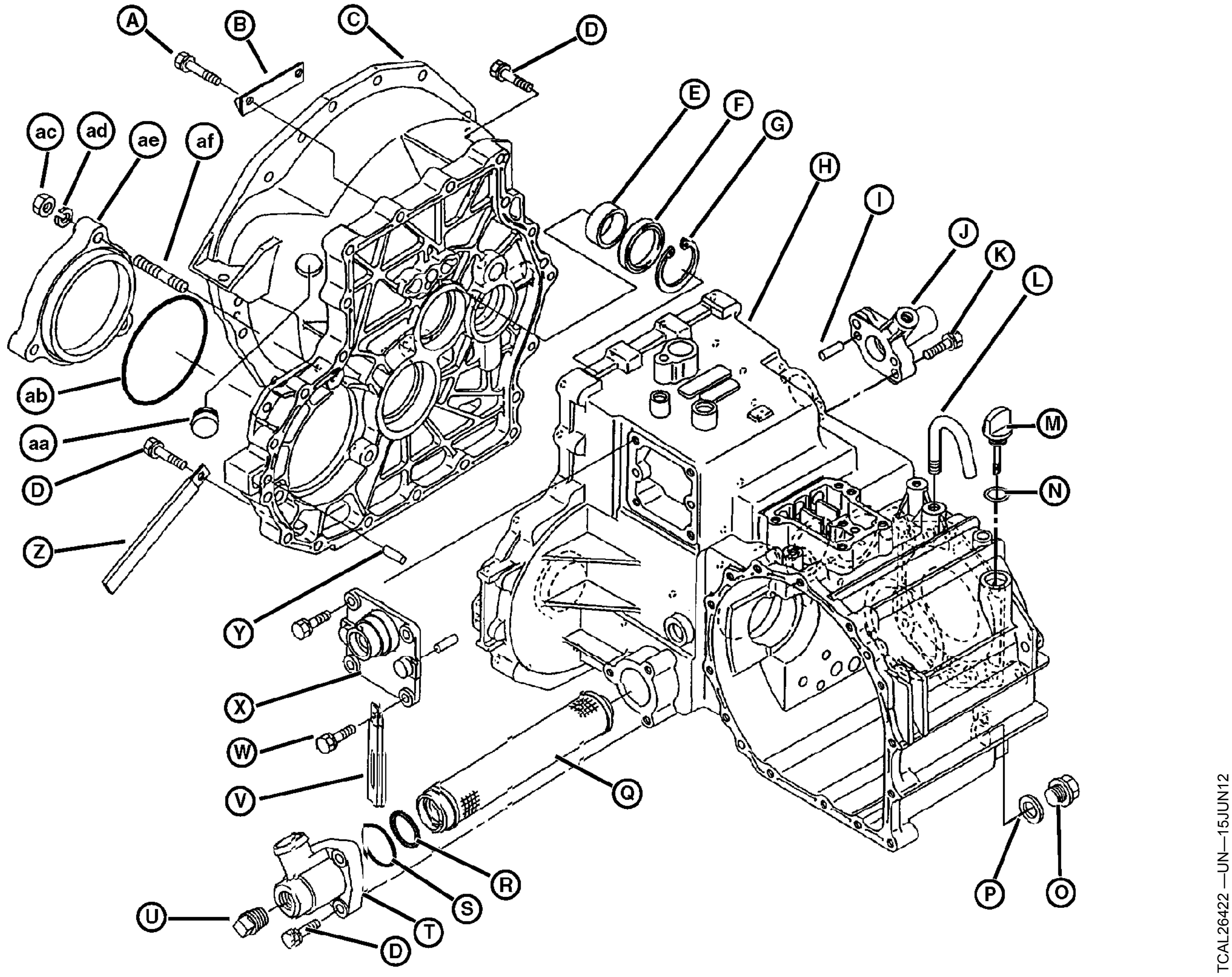
Differential Component Location



A—Transaxle Case
B—Bearing
C—Washer (2 used)
D—Side Lock Gear
E—Pinion Shaft
F—Pinion Gear (2 used)
G—Washer
H—Side Gear
I— Ring Gear
J— Pin (2 used)
K—Differential Case
L—Bearing
M—Bolt (12 used)
N—Spring Pin
O—Pinion

RB14256,00007FD -19-18JUN12-1/1

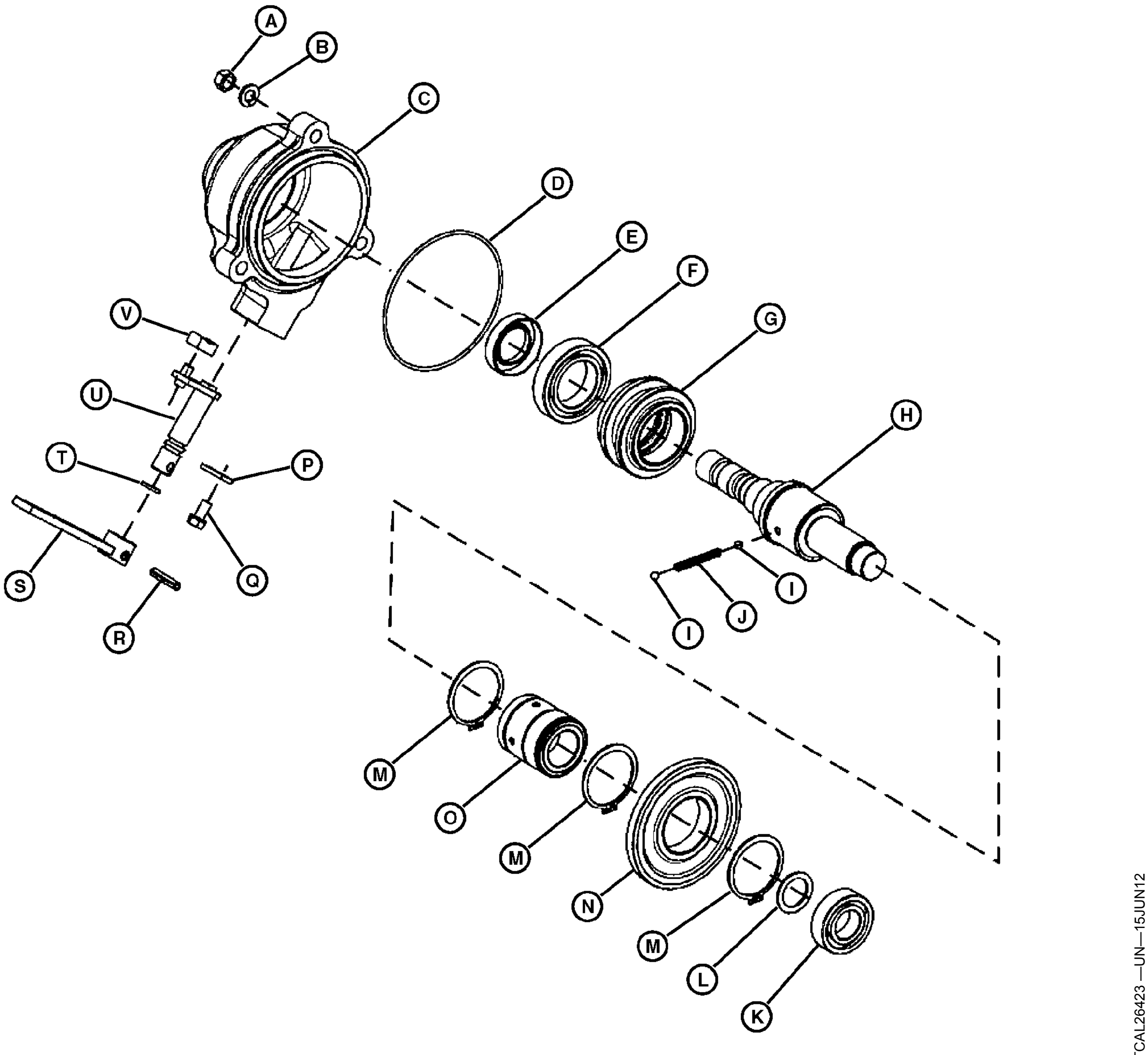
Transaxle Case Component Location



A—Cap Screw with Washer (2 used)
B—Bracket
C—Clutch Housing
D—Cap Screw with Washer (23 used)
E—Sleeve
F—Seal
G—Snap Ring
H—Transaxle Case
I— Pin (4 used)
J— Cover
K—Screw (2 used)
L—Fitting
M—Dipstick
N—O-Ring
O—Drain Plug
P—Gasket
Q—Strainer
R—O-Ring
S—Seal
T—Adapter
U—Drain Plug
V—Clamp
W—Cap Screw with Washer (4 used)
X—Cover
Y—Pin (2 used)
Z—Clamp
AA—Cap (2 used)
AB—Seal
AC—Nut (3 used)
AD—Lock Washer (3 used)
AE—Cover (2WD)
AF—Stud (3 used)

RB14256,00007FE -19-18JUN12-1/1

4-WD Clutch Component Location



A—Nut
B—Washer
C—Housing
D—Packing
E—Seal
F—Bearing
G—Shifter

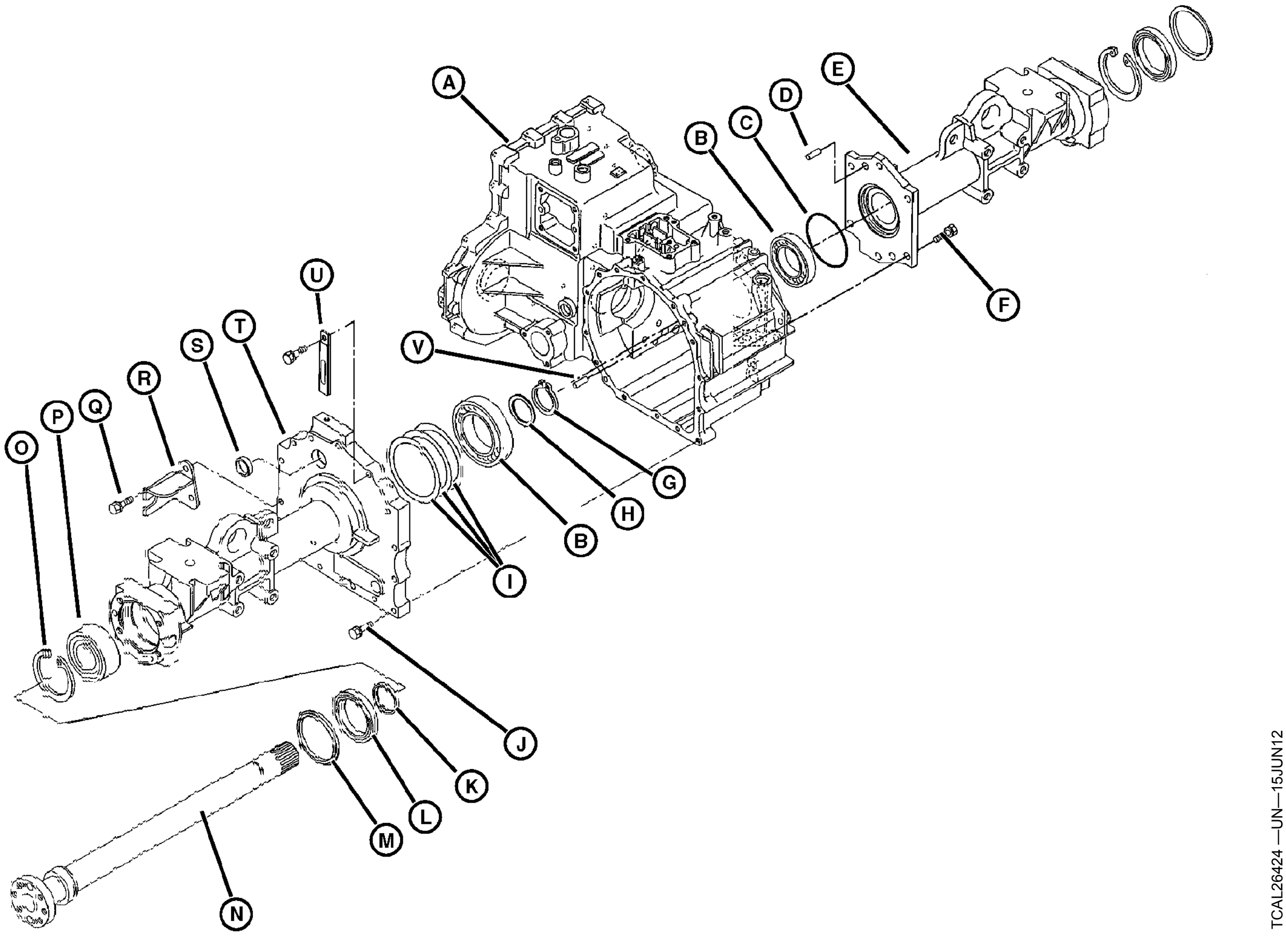
H—Output Shaft
I— Ball
J— Spring
K—Bearing
L—Washer
M—Ring

N—Gear
O—Spline Collar
P—Keep Plate
Q—Bolt
R—Pin
S—Lever

T—Packing
U—Arm
V—Front Shift Block

RB14256,00007FF -19-18JUN12-1/1

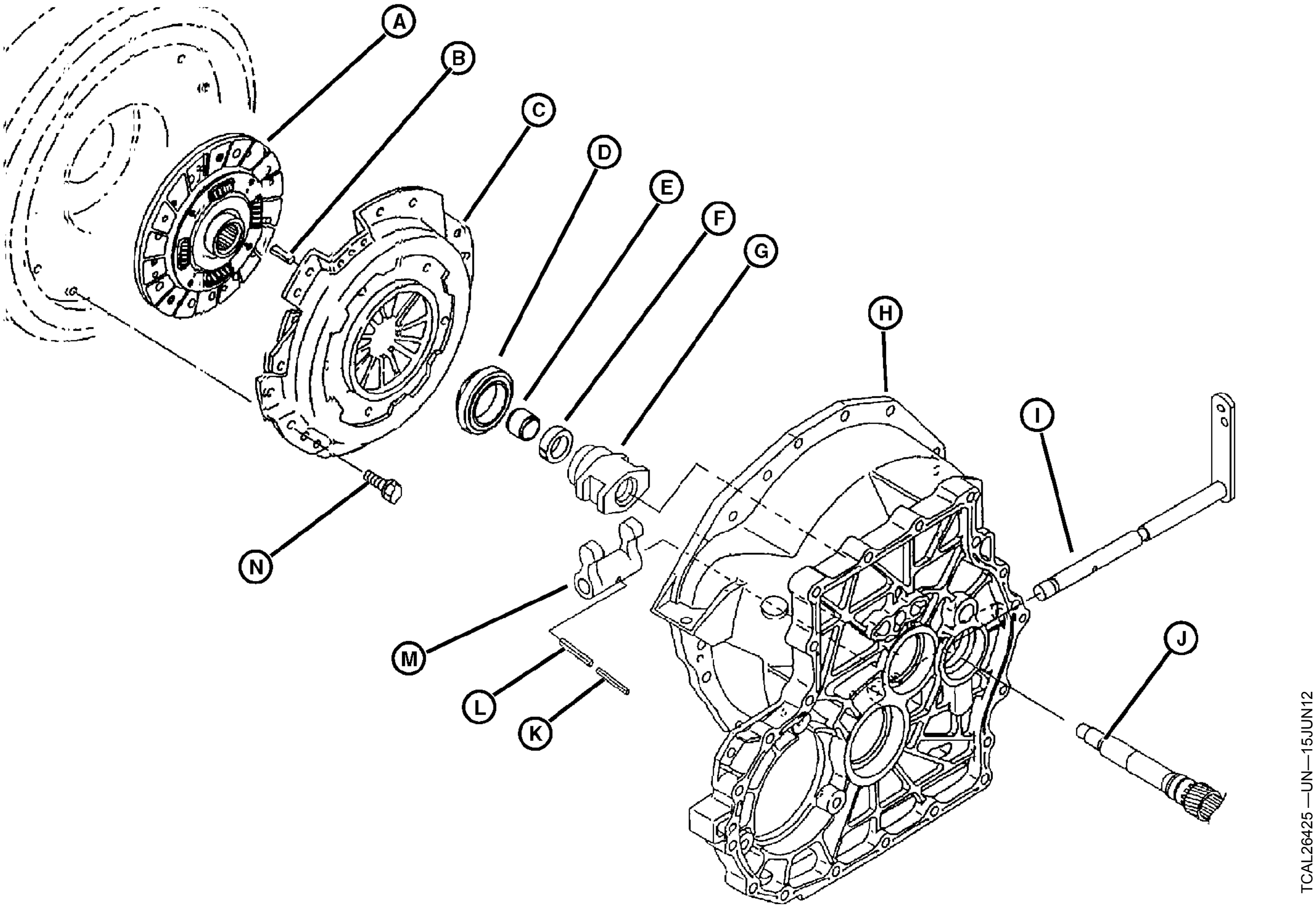
Axle Housing Component Location



A—Transaxle Case
B—Bearing (2 used)
C—O-Ring
D—Pin (2 used)
E—Axle Housing (Right side)
F—Cap Screw (6 used)
G—Snap Ring (2 used)
H—Bushing (2 used)
I— Shim Kit (used for backlash adjustment)
J— Cap Screw with Washer (12 used)
K—Bushing (2 used)
L—Seal (2 used)
M—Bushing (2 used)
N—Axle (Left axle shown)
O—Snap Ring (2 used)
P—Bearing (2 used)
Q—Cap Screw with Washer (2 used)
R—Differential Lock Bracket
S—Cap
T—Axle Housing (Left side)
U—Clamp
V—Pin (2 used)

RB14256,0000800 -19-18JUN12-1/1

Clutch Assembly Component Location



A—Clutch Disk
B—Pin (3 used)
C—Pressure Plate
D—Bearing
E—Bushing
F—Seal
G—Sleeve
H—Clutch Housing
I— Shaft
J— Input Shaft
K—Spring Pin
L—Spring Pin
M—Clutch Fork
N—Bolt (6 used)

RB14256,0000801 -19-18JUN12-1/1

Transaxle

Function

The transaxle contains a transmission with five forward speeds and one reverse speed. The output shaft of the transmission is the pinion shaft of the differential. Power goes through the pinion shaft and ring gear, through the bevel gears to the axles and wheels.

Theory

Primary Drive

The transaxle is a synchronized five speed manual shift transmission with reverse.

The higher the number of the gear selected, the faster the ground speed of the vehicle. The low speeds provide precise ground speeds for use with implements. Neutral allows the ground drive gear train to be disengaged from the engine and still allow use of the PTO to operate implements without the danger of vehicle movement. Reverse allows movement of the vehicle in the reverse direction.

When the shift lever has been moved from the neutral position to gear selection, power goes through the selected gear. It then goes through the pinion shaft to the rear differential and axles to the rear wheels. If equipped with four-wheel drive, a manual shift lever connected to the 4WD clutch will engage the front drive shaft to propel the front wheel drive differential, axles, and wheels.

A rear differential lock is also provided to maximize rear wheel traction. When the rear differential lock is engaged, it locks the spider gears in the rear differential carrier, causing both rear wheels to turn simultaneously regardless of traction conditions. The differential lock should be used under only extreme conditions as it can impair steering.

RB14256,0000802 -19-18JUN12-1/1

Symptom: Machine Will Not Move in Forward or Reverse

RB14256,0000803 -19-11AUG14-1/10

Machine Will Not Move in Forward or Reverse

RB14256,0000803 -19-11AUG14-2/10

Step 1	Park brake disengaged (OFF)?	**YES:** Go to next step. **NO:** Disengage park brake.

RB14256,0000803 -19-11AUG14-3/10

Step 2	Park brake cable properly adjusted and not binding?	**YES:** Go to next step. **NO:** Repair or replace cable and adjust. (See Adjust Park Brake Cable.)

RB14256,0000803 -19-11AUG14-4/10

Step 3	Shift lever and linkage moves freely and is not loose, binding, or damaged?	**YES:** Go to next step. **NO:** Repair or replace as needed.

RB14256,0000803 -19-11AUG14-5/10

Step 4	Clutch pedal, bellcrank, and cable move freely and are not binding or damaged?	**YES:** Go to next step. **NO:** Repair or replace as needed.

RB14256,0000803 -19-11AUG14-6/10

Step 5	Is clutch properly adjusted?	**YES:** Go to next step. **NO:** Adjust clutch. (See Adjust Clutch.)

RB14256,0000803 -19-11AUG14-7/10

Step 6	Is clutch fully engaging and not slipping?	**YES:** Go to next step. **NO:** Remove and repair clutch. (See Remove and Install Clutch and Flywheel—3TNV76 or Remove and Install Clutch and Flywheel—3TNV80F.)

RB14256,0000803 -19-11AUG14-8/10

Step 7	Are splines on input shaft and clutch disk worn or damaged?	**YES:** Replace clutch disk and/or input shaft. **NO:** Go to next step.

RB14256,0000803 -19-11AUG14-9/10

Step 8	Transaxle quiet and spinning freely when clutch is engaged?	**YES:** Go to next step. **NO:** Repair or replace as needed. (See Remove and Install Transaxle.)

RB14256,0000803 -19-11AUG14-10/10

Symptom: Low Power/Erratic Drive

RB14256,0000804 -19-18JUN12-1/9

Low Power/Erratic Drive

RB14256,0000804 -19-18JUN12-2/9

Step 1	Park brake cable properly adjusted and not binding?	**YES:** Go to next step. **NO:** Repair or replace cable and adjust. (See Adjust Park Brake Cable.)

RB14256,0000804 -19-18JUN12-3/9

Step 2	Clutch pedal, bellcrank and cable move freely and are not binding or damaged?	**YES:** Go to next step. **NO:** Check clutch release bearing. Repair as required.

RB14256,0000804 -19-18JUN12-4/9

Step 3	Is clutch properly adjusted?	**YES:** Go to next step. **NO:** Adjust clutch. (See Adjust Clutch.)

RB14256,0000804 -19-18JUN12-5/9

Step 4	Is clutch fully engaging and not slipping?	**YES:** Go to next step. **NO:** Remove and repair clutch. (See Remove and Install Clutch and Flywheel—3TNV76 or Remove and Install Clutch and Flywheel—3TNV80F.)

RB14256,0000804 -19-18JUN12-6/9

Step 5	Are friction surfaces of clutch and clutch cover free of oil and grease contamination?	**YES:** Go to next step. **NO:** Clean or replace components as necessary. Locate and correct source of contamination.

RB14256,0000804 -19-18JUN12-7/9

Step 6	Are splines on input shaft and clutch disk worn or damaged?	**YES:** Replace clutch disk or input shaft. **NO:** Go to next step.

RB14256,0000804 -19-18JUN12-8/9

Step 7	Transaxle quiet and spinning freely when clutch is engaged?	**NO:** Repair or replace as needed. (See Remove and Install Transaxle.)

RB14256,0000804 -19-18JUN12-9/9

Symptom: Jerky and Aggressive Engagement

Continued on next page

RB14256,0000805 -19-18JUN12-1/8

Jerky and Aggressive Engagement

RB14256,0000805 -19-18JUN12-2/8

Step 1	Clutch pedal, bellcrank and cable move freely and are not binding or damaged?	**YES:** Go to next step. **NO:** Check clutch release bearing. Repair or replace as needed.

RB14256,0000805 -19-18JUN12-3/8

Step 2	Is clutch properly adjusted?	**YES:** Go to next step. **NO:** Adjust clutch. (See Adjust Clutch.)

RB14256,0000805 -19-18JUN12-4/8

Step 3	Is clutch cable dragging or binding?	**YES:** Replace cable. **NO:** Go to next step.

RB14256,0000805 -19-18JUN12-5/8

Step 4	Is clutch fully engaging and not slipping?	**YES:** Go to next step. **NO:** Remove and repair clutch. (See Remove and Install Clutch and Flywheel—3TNV76 or Remove and Install Clutch and Flywheel—3TNV80F.)

RB14256,0000805 -19-18JUN12-6/8

Step 5	Are friction surfaces of clutch and clutch cover free of oil and grease contamination?	**YES:** Go to next step. **NO:** Clean or replace components as necessary. Locate and correct source of contamination.

RB14256,0000805 -19-18JUN12-7/8

Step 6	Are splines on input shaft and clutch disk worn or damaged?	**YES:** Replace clutch disk and/or input shaft.

RB14256,0000805 -19-18JUN12-8/8

Symptom: Shifts Hard

RB14256,0000806 -19-18JUN12-1/6

Shifts Hard

RB14256,0000806 -19-18JUN12-2/6

Step 1	Shift lever and/or linkage moves freely and isn't loose, binding or damaged?	**YES:** Go to next step. **NO:** Repair or replace as needed.

Continued on next page RB14256,0000806 -19-18JUN12-3/6

Step 2	Clutch pedal, bellcrank and cable move freely and are not binding or damaged?	**YES:** Go to next step. **NO:** Check clutch release bearing. Repair or replace as needed.

RB14256,0000806 -19-18JUN12-4/6

Step 3	Transaxle quiet and spinning freely when clutch is engaged?	**YES:** Go to next step. **NO:** Repair or replace as needed. (See Remove and Install Transaxle.)

RB14256,0000806 -19-18JUN12-5/6

Step 4	Is clutch properly adjusted?	**YES:** Go to next step. **NO:** Adjust clutch. (See Adjust Clutch.)

RB14256,0000806 -19-18JUN12-6/6

Symptom: Noisy Operation

RB14256,0000807 -19-18JUN12-1/6

Noisy Operation

RB14256,0000807 -19-18JUN12-2/6

Step 1	Is clutch properly adjusted?	**YES:** Go to next step. **NO:** Adjust clutch. (See Adjust Clutch.)

RB14256,0000807 -19-18JUN12-3/6

Step 2	Is noise NOT present when clutch pedal is depressed?	**YES:** Go to next step. **NO:** Possible failing release bearing. (See Replace Clutch Release Bearing.)

RB14256,0000807 -19-18JUN12-4/6

Step 3	Is the engine and transaxle mounting hardware tightened correctly?	**YES:** Go to next step. **NO:** Tighten hardware to specification.

RB14256,0000807 -19-18JUN12-5/6

Step 4	Transaxle quiet and spinning freely when clutch is engaged?	**NO:** Repair or replace as needed. (See Remove and Install Transaxle.)

RB14256,0000807 -19-18JUN12-6/6

Symptom: Front Wheels Lock Up on MFWD When Vehicle Is in Motion

RB14256,0000808 -19-18JUN12-1/4

Front Wheels Lock Up on MFWD When Vehicle Is in Motion

Continued on next page RB14256,0000808 -19-18JUN12-2/4

Step 1	Was vehicle driven in a jerky fashion?	**YES:** Manual shift lever may be improperly stowed in 2WD mode. **NO:** Go to next step.

RB14256,0000808 -19-18JUN12-3/4

Step 2	Does vehicle shift lever pop out of 2WD?	**YES:** Possible failed 4WD clutch. Repair as required.

RB14256,0000808 -19-18JUN12-4/4

Symptom: 4WD Not Functioning

RB14256,0000809 -19-18JUN12-1/6

4WD Not Functioning

RB14256,0000809 -19-18JUN12-2/6

Step 1	With all four wheels off the ground, 4WD lever engaged, transmission in a forward gear, and engine running, does drive shaft rotate?	**YES:** Go to next step. **NO:** Inspect transaxle or 4WD clutch.

RB14256,0000809 -19-18JUN12-3/6

Step 2	With all four wheels off the ground, 4WD lever engaged, transmission in a forward gear, and engine running, do front wheel(s) rotate?	**YES:** Go to next step. **NO:** Inspect front pinion and differential.

RB14256,0000809 -19-18JUN12-4/6

Step 3	With all four wheels off the ground, transmission in neutral, and engine stopped (key switch OFF), manually rotate one front wheel. Does the opposing front wheel rotate in the opposite direction?	**YES:** Go to next step. **NO:** Inspect or repair the front differential.

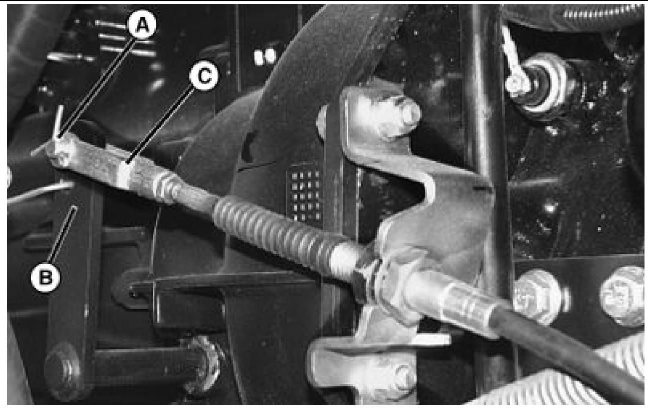
RB14256,0000809 -19-18JUN12-5/6

Step 4	With both rear wheels on the ground, both front wheels off the ground, transmission in neutral and 4WD lever engaged, and engine stopped (key switch OFF), try to manually rotate the drive shaft. Does the drive shaft rotate?	**YES:** Repair the 4WD clutch.

RB14256,0000809 -19-18JUN12-6/6

Adjust Clutch

1. Remove pin (A) from clutch arm (B) and clevis (C).



TCAL26426 —UN—15JUN12

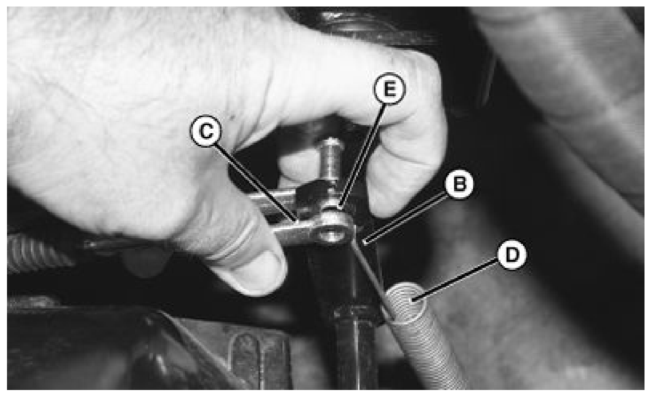
A—Pin
B—Clutch Arm
C—Clevis

RB14256,000080A -19-11AUG14-1/2

2. Disconnect spring (D), and pull clutch arm (B) and clevis (C) toward each other and check alignment of holes.

NOTE: Make sure that enough force is being applied to clevis to pull clutch pedal to the top of its travel, or block clutch pedal up to the top of its travel.

3. If holes (E) do not line up, loosen locknut on clevis and adjust clevis until holes align.
4. Install pin and connect return spring.
5. Have an assistant depress clutch pedal, and measure clutch arm free travel at the clevis pin hole. Record the measurement.
6. Measure the total travel of the clutch arm and record the measurement.
7. Subtract the free play measurement from the total travel measurement to get clutch disengagement travel.
8. Clutch disengagement travel should be within proper specifications If clutch disengagement travel is not within specification, loosen locknut on clevis and adjust to proper specification. Tighten locknut.



TCAL26427 —UN—15JUN12

B—Clutch Arm
C—Clevis
D—Spring
E—Holes to Align

Specification

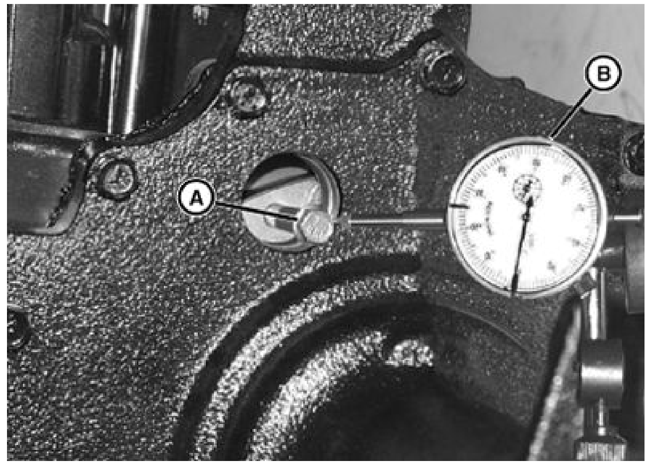
Clutch disengagement
travel—Distance .... 12.5—18.5 mm
(0.5—0.73 in.)

RB14256,000080A -19-11AUG14-2/2

Check Ring Gear Backlash

1. Remove plug from left axle housing. Rotate axle or input shaft until one of the threaded holes in the differential carrier is centered in the hole.
2. Install M8x1.25 cap screw (A) into hole in carrier and bottom lightly against ring gear. Install dial indicator (B) to measure travel of cap screw.
3. Place transmission in gear and hold input shaft.
4. Rotate ring gear back and forth with cap screw and record reading on dial indicator.

A—M8x1.25 Cap Screw **B—Dial Indicator**



TCAL26428 —UN—15JUN12

RB14256,000080B -19-11AUG14-1/2

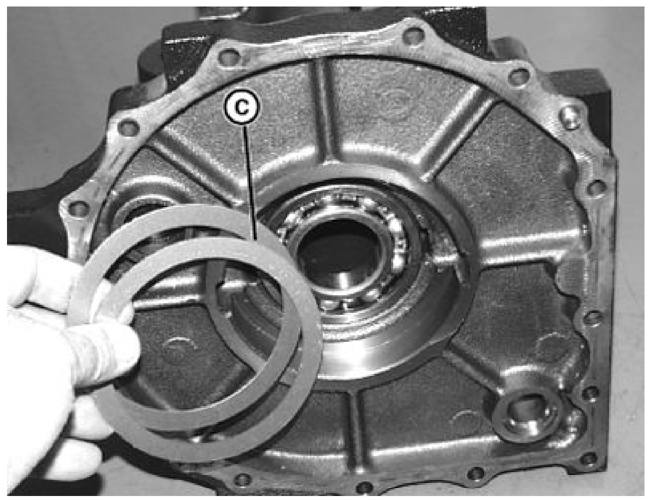
5. If measurement is not within specification, remove left axle housing and add or remove shims (C) in bearing bore to get backlash to specification. Adding shims decreases backlash; removing shims increases backlash.

Specification

Backlash—Distance..0.17—0.23 mm (0.007—0.009 in.)

6. If necessary, repeat step 5 until backlash is within specification.

C—Shims



TCAL26429 —UN—15JUN12

RB14256,000080B -19-11AUG14-2/2

Remove and Install Transaxle

IMPORTANT: Read and understand the following procedure before proceeding.

NOTE: Lift the rear frame of the machine to clear the transaxle as it is rolled out. Park machine where it is accessible to a lift.

Fenders do not need to be removed from machine in order to remove the transaxle. The fenders are removed in this procedure for convenience.

1. Park machine safely.
2. Disconnect plug for tail lights (A).
3. Remove cap screws (B).
4. Remove socket head cap screws (C) and locknuts (D) from fenders.
5. Remove rear fenders.

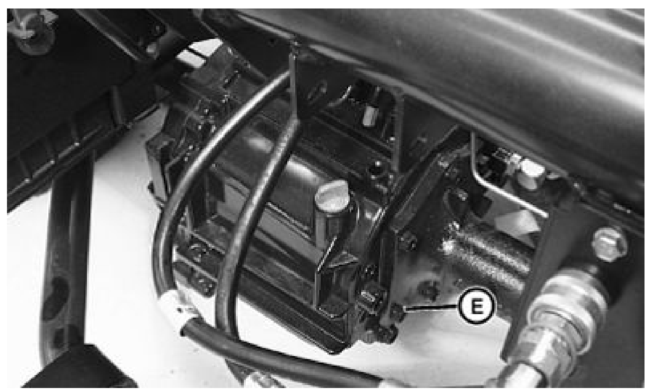
TCAL26430 —UN—15JUN12

A—Taillights
B—Cap Screws
C—Cap Screws
D—Locknuts

RB14256,000080C -19-11AUG14-1/10

6. Remove plug (E) and drain oil from transaxle.

E—Transaxle Drain Plug

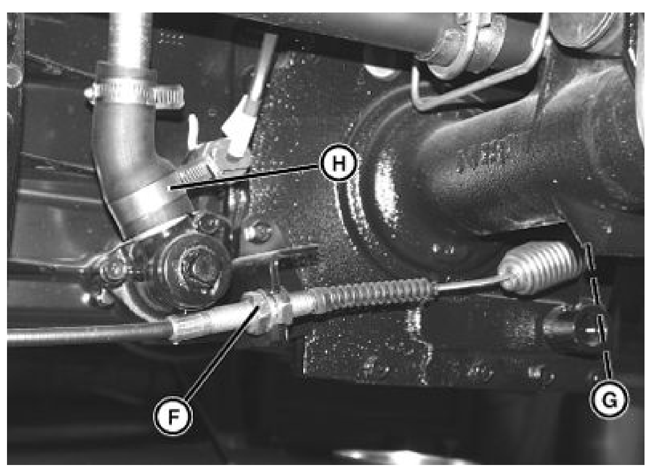


TCAL26431 —UN—15JUN12

RB14256,000080C -19-11AUG14-2/10

7. Loosen nuts (F) on differential lock cable and pull cable away from bracket. Disconnect spring (G) from lever.
8. Disconnect hydraulic oil suction line (H).

F—Nuts
G—Lever Spring
H—Hydraulic Oil Suction Line



TCAL26432 —UN—15JUN12

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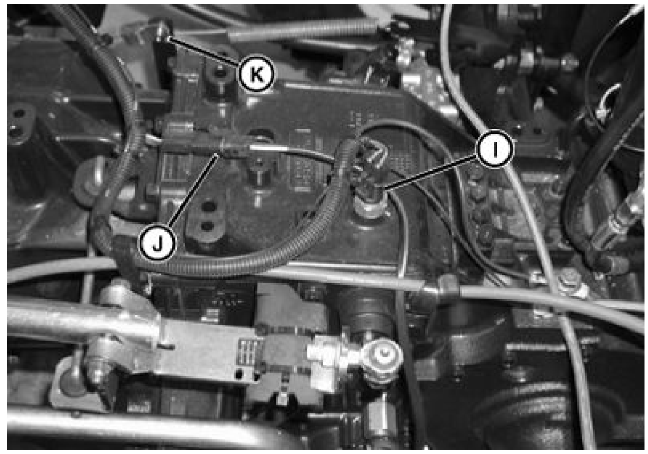
RB14256,000080C -19-11AUG14-3/10

9. Disconnect neutral switch (I) and speedometer sensor (J).

10. Disconnect clutch cable yoke (K) from lever.

I— Neutral Switch
J— Speedometer Sensor
K—Clutch Cable Yolk



TCAL26433 —UN—15JUN12

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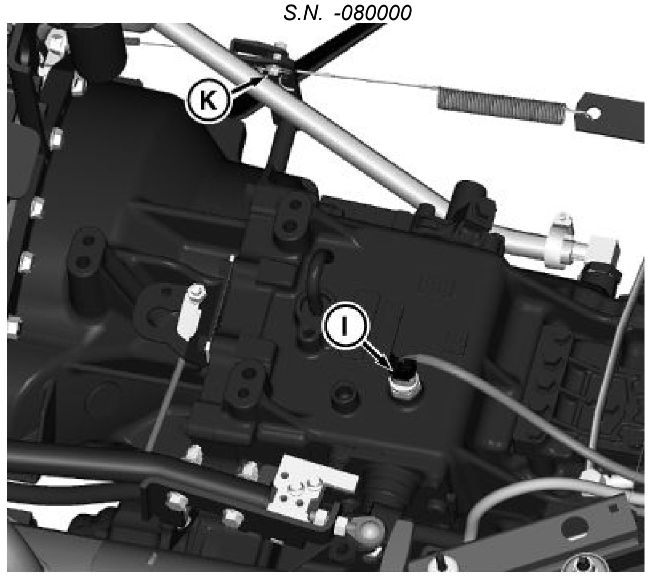

TCT011272 —UN—07JUN14

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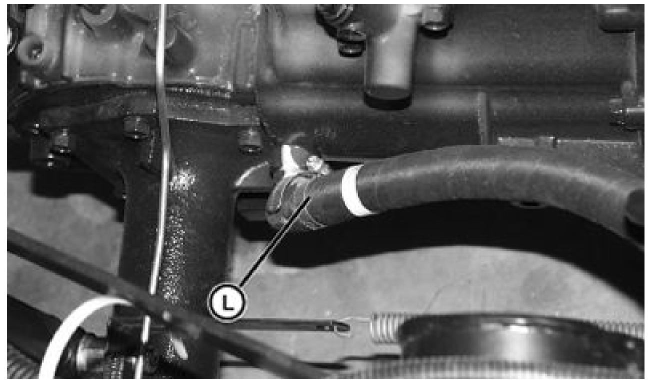
RB14256,000080C -19-11AUG14-4/10

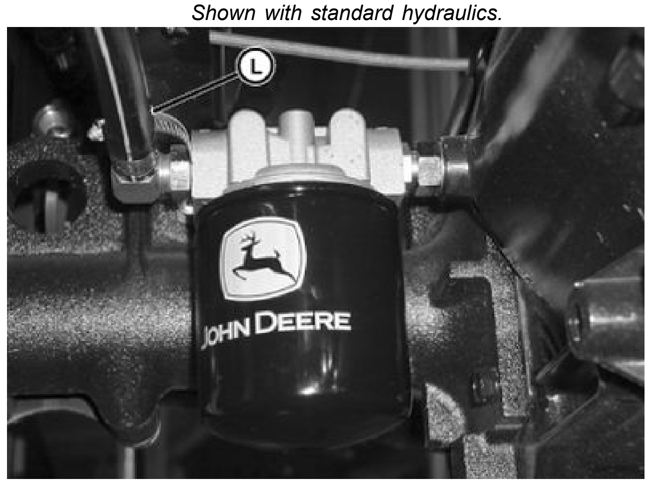
11. Remove hydraulic pump return line (L).

L—Hydraulic Pump Return Line



TCAL26434 —UN—15JUN12

Shown with standard hydraulics.



TCAL26435 —UN—15JUN12

Shown with auxiliary hydraulics.

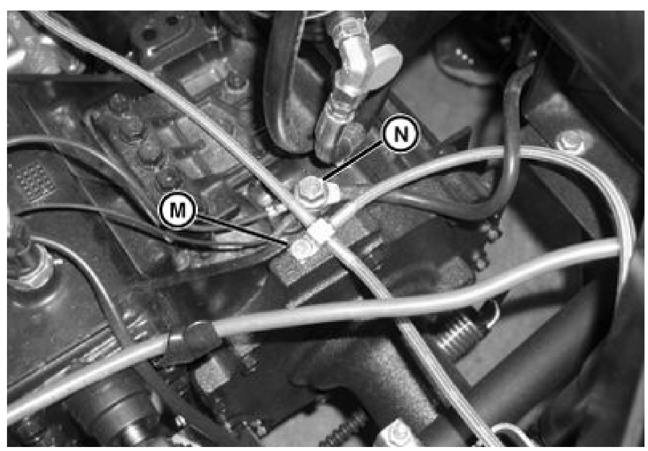
RB14256,000080C -19-11AUG14-5/10

IMPORTANT: Close all lines and fittings with caps and plugs to prevent contamination.

12. Disconnect brake hose (M) from transaxle and from both rear wheels.

13. Disconnect ground wires (N) from transaxle and secure out of the way.

M—Brake Hose **N—Ground Wires**



TCAL26436 —UN—15JUN12

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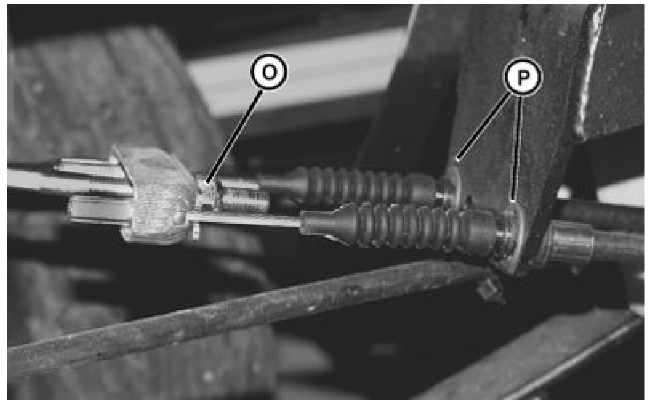
RB14256,000080C -19-11AUG14-6/10

14. Loosen nut (O), remove clips (P), and remove park brake cables from balancer and bracket.

O—Nut **P—Clips**

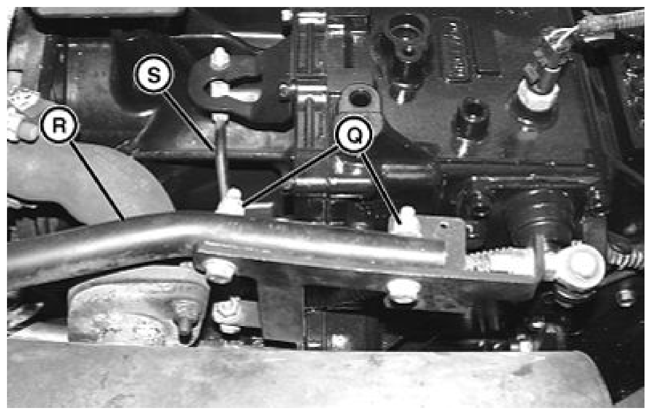


TCAL26437 —UN—15JUN12

RB14256,000080C -19-11AUG14-7/10

15. Remove cap screws and nuts (Q) and disconnect shifter tube (R) from shift lever.
16. Remove pivot rod (S).
17. Unwrap wire ties and secure wires out of the way.
18. Remove engine exhaust system.

Q—Cap Screws and Nuts
R—Shifter Tube
S—Pivot Rod



TCAL26438 —UN—15JUN12

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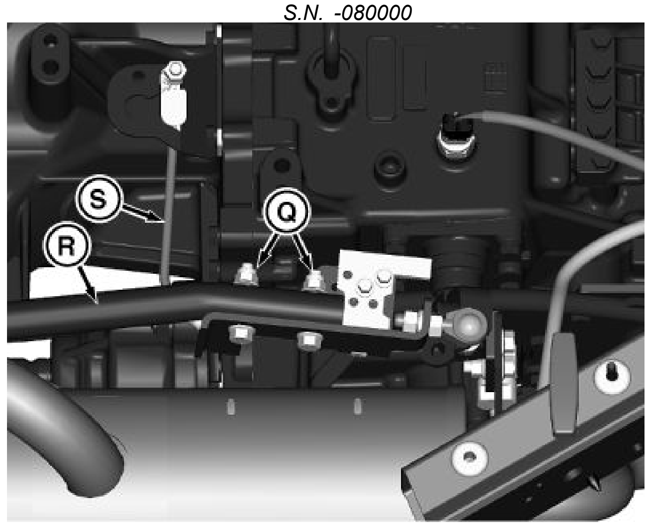

TCT011273 —UN—07JUN14

S.N. 080001-

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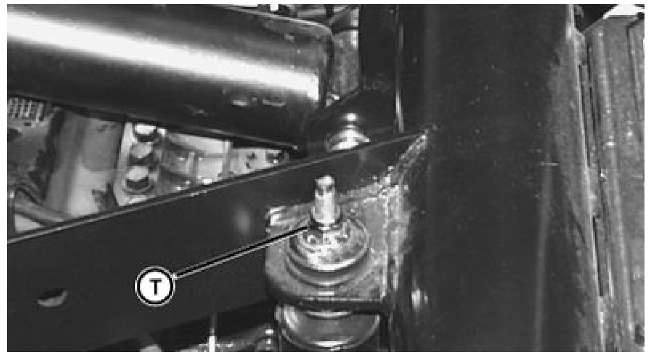
19. Remove nuts (T) from upper shock mounts and push shocks down to clear frame.
20. Support vehicle frame.

T—Upper Shock Mount Nuts



TCAL26439 —UN—15JUN12

RB14256,000080C -19-11AUG14-9/10

21. Remove cap screws (U) from top of spring shackles.
22. Safely support rear of engine with an appropriate hoist or stand.
23. Place floor jack under clutch housing to support front of transaxle.
24. Remove remaining hardware securing transmission to engine. (Refer to appropriate engine section.)
25. Roll transaxle back from engine until input shaft is clear of clutch.
26. Raise rear of machine and remove transaxle.

Installation

1. Install transaxle in the reverse order of removal.
2. If clutch has been disturbed, check alignment with JDG1331 clutch alignment tool before installing transaxle.
3. Tighten clutch housing cap screws to specification.

Specification

Clutch Housing Cap Screws—Torque....................23—29 N·m (17—22 lb.-ft.)

4. If transaxle leaf spring is removed or replaced, spring attaching U-bolts must be tightened correctly. Tighten U-bolt locknuts to specification in a criss-cross pattern using multiple passes. Allow one revolution of nut during each pass to ensure even U-bolt preload.

TCAL26440 —UN—15JUN12

U—Spring Shackle Cap Screws

Specification

Leaf Spring U—Bolt Nut—Torque....................129 N·m (95 lb.-ft.)

5. Tighten spring shackle cap screws to specification.

Specification

Spring Shackle Cap Screws—Torque....................102 N·m (75 lb.-ft.)

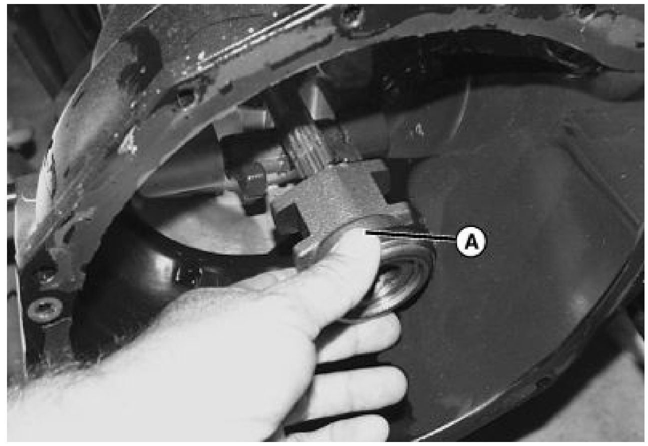
6. Bleed brakes and fill master cylinder reservoir with approved DOT 3 brake fluid after installing brake line.
7. Fill transaxle with oil until oil reaches “full” mark on dipstick.

RB14256,000080C -19-11AUG14-10/10

Replace Clutch Release Bearing

1. Pull release bearing sleeve (A) forward to remove from release yoke.

A—Bearing Sleeve



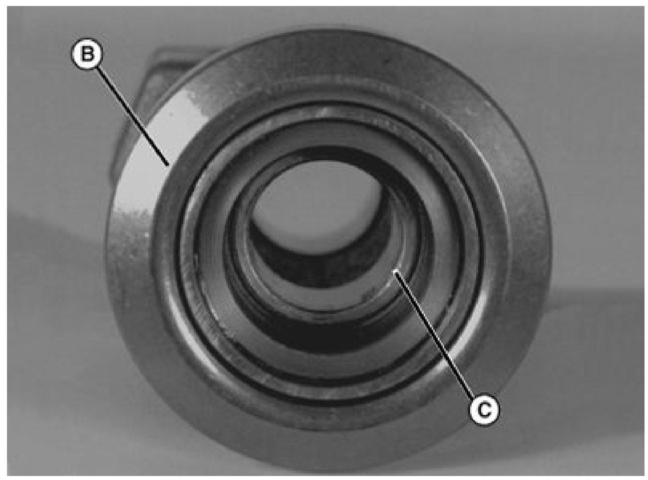
TCAL26441 —UN—15JUN12

RB14256,000080D -19-18JUN12-1/4

NOTE: The bushings in the release bearing sleeve are not serviceable. If they are worn, replace entire sleeve assembly.

2. Inspect release bearing assembly (B) and bushings (C) for wear or damage.

B—Bearing Assembly **C—Bushings**

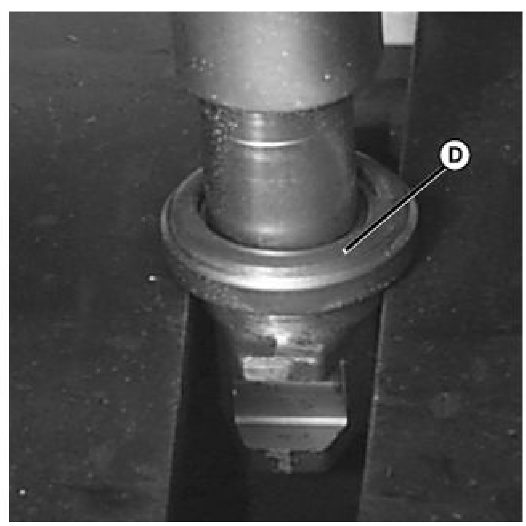


TCAL26442 —UN—15JUN12

RB14256,000080D -19-18JUN12-2/4

3. If replacement is necessary, press release bearing (D) off sleeve.
4. Press release bearing (D) on sleeve until it bottoms on sleeve.

D—Release Bearing



TCAL26443 —UN—15JUN12

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RB14256,000080D -19-18JUN12-3/4

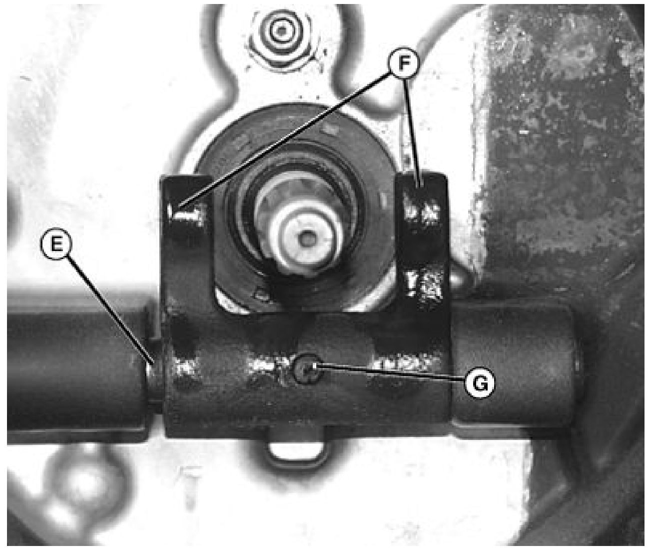
5. Inspect shaft (E) and yoke (F) for wear or damage. To replace any of these, mark shaft and yoke for reassembly purposes and drive out spring pin (G) holding yoke to shaft and remove shaft.

NOTE: Lubricate sparingly to avoid slinging excess grease onto clutch disk.

6. Lubricate input shaft and release bearing bushings, and yoke prior to assembly.

Installation

Make sure the clutch shaft arm and yoke are both facing UP before installing spring pins.



TCAL26444 —UN—15JUN12

E—Shaft
F—Yoke
G—Spring Pin

RB14256,000080D -19-18JUN12-4/4

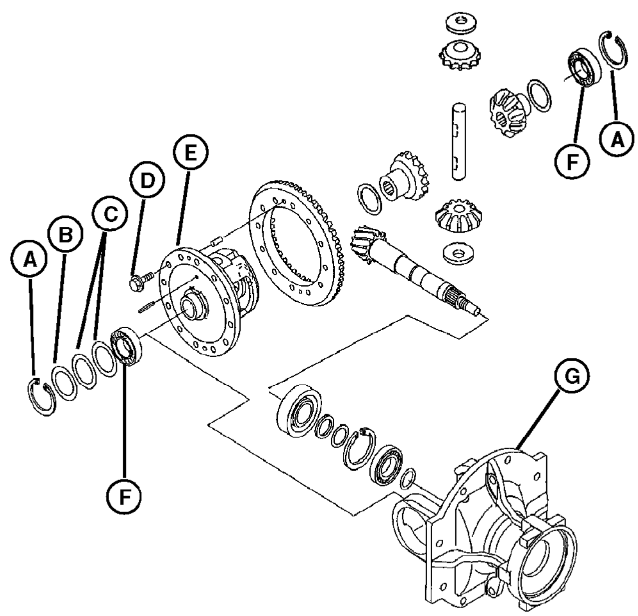
Remove and Disassemble MFWD Differential

Removal

1. Remove both CV axles from the MFWD.
2. Remove the MFWD drive shaft.
3. Remove cap screws fastening the differential cover to the MFWD housing.
4. Remove the differential carrier from the MFWD housing.

Disassembly

1. Remove the snap rings (A) from the differential carrier. Save washer (B) and any shims (C) from the ring gear side of the differential carrier (G).
2. Remove both ball bearings (F) from the differential case (E) and differential carrier.
3. Remove the differential case assembly by pulling it through the reliefs in the back of the differential carrier.

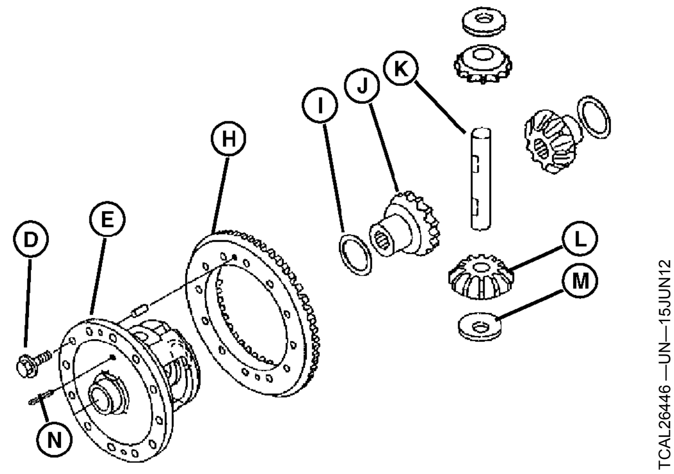


TCAL26445 —UN—15JUN12

A—Snap Rings
B—Washer
C—Shims
D—Cap Screws (12)
E—Differential Case
F—Ball Bearings
G—Differential Carrier

Continued on next page RB14256,000080E -19-11AUG14-1/2

4. Remove cap screws (D). Remove the ring gear (H) from the differential case (E).
5. Drive the spring pin (N) from the pinion shaft (K)., Remove the pinion bevel gears (L), bevel gears (J), and washers (I and M) from the differential housing.
6. Clean all parts and inspect for wear or damage. Replace any unserviceable parts.



D—Cap Screws (12)
E—Differential Case
H—Ring Gear
I— Washer
J— Bevel Gear
K—Pinion Shaft
L— Bevel Gear
M—Washer
N—Spring Pin

The ring gear and pinion are not serviced separately. If either the ring gear or pinion is worn or damaged, BOTH must be replaced and torqued to required specification.

Assembly

1. Install the pinion bevel gears and washers to the pinion shaft. Install the pinion shaft assembly and bevel gears and washers to the differential case.
2. Install the spring pin to the pinion shaft.
3. Install the ring gear to the differential case. Tighten the ring gear cap screws to specifications.
4. Place the differential case into the differential carrier.
5. Install the bearing and snap ring to the side of the differential carrier opposite the ring gear.
6. Install the bearing, shims (if used), washer, and snap ring to the ring gear side of the differential carrier.

NOTE: If the original ring and pinion set is being reused, reuse the original shims or replace with new shims of the same thickness as the original shims. (See MFWD Backlash Adjustment.)

Installation

Installation is done in the reverse order of removal.

Item	Measurement	Specification
Ring Gear Cap Screw Torque	Torque	30—39 N·m (22—28 lb.-ft.)

RB14256,000080E -19-11AUG14-2/2

Remove and Install MFWD Pinion Assembly

Removal

1. Remove the differential case from the differential carrier. (See Remove and Disassemble MFWD Differential.)
2. Remove castle nut (L), washer (K) and coupling (J).
3. Press the pinion (A), bearing (B), bushing (C) and shim (D) from the differential carrier (H).

NOTE: Do not discard the pinion shim(s) at this time.

4. Remove the snap ring (E) and bearing (F) from the differential carrier.

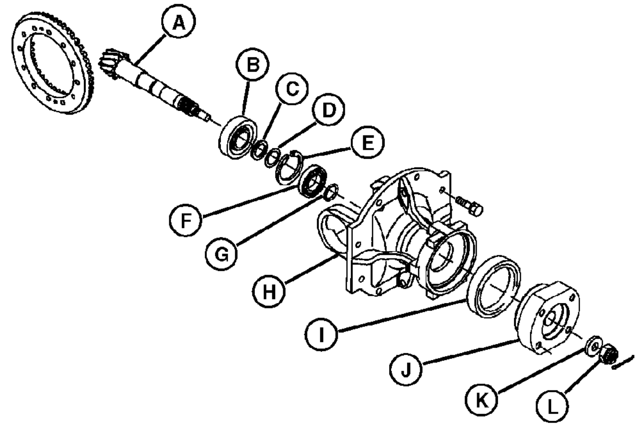
NOTE: The ring and pinion are serviced as a set. If either the ring or pinion has wear or damage, both must be replaced.

5. Clean all parts and inspect for wear or damage. Replace any unserviceable parts. (See MFWD Backlash Adjustment.)
6. Remove and discard seals (G and I).

Installation

1. Install seal (G), bearing (F), and snap ring (E) to the differential carrier.
2. Install the bearing (B), bushing (C) and shim(s) (D) to the pinion.

NOTE: If installing the original ring and pinion set, reuse the original shim(s) or replace with new shims of the original thickness.



A—Castle Nut
B—Bearing
C—Bushing
D—Shim
E—Snap Ring
F—Bearing
G—Seal
H—Differential Carrier
I— Seal
J—Coupling
K—Washer
L—Castle Nut

3. Install the pinion assembly to the differential carrier. Check for smooth rotation of the pinion.

NOTE: The pinion and ring gear are not serviced separately. If either the ring gear or pinion is worn or damaged, BOTH must be replaced.

4. Install the differential case to the differential carrier. (See Remove and Disassemble MFWD Differential.)

RB14256,000080F -19-18JUN12-1/1

MFWD Backlash Adjustment

Purpose

To set cone distance and backlash if gearset is changed.

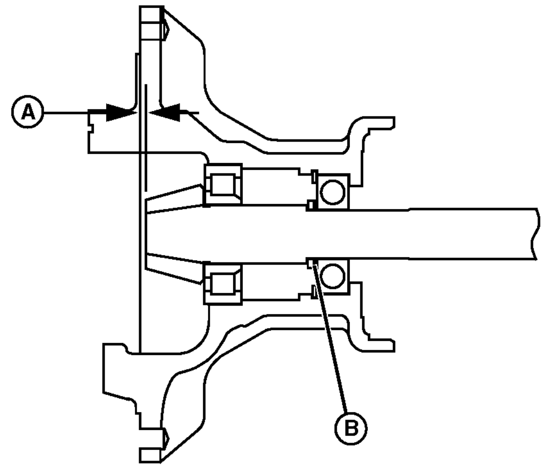
Procedure

1. Assemble pinion assembly without installing shims (D). (See Remove and Install MFWD Pinion Assembly.)
2. Measure the distance (A) from the pinion cone end to the housing case front.
3. Add shims (B) so measured distance meets cone distance specification.

Specification

Pinion Cone End to Case front Distance—Distance.......... 2.1 ± 0.05 mm (0.083 ± 0.002 in.)

4. Install differential assembly. (See Remove and Disassemble MFWD Differential.)
5. Measure differential ring gear backlash.



TCAL26448 —UN—15JUN12

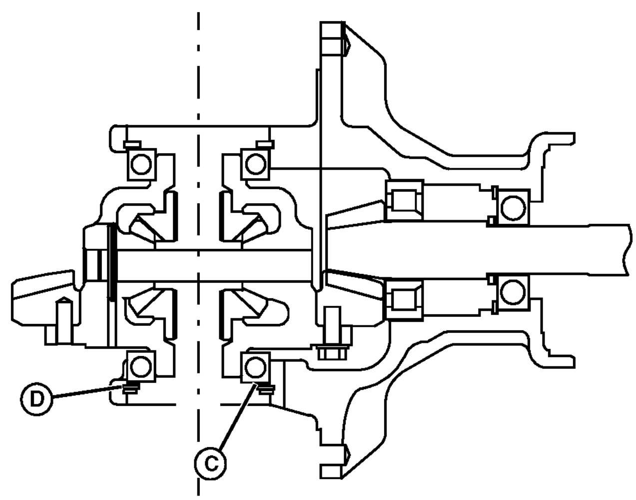
A—Distance **B—Shims location if applicable.**

RB14256,0000810 -19-11AUG14-1/2

6. Install shims (C) between washer (D) and bearing so back lash meets specification.

Specification

Differential Ring Gear Backlash—Backlash.......... 0.17—0.23 mm (0.007—0.009 in.)



TCAL26449 —UN—15JUN12

C—Shims **D—Washer**

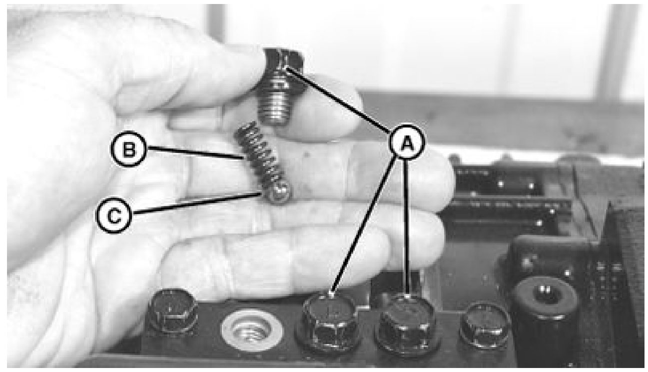
RB14256,0000810 -19-11AUG14-2/2

Disassemble Transaxle

IMPORTANT: Read and understand the following procedure before proceeding.

1. Remove three cap screws (A) from shaft cover.
2. With a magnet, remove springs (B) and balls (C).
3. Remove shaft cover.

A—Cap Screws (3)
B—Springs
C—Balls

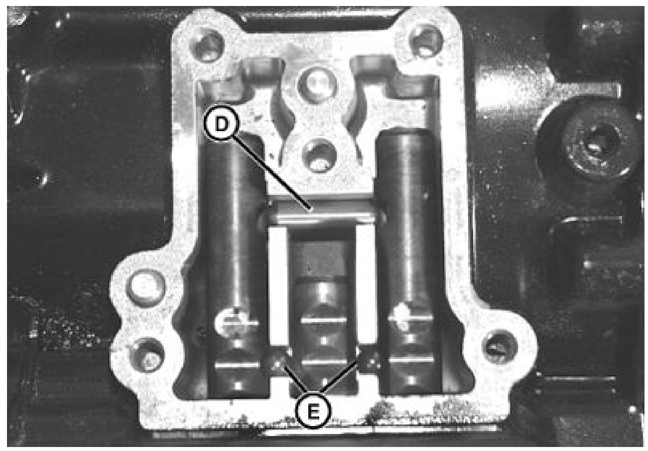


TCAL26450 —UN—15JUN12

RB14256,0000811 -19-18JUN12-1/7

4. Remove pin (D) and balls (E) from shift shafts.

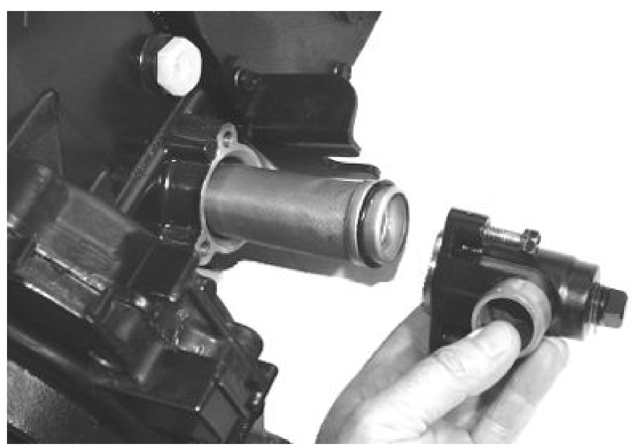
D—Pin
E—Balls



TCAL26451 —UN—15JUN12

RB14256,0000811 -19-18JUN12-2/7

5. Remove elbow and screen.



TCAL26452 —UN—15JUN12

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RB14256,0000811 -19-18JUN12-3/7

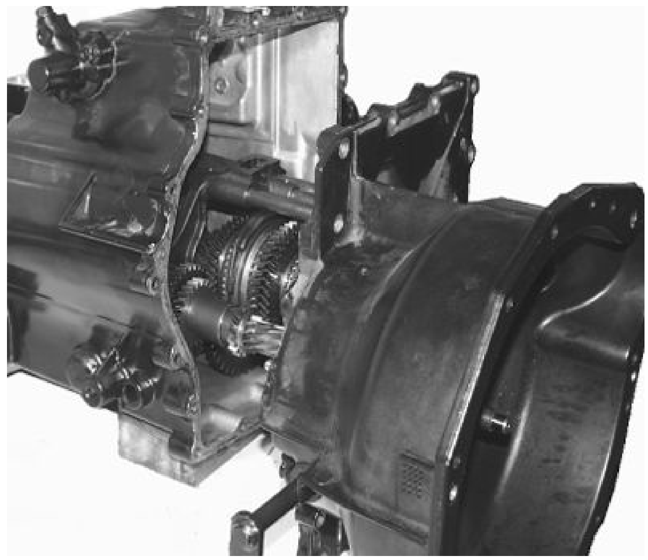
6. Remove cap screws (F) (total of 20) securing clutch housing to transaxle case.

F—Cap Screws (20)

TCAL26453 —UN—15JUN12

RB14256,0000811 -19-18JUN12-4/7

7. Remove clutch cover and all transmission components as an assembly.

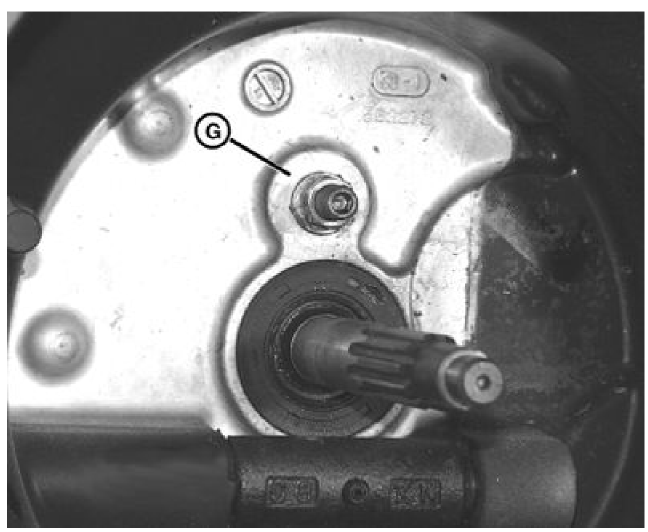


TCAL26454 —UN—15JUN12

RB14256,0000811 -19-18JUN12-5/7

8. Remove nut (G).

G—Nut



TCAL26455 —UN—15JUN12

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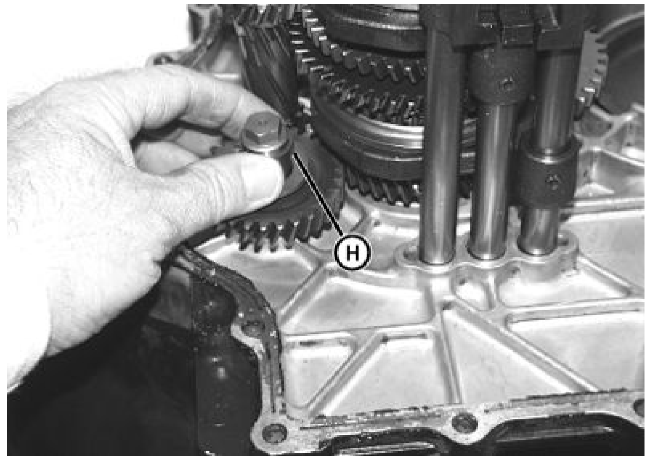
RB14256,0000811 -19-18JUN12-6/7

9. Remove reverse idler gear and shaft (H).

H—Reverse Idler Gear and Shaft

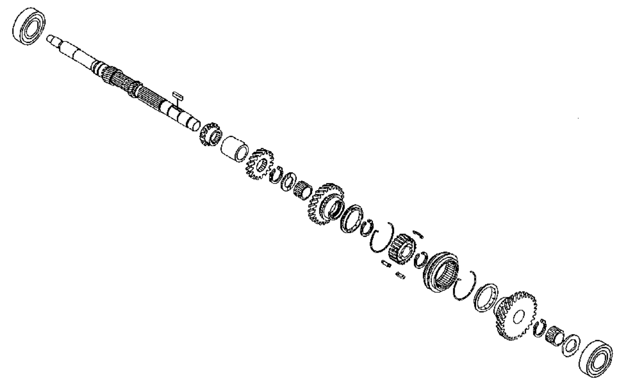


TCAL26456 —UN—15JUN12

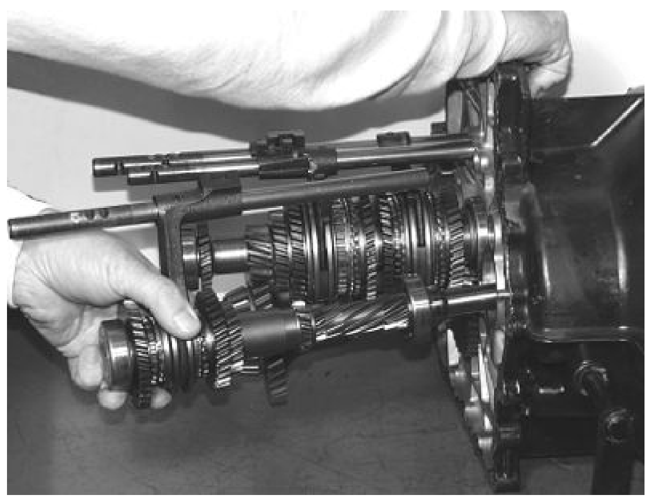
RB14256,0000811 -19-18JUN12-7/7

Disassemble and Assemble Input Shaft

1. Simultaneously pull all three shafts out just enough that input shaft can be removed.



TCAL26457 —UN—15JUN12



TCAL26458 —UN—15JUN12

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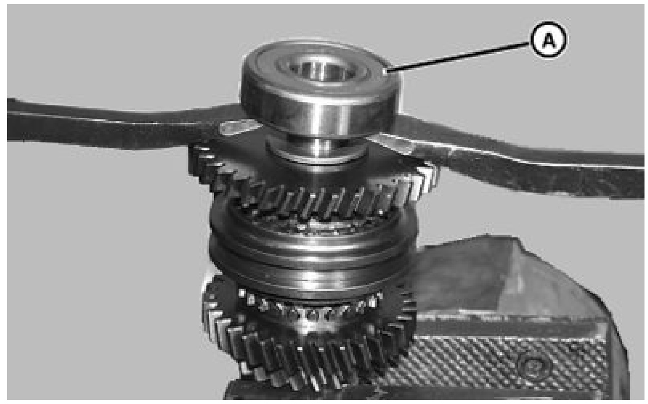
RB14256,0000812 -19-11AUG14-1/9

NOTE: Bearing (A) is sealed only on one side. Sealed side must face away from gear, as shown, when assembled.

2. Remove bearing (A) from end of shaft.

A—Bearing



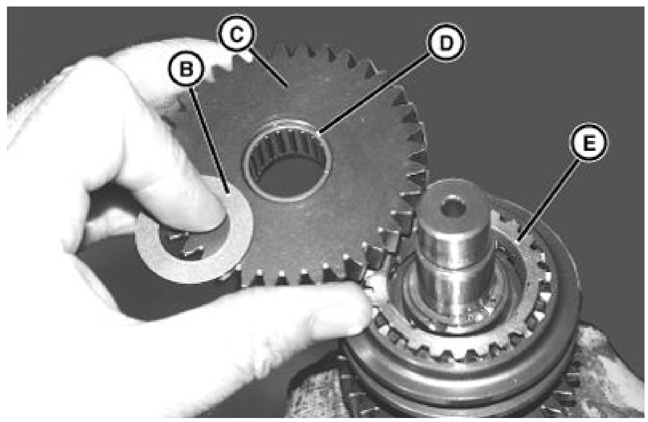
TCAL26459 —UN—15JUN12

RB14256,0000812 -19-11AUG14-2/9

NOTE: Oil grooves in washer (B) face toward gear.

3. Remove washer (B), gear (C), bearing (D), and synchronizer (E).

B—Washer
C—Gear
D—Bearing
E—Synchronizer

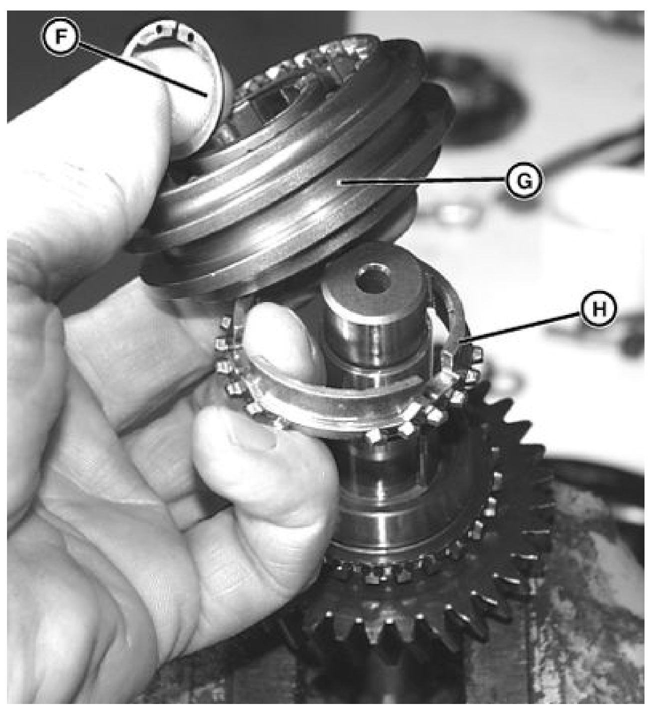


TCAL26460 —UN—15JUN12

RB14256,0000812 -19-11AUG14-3/9

4. Remove snap ring (F), sliding clutch (G), and bottom synchronizer (H).

F—Snap Ring
G—Sliding Clutch
H—Bottom Synchronizer



TCAL26461 —UN—15JUN12

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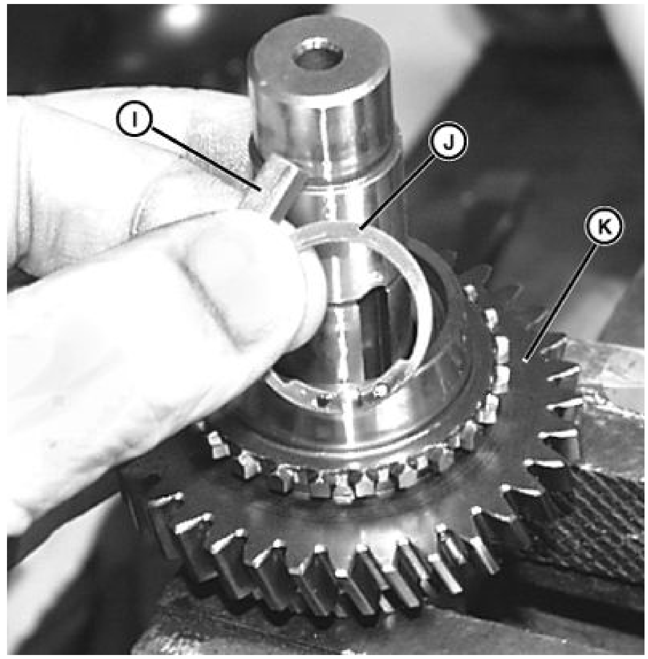
RB14256,0000812 -19-11AUG14-4/9

5. Remove shaft key (I), snap ring (J), and gear (K).

I— Shaft Key
J— Snap Ring
K—Gear



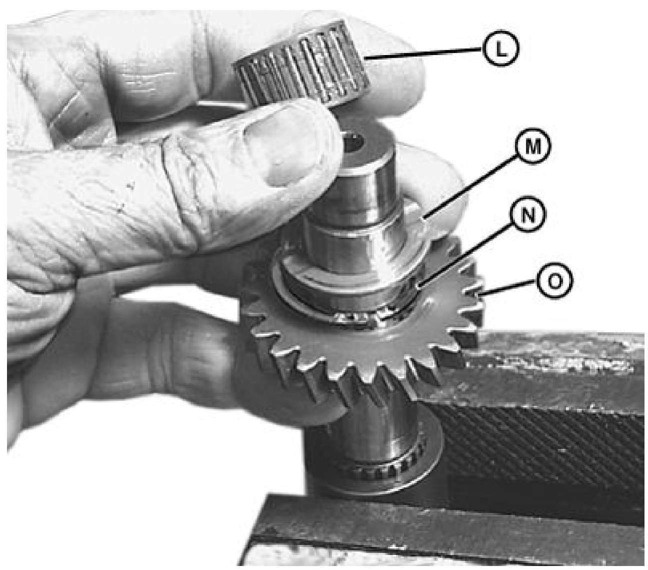
TCAL26462 —UN—15JUN12

RB14256,0000812 -19-11AUG14-5/9

NOTE: Oil grooves in washer (M) face up as shown.

6. Remove bearing (L), washer (M) snap ring (N), and gear (O) from the shaft.

L—Bearing
M—Washer
N—Snap Ring
O—Gear



TCAL26463 —UN—15JUN12

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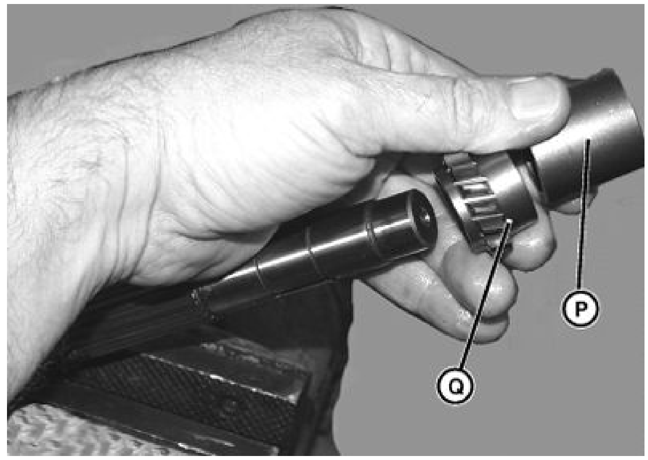
RB14256,0000812 -19-11AUG14-6/9

7. Remove spacer (P) and gear (Q).

P—Spacer **Q—Gear**



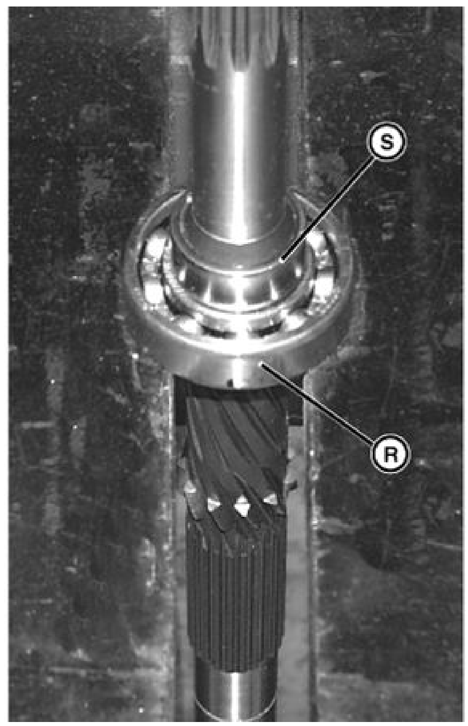
TCAL26464 —UN—15JUN12

RB14256,0000812 -19-11AUG14-7/9

NOTE: If seal sleeve (S) is removed, it must be replaced with a new one.

8. Press off bearing (R) and seal sleeve (S).
9. Clean all parts and inspect for wear or damage.

R—Bearing **S—Seal Sleeve**



TCAL26465 —UN—15JUN12

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RB14256,0000812 -19-11AUG14-8/9

10. Check gap (T) between synchronizer and gear. As synchronizer wears, gap gets smaller. When synchronizer has worn enough that the gap is within specified distance or less, or the synchronizer is touching the gear, replace synchronizer. Check for any damage on synchronizer teeth and gear teeth. Replace parts as needed.

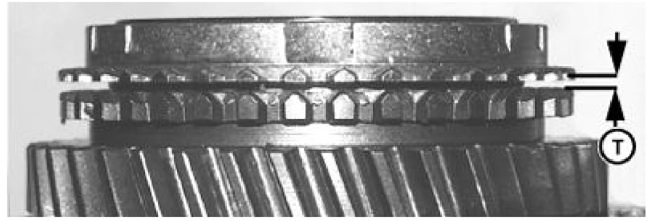
Specification

Synchronizer—Gap
(Wear Limit).. 0.1 mm
(0.004 in.)

Assembly

Assemble in the reverse order of disassembly.

TCAL26466 —UN—15JUN12



T—Gap

RB14256,0000812 -19-11AUG14-9/9

Disassemble and Assemble Reduction Shaft

1. Use a press, bearing puller, or two small pry bars and remove bearing from shaft.

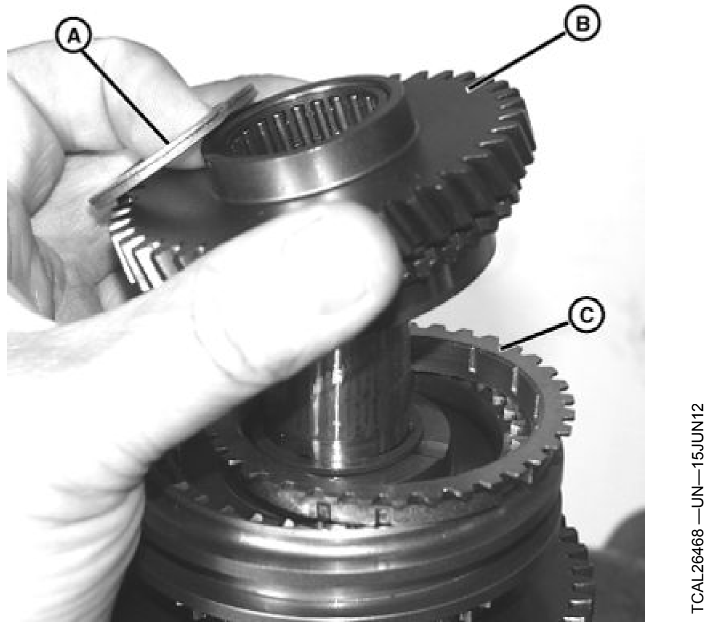
TCAL26467 —UN—15JUN12

Continued on next page

RB14256,0000813 -19-11AUG14-1/15

2. Remove washer (A), 39T gear (B), and synchronizer (C).

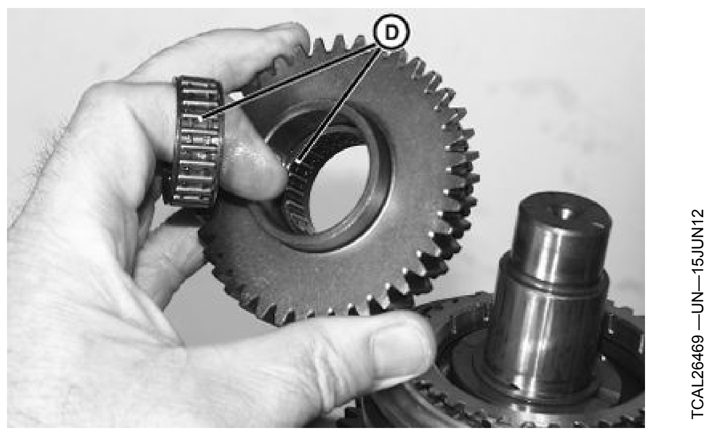
A—Washer
B—39T Gear
C—Synchronizer



RB14256,0000813 -19-11AUG14-2/15

3. Remove bearings (D). Check bearings and inner bore of gear for wear or damage.

D—Bearings



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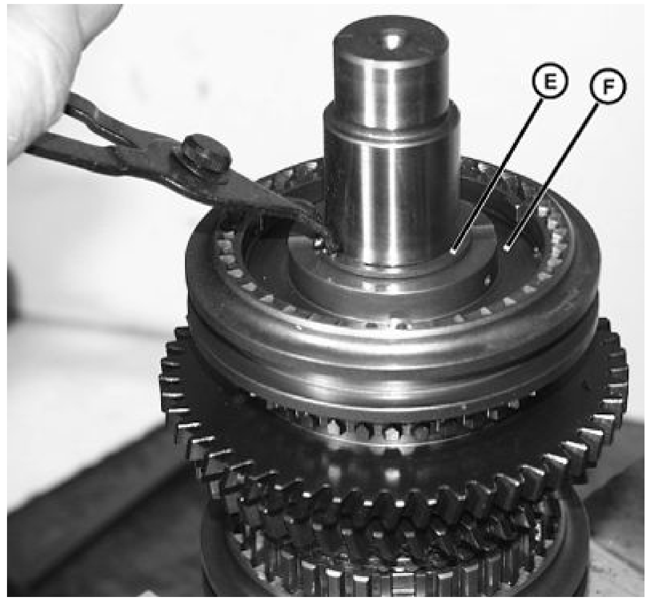
RB14256,0000813 -19-11AUG14-3/15

4. Remove snap ring (E) and sliding clutch (F).

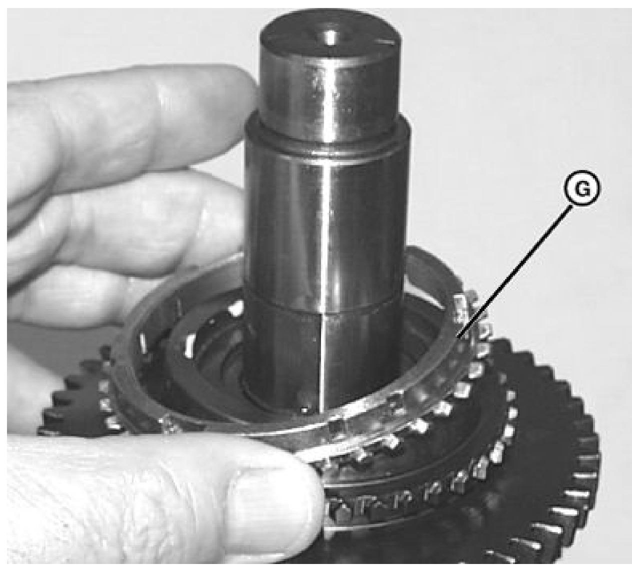
E—Snap Ring **F—Sliding Clutch**



RB14256,0000813 -19-11AUG14-4/15

5. Remove synchronizer (G).

G—Synchronizer



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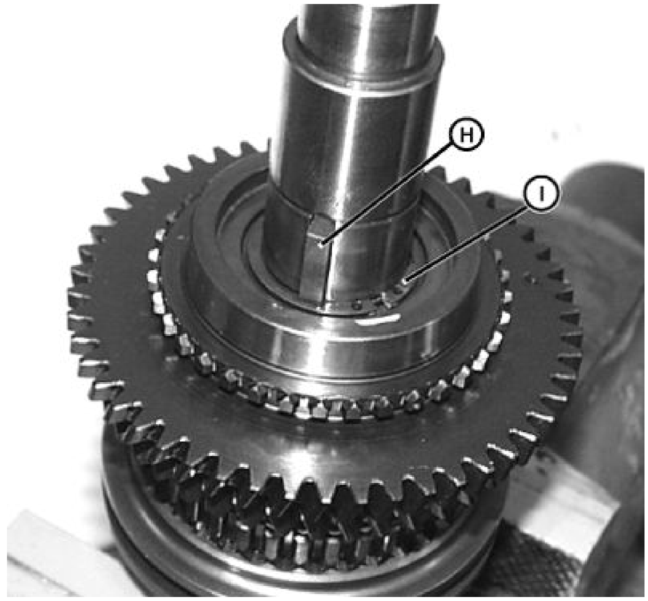
RB14256,0000813 -19-11AUG14-5/15

6. Remove key (H) and snap ring (I).

H—Key **I— Snap Ring**

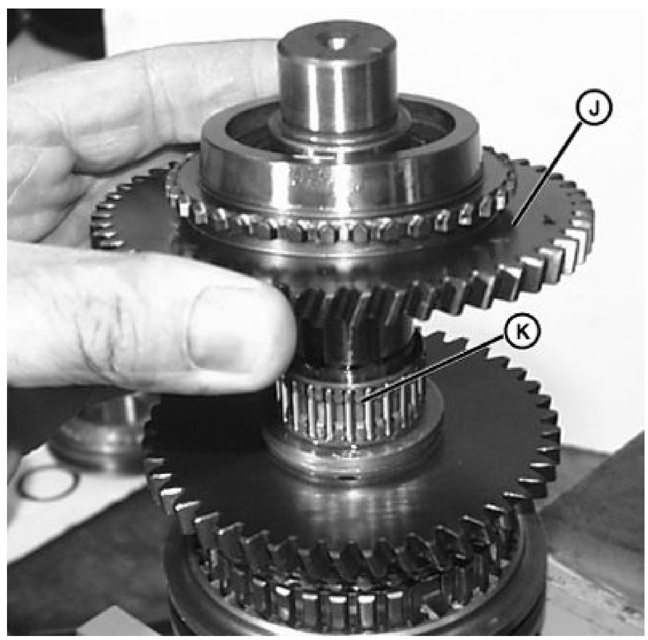


TCAL26472 —UN—15JUN12

RB14256,0000813 -19-11AUG14-6/15

7. Remove 50T gear (J) and bearing (K) from shaft.

J— 50T Gear **K—Bearing**



TCAL26473 —UN—15JUN12

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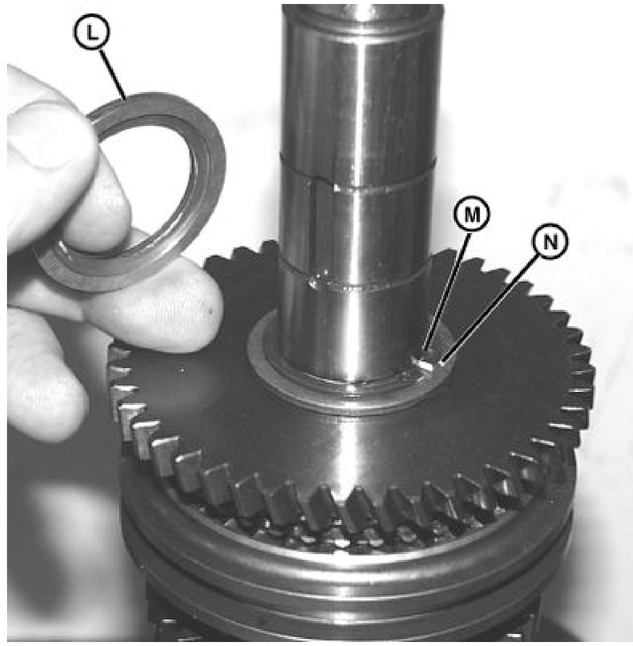
RB14256,0000813 -19-11AUG14-7/15

NOTE: Groove in washer (L) goes toward snap ring (M).

8. Remove washer (L), snap ring (M), and washer (N).

L—Washer
M—Snap Ring
N—Washer

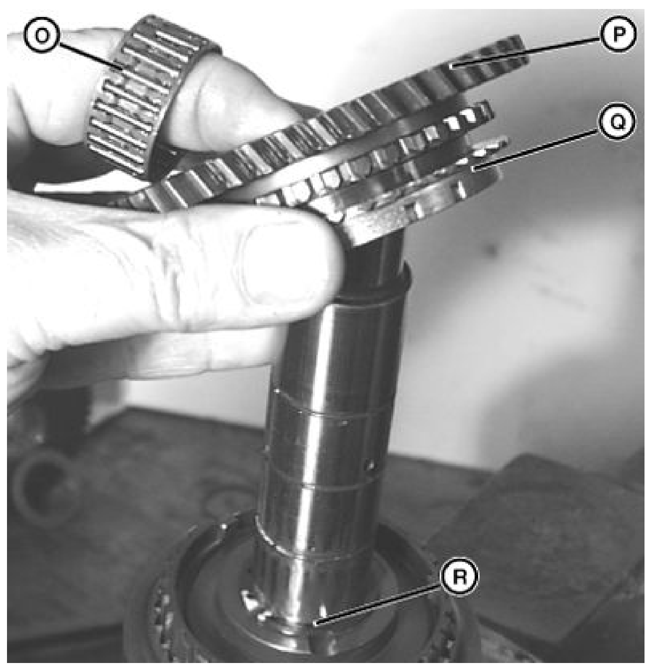


TCAL26474 —UN—15JUN12

RB14256,0000813 -19-11AUG14-8/15

9. Remove bearing (O), 44T gear (P), and synchronizer (Q).
10. Remove snap ring (R).

O—Bearing
P—44T Gear
Q—Synchronizer
R—Snap Ring



TCAL26475 —UN—15JUN12

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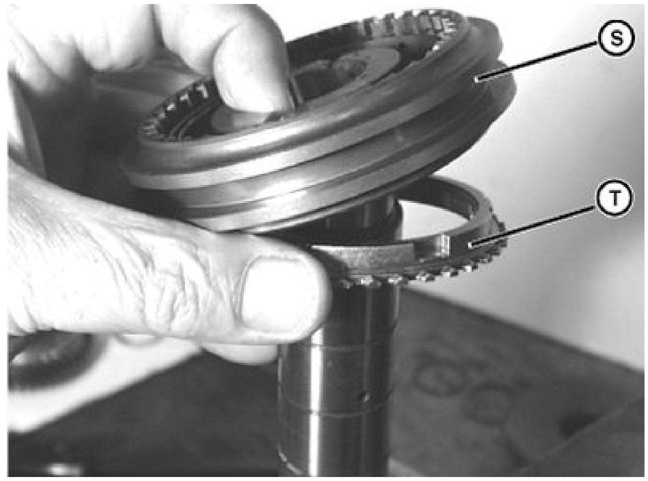
RB14256,0000813 -19-11AUG14-9/15

11. Remove sliding clutch (S) and synchronizer (T).

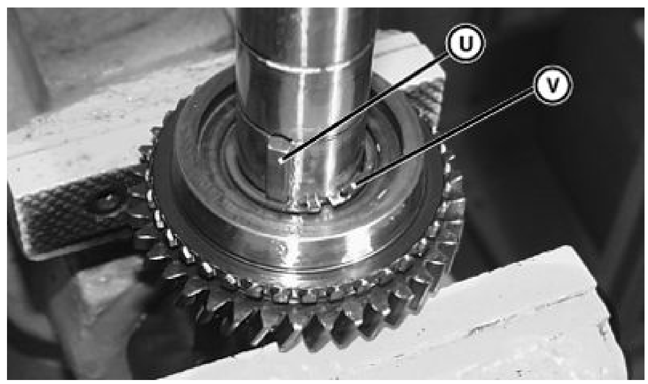
S—Sliding Clutch **T—Synchronizer**



RB14256,0000813 -19-11AUG14-10/15

12. Remove key (U) and snap ring (V).

U—Key **V—Snap Ring**

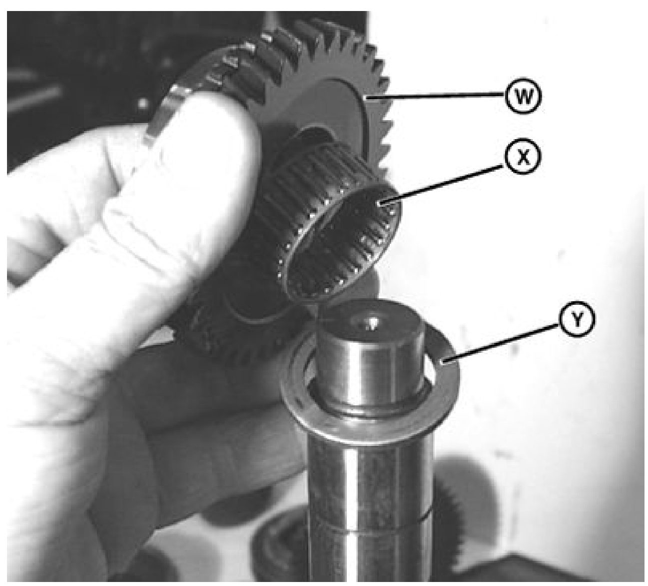


RB14256,0000813 -19-11AUG14-11/15

NOTE: Oil grooves on washer (Y) must face gear (W).

13. Remove 27T gear (W), bearing (X), and washer (Y).

W—27T Gear
X—Bearing
Y—Washer



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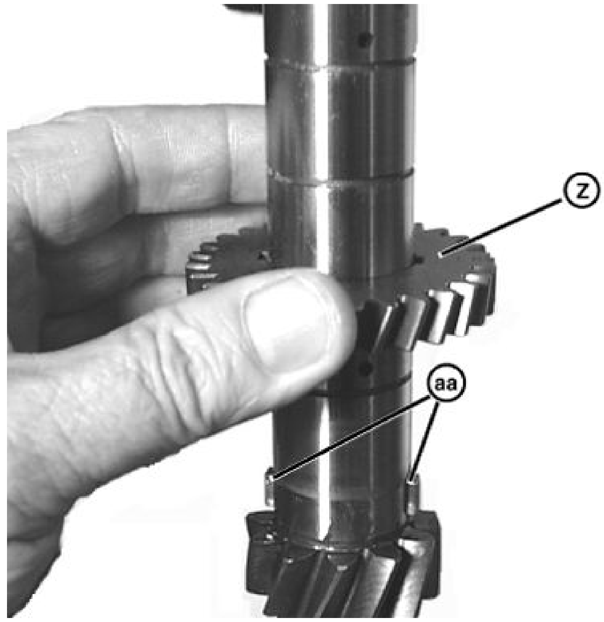
14. Remove 28T gear (Z) and keys (aa).

Z—28T Gear **aa— Keys**



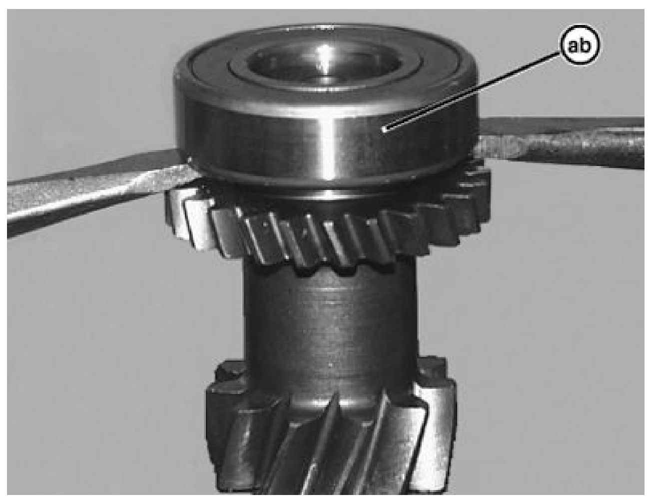
TCAL26479 —UN—15JUN12

RB14256,0000813 -19-11AUG14-13/15

NOTE: Sealed end of bearing must face away from gear.

15. Remove bearing (ab) from shaft.
16. Clean all parts and inspect for wear or damage.

Z—28T Gear **aa— Keys**



TCAL26480 —UN—15JUN12

RB14256,0000813 -19-11AUG14-14/15

17. Check gap (ac) between synchronizer and gear. As synchronizer wears, gap gets smaller. When synchronizer has worn enough that the gap is within specified distance or less, replace synchronizer. Check for any damage on synchronizer teeth and gear teeth. Replace parts as needed.

Specification

Synchronizer Wear Limit—Distance	0.1 mm (0.004 in.)

Assembly

Assemble in the reverse order of disassembly.

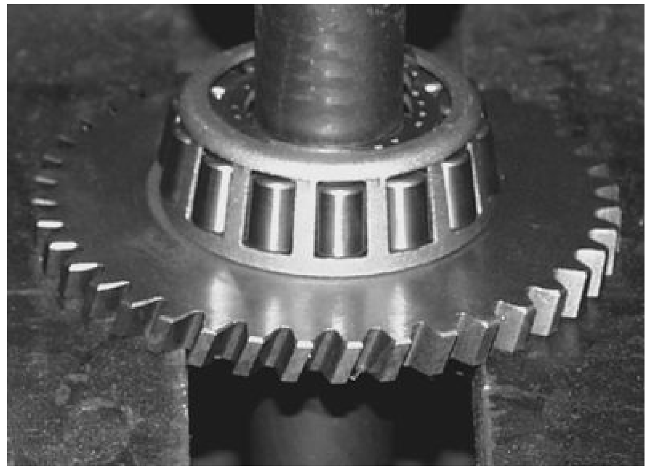
TCAL26481 —UN—15JUN12

ac— Gap between Synchronizer and Gear

RB14256,0000813 -19-11AUG14-15/15

Disassemble and Assemble Countershaft

NOTE: Record position of spacer (A) between bearing and gear for later assembly.

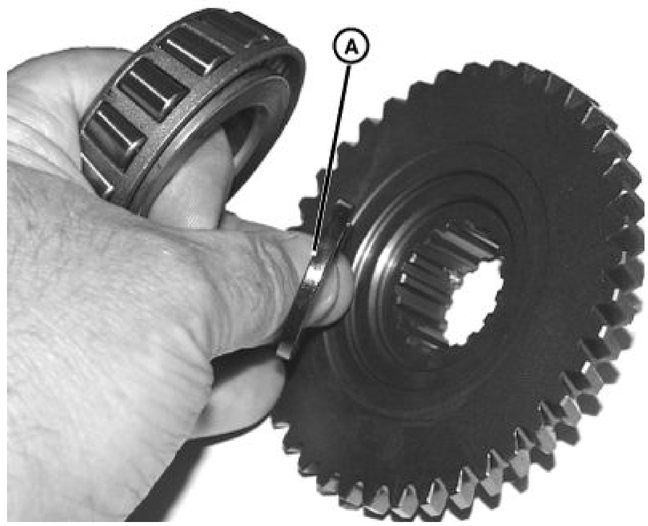


TCAL26482 —UN—15JUN12

RB14256,0000814 -19-11AUG14-1/4

1. Press bearing and 40T gear from countershaft.

A—Spacer between Bearing and Gear

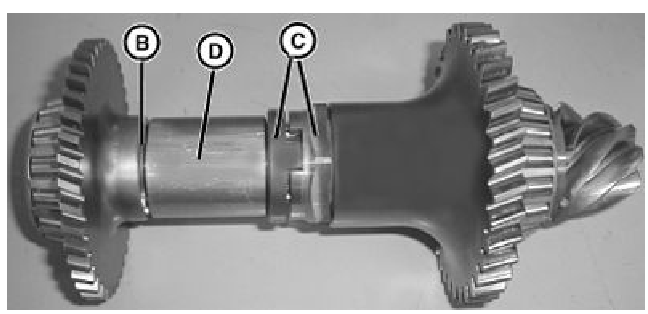


TCAL26483 —UN—15JUN12

RB14256,0000814 -19-11AUG14-2/4

2. Remove snap ring (B). Then slide off spacer (D), and remove locker and nut (C).

B—Snap Ring
C—Spacer
D—Locker and Nut



TCAL26484 —UN—15JUN12

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RB14256,0000814 -19-11AUG14-3/4

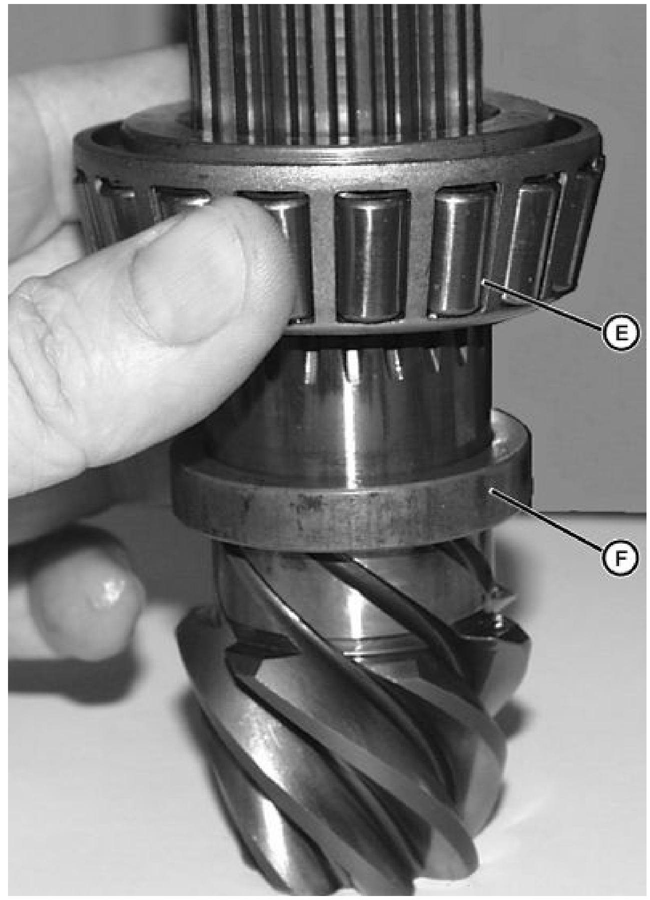
3. Press bearing (E) from shaft and remove spacer (F).

Assembly

Assemble in the reverse order of disassembly.

Tighten locknut on 38T gear to specification and install locker on a spline where it locks into slots on locknut. Install spacer.

Specification	
38T Gear Locknut	
Torque—Torque	166 N·m (123 lb.-ft.)



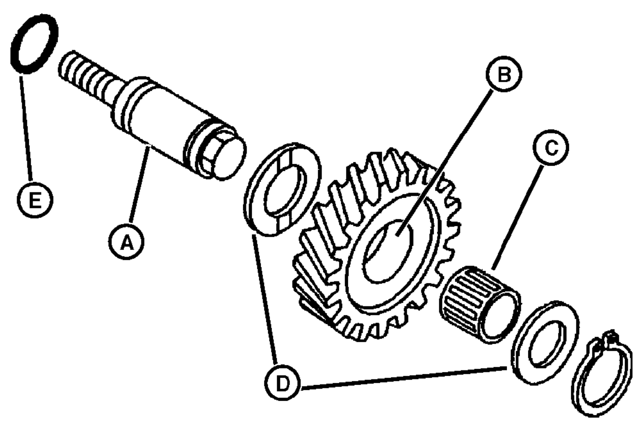
TCAL26485 —UN—15JUN12

E—Bearing **F—Spacer**

RB14256,0000814 -19-11AUG14-4/4

Disassemble and Assemble Reverse Idler Shaft and Gear

1. Disassemble reverse gear and shaft assembly.
2. Inspect shaft (A), inner bore of gear (B), and bearing (C) for wear or damage. Replace parts as needed.
3. When assembling, make sure oil grooves on washers (D) are facing toward the gear and the raised side of gear hub is facing the threaded end of the shaft.
4. Replace O-ring (E).



TCAL26486 —UN—15JUN12

A—Shaft
B—Inner Bore
C—Bearing
D—Washer Grooves
E—O-Ring

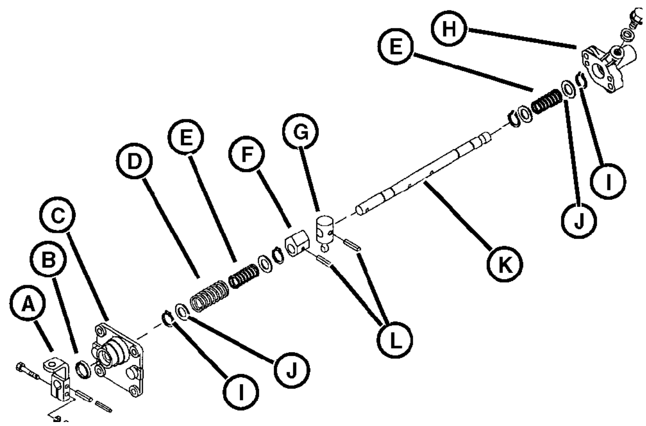
RB14256,0000815 -19-18JUN12-1/1

Disassemble and Assemble Shifter

Number	Name	Use
TY24344 (U.S.) (U.S.)	Form-in-Place Gasket	Applied to covers before installation.

NOTE: Shifter does not need to be removed for transaxle service unless a problem is suspected. Shifter can be removed with transaxle in the vehicle.

1. If transaxle is assembled, place lever in reverse position (lever A out and back).
2. Remove cap screws securing covers (C and H).
3. Remove cover (H).
4. Remove cover (C) and shaft assembly (K).
5. Check shifter for worn or broken parts (A-L); replace as needed.



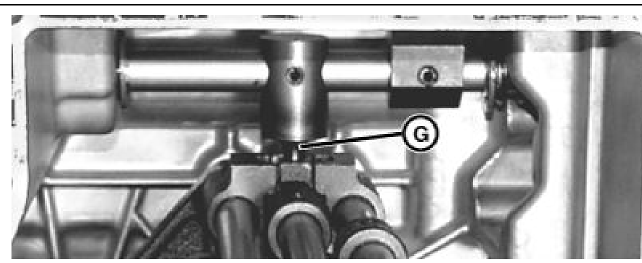
TCAL26487 —UN—15JUN12

A—Lever
B—Shaft Seal
C—Cover
D—Outter Spring
E—Inner Spring
F—Nut
G—Lever
H—Cover
I— Snap Ring
J— Washer
K—Shaft
L—Pins

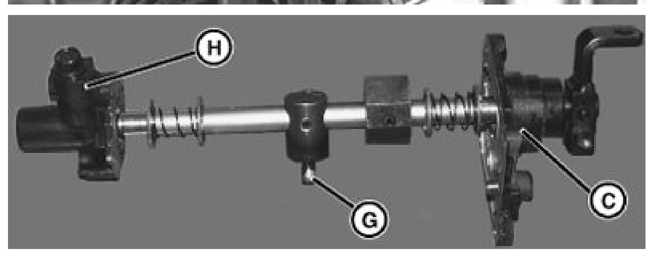
RB14256,0000816 -19-18JUN12-1/2

Assembly

1. Replace shaft seal (B).
2. Install shaft assembly into transaxle. If transaxle is assembled, place outermost shift shaft to front (reverse) position. Make sure lever (G) is engaged in slot in shift shafts.
3. Apply TY24344 John Deere Form-in-Place Gasket to the covers (C and H) and install covers.
4. Check shifting for proper operation.



TCAL26488 —UN—15JUN12



TCAL26489 —UN—15JUN12

C—Cover
G—Lever
H—Cover

RB14256,0000816 -19-18JUN12-2/2

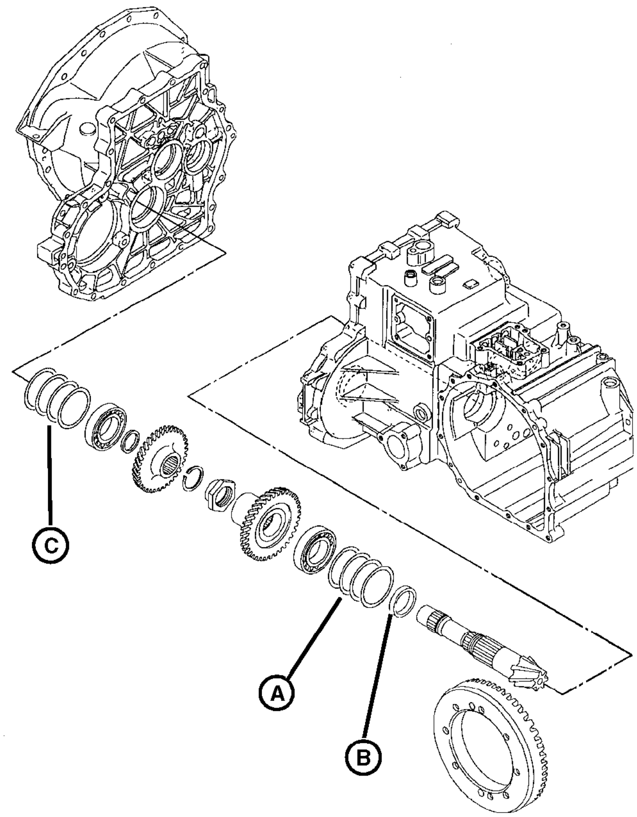
Countershaft Shimming Procedure

NOTE: This procedure needs to be performed only when countershaft, bearings or transaxle cases have been changed. If none of these parts have been changed, install original shims in original positions.

Countershaft and ring gear are a matched set and must be replaced as a set.

- Shims (A) and spacer (B) set pinion depth.
- Shims (C) set bearing preload.

A—Shims
B—Spacer
C—Shims

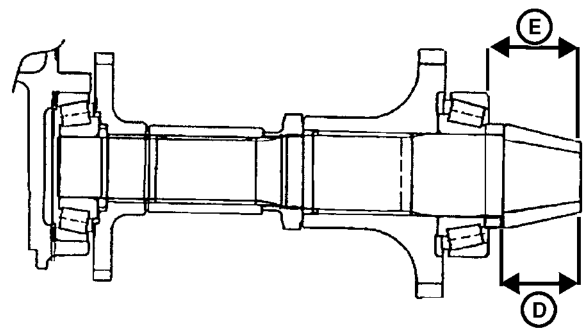


TCAL26490 —UN—15JUN12

RB14256,0000817 -19-18JUN12-1/3

To determine thickness of shims for pinion depth:

1. Measure width of gear (D).
2. Hold bearing race against bearing cone and measure distance between end of outer bearing race (E) and end of gear.
3. Subtract measurement D from measurement E.
4. Subtract 6.25 mm (0.246 in.) from difference calculated in step 3.
5. This is the thickness of shims to be placed between the bearing race and the transaxle case.
6. Install the countershaft into the transaxle case with the shims installed behind the pinion gear end bearing race, and without any shims behind bearing race in front cover.
7. Install the front cover with five or six cap screws and tighten to specification.



TCAL26491 —UN—15JUN12

D—Width of Gear
E—Distance between Race and End of Gear

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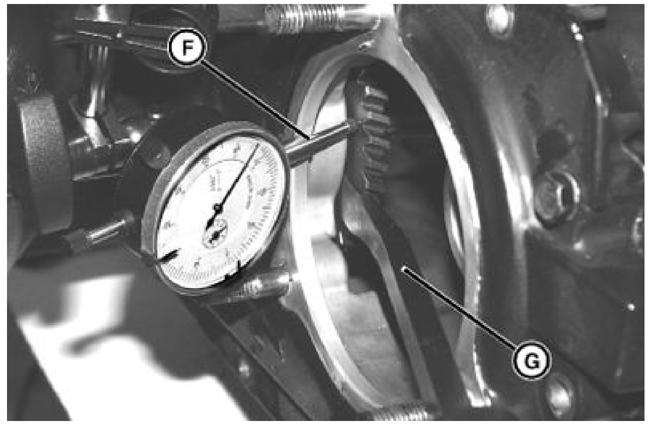
RB14256,0000817 -19-18JUN12-2/3

8. Install dial indicator (F) to transaxle case and countershaft gear as shown.
9. Using a small pry bar or large screwdriver (G), pry countershaft back and zero dial indicator. Pry countershaft forward and record measurement of total travel. Add 0.1 mm (0.003 in.). This is the thickness of shims to be installed behind the front cover bearing race.

F—Dial Indicator **G—Large Screwdriver**



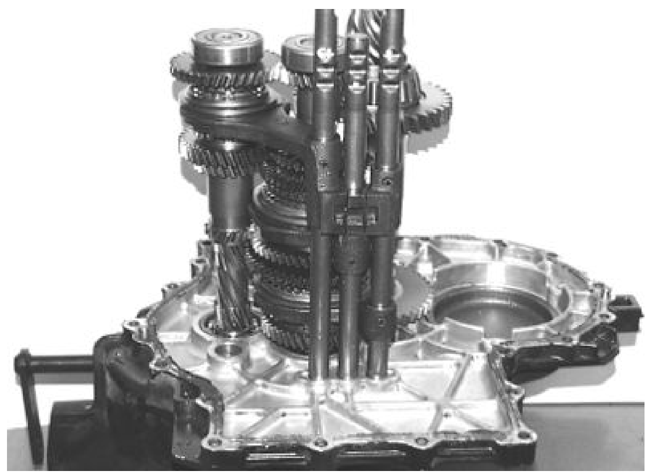
TCAL26492 —UN—15JUN12

RB14256,0000817 -19-18JUN12-3/3

Assemble Transaxle

Number	Name	Use
TY24344 (U.S.) (U.S.)	Form-in-Place Gasket	Applied to front cover mating surface before installation.

1. Group the three shafts and shift forks together and install them into the clutch housing.


TCAL26493 —UN—15JUN12

RB14256,0000818 -19-11AUG14-1/6

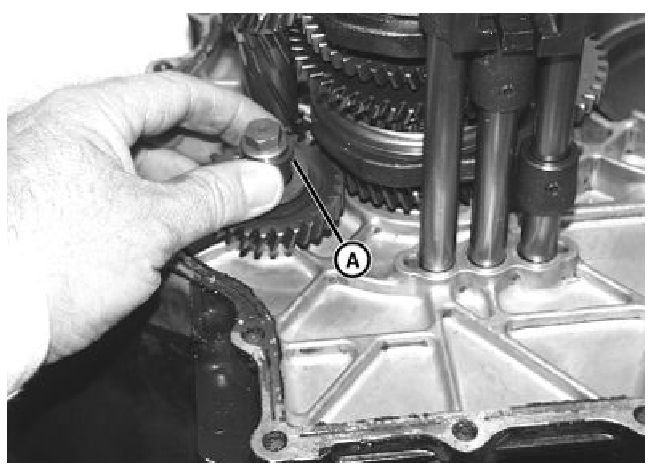
2. Lubricate the O-ring on the reverse idler shaft and install reverse idler (A). Make sure that extended hub side of gear is toward clutch housing and oil grooves in washers are facing gear. Apply medium strength thread lock to threads, and install washer and nut on reverse idler shaft. Tighten to specification.

Specification

Reverse Idler Shaft
Nut—Torque..44—59 N·m
(33—43 lb.-ft.)

3. Apply thin bead of TY24344 John Deere Form-in-Place Gasket to front cover mating surface.

A—Reverse Idler



TCAL26494 —UN—15JUN12

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RB14256,0000818 -19-11AUG14-2/6

4. Slide clutch cover and gear shafts into transaxle case far enough to get shift shafts started in their bores.

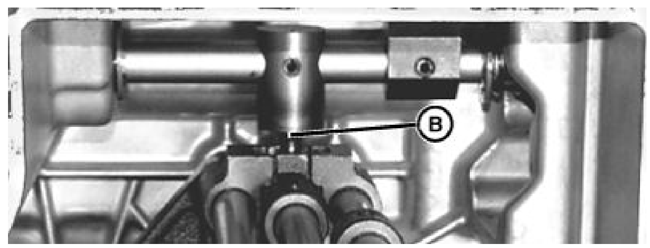
TCAL26495 —UN—15JUN12

RB14256,0000818 -19-11AUG14-3/6

5. While sliding shift shafts in, make sure shift lever (B) engages in slots in shift rods.
6. Replace input shaft seal.
7. Seat the front cover on the transaxle housing and install cap screws. Tighten cap screws to specifications.

Specification

Transaxle Housing Cap Screw—Torque.......23—29 N·m (17—21 lb.-ft.)



TCAL26496 —UN—15JUN12

B—Shift Lever

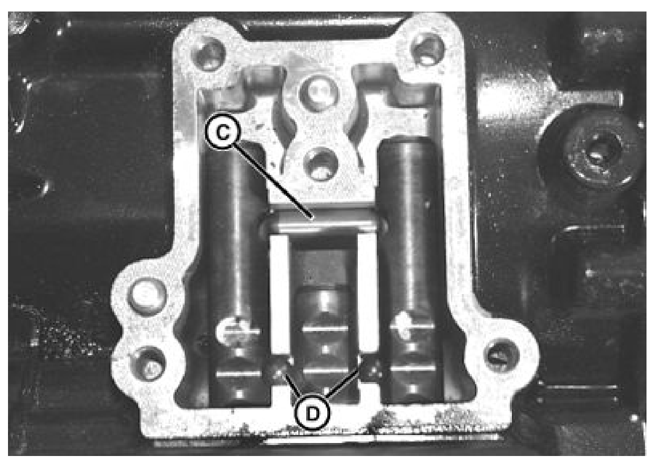
RB14256,0000818 -19-11AUG14-4/6

8. Install pin (C) and balls (D) to shift shafts.

IMPORTANT: Do not use TY24344 Form-in-Place gasket. The clearance created by the new gasket is critical for proper detent operation.

9. Install new gasket.
10. Install detent cover.

C—Pin **D—Balls**



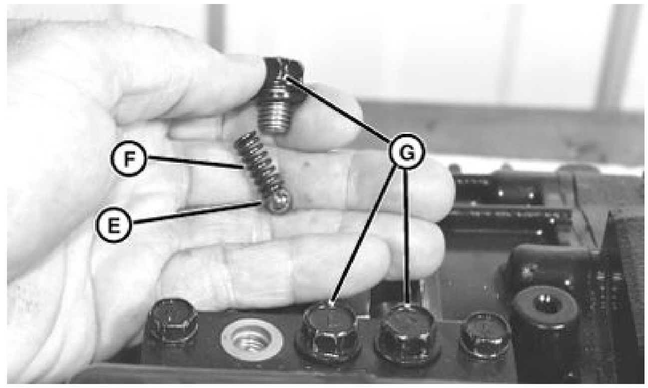
TCAL26497 —UN—15JUN12

Continued on next page

RB14256,0000818 -19-11AUG14-5/6

11. Install balls (E) and springs (F).
12. Install three cap screws (G).

E—Balls
F—Springs
G—Cap Screws (3)



TCAL26498 —UN—15JUN12

RB14256,0000818 -19-11AUG14-6/6

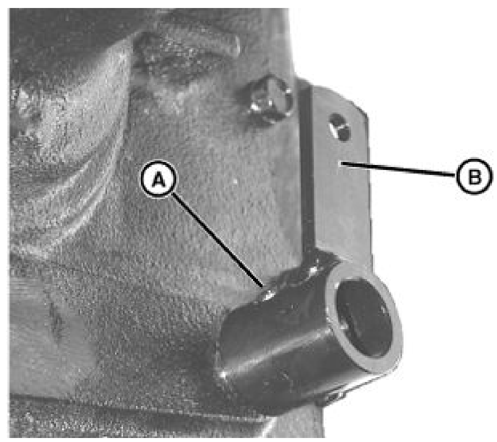
Remove and Install Differential

Number	Name	Use
PM37477 (U.S.) PM38622 (Canada) (U.S.)	Thread Lock and Sealer (Medium Strength)	Applied to threads of ring gear retaining cap screws.

Disassembly

1. Remove roll pin (A) and lever (B) from differential lock shaft.

A—Roll Pin
B—Lever

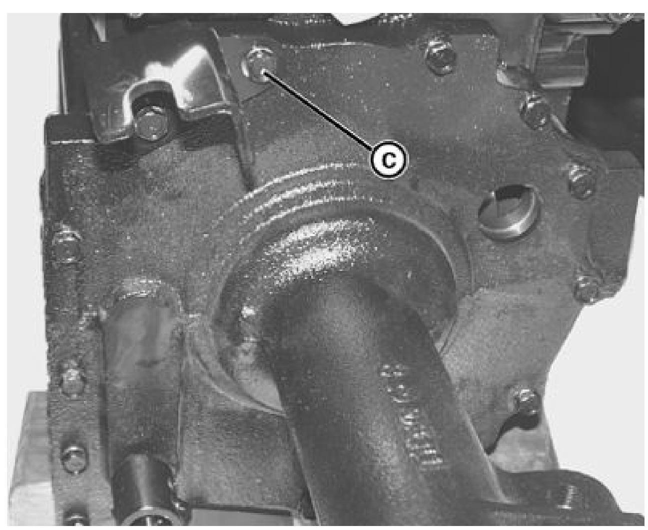


TCAL26499 —UN—15JUN12

RB14256,0000819 -19-11AUG14-1/10

2. Remove cap screws (C) securing left axle housing to transaxle case and remove axle housing.

C—Cap Screws (14)



TCAL26500 —UN—15JUN12

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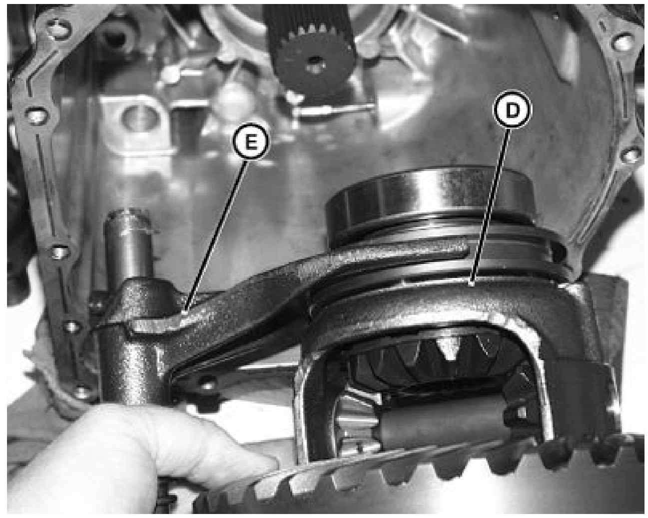
RB14256,0000819 -19-11AUG14-2/10

3. Remove differential carrier (D) and differential lock shifter (E) from housing as an assembly.

D—Differential Carrier **E—Differential Lock Shifter**

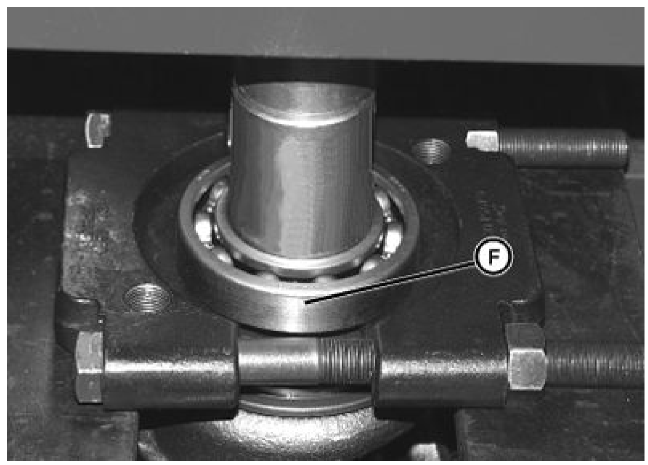


TCAL26501 —UN—15JUN12

RB14256,0000819 -19-11AUG14-3/10

4. Press bearing (F) off each end of differential carrier.

F—Bearing



TCAL26502 —UN—15JUN12

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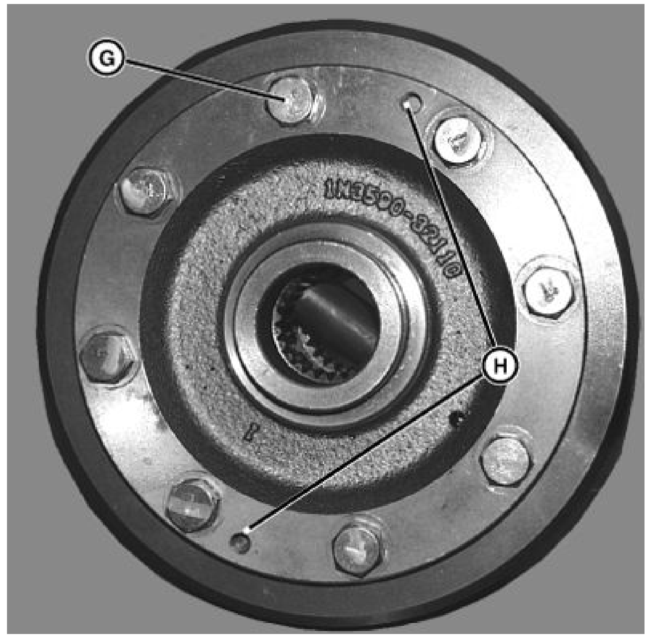
RB14256,0000819 -19-11AUG14-4/10

5. Remove eight cap screws (G) securing ring gear to carrier and remove ring gear. If ring gear is tight on the carrier, install two M8x1.25 cap screws in threaded holes (H) and alternately tighten to push ring gear off carrier.

G—Cap Screws (8) **H—Threaded Holes (2)**

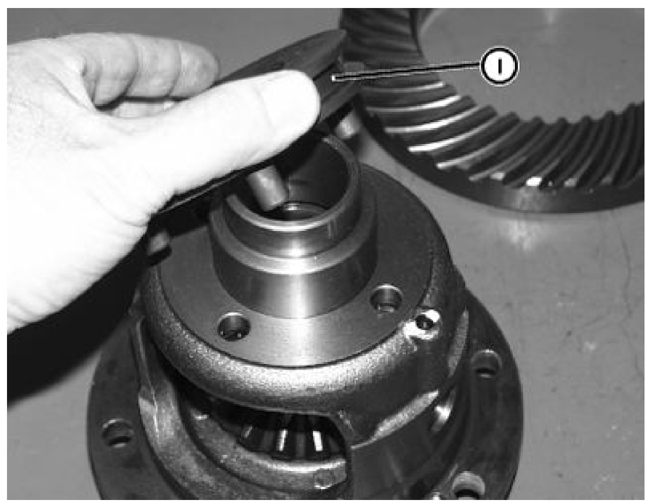


TCAL26503 —UN—15JUN12

RB14256,0000819 -19-11AUG14-5/10

6. Remove differential lock (I).

I— Differential Lock



TCAL26504 —UN—15JUN12

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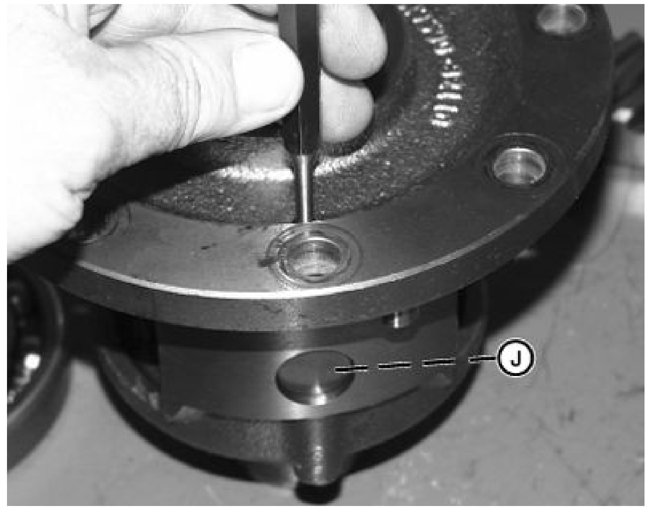
RB14256,0000819 -19-11AUG14-6/10

7. Remove roll pin (J) securing bevel gear shaft to carrier.

J— Bevel Gear Shaft to Carrier Roll Pin

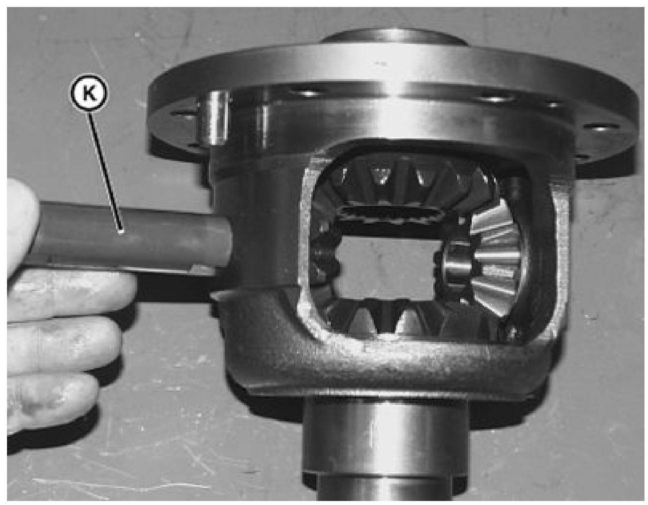


TCAL26505 —UN—15JUN12

RB14256,0000819 -19-11AUG14-7/10

8. Remove shaft (K).

K—Shaft

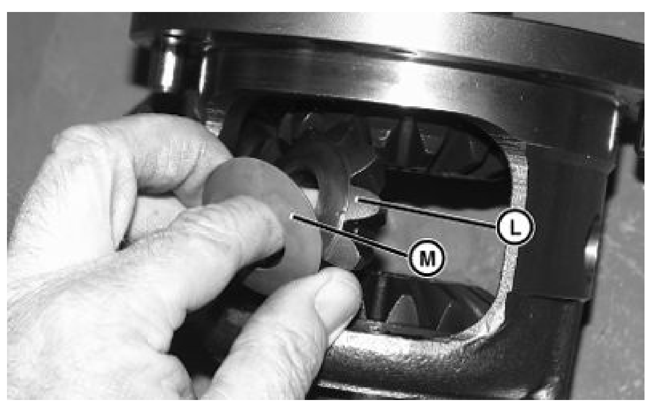


TCAL26506 —UN—15JUN12

RB14256,0000819 -19-11AUG14-8/10

9. Remove beveled gears (L) and washers (M).

L— Beveled Gears **M—Washers**



TCAL26507 —UN—15JUN12

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RB14256,0000819 -19-11AUG14-9/10

NOTE: Gear (N) with notches must go on differential lock side.

10. Remove axle drive gears (N) and washers (O).

11. Clean all parts and inspect for wear or damage. Check all gears for chipped or cracked teeth. Replace parts as needed.

Assembly

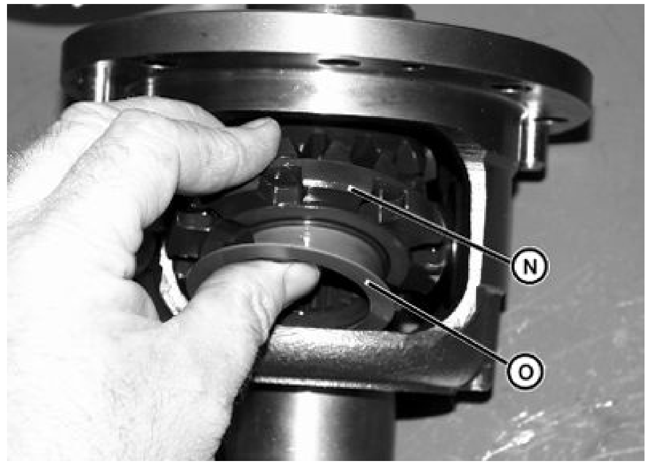
Assemble in the reverse order of disassembly.

- Apply PM37477 John Deere Medium Strength Thread Lock and Sealer to threads on ring gear retaining cap screws and tighten to specification.

Specification

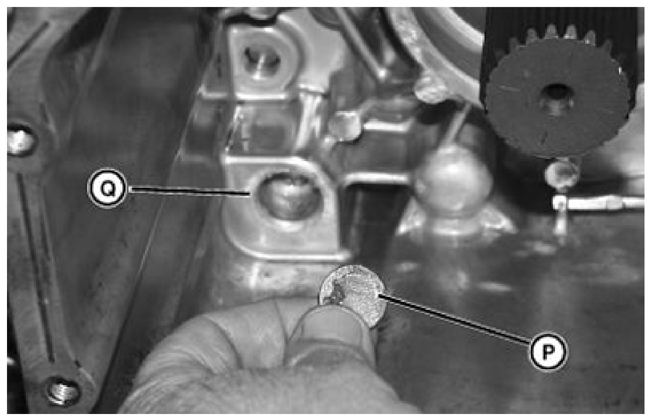
Ring Gear Retaining Cap Screws—Torque........78—98 N·m (58—72 lb.-ft.)

- Apply grease to spacer (P) and install in hole (Q) before installing differential lock fork and differential.
- Install differential lock fork and differential.



TCAL26508 —UN—15JUN12

N—Axle Drive Gears **O—Washers**



TCAL26509 —UN—15JUN12

P—Spacer **Q—Hole**

RB14256,0000819 -19-11AUG14-10/10

Disassemble and Assemble Differential Lock Fork

CAUTION: Fork has strong spring tension against it. Use a vice to cage spring force before removing roll pins or snap ring. Slowly release tension on spring to avoid injury.

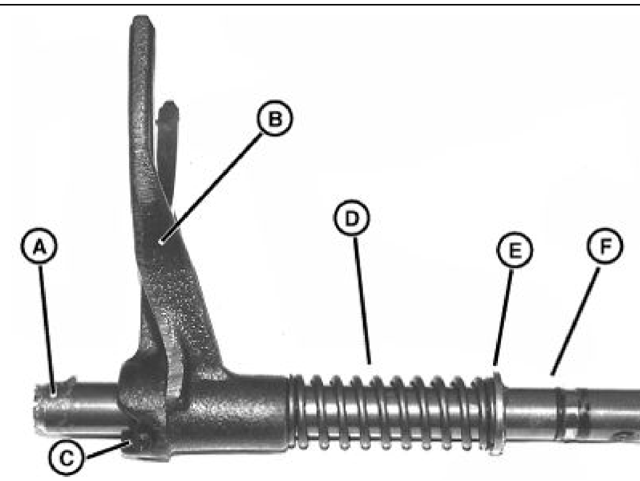
1. Put end of shaft (A) in a soft-jawed vice with fork (B) against sides of vice jaws. Push on other end of shaft until spring tension is off roll pins and tighten vice.

2. Remove roll pins (C) and, while holding shaft, slowly loosen vice and relieve tension from spring (D).

3. Inspect parts, check snap ring and washer (E), and replace any worn/broken parts. Always replace O-ring (F).

Assembly

Assemble in the reverse order of disassembly.



TCAL26510 —UN—15JUN12

A—Shaft
B—Fork
C—Roll Pins
D—Spring
E—Washer
F—O-Ring

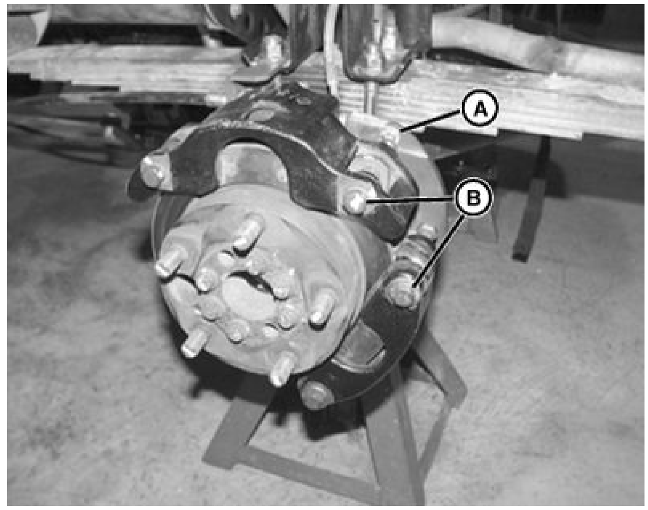
RB14256,000081A -19-18JUN12-1/1

Remove and Install Axle Shaft, Replace Seal

Number	Name	Use
TY24344 (U.S.) (U.S.)	Form-in-Place Gasket	Applied to axle housing mating surface before installation.

1. Disconnect park brake cable (A). Remove bolts (B) securing brake calipers to bracket. Properly secure brake caliper so brake line is not stressed.

A—Park Brake Cable **B—Bolts**

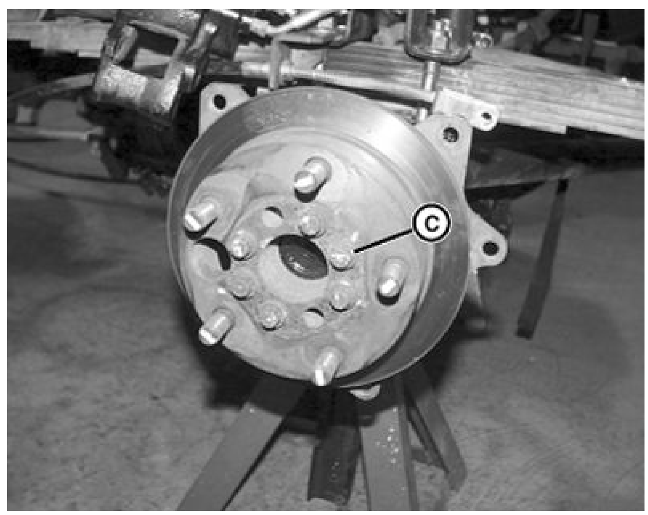


TCAL26511 —UN—15JUN12

RB14256,000081B -19-11AUG14-1/9

2. Remove six bolts (C) securing brake disk to axle shaft.

C—Bolts (6)



TCAL26512 —UN—15JUN12

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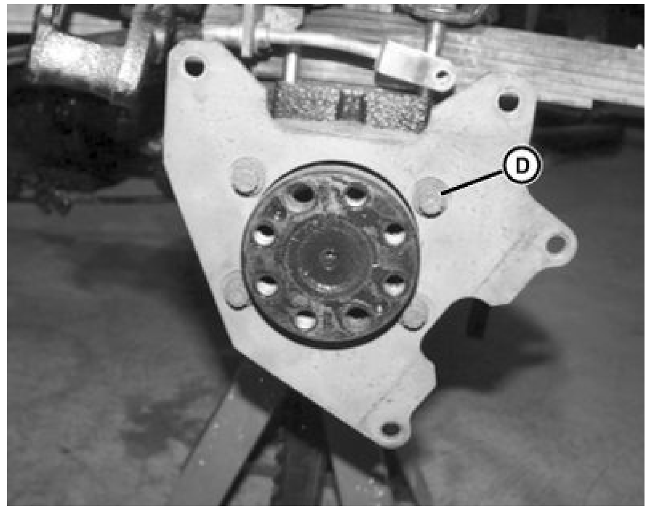
3. Remove four bolts (D) securing brake caliper bracket to axle housing.

D—Bolts (4)

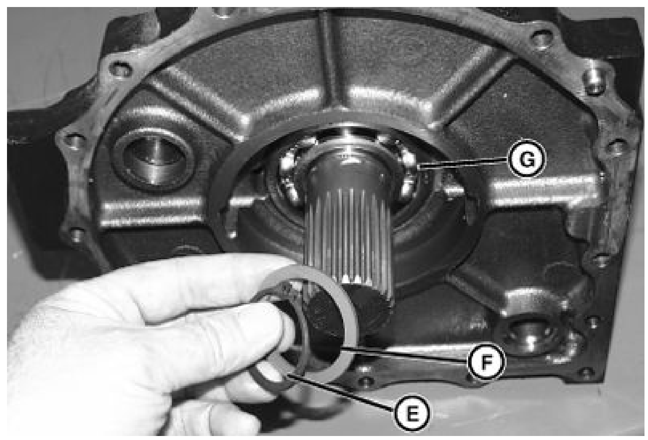


TCAL26513 —UN—15JUN12

RB14256,000081B -19-11AUG14-3/9

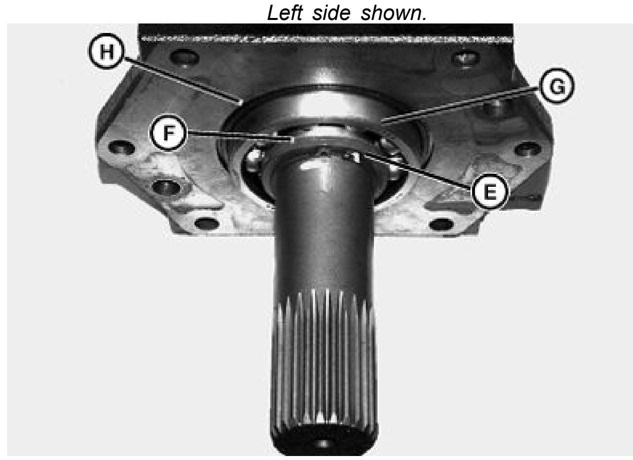
4. Remove snap ring (E) and spacers (F) from splined end of axle shaft.
5. Using a soft hammer, drive axle in through bearing (G) and pull out through outer bearing.
6. On right side, replace O-ring (H) during assembly.

E—Snap Ring
F— Spacer
G—Splined End of Axle Shaft
H—O-ring



TCAL26514 —UN—15JUN12

Left side shown.



TCAL26515 —UN—15JUN12

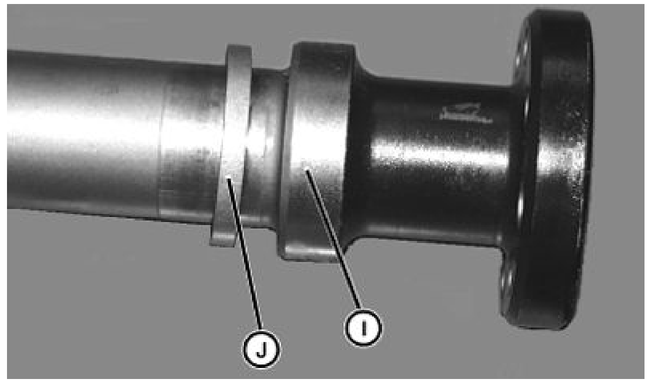
Right side shown.

Continued on next page

RB14256,000081B -19-11AUG14-4/9

7. Check seal contact area (I) for wear or damage. If spacer (J) is removed, make sure that chamfer on inside is facing toward wheel end of axle during assembly.

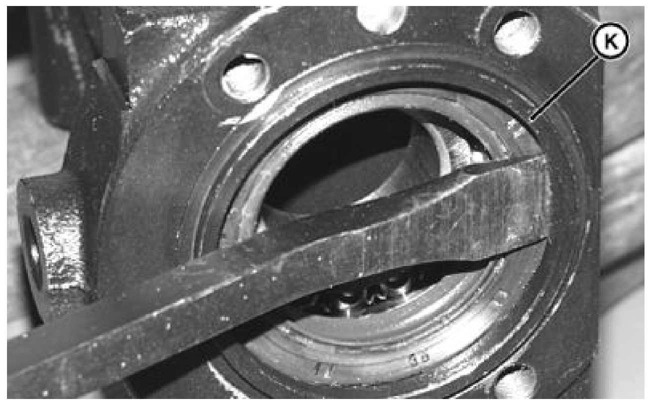
I— Seal Contact Area **J— O-ring**



RB14256,000081B -19-11AUG14-5/9

8. Remove seal retaining ring (K).

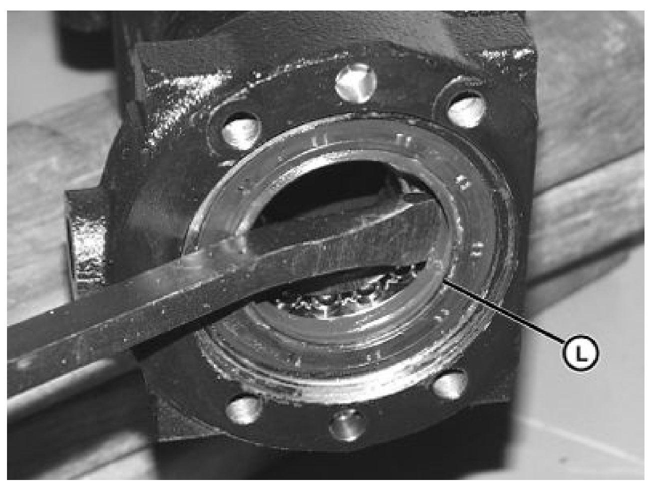
K—Seal Retaining Ring



RB14256,000081B -19-11AUG14-6/9

9. Remove oil seal (L).

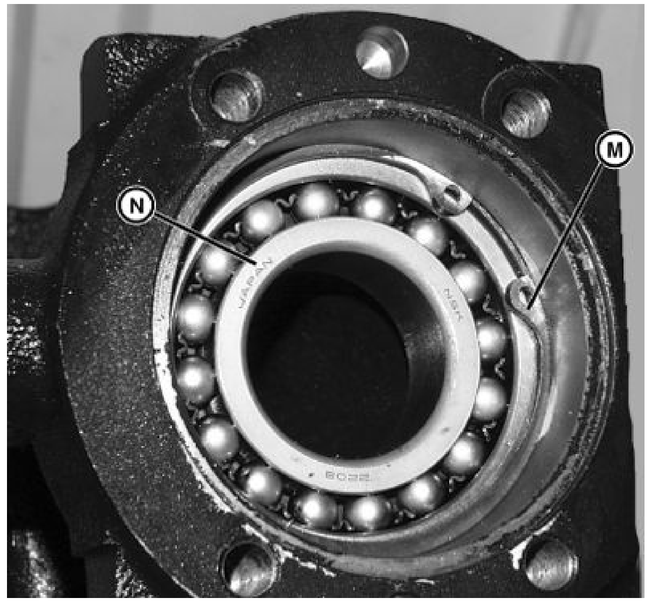
L—Oil Seal



Continued on next page RB14256,000081B -19-11AUG14-7/9

10. Remove snap ring (M) and bearing (N).

M—Snap Ring **N—Bearing**



TCAL26519 —UN—15JUN12

RB14256,000081B -19-11AUG14-8/9

11. Remove inner bearing (O) from axle housing.
12. Clean all parts and inspect for wear or damage.

Assembly

Assemble in the reverse order of disassembly.

- On the left side axle housing, apply a thin bead of TY15130 John Deere Form-in-Place Gasket to mating surfaces. Tighten cap screws to specification.

Specification

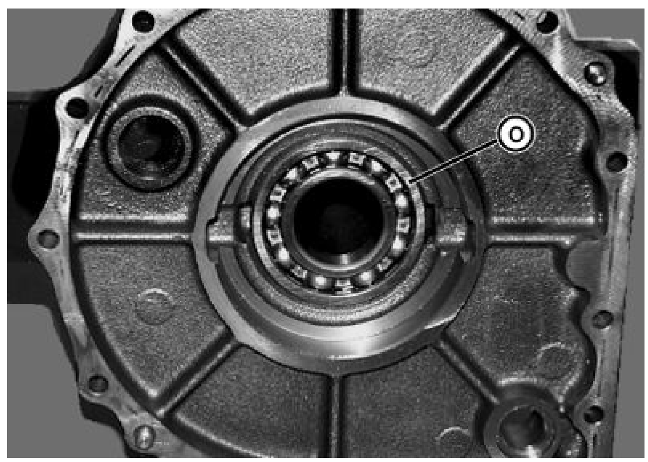
Axle Housing Cap Screw—Torque........................23—29 N·m (17—22 lb.-ft.)

- The right side axle housing is sealed by the O-ring. Replace the O-ring. Tighten cap screws to specification.

Specification

Axle Housing Cap Screw—Torque........................44—59 N·m (33—43 lb.-ft.)

- Install original shims in original positions unless differential ring gear or bearings have been replaced.
- If ring gear and countershaft or differential bearings have been replaced, see “Countershaft Shimming Procedure” on page 410 and “Check Ring Gear Backlash” on page 395.



TCAL26520 —UN—15JUN12

O—Inner Bearing

Item	**Measurement**	**Specification**
Specifications		
Axle Housing Cap Screw Torque (Left Side)		23—29 N·m (17—22 lb.-ft.)
Axle Housing Cap Screw Torque (Right Side)		44—59 N·m (33—43 lb.-ft.)

RB14256,000081B -19-11AUG14-9/9

Section 70
Hydraulics

Contents

Specifications

Item	Measurement	Specification
General		
Base System Capacity		12.5 L (3.3 gal)
Base and Auxiliary System Capacity		14.4 L (3.8 gal)
Oil Temperature (Not to Exceed)		90°C (195°F)
Auxiliary Pump Displacement		8.2 cc/rev (0.50 cu in.)
Steering Pump Displacement		5.1 cc/rev (0.31 cu in.)
Lift/Lower System (Auxiliary)		
Type		Open System
Working Pressure		16 547-17 236 kPa (2400-2500 psi)
Pump Flow (Gasoline Engine @ 3400 RPM)		27.9 liters/min (7.4 gpm)
Pump Flow (Diesel Engine @ 3450 RPM)		28.3 liters/min (7.5 gpm)
Steering System		
Type		Open system
Working Pressure		7000-7500 kPa (1015-1088 psi)
Pump Flow (Gasoline Engine @ 3400 RPM)		17.3 liters/min (4.6 gpm)
Pump Flow (Diesel Engine @ 3450 RPM)		17.6 liters/min (4.7 gpm)
Steering Control Unit		7000-7500 kPa (1015-1088 psi)
Pump Drive Gear-to-Backplate Gap		8-9 mm (.32-.35 in.)
Relief Pressure Control Valve	Pressure	16 547-17 236 kPa(2400-2500 psi)
Spool Height	Height	approximately 5 mm [0.2 in].
Gas Engine Hydraulic Cycle Time		2.5 seconds
Diesel Engine Hydraulic Cycle Time		2.5 seconds
Gas Engine (3400 RPM)	Flow Rate	27.9 liters/min (7.5 gpm)
Diesel Engine (3450 RPM)	Flow Rate	28.3 liters/min (7.4 gpm)
Pump Flow (Gasoline Engine @ 3400 RPM)	Flow Rate	27.9 liters/min (7.4 gpm)
Pump Flow (Diesel Engine @ 3450 RPM)	Flow Rate	28.3 liters/min (7.5 gpm)
Pump Flow (Gasoline Engine @ 3400 RPM)	Flow Rate	17.3 liters/min (4.6 gpm)
Pump Flow (Diesel Engine @ 3450 RPM)	Flow Rate	17.6 liters/min (4.7 gpm)
Steering Wheel Test Torque	Torque	6.8 N·m (60 lb-in.)
Hose Connection Torque	Torque	30 N·m (22 lb-ft)
Pump Drive Gear-to-Backplate Gap	Torque	8-9 mm (.32-.35 in.)

Continued on next page

RB14256,00007D6 -19-18JUN12-1/2

Item	Measurement	Specification
Pump Drive Gear Bolt	Torque	49 N·m (36 lb-ft)
Hydraulic Pump-to-Mounting Bracket Bolt	Torque	61 N·m (45 lb-ft)
Hydraulic Pump Suction Coupler Fitting	Torque	47 N·m (35 lb-ft)
Hydraulic Pump Pressure Coupler Fitting	Torque	47 N·m (35 lb-ft)
M8 Cap Bolt Torque	Torque	50 ±5 N·m (37 ± 4lb-ft)
Hydraulic/PTO Valve-to-FrameCap Screw Torque	Torque	16.7 N·m (147 lb-in.)
Pressure and Return HoseFitting-to-SCU Torque	Torque	40-57 N·m (30-42 lb-ft)
Steering Hose Fitting-to-SCU Torque	Torque	17-24 N·m (150-212 lb-in.)
Adapter Fitting-to-SCU Torque	Torque	14-19 N·m (124-168 lb-in.)
SCU-to-Frame Cap Screw Torque	Torque	30-38 N·m (22-28 lb-ft)

RB14256,00007D6 -19-18JUN12-2/2

Essential or Recommended Tools

NOTE: Order tools from the SERVICEGARD™ Catalog.

ESSENTIAL TOOLS listed are required to perform the job correctly and are obtainable only from the SERVICEGARD™ Catalog.

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RECOMMENDED TOOLS, as noted, are suggested to perform the job correctly. Some tools may be available from local suppliers or may be fabricated.

RB14256,00007D7 -19-19AUG14-1/3

Pressure Gauge, 3000 PSI..................................JT03345

Measure system pressure.
Hose with Coupler JT03017

Measure system pressure.

Connector, 1/4 M NPT x 7/16-20M 37° JT05486

Measure system pressure.

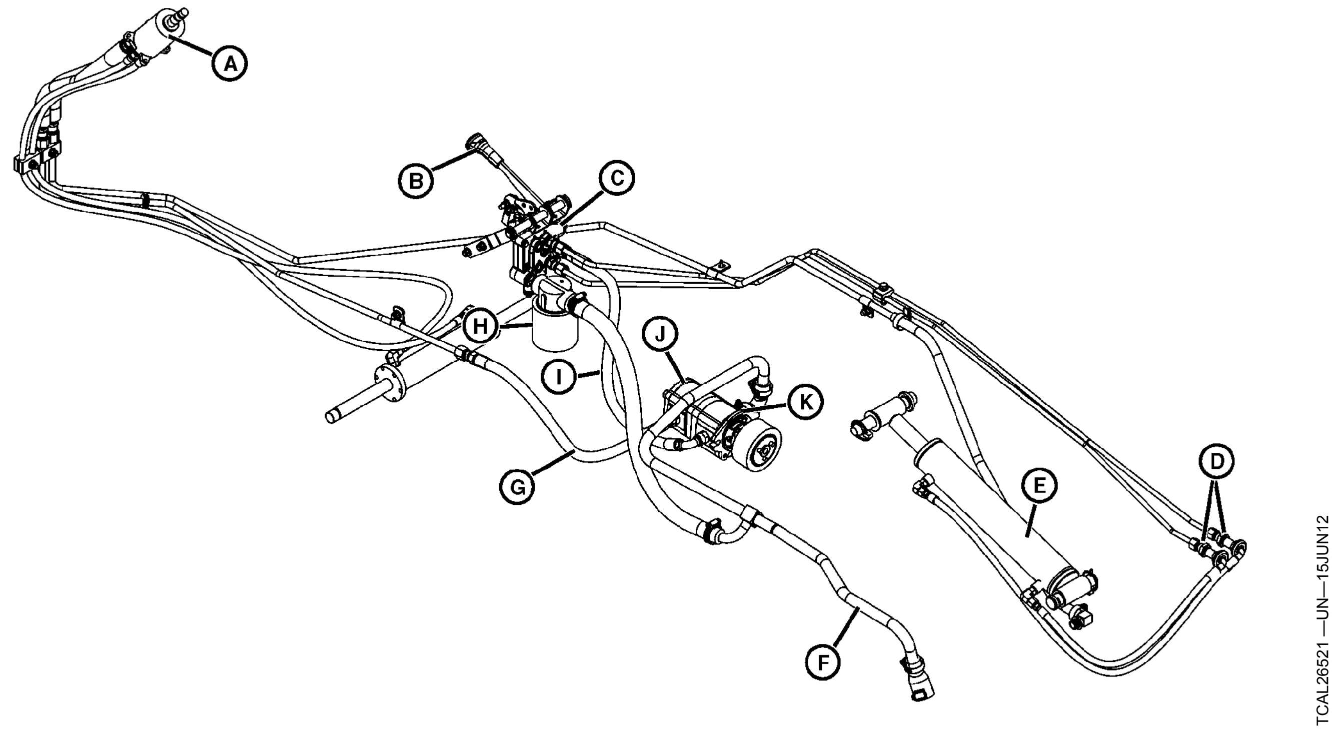
RB14256,00007D7 -19-19AUG14-2/3

Flowmeter.. D01169AA

Test system flow.

RB14256,00007D7 -19-19AUG14-3/3

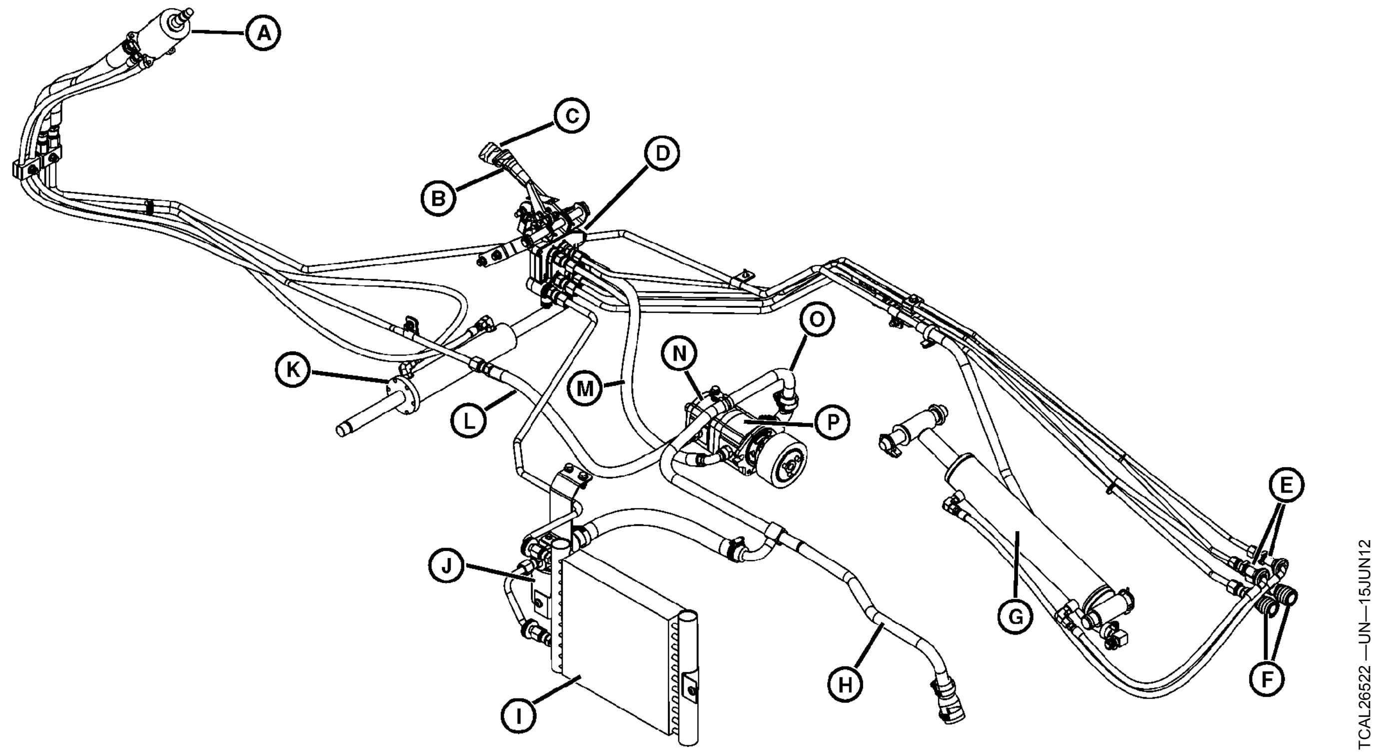
Standard Hydraulic System



A—Steering Control Unit
B—Lift Cylinder Lever
C—Control Valve
D—Lift Cylinder Ports
E—Lift Cylinder
F—Suction Line from Transaxle
G—Steering Pump Outlet Line
H—Oil Filter
I— Auxiliary Pump Outlet Line
J— Steering Pump
K—Auxiliary Pump

RB14256,00007D9 -19-18JUN12-1/1

Hydraulic System with Auxiliary Kit (SN -080000)

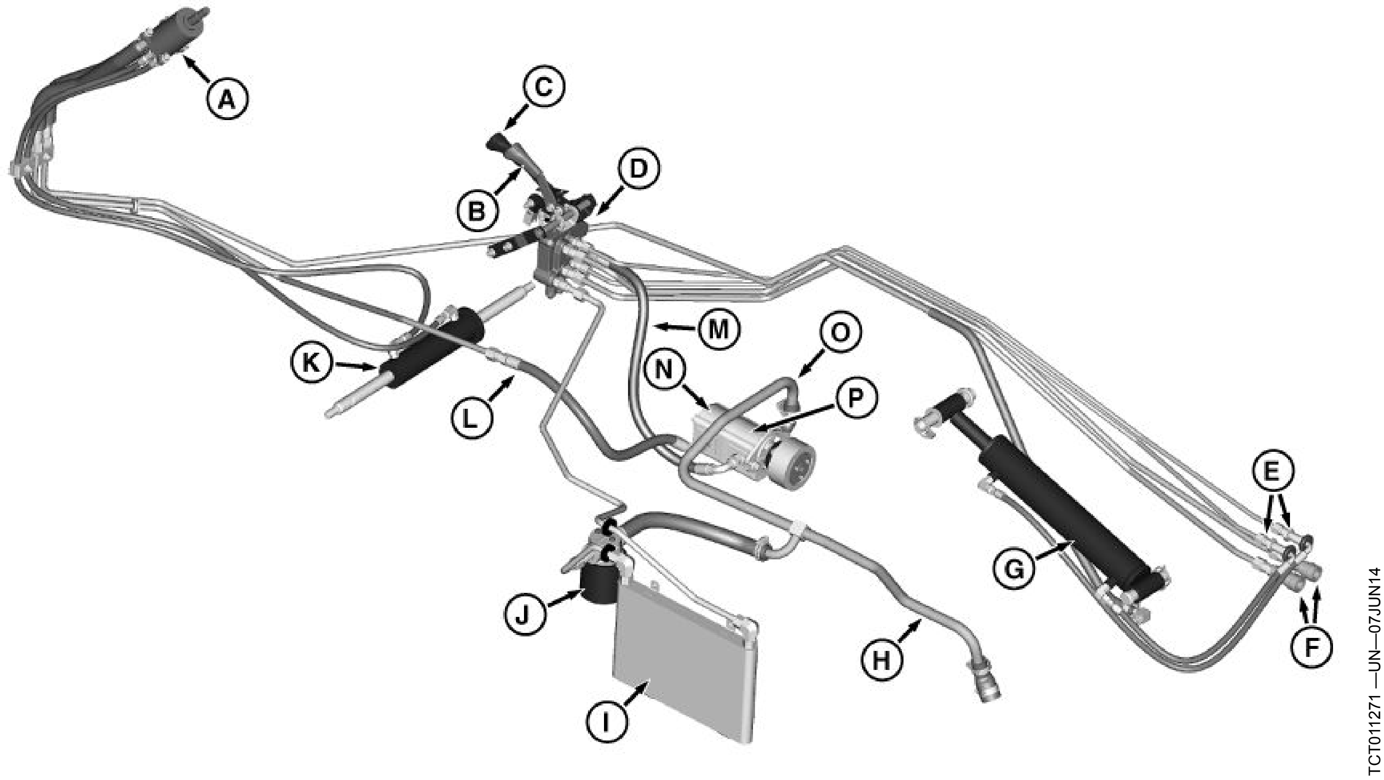


SN -080000

A—Steering Control Unit
B—Auxiliary Control Lever
C—Lift Cylinder Lever
D—Control Valve
E—Lift Cylinder Ports
F—Auxiliary Quick-Disconnect Ports
G—Lift Cylinder
H—Suction Line from Transaxle
I— Oil Cooler
J— Oil Filter
K—Steering Cylinder
L— Steering Pump Outlet Line
M—Auxiliary Pump Outlet Line
N—Steering Pump
O—Pump Inlet
P—Auxiliary Pump

RB14256,00007DA -19-18JUN12-1/1

Hydraulic System with Auxiliary Kit (SN 080001-)



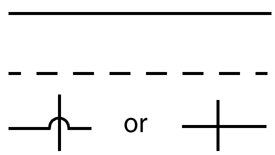
SN 080001-

A—Steering Control Unit
B—Auxiliary Control Lever
C—Lift Cylinder Lever
D—Control Valve
E—Lift Cylinder Ports
F—Auxiliary Quick-Disconnect Ports
G—Lift Cylinder
H—Suction Line from Transaxle
I— Oil Cooler
J—Oil Filter
K—Steering Cylinder
L—Steering Pump Outlet Line
M—Auxiliary Pump Outlet Line
N—Steering Pump
O—Pump Inlet
P—Auxiliary Pump

BS62576,000178B -19-07JUN14-1/1

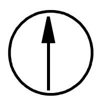
Hydraulic Symbols

TCAL26523 —UN—15JUN12



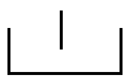
Working (Main) Lines, Pilot Control Lines, Crossing Lines

TCAL26524 —UN—15JUN12



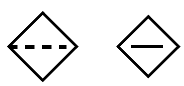
Fixed Displacement Pump

TCAL26525 —UN—15JUN12



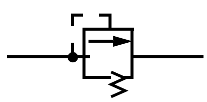
Vented Reservoir with Return above Fluid Level

TCAL26526 —UN—15JUN12



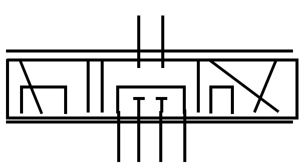
Strainer (left), Filter (right)

TCAL26527 —UN—15JUN12



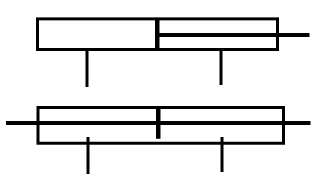
Pressure Relief Valve

TCAL26530 —UN—15JUN12



Three Position, Six Connection Valve with Infinite Positioning

TCAL26531 —UN—15JUN12



Double Acting Single Rod Cylinder (Top), Double Acting Single Rod Cylinder (Bottom)

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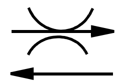
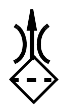
RB14256,00007DB -19-22JUN12-1/2

TCAL26532 —UN—15JUN12



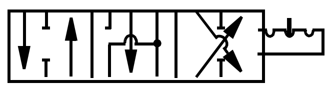
One Way Flow Restrictor (Orifice Plate)

TCAL26533 —UN—15JUN12



Vented Cap

TCAL26528 —UN—15JUN12



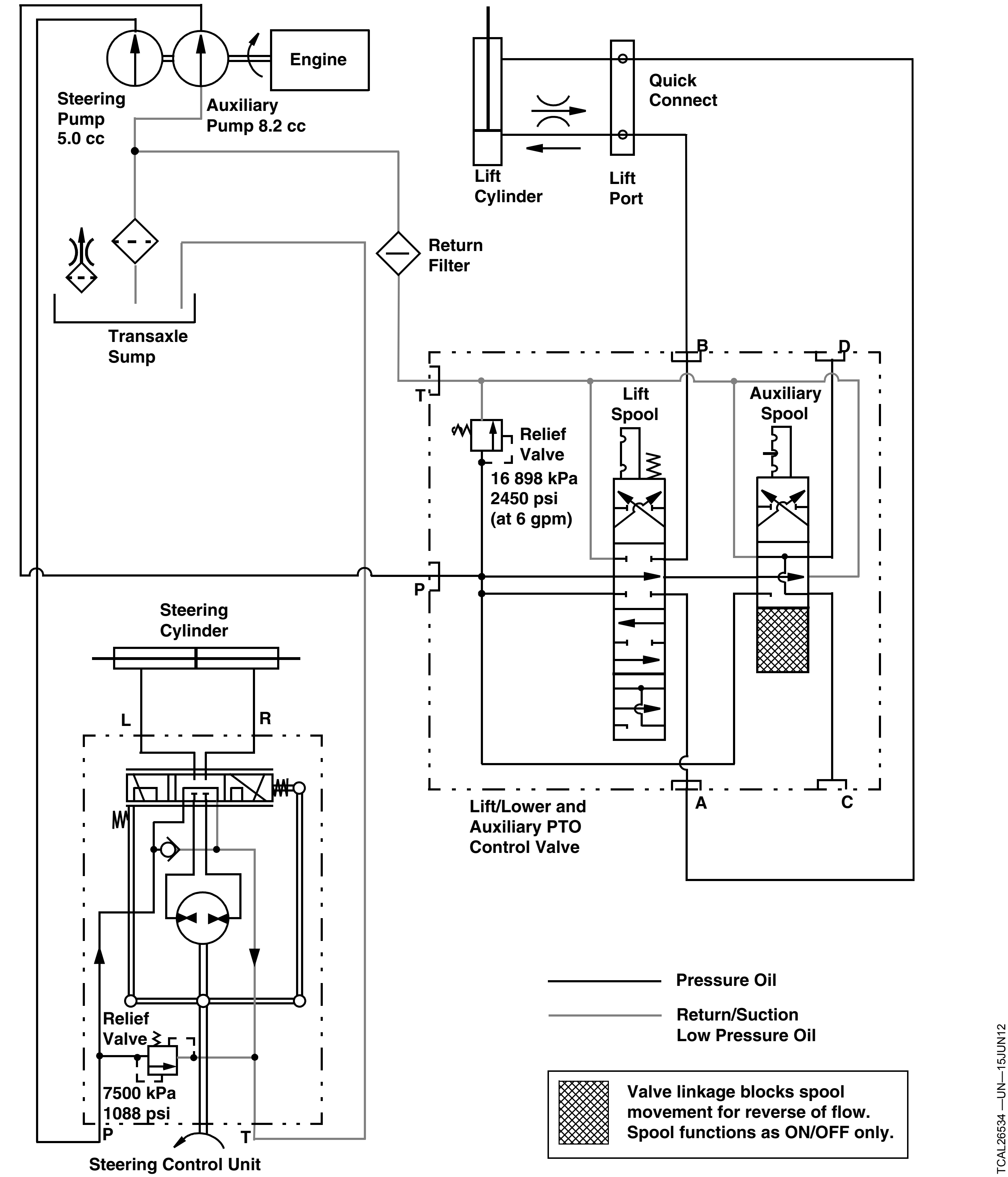
Three Position, Six Connection Valve with Detents

TCAL26529 —UN—15JUN12

Four Position, Spring Return with Detented Float

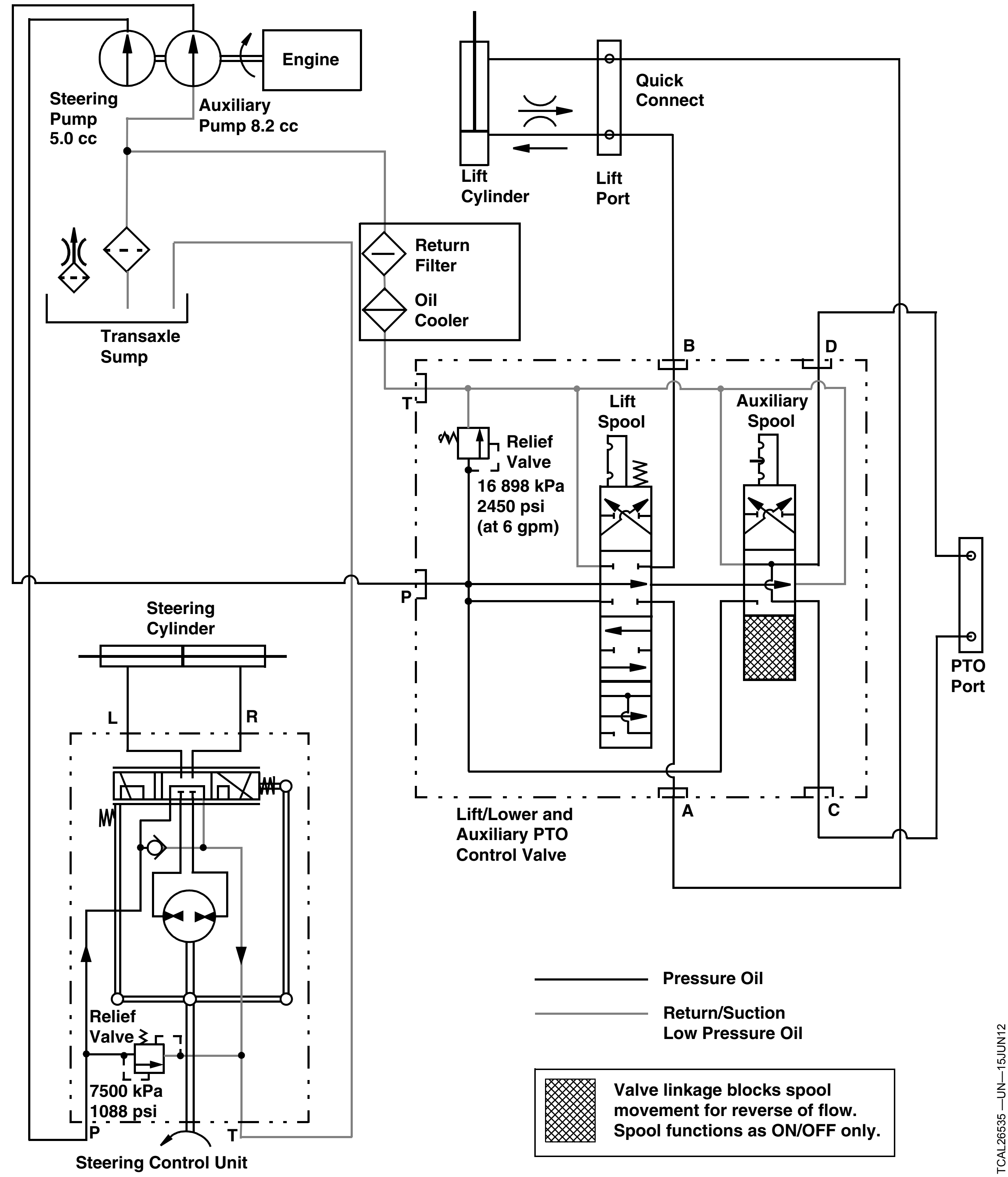
RB14256,00007DB -19-22JUN12-2/2

Hydraulic System Schematic



RB14256,00007DC -19-18JUN12-1/1

Hydraulic System Schematic with Auxiliary Kit



RB14256,00007DD -19-18JUN12-1/1

Hydraulic System

The hydraulic system consists of two functional systems: the steering system and the PTO system.

The steering system and PTO system are run from a tandem hydraulic pump driven by a coupling from the engine crankshaft. The pump nearest the front of the machine is the steering pump.

The steering pump supplies hydraulic pressure to the steering control unit (SCU). The SCU utilizes an open center control valve to operate the steering cylinder. When the steering wheel is turned, the SCU directs hydraulic pressure to the appropriate steering cylinder hose, pushing the steering cylinder ram, which pivots the front spools and wheels. The SCU has a relief valve that operates at 7000-7500 kPa (1015-1088 psi). The SCU and steering cylinder are not serviceable and must be replaced as complete units.

The PTO pump is the pump closest to the engine. High-pressure hydraulic oil is pumped to the hydraulic/PTO control valve.

The lift cylinder control spool (in the hydraulic PTO control valve) routes high-pressure hydraulic oil to either the lift side of the cargo box lift cylinder or the lower side of the cargo box cylinder. While one side of the cargo box lift cylinder is being pressurized, the other side is opened to the hydraulic return system. To prevent the lift cylinder and cargo box from lowering too fast, the rate of descent is limited by an orifice in the lift side of the cylinder.

The standard hydraulic system control valve contains two spools: the lift/lower cylinder control spool and the auxiliary control spool. Unless the auxiliary hydraulic kit is installed in the vehicle, the auxiliary control spool is not used.

When the auxiliary hydraulic kit is installed, the auxiliary control spool controls high-pressure hydraulic oil to an added set of hydraulic PTO ports at the rear of the vehicle. Low-pressure return oil from the PTO port flows through the auxiliary spool.

RB14256,00007DE -19-18JUN12-1/1

Symptom: Jerky Hydraulic Operation

RB14256,00007DF -19-06JUL12-1/7

Jerky Hydraulic Operation

RB14256,00007DF -19-06JUL12-2/7

Step 1	Is hydraulic oil at proper level?	**YES:** Go to next step. **NO:** Fill reservoir to proper level with recommended oil.

RB14256,00007DF -19-06JUL12-3/7

Step 2	Are all fittings tight, keeping air out of the system?	**YES:** Go to next step. **NO:** Tighten fittings and bleed air from system.

RB14256,00007DF -19-06JUL12-4/7

Step 3	Is pump suction strainer free of obstructions?	**YES:** Go to next step. **NO:** Clean suction strainer. (See Remove and Replace Transaxle Oil Strainer.)

RB14256,00007DF -19-06JUL12-5/7

Step 4	Is lift/auxiliary control valve working properly?	**YES:** Go to next step. **NO:** Check for sticking spools. (See Remove and Install PTO Control Valve.) Check linkage adjustment. (See Control Valve Installation in Remove and Install PTO Control Valve.) Check system relief valve. (See Adjust System Pressure Relief.)

RB14256,00007DF -19-06JUL12-6/7

Step 5	Is auxiliary pump operating properly?	**NO:** Perform (Test Auxiliary Pump Flow with Auxiliary Hydraulic Kit Installed.) Proceed as directed in “Results”.

RB14256,00007DF -19-06JUL12-7/7

Symptom: Hydraulic Functions Do Not Operate

RB14256,00007E0 -19-06JUL12-1/5

Hydraulic Functions Do Not Operate

Continued on next page

RB14256,00007E0 -19-06JUL12-2/5

Step 1	Is hydraulic oil at proper level?	**YES:** Go to next step. **NO:** Fill reservoir to proper level with recommended oil.

RB14256,00007E0 -19-06JUL12-3/5

Step 2	Is lift/auxiliary control valve working properly?	**YES:** Go to next step. **NO:** Check for sticking spools. (See Remove and Install PTO Control Valve.) Check linkage adjustment (See Remove and Install PTO Control Valve.) Check system relief valve. (See Adjust System Pressure Relief.)

RB14256,00007E0 -19-06JUL12-4/5

Step 3	Are steering and auxiliary pumps operating properly?	**YES:** Go to next step. **NO:** Perform (Test Steering System.) Perform (Test Auxiliary Pump Flow with Auxiliary Hydraulic Kit Installed.) Proceed as directed in “Results”.

RB14256,00007E0 -19-06JUL12-5/5

Symptom: Lift Cylinder Will Not Retract

RB14256,00007E1 -19-06JUL12-1/4

Lift Cylinder Will Not Retract

RB14256,00007E1 -19-06JUL12-2/4

Step 1	Is lift/auxiliary control valve working properly?	**YES:** Go to next step. **NO:** Check for sticking spools. (See Remove and Install PTO Control Valve.) Check linkage adjustment (See Control Valve Installation in Remove and Install PTO Control Valve.)

RB14256,00007E1 -19-06JUL12-3/4

Step 2	Is lift cylinder operating properly?	**NO:** Replace lift cylinder.

RB14256,00007E1 -19-06JUL12-4/4

Symptom: Lift Cylinder Will Not Lift Rated Load

RB14256,00007E2 -19-06JUL12-1/7

Lift Cylinder Will Not Lift Rated Load

Continued on next page

RB14256,00007E2 -19-06JUL12-2/7

Step 1	Is hydraulic oil at proper level?	**YES:** Go to next step. **NO:** Fill reservoir to proper level with recommended oil.

RB14256,00007E2 -19-06JUL12-3/7

Step 2	Are all fittings tight, keeping air out of the system?	**YES:** Go to next step. **NO:** Tighten fittings and bleed air from system.

RB14256,00007E2 -19-06JUL12-4/7

Step 3	Is pump suction strainer free of obstructions?	**YES:** Go to next step. **NO:** Clean suction strainer. (See Remove and Replace Transaxle Oil Strainer.)

RB14256,00007E2 -19-06JUL12-5/7

Step 4	Is lift/auxiliary control valve working properly?	**YES:** Go to next step. **NO:** Check for sticking spools. (See Remove and Install PTO Control Valve.) Check linkage adjustment (See Remove and Install PTO Control Valve.) Check system relief valve. (See Adjust System Pressure Relief.) Check lift cylinder for leakage.

RB14256,00007E2 -19-06JUL12-6/7

Step 5	Is auxiliary pump operating properly?	**NO:** Perform (Test Auxiliary Pump Flow with Auxiliary Hydraulic Kit Installed.)Proceed as directed in “Results”.

RB14256,00007E2 -19-06JUL12-7/7

Symptom: Lift Cylinder Oscillates

RB14256,00007E3 -19-06JUL12-1/6

Lift Cylinder Oscillates

RB14256,00007E3 -19-06JUL12-2/6

Step 1	Is hydraulic oil at proper level?	**YES:** Go to next step. **NO:** Fill reservoir to proper level with recommended oil.

RB14256,00007E3 -19-06JUL12-3/6

Step 2	Are all fittings tight, keeping air out of the system?	**YES:** Go to next step. **NO:** Tighten fittings and bleed air from system.

Continued on next page

RB14256,00007E3 -19-06JUL12-4/6

Step 3	Is lift/auxiliary control valve working properly?	**YES:** Go to next step. **NO:** Check for sticking spools or improper linkage adjustment. (See Remove and Install PTO Control Valve.) Check system relief valve. (See Adjust System Pressure Relief.)

RB14256,00007E3 -19-06JUL12-5/6

Step 4	Is auxiliary pump operating properly?	**NO:** Perform (Test Auxiliary Pump Flow with Auxiliary Hydraulic Kit Installed.)Proceed as directed in “Results”.

RB14256,00007E3 -19-06JUL12-6/6

Symptom: Lift Cylinder Will Not Support Load with Engine Off

RB14256,00007E4 -19-06JUL12-1/4

Lift Cylinder Will Not Support Load with Engine Off

RB14256,00007E4 -19-06JUL12-2/4

Step 1	Is lift/auxiliary control valve working properly?	**YES:** Go to next step. **NO:** Check for sticking spools. (See Remove and Install PTO Control Valve.) Check linkage adjustment (See Control Valve Installation in Remove and Install PTO Control Valve.) Check system relief valve. (See Adjust System Pressure Relief.)

RB14256,00007E4 -19-06JUL12-3/4

Step 2	Is lift cylinder operating properly?	**NO:** Check lift cylinder for leakage. Replace cylinder as necessary.

RB14256,00007E4 -19-06JUL12-4/4

Symptom: Attachment Motor Connected to PTO Ports, Operates Under Speed

RB14256,00007E5 -19-06JUL12-1/7

Attachment Motor Connected to PTO Ports, Operates Under Speed

RB14256,00007E5 -19-06JUL12-2/7

Step 1	Is hydraulic oil at proper level?	**YES:** Go to next step. **NO:** Fill reservoir to proper level with recommended oil.

Continued on next page

RB14256,00007E5 -19-06JUL12-3/7

Step 2	Are all fittings tight, keeping air out of the system?	**YES:** Go to next step. **NO:** Tighten fittings and bleed air from system.

RB14256,00007E5 -19-06JUL12-4/7

Step 3	Is pump suction strainer free of obstructions?	**YES:** Go to next step. **NO:** Clean suction strainer. (See Remove and Replace Transaxle Oil Strainer.)

RB14256,00007E5 -19-06JUL12-5/7

Step 4	Is lift/auxiliary control valve working properly?	**YES:** Go to next step. **NO:** Check for sticking spools. (See Remove and Install PTO Control Valve.) Check linkage adjustment (See Remove and Install PTO Control Valve.) Check system relief valve. (See Adjust System Pressure Relief.) Check lift cylinder for leakage.

RB14256,00007E5 -19-06JUL12-6/7

Step 5	Is auxiliary pump operating properly?	**NO:** Perform (Test Auxiliary Pump Flow with Auxiliary Hydraulic Kit Installed.) Proceed as directed in "Results".

RB14256,00007E5 -19-06JUL12-7/7

Symptom: Attachment Motor Connected to PTO Ports, Does Not Operate

RB14256,00007E6 -19-06JUL12-1/6

Attachment Motor Connected to PTO Ports, Does Not Operate

RB14256,00007E6 -19-06JUL12-2/6

Step 1	Is hydraulic oil at proper level?	**YES:** Go to next step. **NO:** Fill reservoir to proper level with recommended oil.

RB14256,00007E6 -19-06JUL12-3/6

Step 2	Are PTO quick couplers connected?	**YES:** Go to next step. **NO:** Connect couplers.

Continued on next page RB14256,00007E6 -19-06JUL12-4/6

Step 3	Is lift/auxiliary control valve working properly?	**YES:** Go to next step. **NO:** Check for sticking spools. (See Remove and Install PTO Control Valve.) Check linkage adjustment (See Control Valve Installation in Remove and Install PTO Control Valve.) Check system relief valve. (See Adjust System Pressure Relief.) Check lift cylinder for leakage.

RB14256,00007E6 -19-06JUL12-5/6

Step 4	Is auxiliary pump operating properly?	**NO:** Perform (Test Auxiliary Pump Flow with Auxiliary Hydraulic Kit Installed.) Proceed as directed in “Results”.

RB14256,00007E6 -19-06JUL12-6/6

Symptom: Attachment Motor Connected to PTO Ports, Turns in Wrong Direction

RB14256,00007E7 -19-18JUN12-1/3

Attachment Motor Connected to PTO Ports, Turns in Wrong Direction

RB14256,00007E7 -19-18JUN12-2/3

Step 1	Are PTO quick couplers connected to the correct ports?	**NO:** Connect couplers correctly.

RB14256,00007E7 -19-18JUN12-3/3

Symptom: High Steering Wheel Effort

RB14256,00007E8 -19-18JUN12-1/7

High Steering Wheel Effort

RB14256,00007E8 -19-18JUN12-2/7

Step 1	Is hydraulic oil at proper level?	**YES:** Go to next step. **NO:** Fill reservoir to proper level with recommended oil.

RB14256,00007E8 -19-18JUN12-3/7

Step 2	Are all fittings tight, keeping air out of the system?	**YES:** Go to next step. **NO:** Tighten fittings and bleed air from system.

Continued on next page

RB14256,00007E8 -19-18JUN12-4/7

Step 3	Is pump suction strainer free of obstructions?	**YES:** Go to next step. **NO:** Clean suction strainer. (See Remove and Replace Transaxle Oil Strainer.)

RB14256,00007E8 -19-18JUN12-5/7

Step 4	Is steering control valve working properly?	**YES:** Go to next step. **NO:** Perform (Test Steering System.) (See Steering Control Unit (SCU).)

RB14256,00007E8 -19-18JUN12-6/7

Step 5	Is steering pump operating properly?	**NO:** (See Disassemble and Assemble Hydraulic Pump.)

RB14256,00007E8 -19-18JUN12-7/7

Symptom: No Steering Function

RB14256,00007E9 -19-18JUN12-1/8

No Steering Function

RB14256,00007E9 -19-18JUN12-2/8

Step 1	Is hydraulic oil at proper level?	**YES:** Go to next step. **NO:** Fill reservoir to proper level with recommended oil.

RB14256,00007E9 -19-18JUN12-3/8

Step 2	Are all fittings tight, keeping air out of the system?	**YES:** Go to next step. **NO:** Tighten fittings and bleed air from system.

RB14256,00007E9 -19-18JUN12-4/8

Step 3	Is pump suction strainer free of obstructions?	**YES:** Go to next step. **NO:** Clean suction strainer. (See Remove and Replace Transaxle Oil Strainer.)

RB14256,00007E9 -19-18JUN12-5/8

Step 4	Is steering control valve working properly?	**YES:** Go to next step. **NO:** Perform (Test Steering System.) (See Steering Control Unit (SCU).)

RB14256,00007E9 -19-18JUN12-6/8

Step 5	Is steering cylinder operating properly?	**YES:** Go to next step. **NO:** Perform (Test Steering Cylinder Leakage.)

Continued on next page RB14256,00007E9 -19-18JUN12-7/8

Step 6	Is steering pump operating properly?	**NO:** (See Disassemble and Assemble Hydraulic Pump.)

RB14256,00007E9 -19-18JUN12-8/8

Adjust System Pressure Relief

Reason

To make sure that the hydraulic system pressure relief valve is correctly set.

Special or Required Tools

- JT03345 Pressure Gauge
- JT03017 Hose with Coupler
- JT05486 Connector

Procedure

CAUTION: Escaping fluid under pressure can penetrate the skin, causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body from high-pressure fluids.

If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury may call Deere & Company Medical Department in Moline, Illinois, or other knowledgeable medical source.

IMPORTANT: Oil in system should be at normal operating temperature.

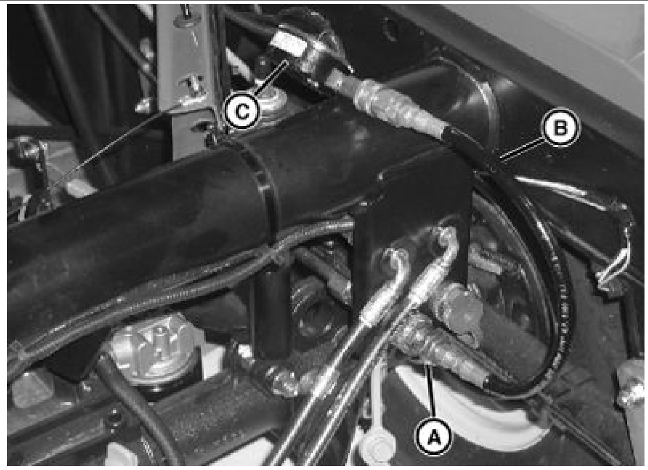
1. Install pressure gauge as follows:
   - Install JT05486 Connector (A), JT03017 Hose with Coupler (B), and JT03345 Pressure Gauge (C) to pressure port.
   - Install t-connector (D) with hose assembly to rod end of hydraulic cylinder.
   - Attach JT03345 Pressure Gauge (E) to quick coupler.
2. Start engine and run at fast idle.

IMPORTANT: The following step puts the hydraulic pump into relief. DO NOT operate in this condition for more than 5 seconds!

3. Activate the appropriate lever with the lift cylinder fully retracted. Read pressure gauge and then release handle.
   - **Vehicles with auxiliary hydraulic kit:** PTO lever to the up position.
   - **Vehicles without auxiliary hydraulic kit:** lift/lower handle in down position.

Results

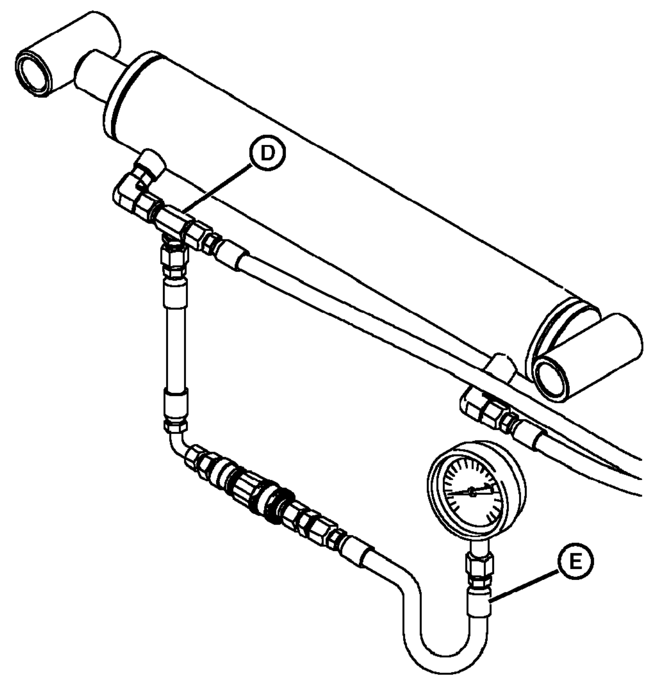
Verify system pressure is within specification.



TCAL26536 —UN—15JUN12

Vehicles with auxiliary hydraulic kit installed.

A—Connector
B—Coupler
C—Pressure Gauge



TCAL26537 —UN—15JUN12

Vehicles without auxiliary hydraulic kit installed.

D—T-connector
E—Pressure Gauge

Specification

Relief Pressure Control Valve—Pressure.............................16 547-17 236 kPa (2400-2500 psi)

If not, adjust as follows:

Continued on next page

RB14256,00007EA -19-18JUN12-1/2

Adjustment

1. Remove control panel cover to gain access to relief valve.
2. Ensure that both spools are of equal specified height above the valve body and are in their neutral position.

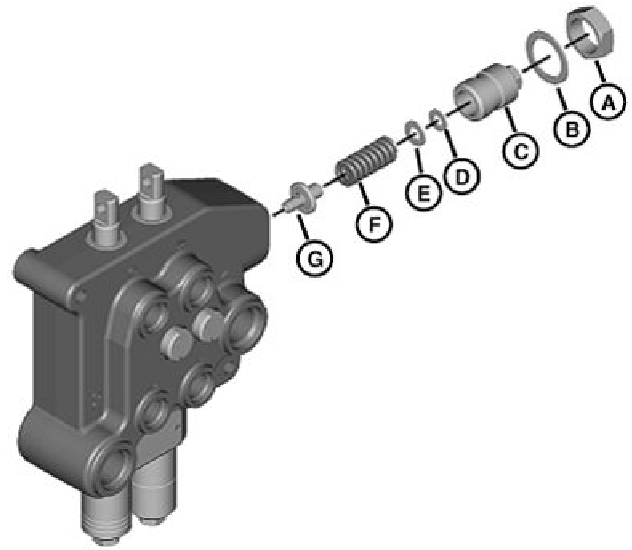
Specification

Spool Height—Height................................Approximately 5 mm [0.2 in].

3. Adjust system pressure as follows:
   - Loosen nut (A) and washer (B).
   - Adjust pressure by rotating spring body (C) counter clockwise to decrease pressure, or by rotating spring body clockwise to increase pressure. The spring body shim (D) is installed at the factory: Do not remove shims.
4. Tighten nut. Retest system pressure, and repeat adjustment as required until pressure is set to specification.

Specification

System Pressure—Pressure..Be Approximately 16 547-17 236 kPa (2400-2500 Psi)



A—Nut
B—Washer
C—Spring Body
D—Spring Body Shim
E—Spring Body Shim
F—Spring
G—Screw

RB14256,00007EA -19-18JUN12-2/2

Hydraulic Cycle Time Test

Reason

To determine if hydraulic system is working efficiently.

Procedure

IMPORTANT: To obtain accurate readings, oil in system should be at normal operating temperature and machine should be equipped with a cargo box.

1. Park machine on flat level surface.
2. Warm up hydraulic oil to normal operating temperature.
3. Shift machine into neutral position and apply park brake. Lower cargo box.
4. Run engine at fast idle.
5. Raise the cargo box and start the stopwatch at the same time. Note the time required to raise the box to fully raised position.

Results

Cycle times should be to specification.

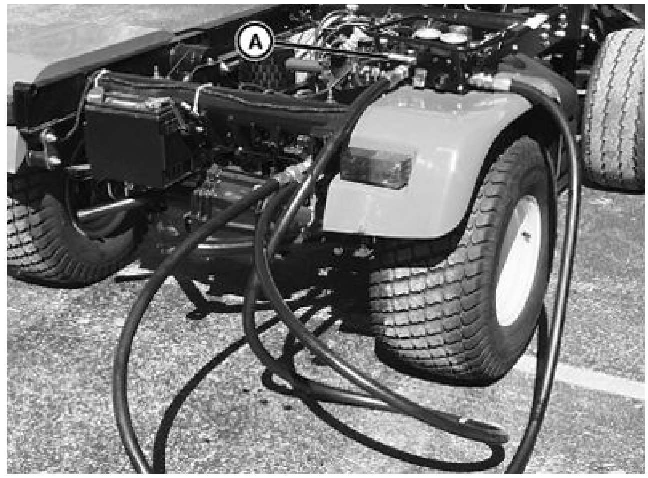
Item	Measurement	Specification
Gas Engine Hydraulic Cycle Time		2.5 seconds
Diesel Engine Hydraulic Cycle Time		2.5 seconds

If not:

- Check that oil is at the proper level and at normal operating temperature.
- Replace hydraulic system filter cartridge or check for screen filter for obstruction. (See Remove and Replace Transaxle Oil Strainer.)
- Check system relief pressure. (See Adjust System Pressure Relief.)
- Perform pump flow test. (See Test Auxiliary Pump Flow with Auxiliary Hydraulic Kit Installed.)
- Repair or replace pump or lift cylinder as required. (See Remove and Install Hydraulic Pump.)

RB14256,00007EB -19-19AUG14-1/1

Test Auxiliary Pump Flow with Auxiliary Hydraulic Kit Installed



TCAL26539 —UN—15JUN12

A—Flowmeter

Reason

To determine if auxiliary hydraulic pump is providing adequate flow under pressure.

Special or Required Tools

- D01169AA

Procedure

IMPORTANT: Oil in system should be at normal operating temperature.

1. Install D01169AA Flowmeter (A) or equivalent and hoses between PTO ports on rear of vehicle.
2. Open valve on flowmeter all the way.
3. Start engine and run at fast idle.
4. Hold the lift cylinder lever in the UP position.
5. Observe flow.

Results

Pump flow should be to specification.

NOTE: Pump output is based on pump volume, which would be pump displacement x rpm = flow (Example: 0.0082 L x 3400 rpm = 27.9 L/min).

Specification

Gas Engine (3400 RPM)—Flow Rate... 27.9 liters/min (7.5 gpm)

Diesel Engine (3450 RPM)—Flow Rate... 28.3 liters/min (7.4 gpm)

If not:

- Check intake filter for obstruction. Clean and/or replace as required. (See Remove and Replace Transaxle Oil Strainer.)
- Repair/replace pump as required. (See Remove and Install Hydraulic Pump.)

RB14256,00007EC -19-18JUN12-1/1

Test Auxiliary Pump Flow without Auxiliary Hydraulic Kit Installed

Reason

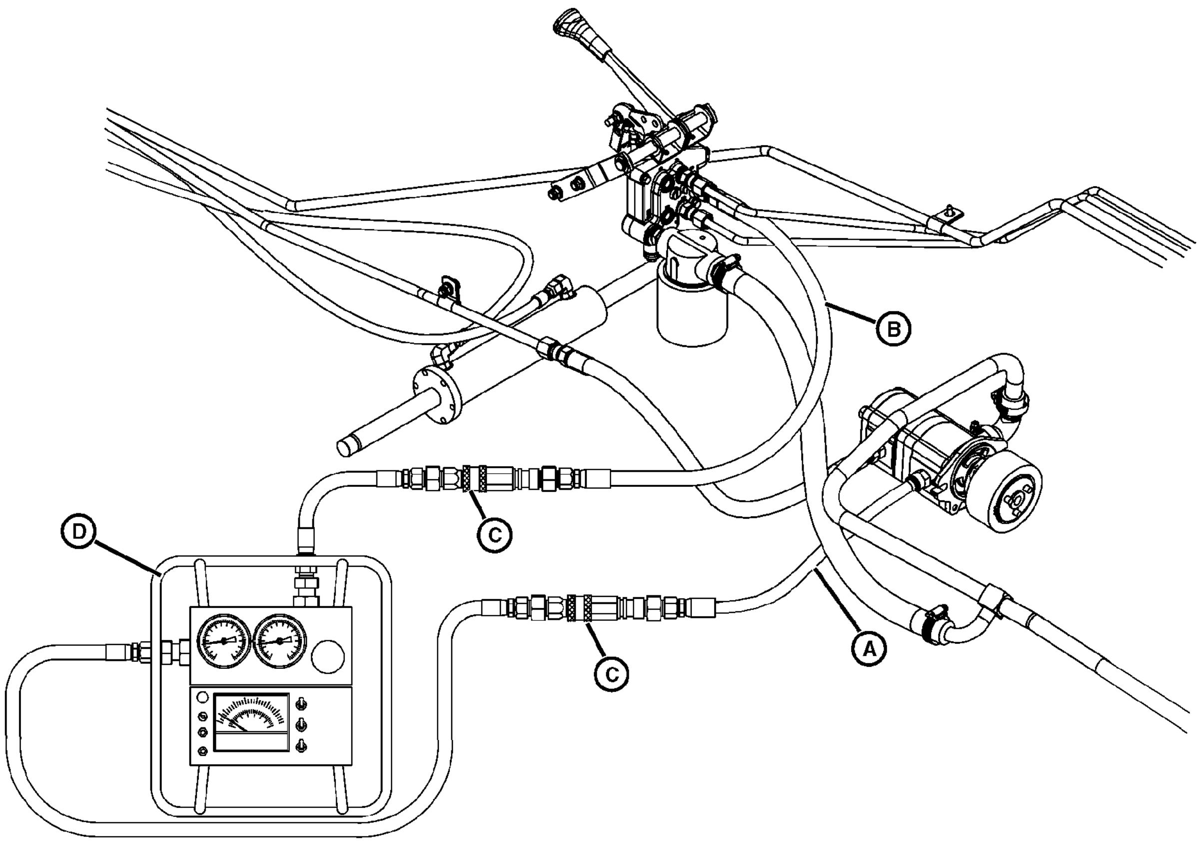
To determine if auxiliary hydraulic pump is providing adequate flow under pressure.

Special or Required Tools

- D01169AA

Procedure

IMPORTANT: Oil in system should be at normal operating temperature.



A—Hydraulic Hose
B—Hydraulic Hose
C—Quick Coupler Fittings
D—Flowmeter

1. Place a drain pan under auxiliary pump.
2. Disconnect output hose from pump at pump fitting.
3. Disconnect input hose to valve control at fitting.
4. Connect hydraulic hose (A) to auxiliary pump. Connect hydraulic hose (B) to valve controller.
5. Use Quick Coupler fittings (C) to connect hose (A) and hose (B) to Flowmeter (D) D01169AA or equivalent.
6. Open valve on flowmeter all the way.
7. Start engine and run at fast idle.
8. Observe flow.

Results

Pump flow should be to specification.

NOTE: Pump output is based on pump volume, which would be pump displacement x rpm = flow(Example: 0.0082 L x 3400 = 27.9 L/min)

Item	Measurement	Specification
Pump Flow (Gasoline Engine @ 3400 RPM)	Flow Rate	27.9 liters/min (7.4 gpm)
Pump Flow (Diesel Engine @ 3450 RPM)	Flow Rate	28.3 liters/min (7.5 gpm)

If not:

Continued on next page

RB14256,00007ED -19-18JUN12-1/2

- Check intake filter for obstruction. Clean and/or replace as required. (See Remove and Replace Transaxle Oil Strainer.)
- Repair/replace pump as required. (See Remove and Install Hydraulic Pump.)

RB14256,00007ED -19-18JUN12-2/2

Test Steering Pump Flow

Reason

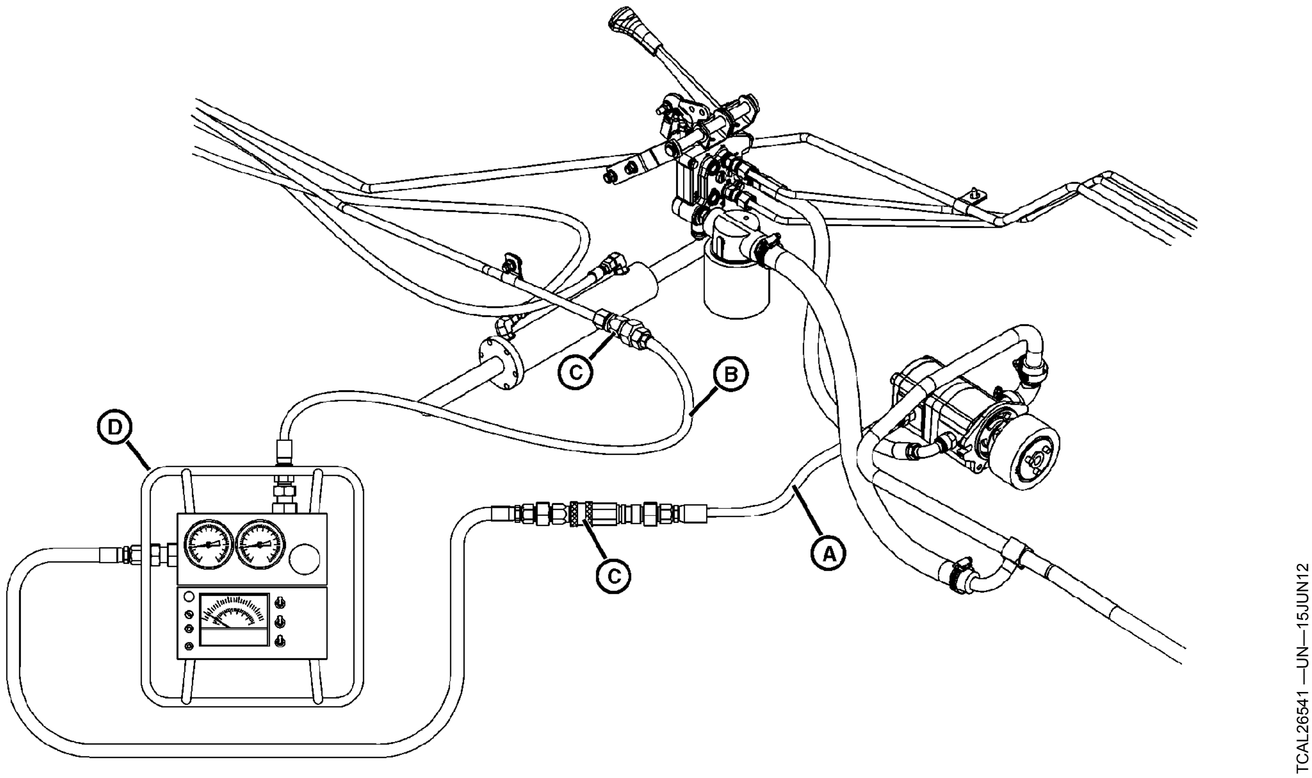
To determine if steering hydraulic pump is providing adequate flow under pressure.

Special or Required Tools

- D01169AA

Procedure

IMPORTANT: Oil in system should be at normal operating temperature.



A—Hydraulic Hose
B—Hydraulic Hose
C—Quick Coupler Fittings
D—Flowmeter

1. Place a drain pan under steering pump.
2. Disconnect output hose from pump at pump fitting.
3. Disconnect input hose to steering control line at fitting.
4. Connect hydraulic hose (A) to steering pump. Connect hydraulic hose (B) to steering control line.
5. Use Quick Coupler fittings (C) to connect hose (A) and hose (B) to Flowmeter (D) D01169AA or equivalent.
6. Open valve on flowmeter all the way.
7. Start engine and run at fast idle.
8. Observe flow.

Results

Pump flow should be to specification.

Item	Measurement	Specification
Pump Flow (Gasoline Engine @ 3400 RPM)	Flow Rate	17.3 liters/min (4.6 gpm)
Pump Flow (Diesel Engine @ 3450 RPM)	Flow Rate	17.6 liters/min (4.7 gpm)

NOTE: Pump output is based on pump volume, which would be pump displacement x engine rpm = flow(Example: 0.005 L x 3400 = 17.3 L/min)

If not:

- Check intake filter for obstruction. Clean and/or replace as required. (See Remove and Replace Transaxle Oil Strainer.)

Continued on next page RB14256,00007EE -19-18JUN12-1/2

- Repair/replace pump as required. (See Remove and Install Hydraulic Pump.)

RB14256,00007EE -19-18JUN12-2/2

Test Steering System

Reason

To check steering control unit (SCU) and steering cylinder operation and to check for internal leakage.

Procedure

1. Park vehicle safely.
2. Run the engine until the hydraulic fluid is at operating temperature.
3. Turn the steering wheel to the full right position.
4. Remove steering wheel cap.
5. Place a torque wrench on steering wheel nut. Turn steering shaft to the right at a constant specified torque of and count the number of turns in one minute.

Specification

Steering Wheel Test
Torque—Torque.. 6.8 N·m (60 lb-in.)

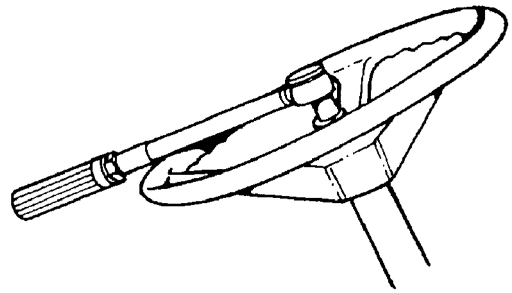
6. Repeat the procedure, turning the steering wheel to the full left position.
7. Stop engine.

Results

If the rotation in left or right direction exceeded 5 rpm, the steering system has internal leakage. To determine whether it is the SCU or cylinder that is leaking, proceed as directed below.

Procedure

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



TCAL26542 —UN—15JUN12

Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body from high-pressure fluids.

If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury may call Deere & Company Medical Department in Moline, Illinois, or other knowledgeable medical source.

1. Label and remove both left and right hydraulic hoses at the steering cylinder.
2. Cap the ends of both hoses.
3. Repeat the SCU test.

Results

- If the rotation speed is now below 5 rpm, replace the steering cylinder.
- If the rotation speed remains above 5 rpm, replace the SCU.

RB14256,00007EF -19-19AUG14-1/1

Test Steering Cylinder Leakage

Reason

To check steering cylinder for internal leakage.

Procedure

1. Park machine safely.
2. With machine at room temperature, start and run engine at fast idle for five minutes, to warm up hydraulic oil.
3. Turn key switch to OFF position.
4. Turn steering wheel to full right to fully retract cylinder end.
5. Disconnect hydraulic hose from right side of steering cylinder. Cap hydraulic line with O-ring seal plug.
6. Start engine and run at fast idle.
7. Continue turning steering wheel to the right.
8. Watch for any flow of oil out of the cylinder.
9. Repeat steps 5 through 8 for left turn and opposite end of cylinder.

Results

- If any flow of oil out of the cylinder occurred, replace cylinder.
- If no oil flow:
- Shut off engine.
- Connect hydraulic hose. Tighten hose connection to specification.

Specification

Hose Connection
Torque—Torque.. 30 N·m (22 lb-ft)

RB14256,00007F0 -19-18JUN12-1/1

Remove and Install Hydraulic Pump

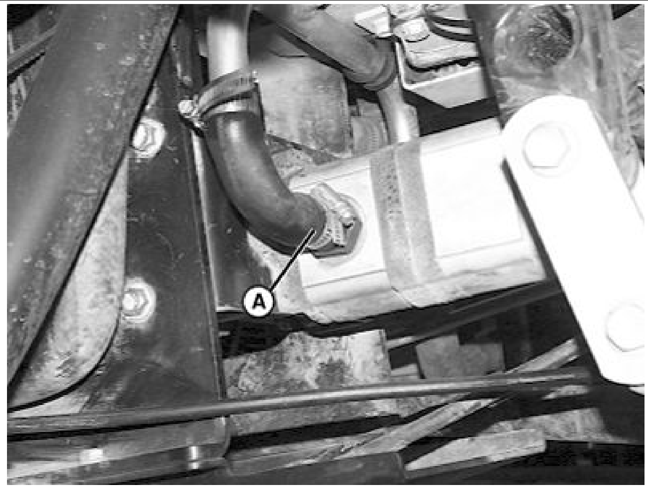
Removal

NOTE: Gasoline engine procedure shown, 3TNV76 and 3TNV80F diesel engines are similar.

1. Disconnect the negative (-) battery cable.
2. Remove pump guard.

NOTE: Place a suitable container under hydraulic pump to catch oil.

3. Disconnect hydraulic suction line (A) from pump assembly.

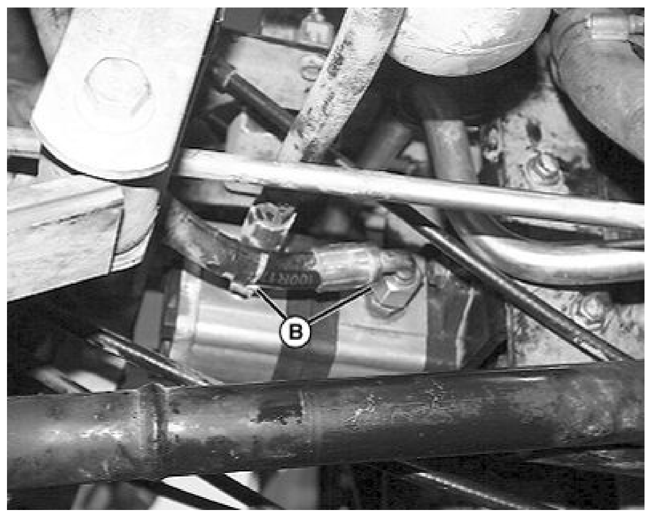


TCAL26543 —UN—15JUN12

A—Hydraulic Suction Line

RB14256,00007F1 -19-10JUN14-1/7

4. Remove pressure lines (B) from steering and auxiliary pump.

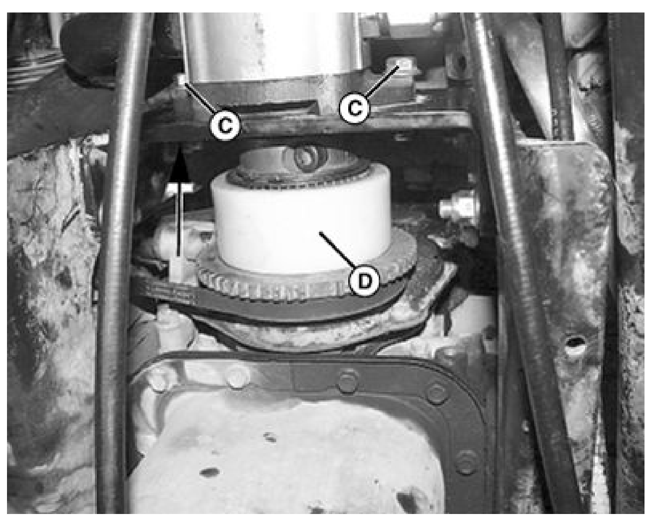


TCAL26544 —UN—15JUN12

B—Pressure Lines

RB14256,00007F1 -19-10JUN14-2/7

5. Remove flange bolts (C) securing pump to mounting bracket.
6. Separate hydraulic pump from engine and coupler (D). Remove coupler and inspect splines for wear or damage.
7. Remove auxiliary pump.



TCAL26545 —UN—15JUN12

C—Flange Bolts **D—Coupler**

Continued on next page

RB14256,00007F1 -19-10JUN14-3/7

Installation

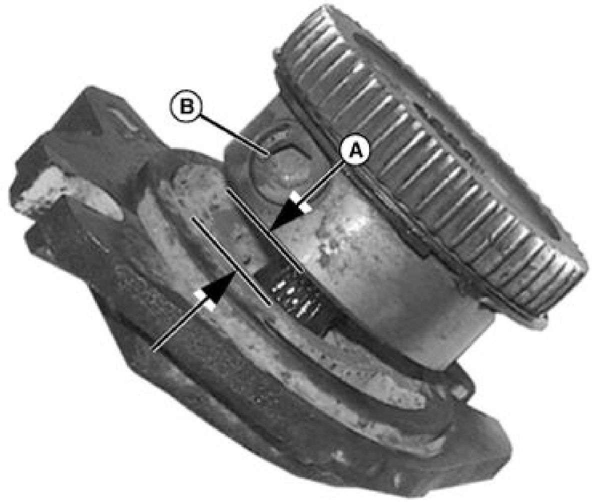
1. If pump drive gear was removed for disassembly purposes it may be necessary to adjust the gap (A) of the drive gear to specification. Tighten collar bolt (B) to specification.

Specification

Pump Drive Gear-to-Backplate Gap—Torque..8-9 mm (.32-.35 in.)

Pump Drive Gear Bolt—Torque.. 49 N·m (36 lb-ft)

A—Distance **B—Collar Bolt**



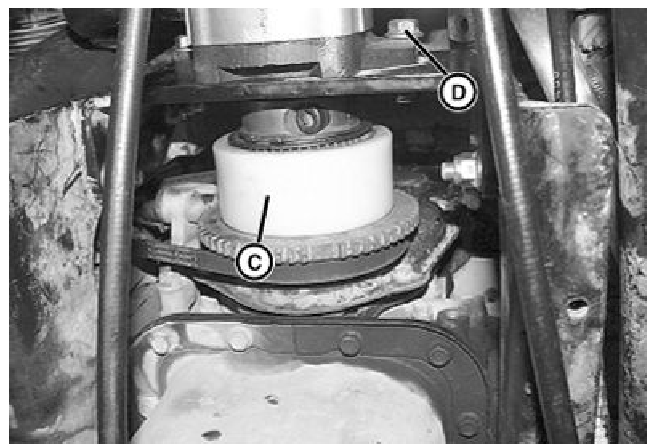
TCAL26546 —UN—15JUN12

RB14256,00007F1 -19-10JUN14-4/7

2. Slide pump coupler (C) onto engine crankshaft. Install pump while inserting pump drive gear into coupler. Do not tighten bolts at this time.
3. Install flange bolts (D) securing pump to bracket at specified torque.
4. With flange bolts finger tight, coupler should be able to freely slide back and forth. Crankshaft and pump drive gear should have an equal gap around the coupler sleeve.
5. Torque bolts (D) securing pump to bracket to specification while maintaining equal gap around the coupler sleeve and free sliding movement.

Specification

Hydraulic Pump-to-Mounting Bracket Bolt—Torque.. 61 N·m (45 lb-ft)



TCAL26547 —UN—15JUN12

C—Pump Coupler **D—Flange Bolts**

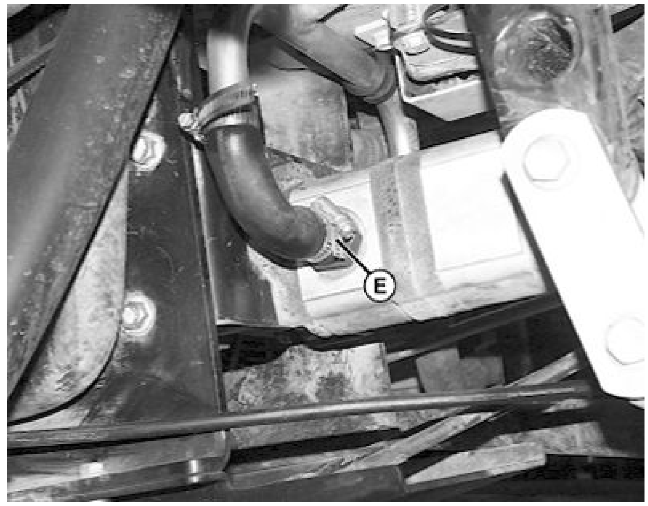
Continued on next page

RB14256,00007F1 -19-10JUN14-5/7

6. Install suction line (E) to auxiliary pump. Tighten to specification.

Specification

Hydraulic Pump Suction
Coupler Fitting—Torque.. 47 N·m (35 lb-ft)



TCAL26548 —UN—15JUN12

E—Suction Line

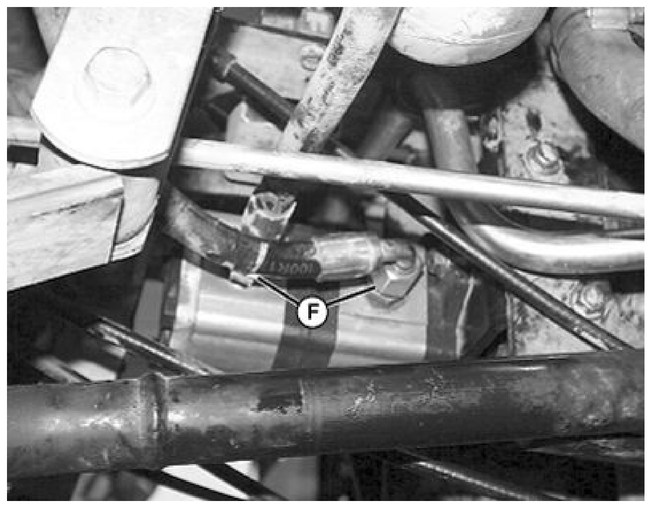
RB14256,00007F1 -19-10JUN14-6/7

7. Install pressure lines (F) to auxiliary and steering pumps. Tighten to specification.

Specification

Hydraulic Pump Pressure
Coupler Fitting—Torque.. 47 N·m (35 lb-ft)

8. Service reservoir as needed.
9. Connect the negative (-) battery cable.



TCAL26549 —UN—15JUN12

F—Pressure Lines

RB14256,00007F1 -19-10JUN14-7/7

Disassemble and Assemble Hydraulic Pump

Disassemble

NOTE: The only serviceable parts are the seals and backup rings. If the pump is excessively worn or damaged, replace the pump.

1. Remove fittings from pump housing.
2. Remove cap screws (A) from pump front cover (B).
3. Remove the front cover.

TCAL26550 —UN—15JUN12

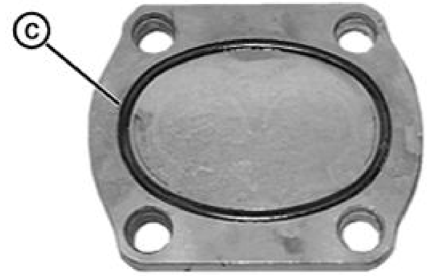
A—Cap Screws **B—Front Cover**

Continued on next page

RB14256,00007F2 -19-18JUN12-1/23

4. Remove and discard body seal (C).
5. Inspect front cover for wear or damage.

C—Body Seal



TCAL26551 —UN—15JUN12

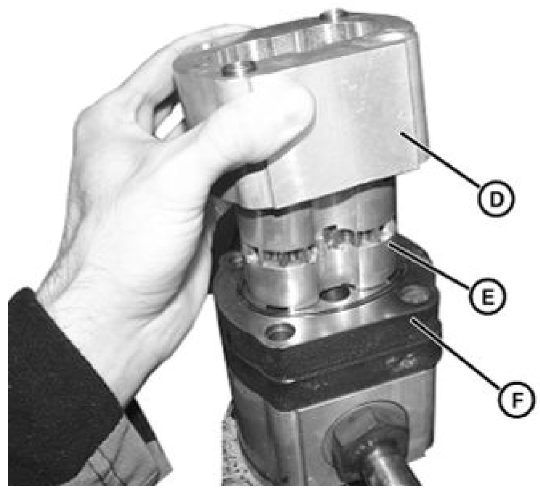
RB14256,00007F2 -19-18JUN12-2/23

IMPORTANT: Internal components like the bushing blocks and the gear set are liable to slip out of the pump body while dismantling. Take extreme care in handling parts.

NOTE: Internal components are defined as bushing blocks and gear set.

6. Remove steering pump body (D) and internal components (E) from backing plate (F).

D—Steering Pump Body
E—Internal Components
F—Backing Plate

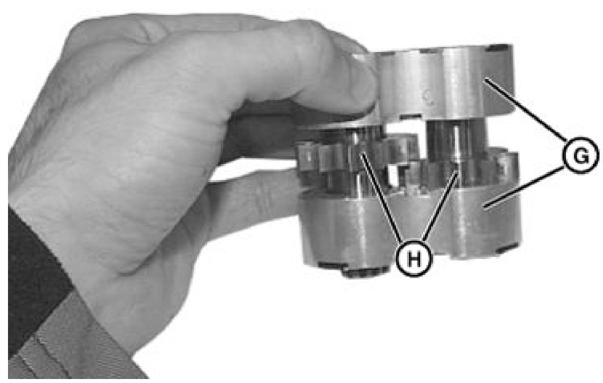


TCAL26552 —UN—15JUN12

RB14256,00007F2 -19-18JUN12-3/23

7. Disassemble bushing blocks (G) and pump gears (H).

G—Bushing Blocks
H—Pump Gears



TCAL26553 —UN—15JUN12

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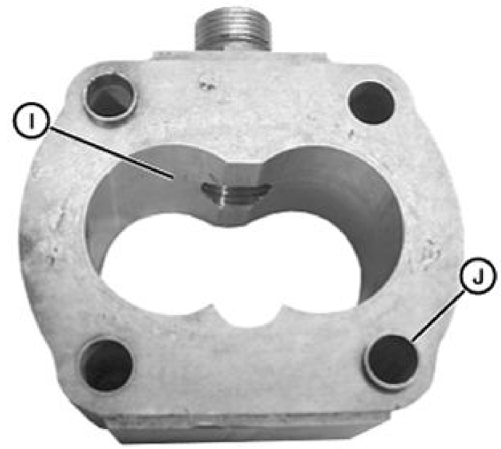
RB14256,00007F2 -19-18JUN12-4/23

8. Inspect pump housing walls (I) for wear or scoring. Inspect the two alignment dowels (J) for damage.

I— Pump Housing Walls **J— Alignment Dowels**

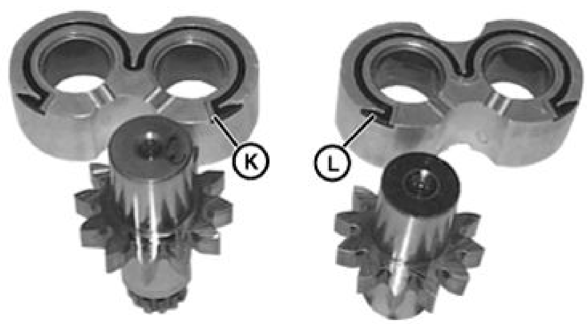


TCAL26554 —UN—15JUN12

RB14256,00007F2 -19-18JUN12-5/23

9. Remove and discard backing ring (K) and seal (L). Inspect bushing blocks for wear. Inspect gears for cracked or broken teeth.

K—Backing Ring **L—Seal**

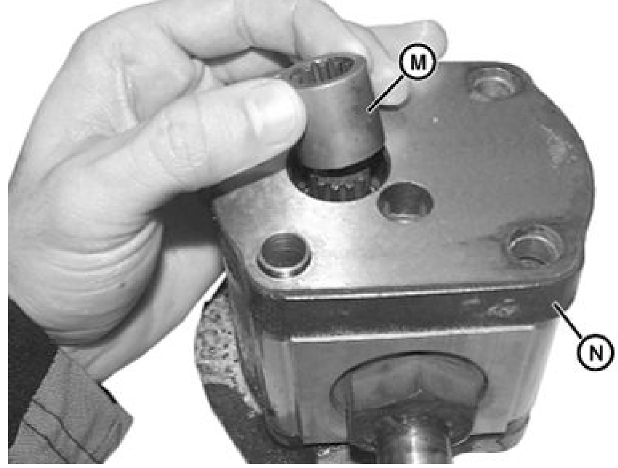


TCAL26555 —UN—15JUN12

RB14256,00007F2 -19-18JUN12-6/23

10. Remove pump shaft coupling (M) and auxiliary pump cover (N).

M—Pump Shaft Coupling **N—Auxiliary Pump Cover**



TCAL26556 —UN—15JUN12

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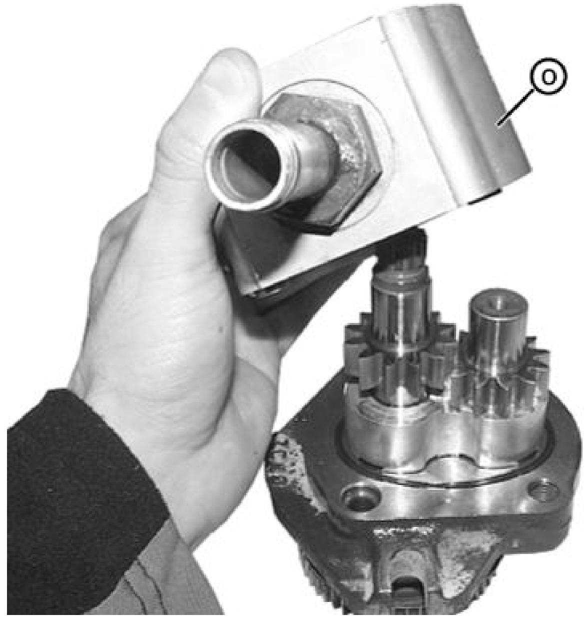
RB14256,00007F2 -19-18JUN12-7/23

11. Remove auxiliary pump body (O) from base plate. Inspect pump housing walls for wear or scoring.

O—Auxiliary Pump Body



TCAL26557 —UN—15JUN12

RB14256,00007F2 -19-18JUN12-8/23

12. Remove bolt (P) securing pump drive gear to pump assembly. Remove gear.

P—Bolt

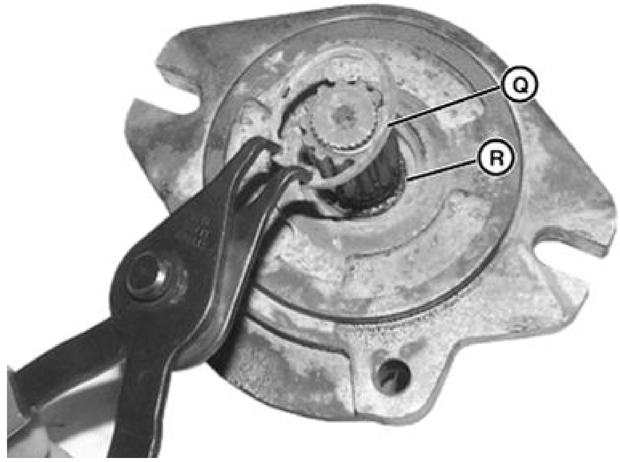
TCAL26558 —UN—15JUN12

Continued on next page

RB14256,00007F2 -19-18JUN12-9/23

13. Remove snap ring (Q). Remove and discard shaft seal (R). Inspect shaft and mating surface of back plate for damage.

Q—Snap Ring **R—Shaft Seal**

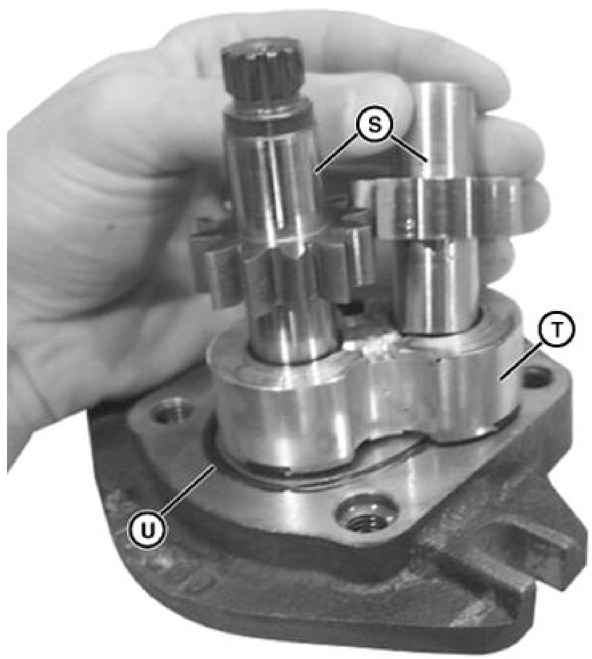


TCAL26559 —UN—15JUN12

RB14256,00007F2 -19-18JUN12-10/23

14. Remove auxiliary pump gears (S) and bushing block (T) from back plate. Remove seal (U) from back plate and inspect surface for damage or wear.
15. Inspect gear teeth and shafts for cracks, wear, or broken teeth.

S—Auxiliary Pump Gears **U—Seal**
T—Bushing Block



TCAL26560 —UN—15JUN12

RB14256,00007F2 -19-18JUN12-11/23

16. Remove and discard backing ring (V) and seal (W). Inspect bushing blocks for wear.

V—Backing Ring **W—Seal**

TCAL26561 —UN—15JUN12

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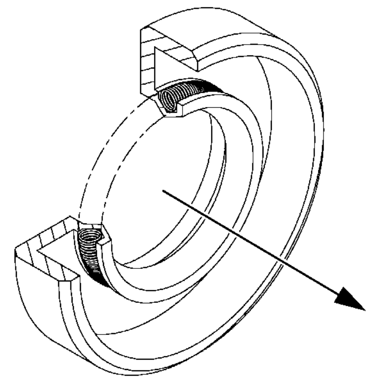
RB14256,00007F2 -19-18JUN12-12/23

Assembly

1. Lubricate all parts with a light coat of oil before assembly.
2. Install the shaft seal into the backing plate.



TCAL26562 —UN—15JUN12

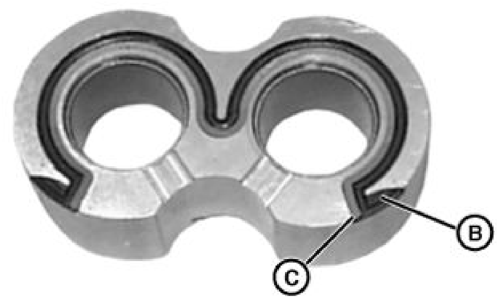
The arrow shows which direction the spring should be facing when looking at the backing plate.

RB14256,00007F2 -19-18JUN12-13/23

NOTE: The seal and the backing ring MUST be installed in the correct orientation. The flat side of the seal must face the bushings. The flat side of the backing ring must face the pump cover.

3. Install seal (B) and backing ring (C) into both bushing blocks.

B—Seal **C—Backing Ring**

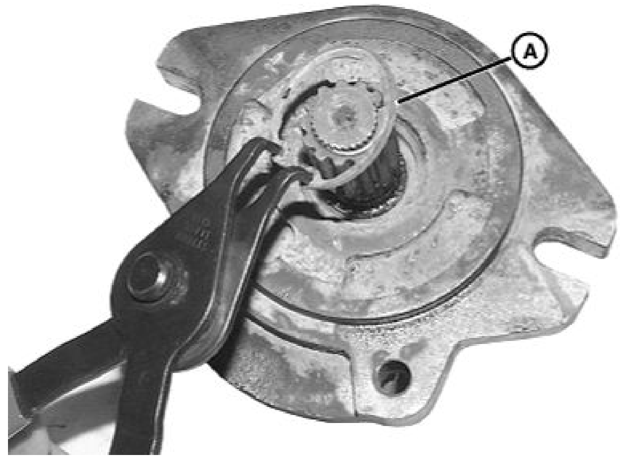


TCAL26563 —UN—15JUN12

RB14256,00007F2 -19-18JUN12-14/23

4. Install shaft and snap ring (A) with first bushing block in between gear and the backing plate.

A—Snap Ring



TCAL26564 —UN—15JUN12

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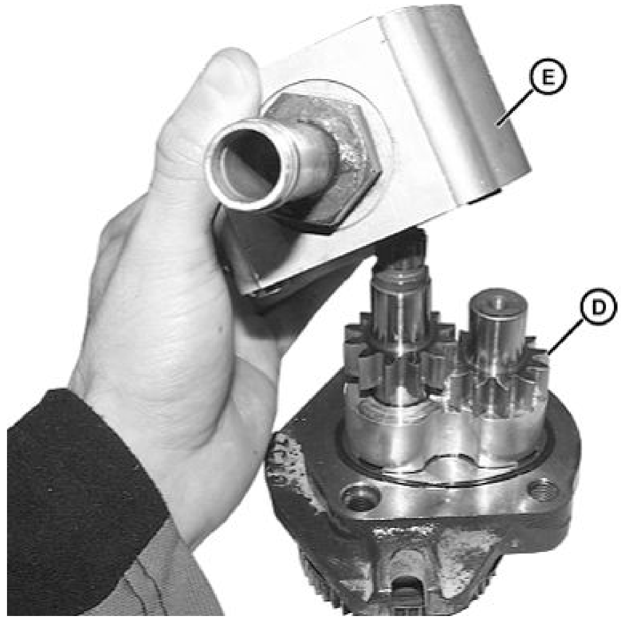
RB14256,00007F2 -19-18JUN12-15/23

NOTE: The idler gear is symmetrical and can be placed in the pump body either end first.

5. Install idler gear (D) and auxiliary pump body (E) to base plate.



D—Idler Gear **E—Pump Body**

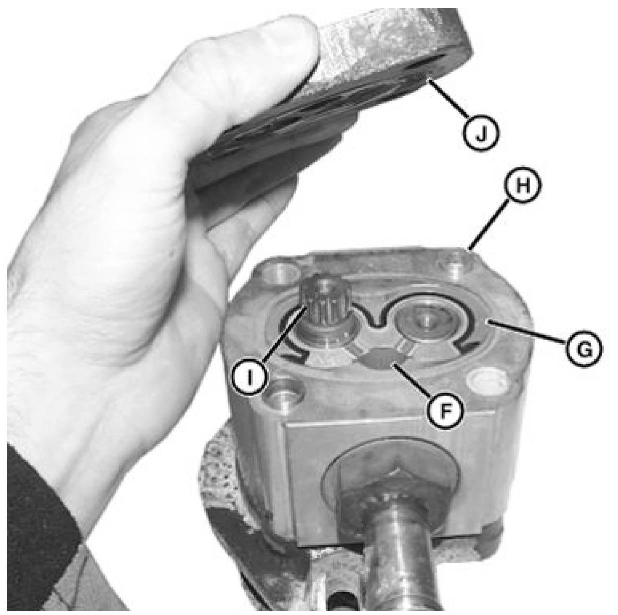
RB14256,00007F2 -19-18JUN12-16/23

NOTE: The mating of the pump housing and backing plate can be oriented in only one direction. Install the pump housing with the wide end of the cylinder walls positioned as shown. The bushings must be oriented so that the opening (F) formed by the seal faces the suction side of the pump.

6. Install the bushing block (G) with the seals facing the backing plate

NOTE: Using the alignment dowels (H) in the pump housing, line up the pump housing with the backing plate.

7. Install the drive gear (I) with the splined end being inserted through the backing plate.
8. Install new body seal (J) on front plate. Using the dowel pins (D) line up pump body and front plate.

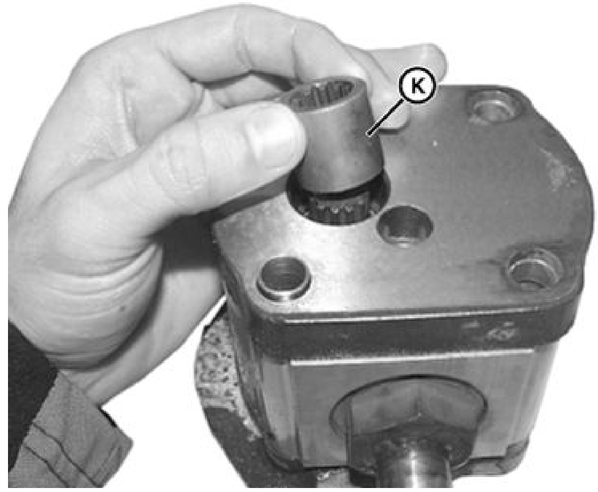


F—Opening **I— Gear Drive**
G—Bushing Block **J—Body Seal**
H—Alignment Dowels

Continued on next page

RB14256,00007F2 -19-18JUN12-17/23

9. Install pump shaft coupling (K) to splined shaft.



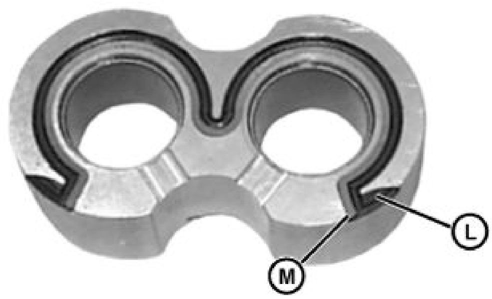
TCAL26567 —UN—15JUN12

RB14256,00007F2 -19-18JUN12-18/23

NOTE: The seal and the backing ring MUST be installed in the correct orientation. The flat side of the seal must face the bushings. The flat side of the backing ring must face the pump cover.

10. Install seal (L) and backing ring (M) into both bushing blocks.

L—Seal **M—Backing Ring**

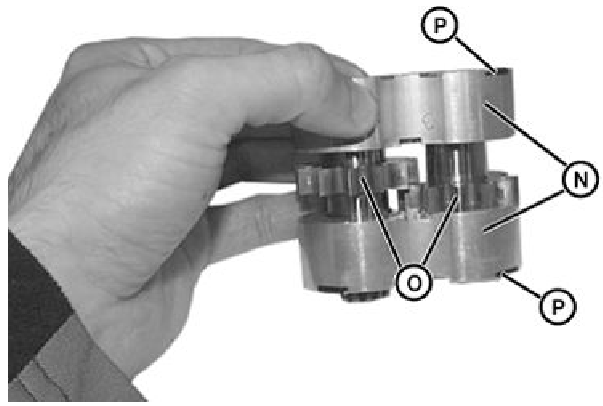


TCAL26568 —UN—15JUN12

RB14256,00007F2 -19-18JUN12-19/23

11. Assemble steering pump bushing blocks (N) and gears (O). Be sure that bushing seals (P) face away from each other.

N—Bushing Blocks
O—Gears
P—Bushing Seals



TCAL26569 —UN—15JUN12

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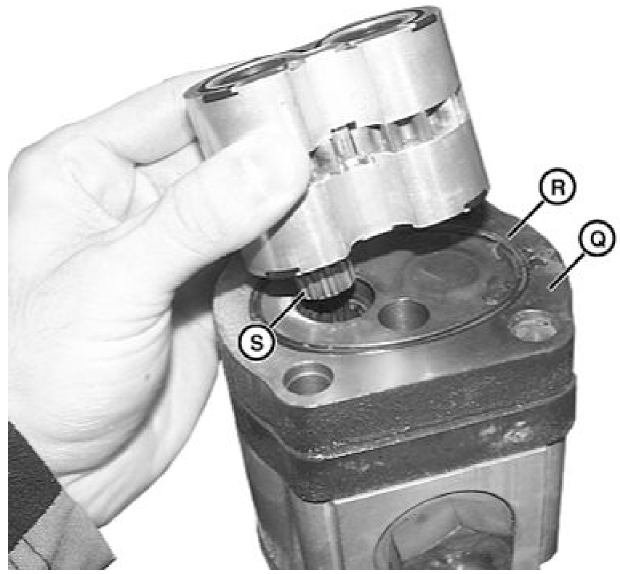
12. Align dowel pins with steering pump backplate (Q). Install new body seal on back plate (R). Install splined shaft (S) into coupler on pump assembly.

Q—Steering Pump Backplate
R—Back Plate
S—Splined Shaft



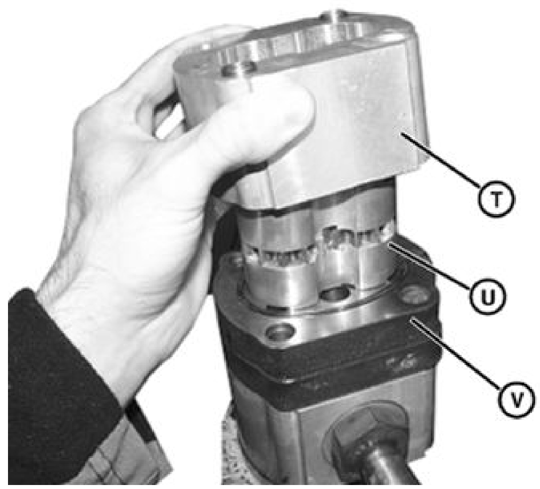
TCAL26570 —UN—15JUN12

RB14256,00007F2 -19-18JUN12-21/23

NOTE: Output fittings are located on the same side of the both pumps. Suction fitting is on its own side located on the auxiliary pump.

13. Install steering pump body (T) over internal components (U) onto backing plate (V).

T—Steering Pump Body
U—Internal Components
V—Backing Plate



TCAL26571 —UN—15JUN12

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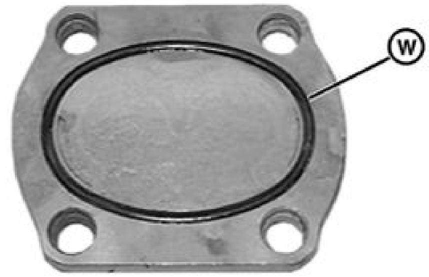
RB14256,00007F2 -19-18JUN12-22/23

14. Install new cover seal (W). Tighten bolts (X) to specification.

Specification

M8 Cap Bolt
Torque—Torque.. 50 ±5 N·m (37 ± 4lb-ft)

W—Cover Seal **X—Bolts**



TCAL26572 —UN—15JUN12

TCAL26573 —UN—15JUN12

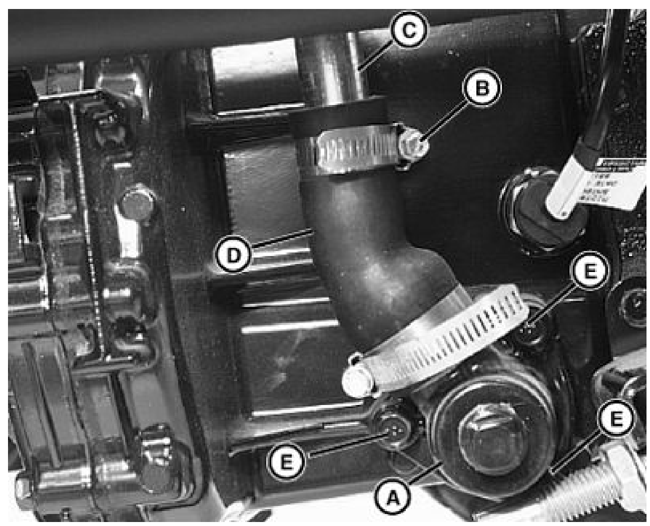
RB14256,00007F2 -19-18JUN12-23/23

Remove and Replace Transaxle Oil Strainer

NOTE: System capacity is approximately 12.5L (3.3 gal). Capacity with auxiliary system is approximately 14.4 (3.8 gal).

1. Drain oil from transaxle through drain plug.
2. Locate strainer housing (A) on the left side of vehicle.
3. Loosen hose clamp (B).
4. Remove hydraulic line (C) from rubber hose (D).
5. Loosen and remove three hex bolts (E).

A—Strainer Housing
B—Hose Clamp
C—Hydraulic Line
D—Rubber Hose
E—Hex Bolts



TCAL26574 —UN—15JUN12

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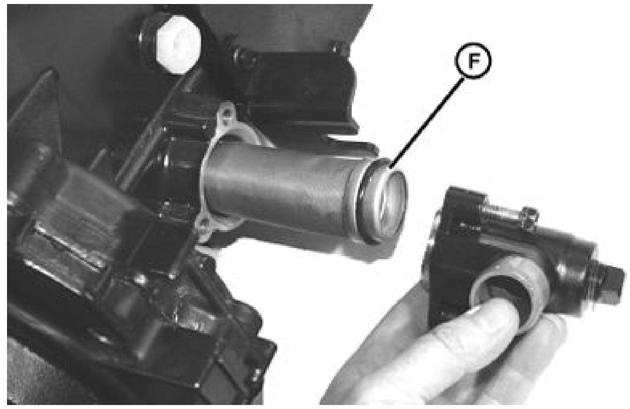
RB14256,00007F3 -19-18JUN12-1/4

6. Remove strainer housing and strainer (F).
7. Clean strainer with solvent or mineral spirits.
8. If strainer is damaged, torn or bent, replace it.

F—Strainer

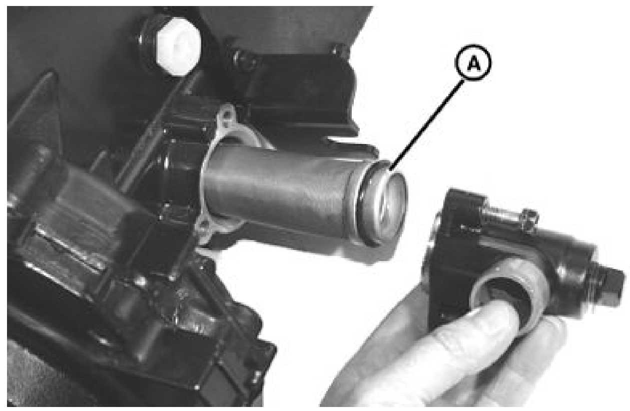


TCAL26575 —UN—15JUN12

RB14256,00007F3 -19-18JUN12-2/4

Installation

1. If strainer is damaged, torn or bent, replace it.
2. Clean strainer with solvent or mineral spirits.
3. Install strainer (A) and housing to transaxle.

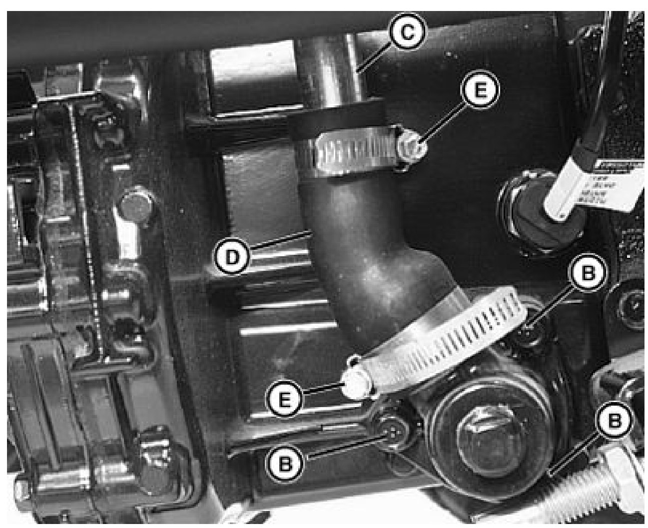


TCAL26576 —UN—15JUN12

RB14256,00007F3 -19-18JUN12-3/4

4. Secure housing bolts (B) to transaxle.
5. Install hydraulic line (C) to rubber hose (D) and secure with hose clamps (E).
6. Remove hydraulic line (C) from rubber hose (D).
7. Refill transaxle with correct oil.

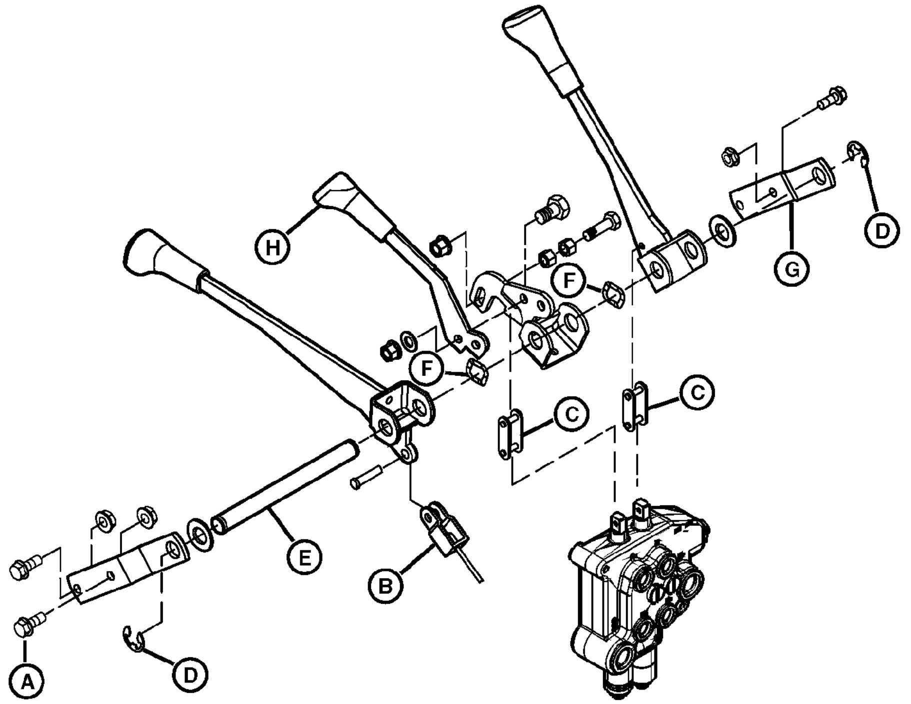
B—Housing Bolts
C—Hydrualic Line
D—Rubber Hose
E—Hose Clamps



TCAL26577 —UN—15JUN12

RB14256,00007F3 -19-18JUN12-4/4

Remove and Install PTO Control Valve



A—Cap Screw and Locknut (4 used)
B—Differential Lock Cable
C—Master Links
D—E-Clip
E—Shaft
F—Wave Washers
G—Bracket
H—Hydraulic Control Valve Handle (PTO) (If equipped with auxiliary kit)

Control Valve Removal

1. Remove control plate. (See Remove and Install Control Plate.)
2. Remove seat base cover. (See Remove and Install Seat Base Cover.)

NOTE: Hydraulic/PTO controls can be adjusted without removing seat base cover.

3. Disconnect hydraulic lines from control valve.
4. Remove two hex head cap screws and nuts securing hydraulic/PTO valve to frame.
5. Remove four cap screws (A) and lock washers securing pivot brackets to frame.
6. Disconnect differential lock cable (B).
7. Remove hydraulic/PTO valve assembly (valve block and control lever[s]).
8. Remove chain master links (C) securing lever assembly to hydraulic/PTO valve. Remove lever(s).

Shift Assembly Disassembly

1. Remove either E-clip (D) from lever shaft (E).
2. Slowly slide shaft out of bracket and control levers.

NOTE: Washers and wave washers are loose on the shaft and will fall out when the shaft is removed.

Continued on next page

RB14256,00007F4 -19-06JUL12-1/3

Control Valve Disassembly

1. Remove end cap (A) securing components to housing.

NOTE: When removing spools from hydraulic/PTO valve body, be sure to note or mark which spool is removed from which bore. Spools MUST be returned to their original locations.

2. Carefully remove spools from body. Clean and inspect spools. Replace spool O-ring seal in hydraulic/PTO valve body.
3. Remove check valve (B) from port in hydraulic/PTO valve.
4. Clean cap, spring and plunger in suitable solvent.
5. Remove nut (C) and washer securing relief valve.
6. Remove relief valve assembly (D). Clean all parts in suitable solvent.
7. Inspect all components for wear or damage. Replace as required.

Control Valve Assembly

Assembly is done in the reverse order of disassembly.

During assembly:

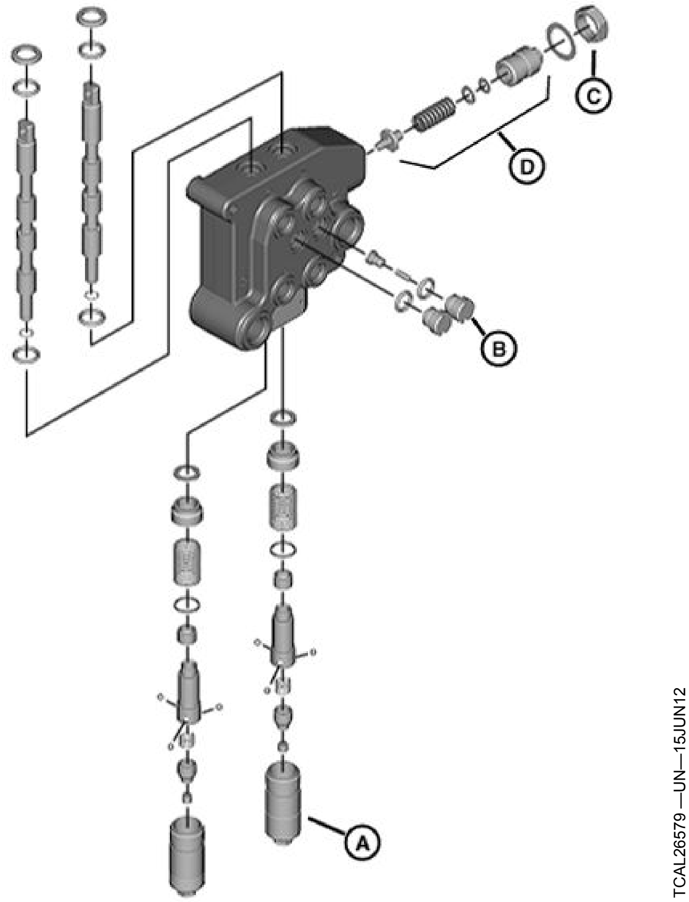
- Lubricate spools, relief valve and all O-rings in clean hydraulic oil before installation.
- Ensure that both spools are of equal height above the valve body in their neutral position when installed.
- Each spool is spring loaded to return to its neutral position (except the lift spool in the float position). Operate both spools to ensure they do not stick and freely return to neutral.

Control Valve Installation

Installation is done in the reverse order of removal.

During installation:

- Lubricate the exposed end of each spool with clean hydraulic oil.



A—End Cap
B—Check Valve
C—Nut
D—Relief Valve Assembly

- Tighten cap screws securing hydraulic/PTO valve to frame to specification.

Specification

Hydraulic/PTO
Valve-to-FrameCap
Screw Torque—Torque... 16.7 N·m (147 lb-in.)

Continued on next page

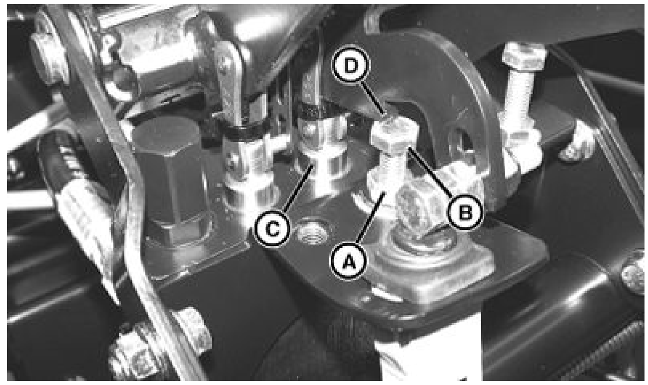
RB14256,00007F4 -19-06JUL12-2/3

- Loosen jam nut (A) and lower the limit bolt (B). Ensure that the PTO spool (C) is in the neutral position and raise the limit bolt up until it just contacts the lever bracket (D). Tighten the jam nut securely.
- Ensure that the PTO control lever moves its corresponding spool through its range of travel and returns to neutral when released.
- Ensure that the lift control lever moves its corresponding spool through its entire range of travel, holds by detent in the float position and returns to neutral from the raise and lower positions when released.
- Tighten hydraulic lines to specification. (See Service Recommendations For Flat Face O-Ring Seal Fittings.)

Specification

Hydraulic/PTO
Valve-to-FrameCap
Screw Torque—Torque.. 16.7 N·m (147 lb-in.)

- Adjust PTO switch linkage. (See PTO Switch Adjustment.)
- Adjust system relief pressure. (See Adjust System Pressure Relief.)



TCAL26580 —UN—15JUN12

A—Jam Nut
B—Limit Bolt
C—PTO Spool
D—Lever bracket

RB14256,00007F4 -19-06JUL12-3/3

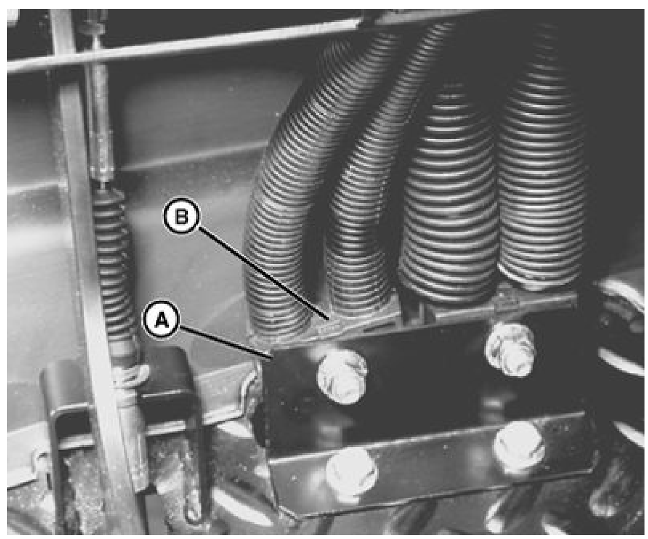
Steering Control Unit (SCU)

Removal - Method 1

1. Remove steering wheel and rubber boot.
2. Remove four cap screws securing steering control unit to dash.
3. Disconnect pressure and return hydraulic hoses from bracket (A) and clamp (B) assembly.
4. Slide SCU down and out from behind dash, being careful to avoid kinking hydraulic hoses.
5. Mark hydraulic lines to ensure proper placement during installation.

NOTE: Adapter fitting torques are lower than hose fittings. Hold adapter fittings with a wrench while disconnecting hoses.

6. Disconnect and remove pressure hoses and steering hoses.
7. Disconnect and remove steering cylinder hoses.
8. Remove SCU.



TCAL26581 —UN—15JUN12

A—Bracket
B—Clamp

Continued on next page

RB14256,00007F5 -19-18JUN12-1/3

Removal - Method 2

1. Remove front hood. (See Remove and Install Hood.)
2. Remove steering wheel and rubber boot.
3. Remove four cap screws securing steering control unit to dash.
4. Remove dash panel. (See Remove and Install Dash.)
5. Mark hydraulic lines to ensure proper placement during installation.

NOTE: Adapter fitting torques are lower than hose fittings. Hold adapter fittings with a wrench while disconnecting hoses.

6. Disconnect and remove pressure hoses (A) and steering hoses.
7. Disconnect and remove steering cylinder hoses (B).

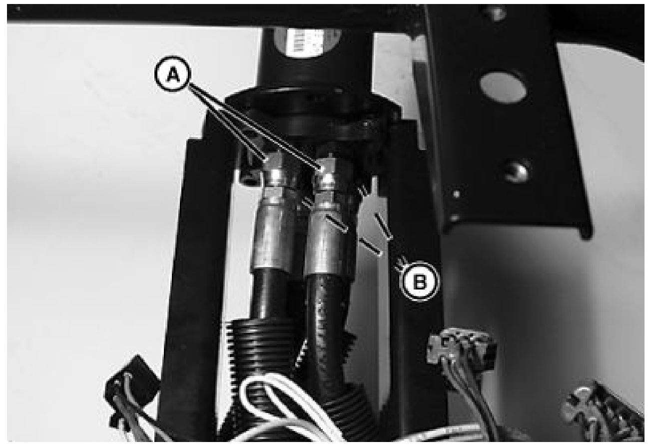
NOTE: It may be necessary to cut and remove tie wraps securing hydraulic lines to frame. Replace tie wraps during installation.

8. Remove SCU.

Installation

Installation is done in the reverse order of removal.

- If adapter fittings were removed, inspect O-rings in adapter fittings for cracks or damage. Replace if required.
- Secure SCU to frame.
- Tighten hydraulic fittings to specification.



TCAL26582 —UN—15JUN12

A—Pressure Hoses **B—Steering Cylinder Hoses**

Specification

Pressure and Return Hose Fitting-to-SCU Torque—Torque....40-57 N·m (30-42 lb-ft)
Steering Hose Fitting-to-SCU Torque—Torque....17-24 N·m (150-212 lb-in.)
Adapter Fitting-to-SCU Torque—Torque....14-19 N·m (124-168 lb-in.)

- Install four cap screws securing SCU to frame.

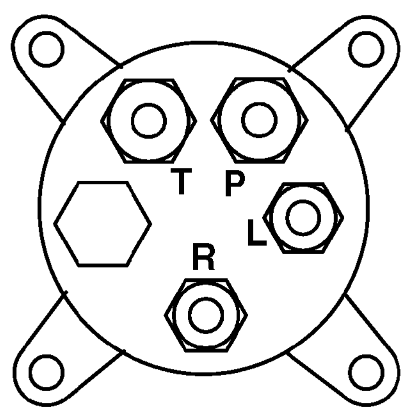
Specification

SCU-to-Frame Cap Screw Torque—Torque....30-38 N·m (22-28 lb-ft)

- Install dash (if removed) and steering wheel.

RB14256,00007F5 -19-18JUN12-2/3

P—Pressure input from pump
T—Return line to suction manifold
L—Left side of steering cylinder
R—Right side of steering cylinder



TCAL26583 —UN—15JUN12

Viewed from Bottom

RB14256,00007F5 -19-18JUN12-3/3

Section 80
Steering

Contents

Specifications

Item	Measurement	Specification
Steering System Leakage Test at Fast Idle		
Torque Applied to Steering Shaft		6.8 N·m (60 lb-in.)
Maximum Right Turn RPM		5 rpm
Brakes		
Brake Drum Diameter (Maximum)		221.21 mm (8.71 in.)
Input Shaft (4WD)		
#1 Bearing (#6009) Shaft OD		45.002-45.018 mm (1.7717-1.7724 in.)
#1 Bearing Case Bore ID		75.000-75.030 mm (2.9528-2.9539 in.)
#2 Bearing (#6305R) Shaft OD		25.002-25.015 mm (0.9843-0.9848 in.)
#2 Bearing Case Bore ID		62.000-62.030 mm (2.4409-2.4421 in.)
#3 Bearing (#NJ306EG) Shaft OD		30.002-30.015 mm (1.1812-1.1817 in.)
#3 Bearing Case Bore ID		72.000-72.030 mm (2.8346-2.8358 in.)
Differential (4WD)		
#1 Bearing (#6207) Shaft OD		34.9875-35.0125 mm (1.3775-1.3785 in.)
#1 Bearing Case Bore ID		75.000-75.030 mm (2.9528-2.9539 in.)
Axle Shaft (4WD)		
#1 Bearing (#6005) Shaft OD		24.977-24.990 mm (0.9833-0.9839 in.)
#1 Bearing Case Bore ID		46.9875-47.0125 mm (1.8499-1.8509 in.)
Wheel Hub		
#1 Bearing (#32008) Shaft OD		40.002-40.018 mm (1.5749-1.5755 in.)
#1 Bearing Case Bore ID		68.000-68.030 mm (2.6772-2.6783 in.)
Steering Control Unit (SCU)		
Steering Wheel Nut Torque		54 N·m (40 lb-ft)
SCU Mounting Screw		54 N·m (40 lb-ft)
SCU (-4) Small Hose Connection		24 N·m (18 lb-ft)
SCU (-6) Large Hose Connection		27 N·m (20 lb-ft)
Hydraulic Pump		
Pressure Outlet Fitting Screw		6.8 N·m (60 lb-in.)
Maximum Flow (Gas Engine @ 3400 RPM)		17.3 liters/min (4.6 gpm)
Maximum Flow (Diesel Engine @ 3450 RPM)		17.6 liters/min (4.7 gpm)
Specifications		
Front Axle Case-to-Bracket Bolt (M10)		44-59 N·m (33-43 lb-ft)
Steering Ball Joint Nut		167-206 N·m (123-152 lb-ft)

Continued on next page
RB14256,000079A -19-18JUN12-1/2

Item	Measurement	Specification
Steering Knuckle Stop Bolt Nut (4WD)		44-59 N·m (33-43 lb-ft)
Ring Gear Cap Screw (M8) (4WD)		30-39 N·m (22-29 lb-ft)
Input Coupling Bolt (M10) (4WD)		61-80 N·m (45-59 lb-ft)
Input Shaft Nut (M14) (4WD)		61-80 N·m (45-59 lb-ft)
Drain Plug (M14) (4WD)		49 N·m (36 lb-ft)
Specifications		
MFWD Gear Lube (J20C)		3.4-4.0 L (0.90-1.06 gal)
Toe-In (Less in Front than Rear)	Distance	3 mm ± 1.5 mm (0.125 ± 0.062 in.)
Steering Cylinder Mounting Cap Screw	Torque	54 N·m (40 lb-ft)
Steering Cylinder Hose Connection	Torque	24.4 N·m (18 lb-ft)
Steering Cylinder-to-Tie Rod Socket	Torque	169 N·m (125 lb-ft)
Drag Link Slide Bearing Retainer Cap Screw	Torque	13.7 N·m (60 lb-ft)
Bridge Plate Rear Locknut (M16)	Torque	142 N·m (105 lb-ft)
Bridge Plate Front Locknut (M12)	Torque	95 N·m (70 lb-ft)
Rear Shackle Plate Cap Screw	Torque	102 N·m (75 lb-ft)
Leaf Spring-to-Axle Cap Screw	Torque	129 N·m (95 lb-ft)
Front Chassis Bracket Hardware	Torque	80 N·m (60 lb-ft)
Upper Shock Locknut	Torque	45 N·m (33 lb-ft)
Lower Shock Locknut	Torque	70 N·m (52 lb-ft)
Wheel Lug Nut	Torque	115 N·m (85 lb-ft)
Tie Rod-to-Bridge Plate (MFWD)	Torque	170 N·m (125 lb-ft)
Tie Rod-to-Cylinder Rod (2WD)	Torque	170 N·m (125 lb-ft)
Tie Rod-to-Steering Knuckle	Torque	95 N·m (70 lb-ft)
Hub Nut	Torque	157-196 N·m (116-144 lb-ft)
Bearing Housing-to-Steering Knuckle Cap Screw (M10)	Torque	44-59 N·m (33-43 lb-ft)

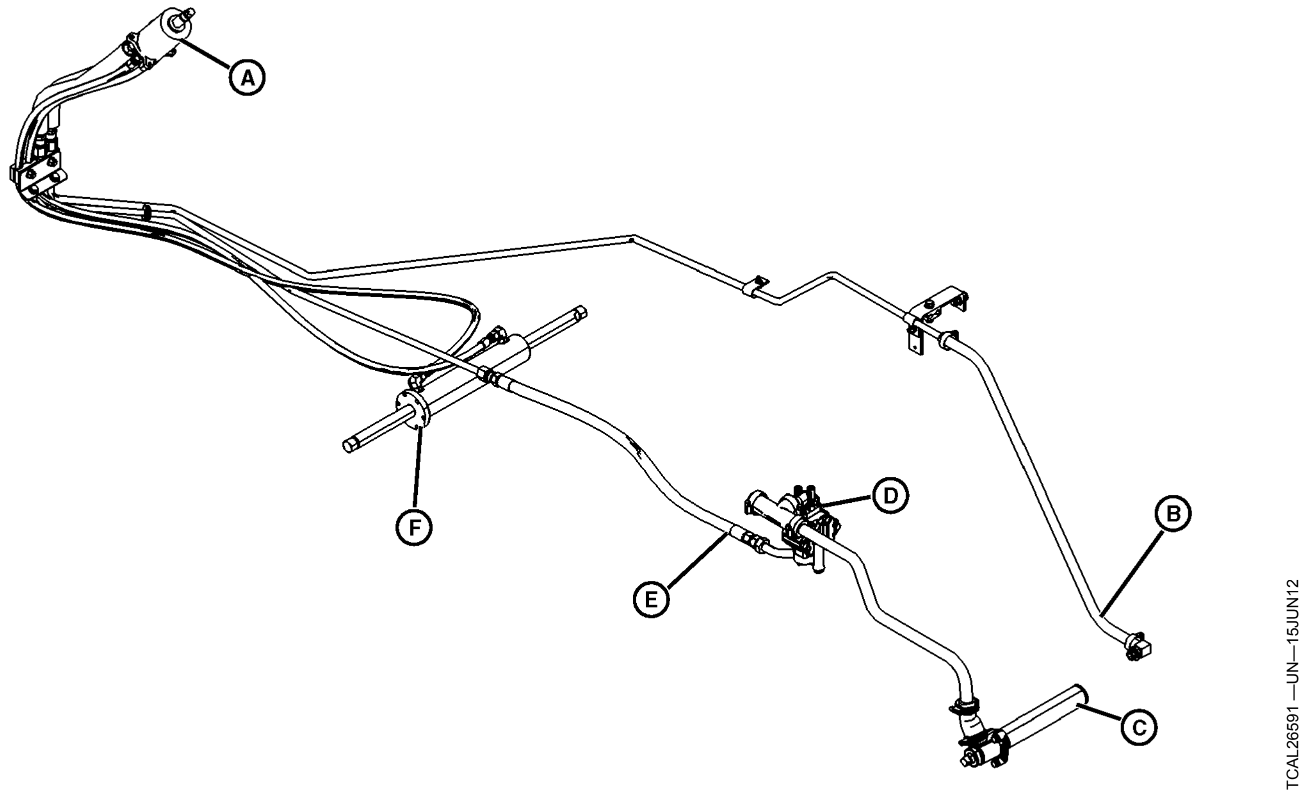
RB14256,000079A -19-18JUN12-2/2

Other Material

Number	Name	Use
TY6333 (U.S.)	Moly High Temperature EP Grease	Apply to splines of transaxle input shaft and MFWD drive shaft.
TY24416 (U.S.)	Special-Purpose HD Lithium Complex Grease	Used to pack bearings

RB14256,000079B -19-18JUN12-1/1

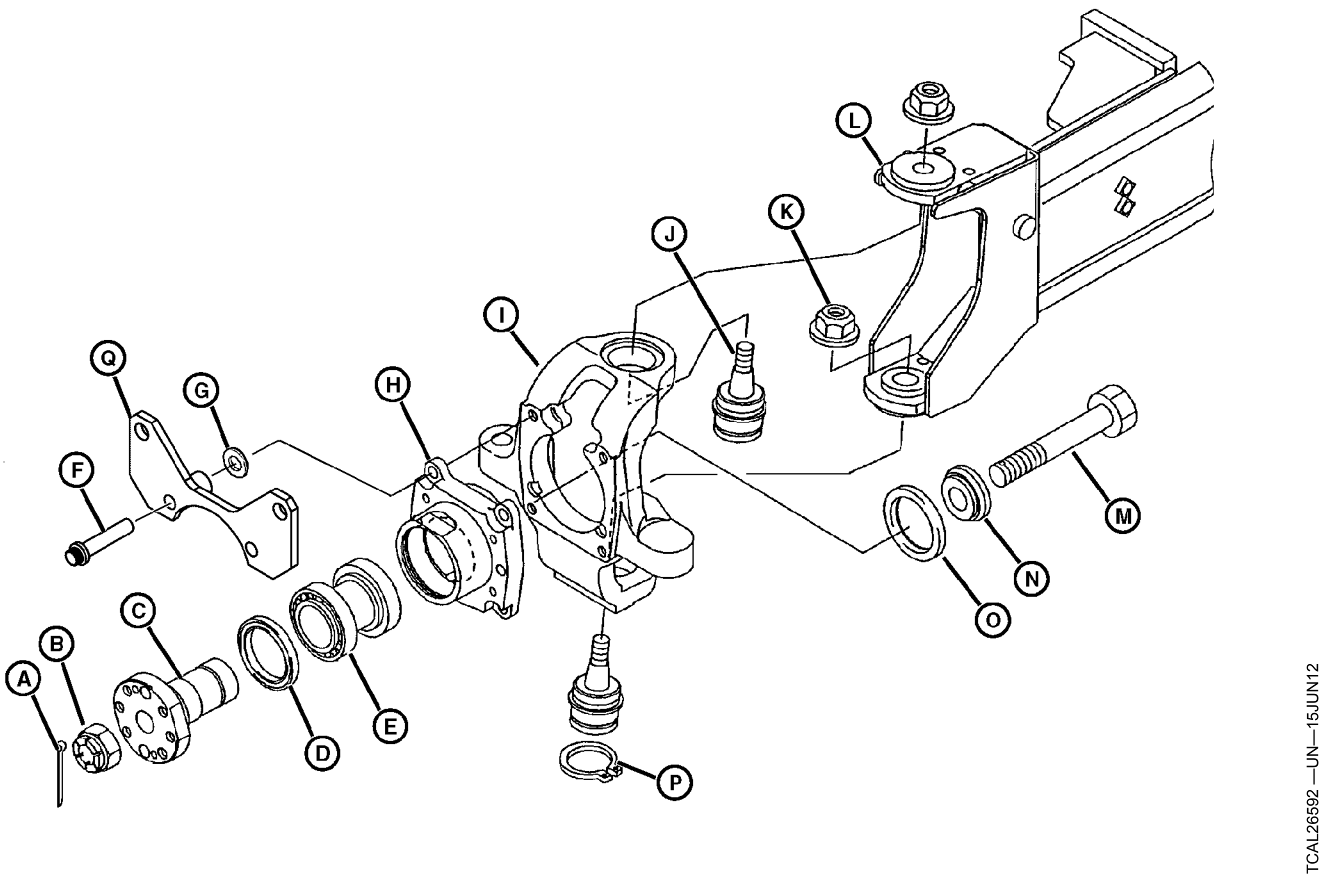
Hydraulic Components



A—Steering Control Unit
B—Return Line to Sump
C—Suction Strainer (inside transaxle housing)
D—Steering Pump
E—Pressure Line
F—Steering Cylinder

RB14256,000079C -19-18JUN12-1/1

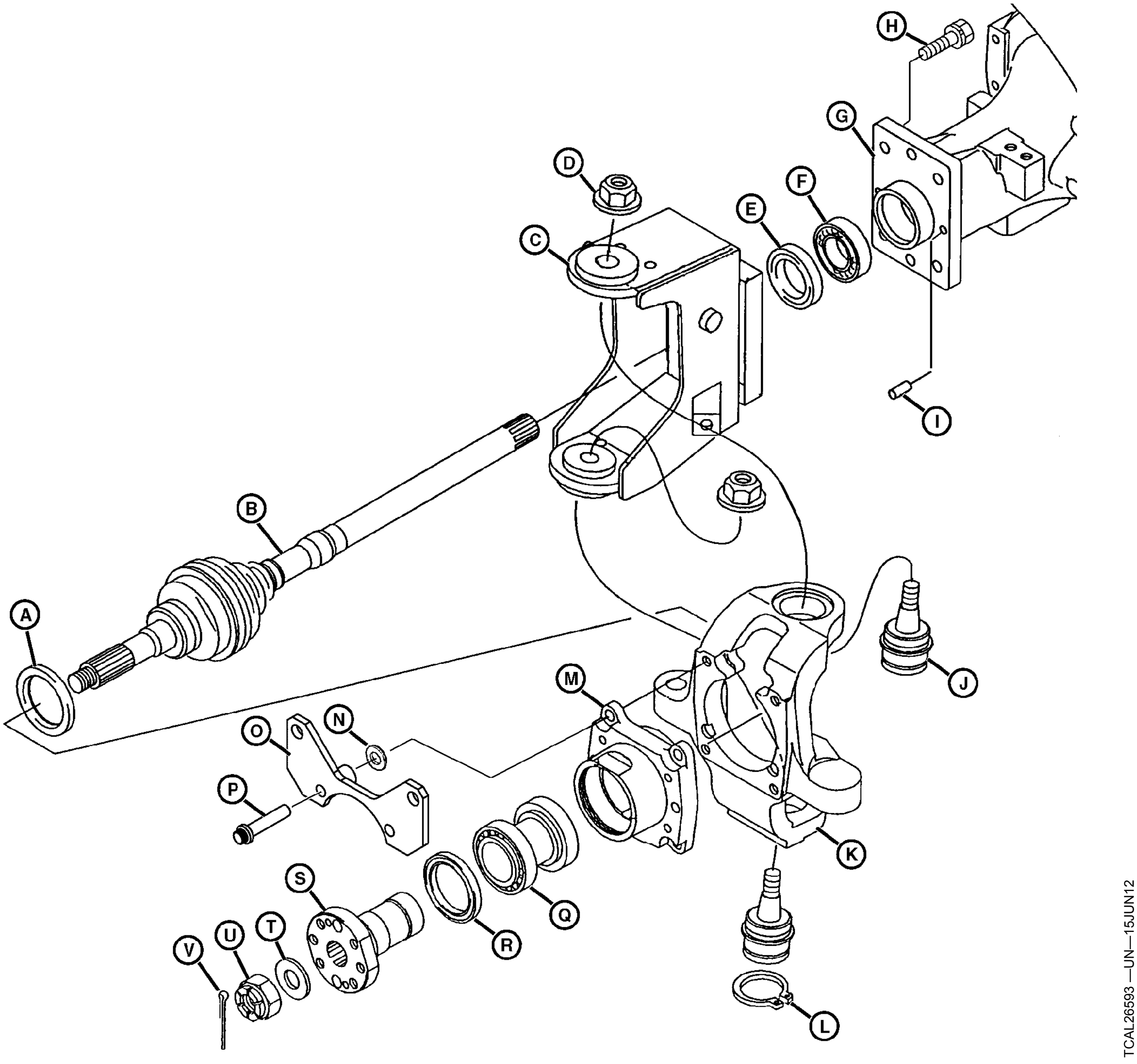
2WD Axle Component Location



A—Cotter Pin
B—Nut
C—Hub
D—Seal
E—Bearing
F—Bolt (4 used)
G—Washer (4 used)
H—Bearing Housing
I— Steering Knuckle
J— Ball Joint (2 used)
K—Nut (2 used)
L—Steering Bracket
M—Axle
N—Washer
O—Seal
P—Snap Ring
Q—Brake Caliper Bracket

RB14256,000079D -19-18JUN12-1/1

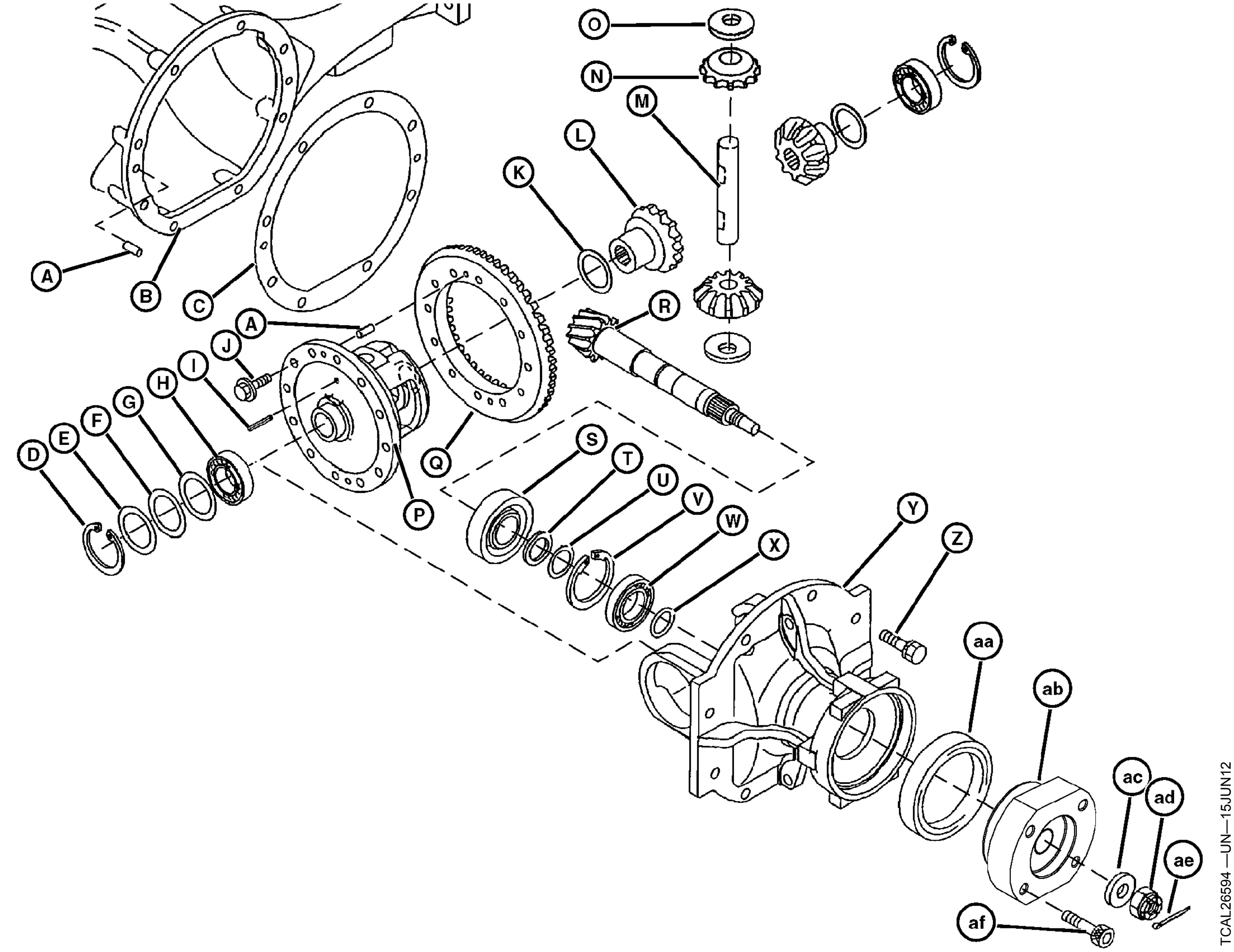
MFWD Axle Component Location



A—Seal
B—CV Joint
C—Steering Bracket
D—Locknut
E—Seal
F—Bearing
G—Differential Housing
H—Cap Screw (6 used)
I— Pin (2 used)
J— Ball Joint (2 used)
K—Steering Knuckle
L—Snap Ring (2 used)
M—Bearing Housing
N—Washer
O—Brake Caliper Bracket
P—Cap Screw
Q—Bearing Assembly
R—Seal
S—Hub
T—Washer
U—Nut
V—Cotter Pin

RB14256,000079E -19-18JUN12-1/1

MFWD Differential Component Location



A—Pin
B—Differential Housing
C—Gasket
D—Snap Ring (2 used)
E—Washer
F—Shim (as required)
G—Shim (as required)
H—Ball Bearing (2 used)
I— Spring Pin
J— Cap Screw (12 used)
K—Thrust Washer (2 used)
L—Bevel Gear (2 used)
M—Pinion Shaft
N—Pinion Bevel Gear (2 used)
O—Washer (2 used)
P—Case
Q—Ring Gear
R—Pinion
S—Bearing
T—Bushing
U—Shim (as required)
V—Snap Ring
W—Ball Bearing
X—Seal
Y—Differential Carrier
Z—Cap Screw (8 used)
AA—Seal
AB—Coupling
AC—Washer
AD—Nut
AE—Cotter Pin
AF—Cap Screw (4 used)

RB14256,000079F -19-18JUN12-1/1

SCU and System Operation

Function

Supply pressurized oil to the proper side of the steering cylinder to turn the wheels when the engine is running.

Theory of Operation

All external oil flow from the steering pump is routed through the steering control unit (SCU). The SCU is an open-center type valve.

The SCU consists of a self-centering fluid control valve section and a fluid metering section. These are hydraulically and mechanically interconnected inside the unit.

Neutral

Whenever the steering wheel is released, the SCU returns to the neutral position. In this position, charge pressure oil entering the SCU through port “P” is allowed to flow through the control valve and out through port “T.” In this position, the control valve prevents charge pressure oil from entering the fluid metering section.

Power Turn

As the steering wheel is turned to the right, the SCU section is shifted by the drive link assembly. This shifting opens the steering cylinder ports “R” and “L.”

Oil flows from port “P” directly to the inlet of the control valve section. As the steering wheel is turned to the right, metered oil is routed to port “R” at the front of the steering cylinder. Return oil from the rear of the steering cylinder is routed back to port “L,” through the control valve and out port “T.” As oil exits port “T” of the SCU, it returns to the transaxle and is considered to be “charge make-up oil.”

When the rotation of the steering wheel stops, the centering springs move the control valve section back to the center (neutral) position, and will remain there until the steering wheel is moved again.

Manual Turn

If hydraulic pressure is lost, the machine can still be steered without hydraulic assistance. All components still function the same with the exception of the fluid metering section. The fluid metering section now acts as a pump, moving oil from one side of the metering section to the other as the steering wheel is turned. Metered oil is routed through port “R” to the front of the steering cylinder. Return oil from the rear of the steering cylinder is routed back to port “L,” through the control valve and check valve, and is drawn back into the control valve section.

When the rotation of the steering wheel stops, the centering springs move the valve back to the center (neutral) position, and will remain there until the steering wheel is moved again.

Steering Cylinder Operation

The steering cylinder is a double-acting design.

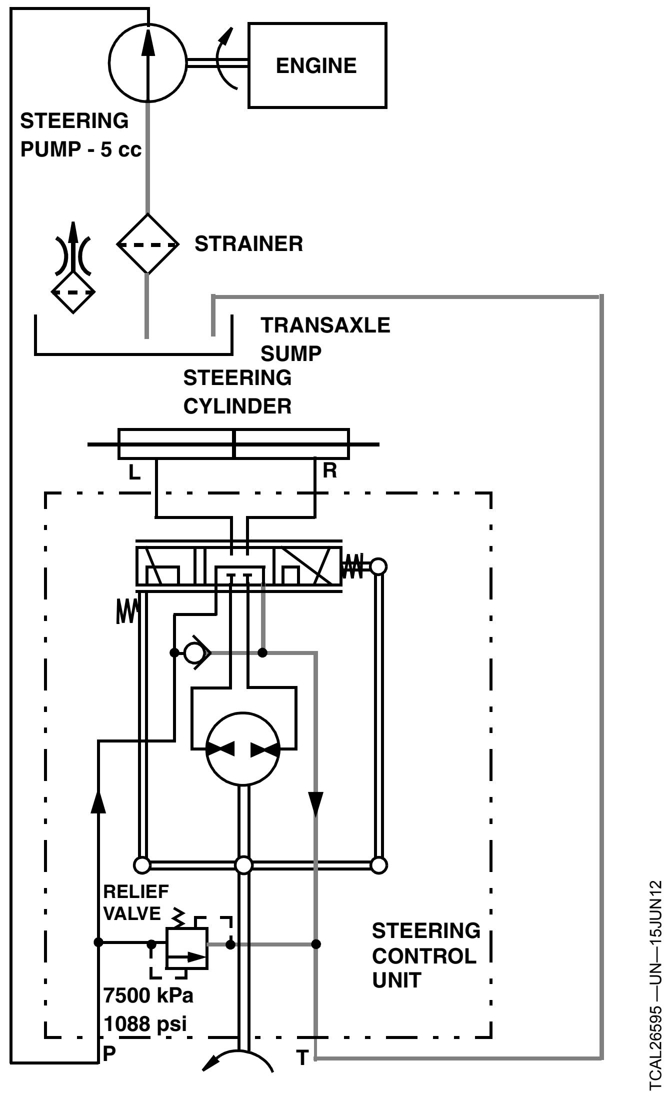
One end of the cylinder is attached to the axle housing, which prevents the cylinder from moving. The rod ends are attached to the steering knuckles.

As pressurized oil enters the cylinder, the piston and rods move, which in turn causes the steering knuckles to move, causing the machine to turn.

To turn in the other direction, pressurized oil is applied to the other port, moving the cylinders in the opposite direction.

RB14256,00007A0 -19-18JUN12-1/1

Steering Hydraulic Schematic



RB14256,00007A1 -19-18JUN12-1/1

Symptom: Steers Hard or No Steering One or Both Directions

RB14256,00007A2 -19-18JUN12-1/13

Steers Hard or No Steering One or Both Directions

RB14256,00007A2 -19-18JUN12-2/13

Step 1	Is the air pressure in both front tires at specification?	**YES:** Go to next step. **NO:** Increase or decrease air pressure as necessary.

RB14256,00007A2 -19-18JUN12-3/13

Step 2	Is the transaxle oil strainer clean and free of debris and fungus?	**YES:** Go to next step. **NO:** Clean transaxle oil strainer.

RB14256,00007A2 -19-18JUN12-4/13

Step 3	Are both front tires the correct size and same circumference?	**YES:** Go to next step. **NO:** Install the correct size tires.

RB14256,00007A2 -19-18JUN12-5/13

Step 4	Are the steering lines and hoses in good condition (not leaking or restricted)?	**YES:** Go to next step. **NO:** Replace lines and hoses as necessary. (See Steering Hydraulic Schematic.)

RB14256,00007A2 -19-18JUN12-6/13

Step 5	Is the steering cylinder in good condition (no internal or external leaks)?	**YES:** Go to next step. **NO:** Replace cylinder as necessary. (See Remove and Install Steering Cylinder (4WD).)

RB14256,00007A2 -19-18JUN12-7/13

Step 6	Is the steering control unit (SCU) in good condition (no internal or external leaks)?	**YES:** Go to next step. **NO:** Perform Check Steering System procedure. Replace SCU as necessary. (See Steering Control Unit.)

RB14256,00007A2 -19-18JUN12-8/13

Step 7	Are the tie rods and steering cylinder end sockets in good condition and properly lubricated?	**YES:** Go to next step. **NO:** Replace tie rods and/or lubricate as necessary. (See Remove and Install Tie Rod.)

Continued on next page

RB14256,00007A2 -19-18JUN12-9/13

Step 8	Are the steering knuckle ball joints in good condition and properly lubricated?	**YES:** Go to next step. **NO:** Replace steering knuckle ball joints and/or lubricate as necessary.

RB14256,00007A2 -19-18JUN12-10/13

Step 9	Are the wheel bearings and hubs in good condition and properly lubricated?	**YES:** Go to next step. **NO:** Replace wheel bearings and hub as necessary. Repack wheel bearings. (See Remove and Install Front Hub.)

RB14256,00007A2 -19-18JUN12-11/13

Step 10	Is toe-in within specification?	**YES:** Go to next step. **NO:** Perform toe-in procedure. (See Adjust Toe-In.)

RB14256,00007A2 -19-18JUN12-12/13

Step 11	4WD Only: Are the drag link and the drag link slide bearings in good condition and properly lubricated?	**NO:** Replace and/or lubricate drag link and slide bearings as necessary.

RB14256,00007A2 -19-18JUN12-13/13

Symptom: Steering Pulls in One Direction

RB14256,00007A3 -19-18JUN12-1/8

Steering Pulls in One Direction

RB14256,00007A3 -19-18JUN12-2/8

Step 1	Is the air pressure in both front tires at specification?	**YES:** Go to next step. **NO:** Increase or decrease air pressure as necessary.

RB14256,00007A3 -19-18JUN12-3/8

Step 2	Are both front tires the correct size and same circumference?	**YES:** Go to next step. **NO:** Install the correct size tires.

RB14256,00007A3 -19-18JUN12-4/8

Step 3	Is the steering cylinder in good condition (no internal or external leaks)?	**YES:** Go to next step. **NO:** Replace cylinder as necessary. (See Remove and Install Steering Cylinder (4WD).)

Continued on next page

RB14256,00007A3 -19-18JUN12-5/8

Step 4	Is the steering control unit (SCU) in good condition (no internal or external leaks)?	**YES:** Go to next step. **NO:** Perform Check Steering System procedure. Replace SCU as necessary. (See Steering Control Unit.)

RB14256,00007A3 -19-18JUN12-6/8

Step 5	Are the steering knuckle ball joints in good condition and properly lubricated?	**YES:** Go to next step. **NO:** Replace steering knuckle ball joints and/or lubricate as necessary.

RB14256,00007A3 -19-18JUN12-7/8

Step 6	Are the wheel bearings and hubs in good condition and properly lubricated?	**YES:** Go to next step. **NO:** Replace wheels bearings and hub as necessary. Repack wheel bearings. (See Remove and Install Front Hub.)

RB14256,00007A3 -19-18JUN12-8/8

Symptom: Steering Wheel Creeps

RB14256,00007A4 -19-18JUN12-1/5

Steering Wheel Creeps

RB14256,00007A4 -19-18JUN12-2/5

Step 1	Are the steering lines and hoses in good condition (not leaking or restricted)?	**YES:** Go to next step. **NO:** Replace lines and hoses as necessary. (See Steering Hydraulic Schematic.)

RB14256,00007A4 -19-18JUN12-3/5

Step 2	Is the steering cylinder in good condition (no internal or external leaks)?	**YES:** Go to next step. **NO:** Replace cylinder as necessary. (See Remove and Install Steering Cylinder (4WD).)

RB14256,00007A4 -19-18JUN12-4/5

Step 3	Is the steering control unit (SCU) in good condition (no internal or external leaks)?	**NO:** Perform Check Steering System procedure. Replace SCU as necessary. (See Steering Control Unit.)

RB14256,00007A4 -19-18JUN12-5/5

Symptom: Steering Shimmy or Vibration

RB14256,00007A5 -19-18JUN12-1/10

Steering Shimmy or Vibration

Continued on next page

RB14256,00007A5 -19-18JUN12-2/10

Step 1	Is the air pressure in both front tires at specification?	**YES:** Go to next step. **NO:** Increase or decrease air pressure as necessary.

RB14256,00007A5 -19-18JUN12-3/10

Step 2	Are both front tires the correct size and same circumference?	**YES:** Go to next step. **NO:** Install the correct size tires.

RB14256,00007A5 -19-18JUN12-4/10

Step 3	Are the front rims in good condition (not bent)?	**YES:** Go to next step. **NO:** Replace tire rim(s).

RB14256,00007A5 -19-18JUN12-5/10

Step 4	Are the tie rods and steering cylinder end sockets in good condition and properly lubricated?	**YES:** Go to next step. **NO:** Replace tie rods and/or lubricate as necessary. (See Remove and Install Tie Rod.)

RB14256,00007A5 -19-18JUN12-6/10

Step 5	Are the steering knuckle ball joints in good condition and properly lubricated?	**YES:** Go to next step. **NO:** Replace steering knuckle ball joints and/or lubricate as necessary.

RB14256,00007A5 -19-18JUN12-7/10

Step 6	Are the wheel bearings and hubs in good condition and properly lubricated?	**YES:** Go to next step. **NO:** Replace wheels bearings and hub as necessary. Repack wheel bearings. (See Remove and Install Front Hub.)

RB14256,00007A5 -19-18JUN12-8/10

Step 7	Are lug nuts and brake drum cap screws tight?	**YES:** Go to next step. **NO:** Tighten to proper torque.

RB14256,00007A5 -19-18JUN12-9/10

Step 8	Is toe-in within specification?	**NO:** Perform toe-in procedure. (See Adjust Toe-In.)

RB14256,00007A5 -19-18JUN12-10/10

Symptom: Noise During Turn

RB14256,00007A6 -19-18JUN12-1/13

Noise During Turn

Continued on next page

RB14256,00007A6 -19-18JUN12-2/13

Step 1	4WD Only: Is machine in 4WD?	**YES:** Disengage when not needed. **NO:** Go to next step.

RB14256,00007A6 -19-18JUN12-3/13

Step 2	Are the steering lines and hoses in good condition (not leaking or restricted)?	**YES:** Go to next step. **NO:** Replace lines and hoses as necessary. (See Steering Hydraulic Schematic.)

RB14256,00007A6 -19-18JUN12-4/13

Step 3	Is the transaxle oil strainer clean and free of debris and fungus?	**YES:** Go to next step. **NO:** Clean transaxle oil strainer.

RB14256,00007A6 -19-18JUN12-5/13

Step 4	Is the steering cylinder in good condition (no internal or external leaks)?	**YES:** Go to next step. **NO:** Perform Check Steering System procedure. Replace steering cylinder as necessary. (See Remove and Install Steering Cylinder (4WD).)

RB14256,00007A6 -19-18JUN12-6/13

Step 5	Is the steering control unit (SCU) in good condition (no internal or external leaks)?	**YES:** Go to next step. **NO:** Perform Check Steering System procedure. Replace SCU as necessary. (See Steering Control Unit.)

RB14256,00007A6 -19-18JUN12-7/13

Step 6	Are the tie rods and steering cylinder end sockets in good condition and properly lubricated?	**YES:** Go to next step. **NO:** Replace tie rods and/or lubricate as necessary. (See Remove and Install Tie Rod.)

RB14256,00007A6 -19-18JUN12-8/13

Step 7	Are the steering knuckle ball joints in good condition and properly lubricated?	**YES:** Go to next step. **NO:** Replace steering knuckle ball joints and/or lubricate as necessary.

RB14256,00007A6 -19-18JUN12-9/13

Step 8	Are the wheel bearings and hubs in good condition and properly lubricated?	**YES:** Go to next step. **NO:** Replace wheels bearings and hub as necessary. Repack wheel bearings. (See Remove and Install Front Hub.)

Continued on next page RB14256,00007A6 -19-18JUN12-10/13

Step 9	Is toe-in within specification?	**YES:** Go to next step. **NO:** Perform toe-in procedure. (See Adjust Toe-In.)

RB14256,00007A6 -19-18JUN12-11/13

Step 10	4WD Only: Are the drag link and the drag link bushings in good condition?	**YES:** Go to next step. **NO:** Replace drag link and bushings as necessary.

RB14256,00007A6 -19-18JUN12-12/13

Step 11	4WD Only: Are constant velocity joints (CV) and boots in good condition and properly lubricated?	**NO:** Repair or replace as necessary.

RB14256,00007A6 -19-18JUN12-13/13

Symptom: Slow Steering Response

RB14256,00007A7 -19-18JUN12-1/5

Slow Steering Response

RB14256,00007A7 -19-18JUN12-2/5

Step 1	Are the steering lines and hoses in good condition (not leaking or restricted)?	**YES:** Go to next step. **NO:** Replace lines and hoses as necessary. (See Steering Hydraulic Schematic.)

RB14256,00007A7 -19-18JUN12-3/5

Step 2	Is the steering cylinder in good condition (no internal or external leaks)?	**YES:** Go to next step. **NO:** Replace cylinder as necessary. (See Remove and Install Steering Cylinder (4WD).)

RB14256,00007A7 -19-18JUN12-4/5

Step 3	Is the steering control unit (SCU) in good condition (no internal or external leaks)?	**NO:** Perform Check Steering System procedure. Replace SCU as necessary. (See Steering Control Unit.)

RB14256,00007A7 -19-18JUN12-5/5

Check Steering System

Procedure

1. Lock park brake.
2. With machine at room temperature, start and run engine at fast idle for five minutes to warm up hydraulic oil.
3. Run engine at high rpm.
4. Turn steering wheel, at a very fast rate, for a full right turn then a full left turn.

Results

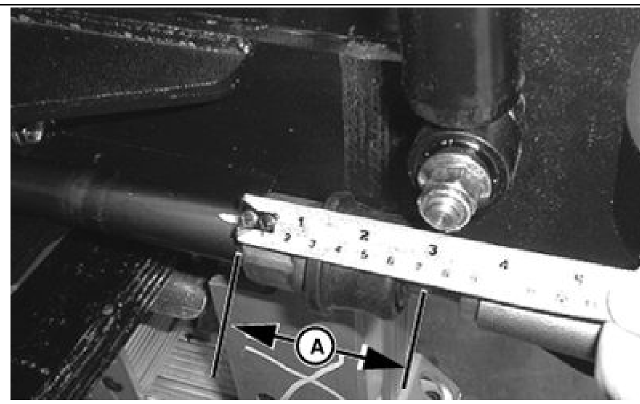
- Power steering available at all times (low effort).
- If not: Check hydraulic lines for sharp bends or restrictions. Replace damaged lines as necessary.

Check steering cylinder for external or internal leakage. Replace cylinder if necessary. (See Test Steering Cylinder Leakage.)

Check SCU for external or internal leakage. Repair or replace as necessary. (See Test Steering System.)

RB14256,00007A8 -19-18JUN12-1/1

Adjust Toe-In



TCAL26596 —UN—15JUN12

A—Distance

Reason

Correct toe-in adjustment prevents premature tire wear and steering wander.

Initial Adjustment Procedure

NOTE: Toe-in cannot be adjusted with wheels off the ground or on an uneven surface.

1. Park machine on level surface.
2. Turn key switch OFF.
3. Lock park brake.
4. Place wheels in straight-ahead position. Measure the distance (A) from the inside edge of the ball socket nut to the center of the lower shock mounting stud on each side of the vehicle. Turn the steering wheel left or right until this measurement is equal on both sides.

Continued on next page

RB14256,00007A9 -19-18JUN12-1/2

5. Measure the distance (B) from the outside edge of the front leaf spring to the center of the tie rod bolt on each side of the vehicle. This dimension should be equal.

Results

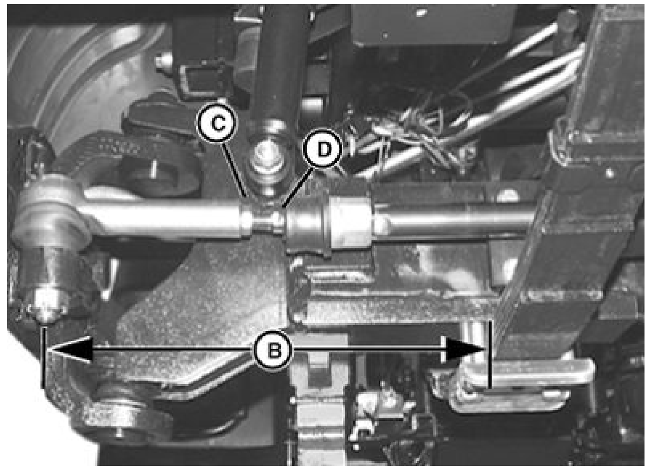
If the dimension from the center of the wheel to the edge of the leaf spring is not equal, loosen tie rod locknut (C) and turn link (D) until the measurement is equal. Tighten locknuts.

Final Adjustment Procedure

1. Measure the distance between the center of the tire beads (center of tire) at front of tire, hub height. Record measurement.
2. Measure the distance between the center of the tire beads (center of tire) at rear of tire, hub height. Record measurement.

Results

If not according to specifications, loosen both tie rod locknuts and turn left and right links equal amounts until toe-in is to specification. Tighten nuts. Check toe-in dimension again after tightening nuts and readjust if necessary.



TCAL26597 —UN—15JUN12

Tires Removed for Photo Only; Perform Adjustment with Tires on Vehicle.

B — Distance
C—Locknut
D—Link

Specification

Toe-In (Less in Front than Rear)—Distance.............................. 3 mm ± 1.5 mm (0.125 ± 0.062 in.)

RB14256,00007A9 -19-18JUN12-2/2

Steering Control Unit

(See Steering Control Unit (SCU).)

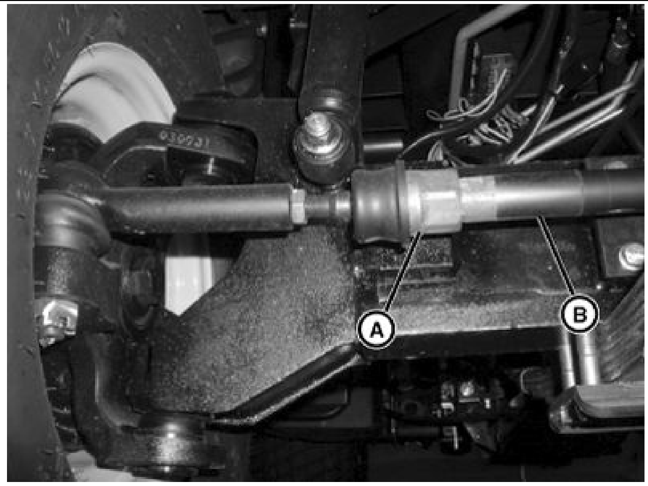
RB14256,00007AA -19-18JUN12-1/1

Remove and Install Steering Cylinder (2WD)

Removal

1. Park machine on level surface.
2. Lock park brake.
3. Place wheels in a straight-ahead position and raise the front of the vehicle until the front wheels are off the ground.
4. Remove both socket ends (A) from steering cylinder rod (B).

A—Socket End **B—Steering Cylinder Rod**



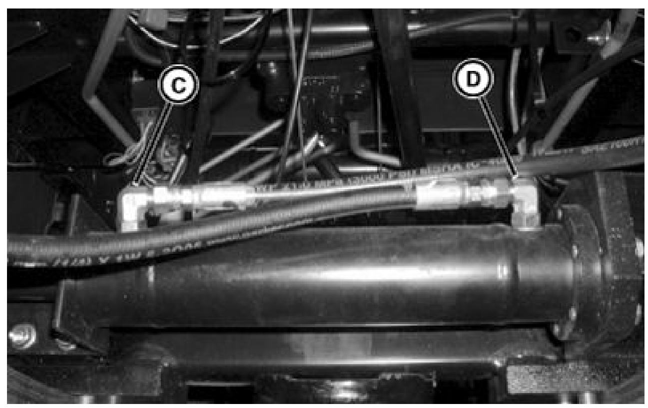
TCAL26598 —UN—15JUN12

Passenger side shown.

RB14256,00007AB -19-18JUN12-1/4

5. Disconnect steering hoses (C and D). Install caps and plugs.

C—Hose **D—Hose**

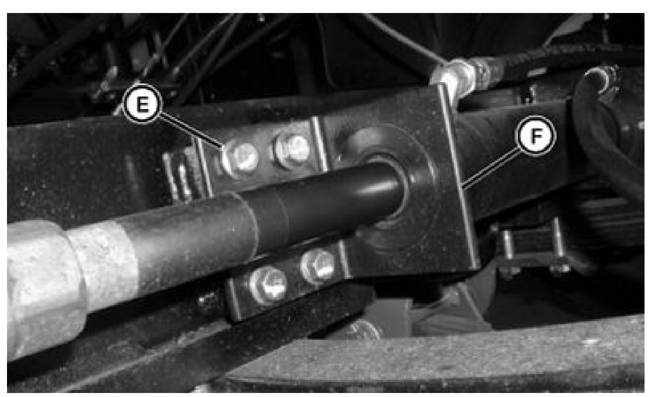


TCAL26599 —UN—15JUN12

RB14256,00007AB -19-18JUN12-2/4

6. Remove cap screws (E) and support bracket (F).

E—Cap Screws **F—Bracket**



TCAL26600 —UN—15JUN12

Continued on next page RB14256,00007AB -19-18JUN12-3/4

7. Remove cap screws (G) from the axle mounting bracket (H).
8. Remove steering cylinder.

Installation

Installation is done in the reverse order of removal.

- Tighten steering cylinder mounting cap screws to specification.

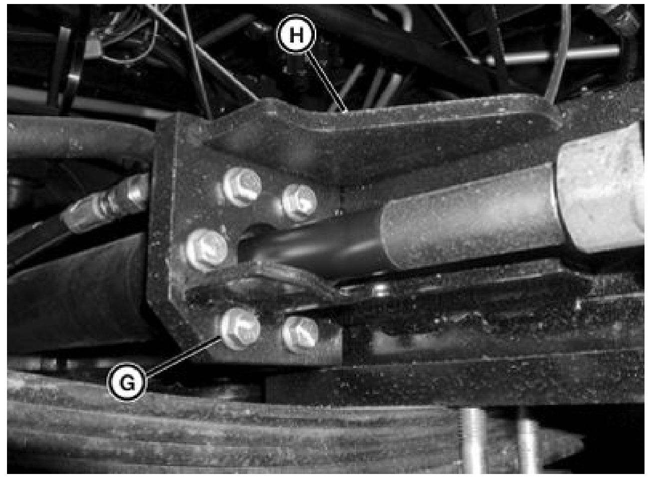
Specification	
Steering Cylinder Mounting Cap Screw—Torque	54 N·m (40 lb-ft)

- Tighten hose connections to specification.

Specification	
Steering Cylinder Hose Connection—Torque	24.4 N·m (18 lb-ft)

- Tighten socket ends to specification.

Specification	
Steering Cylinder-to-Tie Rod Socket—Torque	169 N·m (125 lb-ft)



TCAL26601 —UN—15JUN12

G—Cap Screws **H**—Bracket

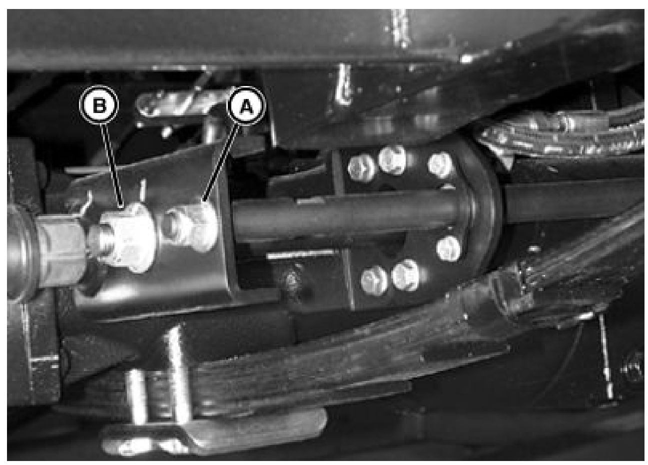
- Check toe-in adjustment. (See Adjust Toe-In.)

RB14256,00007AB -19-18JUN12-4/4

Remove and Install Steering Cylinder (4WD)

Removal

1. Park machine on level surface.
2. Lock park brake.
3. Place wheels in straight-ahead position.
4. Remove the front locknut (A) and the rear locknut (B) securing the drag link and the steering cylinder rod to the bridge plate on each side of the vehicle.
5. Carefully raise the front of the vehicle until the front wheels are off the ground.



TCAL26602 —UN—15JUN12

A—Front Locknut **B**—Rear Locknut

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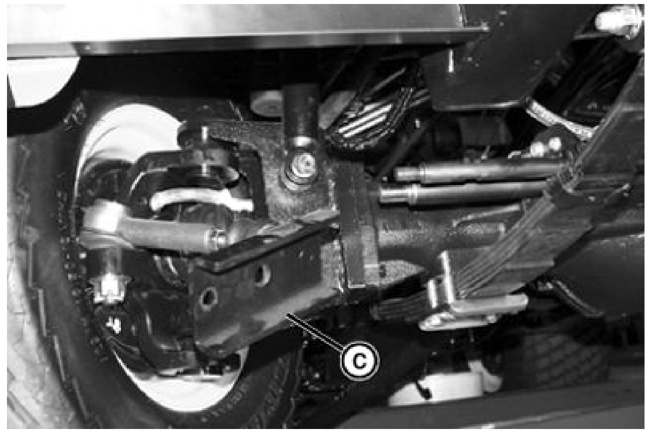
RB14256,00007AC -19-18JUN12-1/5

6. Remove the bridge plate assembly (C) by pivoting each wheel fully outward.
7. Lower the vehicle back to the ground.



TCAL26603 —UN—15JUN12

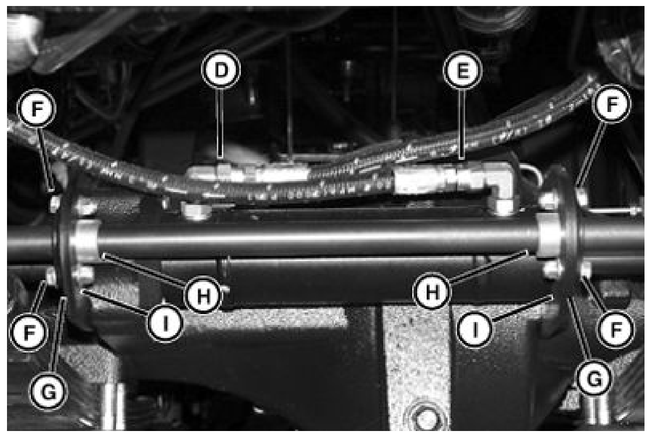
C—Bridge Plate Assembly

RB14256,00007AC -19-18JUN12-2/5

CAUTION: Escaping fluid under pressure can penetrate the skin, causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body from high-pressure fluids.

If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury may call Deere & Company Medical Department in Moline, Illinois, or other knowledgeable medical source.

8. Remove and cap the steering hoses (D and E).
9. Remove the cap screws (F) and retainer plate (G) from the drag link bushings (H) and remove the bushings.
10. Slide the drag link out of the cylinder plates (I).

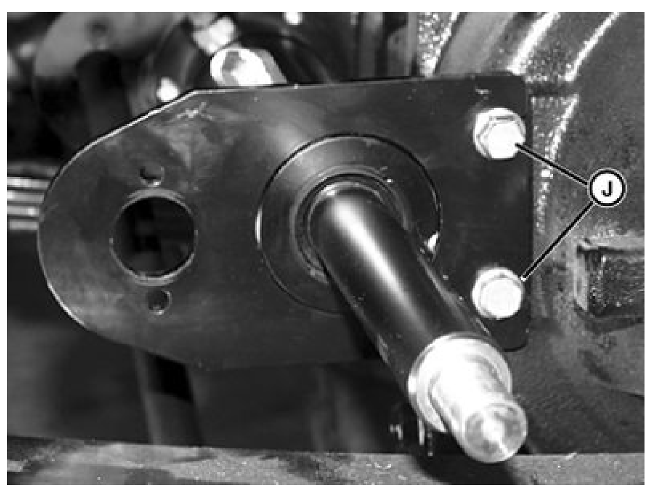


TCAL26604 —UN—15JUN12

D—Hose
E—Hose
F—Cap Screws
G—Retainer Plate
H—Bushings
I— Cylinder Plates

RB14256,00007AC -19-18JUN12-3/5

11. Remove the two cap screws (J) securing the steering cylinder to the left side of the front axle and remove the cylinder plate.



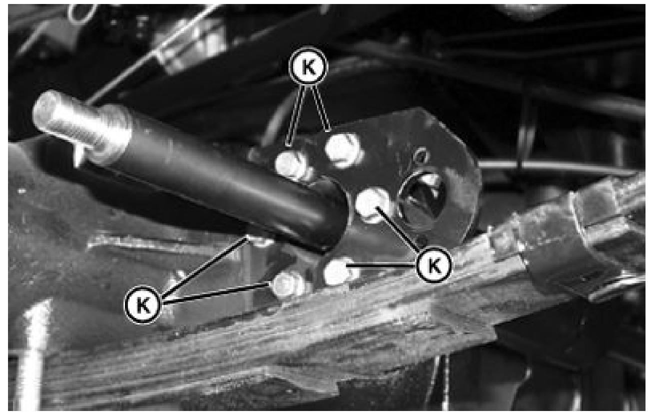
TCAL26605 —UN—15JUN12

J— Cap Screws

Continued on next page

RB14256,00007AC -19-18JUN12-4/5

12. Remove the six cap screws (K) securing the cylinder plate and the steering cylinder to the axle on the right side of the vehicle. Remove the steering cylinder. Note the position of the three longer cap screws.



K—Cap Screws

Installation

Installation is done in the reverse order of removal.

- Tighten steering cylinder mounting cap screws to specification.

Specification

Steering Cylinder Mounting Cap Screw—Torque .... 54 N·m (40 lb-ft)

- Tighten drag link slide bearing retainer cap screws to specification.

Specification

Drag Link Slide Bearing Retainer Cap Screw—Torque .... 13.7 N·m (60 lb-ft)

- Tighten hose connections to specification.

Specification

Steering Cylinder Hose Connection—Torque .... 24.4 N·m (18 lb-ft)

- Tighten rear locknut to specification.

Specification

Bridge Plate Rear Locknut (M16)—Torque .... 142 N·m (105 lb-ft)

Hy-Gard is a trademark of Deere & Company

- Tighten front locknut to specification.

Specification

Bridge Plate Front Locknut (M12)—Torque .... 95 N·m (70 lb-ft)

- Fill transaxle to proper level with low viscosity Hy-Gard™ oil. (See Transaxle Oil.)
- Check the toe-in adjustment. (See Adjust Toe-In.)

RB14256,00007AC -19-18JUN12-5/5

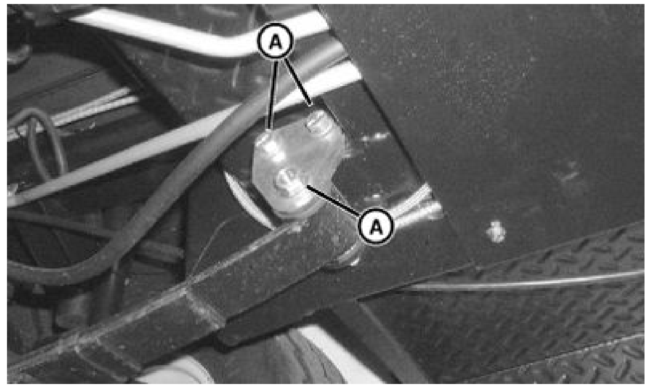
Remove and Install Front Leaf Spring

Removal

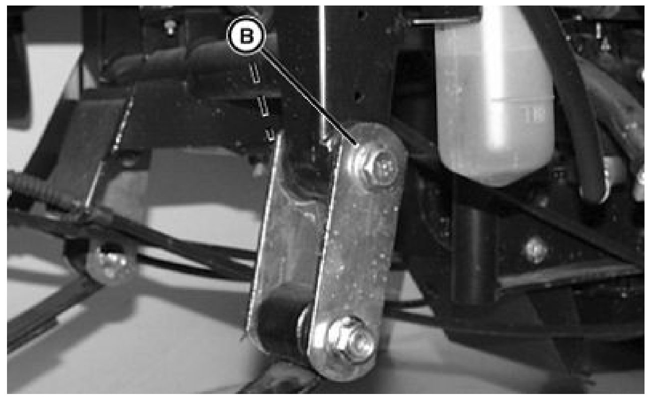
1. Park machine on level surface.
2. Turn key switch to OFF position, place shift lever in NEUTRAL, and lock park brake.
3. Raise the front of the vehicle and place on jack stand so that the front tires are at least 25 mm (1 in.) off the ground.

NOTE: Remove and replace one leaf spring at a time to hold the front axle in place during installation.

4. Loosen, but do not remove, the hardware securing the front chassis bracket (A) and rear shackle plates (B) to vehicle frame.



TCAL26607 —UN—15JUN12

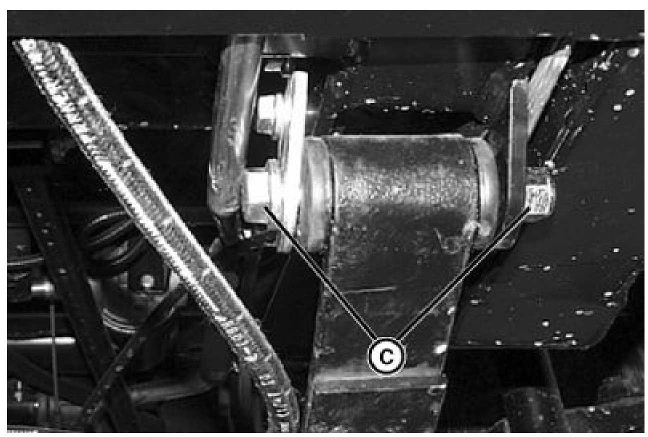


TCAL26608 —UN—15JUN12

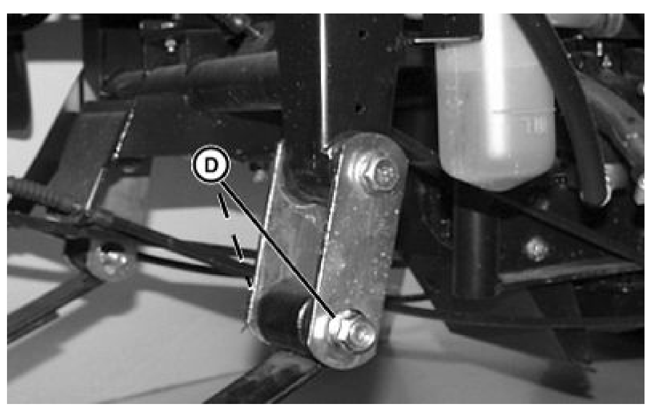
B—Rear Shackle Plates

RB14256,00007AD -19-18JUN12-1/7

5. Remove cap screw and nut (C) from the front and cap screw and nut (D) from the rear of the leaf spring. Retain hardware for new installation.



TCAL26609 —UN—15JUN12



TCAL26610 —UN—15JUN12

D—Rear Cap Screw and Nut

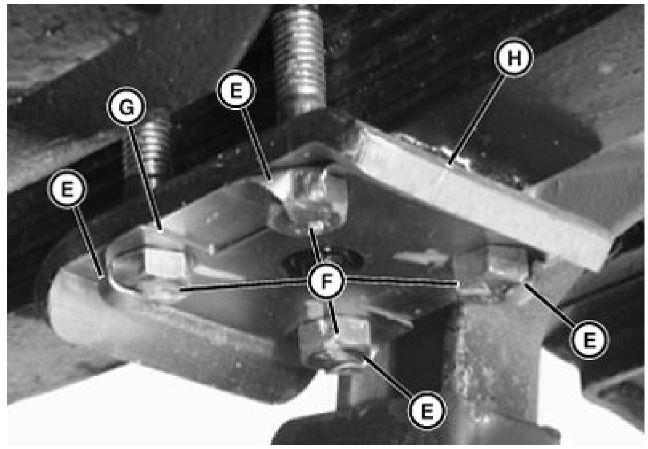
Continued on next page

RB14256,00007AD -19-18JUN12-2/7

CAUTION: The leaf spring is heavy, use care while removing bolts to avoid injury.

6. Bend the lock plate tabs (E) away from the mounting cap screws (F).
7. Hold the leaf spring assembly and remove the four cap screws, lock plate (G), spring plate (H) and leaf spring.
8. Discard lock plate (G).

E—Tabs
F—Cap Screws
G—Lock Plate
H—Spring Plate



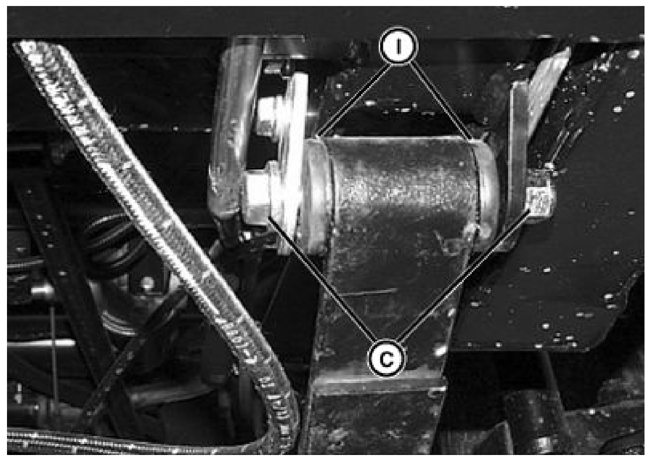
TCAL26611 —UN—15JUN12

RB14256,00007AD -19-18JUN12-3/7

Installation

1. Lubricate the rubber bushings (I) with liquid soap and install bushings into the new leaf spring.
2. Install front of new leaf spring between chassis brackets. Install cap screw and nut (C) but do not tighten.

C—Cap Screw and Nut
I— Rubber Bushings

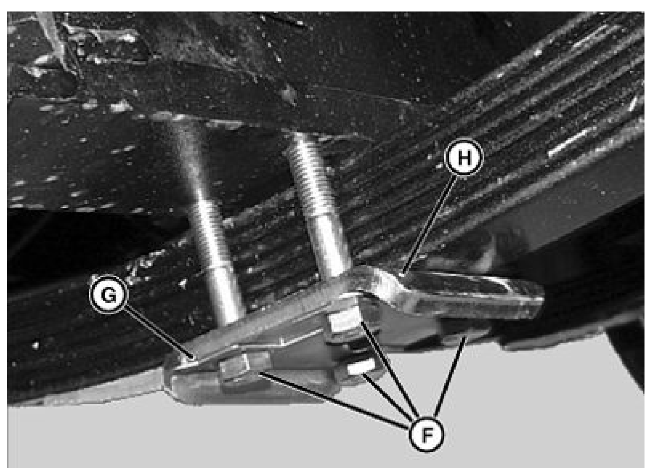


TCAL26612 —UN—15JUN12

RB14256,00007AD -19-18JUN12-4/7

3. Install four cap screws (F) through the holes of the new lock plate (G) and the spring plate (H).
4. Place the bolts around the leaf spring and install the cap screws until snug.

F—Cap Screws
G—Lock Plate
H—Spring Plate



TCAL26613 —UN—15JUN12

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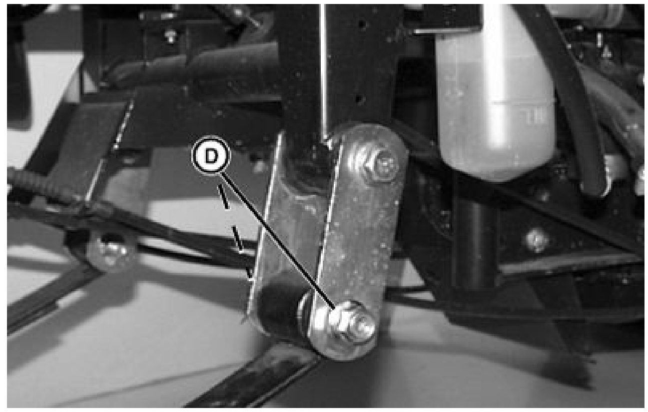
RB14256,00007AD -19-18JUN12-5/7

5. Place a floor jack under the front axle and raise the axle until the leaf spring aligns with the rear shackle plates. Install cap screw and nut (D) but do not tighten.
6. Tighten all the hardware securing the front chassis brackets and rear shackle plates to vehicle frame and the leaf spring to specification.

Specification

Rear Shackle Plate Cap Screw—Torque	102 N·m (75 lb-ft)
Leaf Spring-to-Axle Cap Screw—Torque	129 N·m (95 lb-ft)
Front Chassis Bracket Hardware—Torque	80 N·m (60 lb-ft)

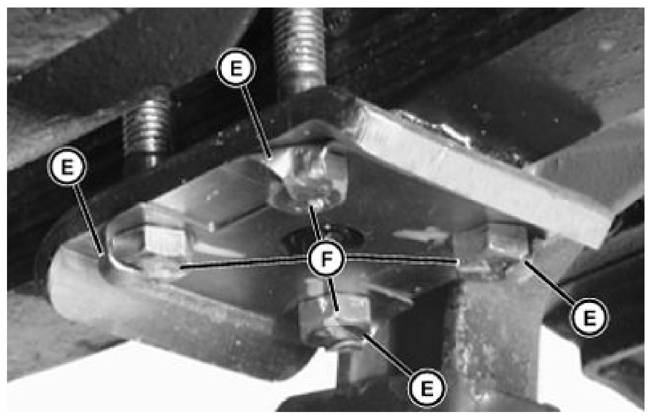
7. Raise the front axle and remove the jack stands.
8. Lower the vehicle to the floor.

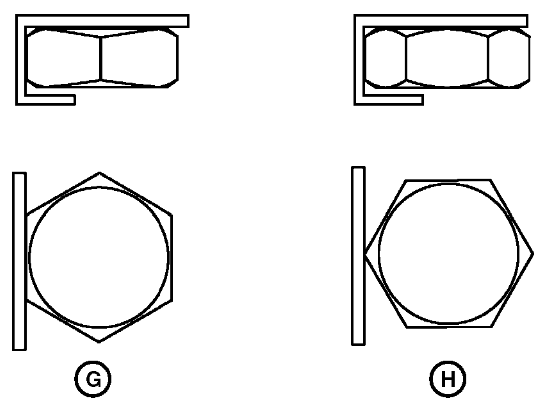


D—Cap Screw and Nut

RB14256,00007AD -19-18JUN12-6/7

9. Tighten the four cap screws (F) securing the leaf spring to the axle to specification.
10. Bend the tabs (E) of the lock plate against the flat side of cap screw head to prevent rotation.





G—Correct Positioning of Cap Screw Head With Tab

H—Incorrect Positioning of Cap Screw Head With Tab

RB14256,00007AD -19-18JUN12-7/7

Remove and Install Front Shock

Removal

1. Park machine on level surface, turn key switch to OFF position, place shift lever in NEUTRAL, and lock park brake.
2. Loosen lug nuts on wheel(s) being removed.
3. Raise and support machine so that the wheel being removed is just off the ground.
4. Remove lug nuts and remove wheel.
5. Remove the upper locknut, washer and rubber bushing (A).
6. Remove the lower locknut (B) and slide the shock off of the mounting pin.

Installation

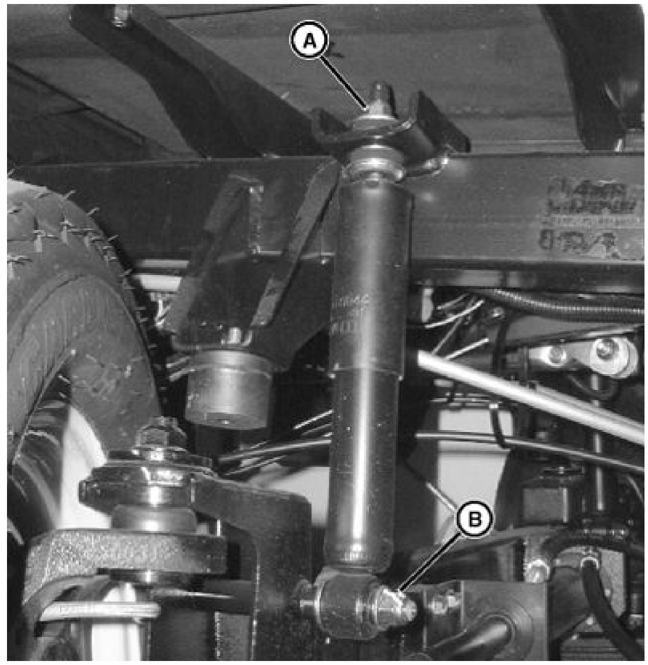
Installation is done in the reverse order of removal.

- Tighten shock mounting locknuts to specification.

Specification

Upper Shock
Locknut—Torque.. 45 N·m (33 lb-ft)
Lower Shock
Locknut—Torque.. 70 N·m (52 lb-ft)

- Install wheel(s) with stems toward outside of machine and tighten lug nuts to specification.



TCAL26617 —UN—15JUN12

A—Upper Locknut, Washer, and Bushing **B—Lower Locknut**

Specification

Wheel Lug Nut—Torque..115 N·m (85 lb-ft)

RB14256,00007AE -19-18JUN12-1/1

Remove and Install Tie Rod

Removal

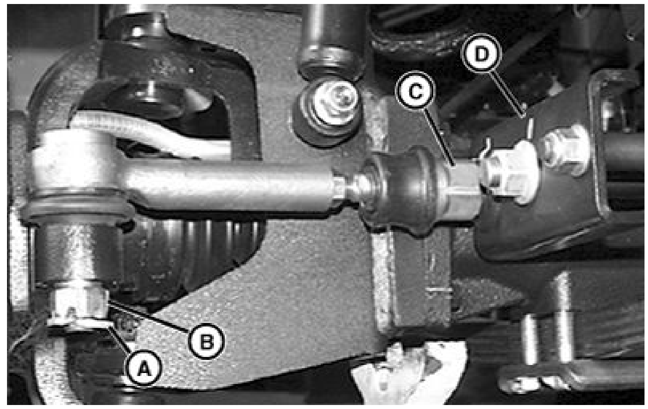
1. Park machine on level surface, turn key switch to OFF position, place shift lever in NEUTRAL, and lock park brake.
2. Loosen lug nuts on wheel(s) being removed.
3. Raise and support machine so that the wheel being removed is just off the ground.
4. Remove lug nuts and remove wheel.
5. Remove cotter pin (A) and castle nut (B) securing tie rod to steering knuckle.
6. Remove socket (C) from bridge plate (D) (MFWD) or cylinder rod (2WD), and remove tie rod.

Installation

Installation is done in the reverse order of removal.

- Tighten mounting hardware to specification.

Specification	
Tie Rod-to-Bridge Plate (MFWD)—Torque	170 N·m (125 lb-ft)
Tie Rod-to-Cylinder Rod (2WD)—Torque	170 N·m (125 lb-ft)
Tie Rod-to-Steering Knuckle—Torque	95 N·m (70 lb-ft)



TCAL26618 —UN—15JUN12

A—Cotter Pin
B—Castle Nut
C—Socket
D—Bridge Plate (MFWD)

- Install cotter pin.
- Install wheel(s) with stems toward outside of machine and tighten lug nuts to specification.

Specification	
Wheel Lug Nut—Torque	115 N·m (85 lb-ft)

- Check the toe-in adjustment. (See Adjust Toe-In.)

RB14256,00007AF -19-18JUN12-1/1

Remove and Install Front Axle

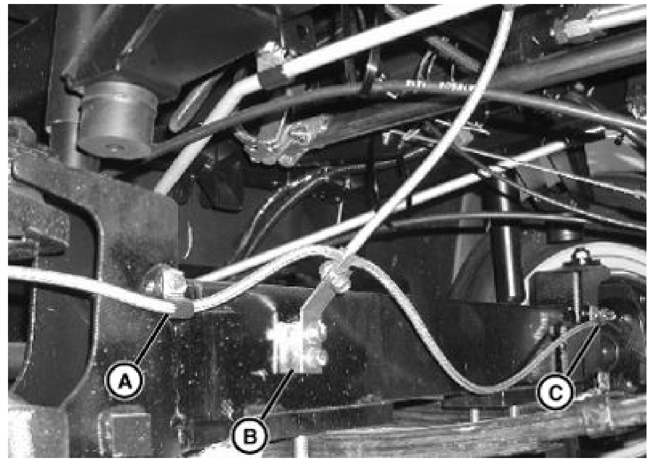
Removal

NOTE: The hubs of the 2WD front axle and the hubs, CV joints and differential of the MFWD are serviceable with the axle on the machine.

1. Safely raise and support the front of the unit. Remove the tires.
2. Disconnect the steering cylinder and shock absorbers. (See Remove and Install Steering Cylinder (4WD) and Remove and Install Front Shock.)
3. Disconnect the front brake hose brackets (A, B, and C) from frame.
4. Disconnect front brake hose from both front brake assemblies. Cap or plug brake assemblies and hose to prevent contamination.
5. Disconnect the drive shaft to the MFWD (if equipped).
6. Remove the leaf springs and front axle from the machine. (See Remove and Install Front Leaf Spring.)

Installation

1. Install the leaf springs and front axle to the machine.
2. Connect the drive shaft to the MFWD (if equipped). Lubricate splines with TY6333 Moly High Temperature EP Grease.



A—Bracket
B—Bracket
C—Bracket

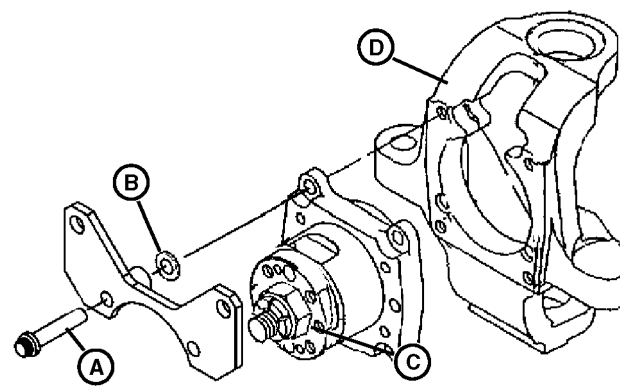
3. Connect the front brake hose and bleed the brakes. (See Bleeding Brakes.)
4. Connect the steering cylinder and shock absorbers.
5. Install the tires and lower the unit.

RB14256,00007B0 -19-18JUN12-1/1

Remove and Install Front Hub

Removal

1. Raise and safely support the hub being serviced.
2. Remove the wheel and tire from the hub.
3. Remove four cap screws (A) and washers (B). Pull the bearing housing and hub (C) from the steering knuckle (D).



A—Cap Screws
B—Washers
C—Bearing Housing and Hub
D—Steering Knuckle

Continued on next page

RB14256,00007B1 -19-18JUN12-1/2

4. Remove the cotter pin (F), and hub nut (G) from the axle retaining cap screw (E) (shaft for 4WD). Slide out the retaining cap screw (shaft for 4WD).
5. Remove the hub (H), seals (I), and bearing (J) from the bearing housing (C).
6. Clean and inspect all parts. Replace any unserviceable components.

Installation

Installation is done in the reverse order of removal.

- Pack the bearings with TY24416 Special-Purpose HD Lithium Complex Grease and fill the bearing housing 1/3 full with wheel bearing grease.
- Tighten the hub nut to specification.

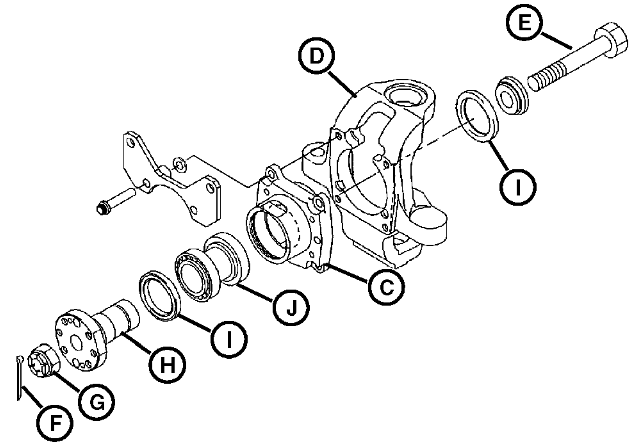
Specification

Hub Nut—Torque... 157-196 N·m (116-144 lb-ft)

- Tighten the bearing housing mounting screws to specification.

Specification

Bearing Housing-to-
Steering Knuckle Cap
Screw (M10)—Torque..44-59 N·m (33-43 lb-ft)



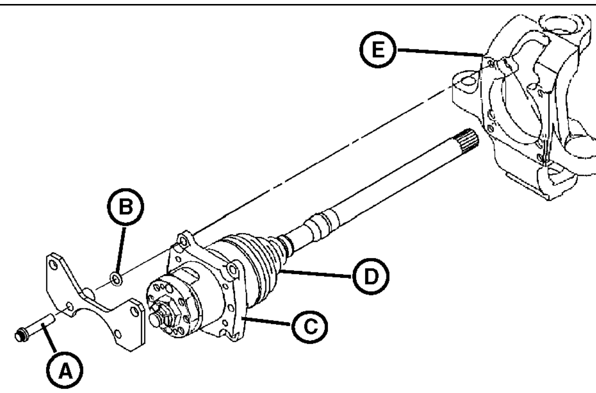
C—Bearing Housing
D—Steering Knuckle
E—Cap Screw
F—Cotter Pin
G—Hub Nut
H—Hub
I— Seals
J—Bearing

RB14256,00007B1 -19-18JUN12-2/2

Remove and Install CV Joint with Axle Shaft (4WD)

Removal

1. Raise and safely support the hub being serviced.
2. Remove the wheel and tire from the hub.
3. Remove four cap screws (A) and washers (B). Pull the bearing housing and hub (C) with the CV joint assembly (D) from the steering knuckle (E).



A—Cap Screws
B—Washers
C—Bearing Housing and Hub
D—CV Joint Assembly
E—Steering Knuckle

Continued on next page

RB14256,00007B2 -19-18JUN12-1/2

NOTE: The CV joint assembly has no serviceable components. If the CV joint makes noise, has bent or damaged parts, or does not operate smoothly, replace the assembly.

4. Remove the cotter pin (K), nut (J), and washer (I) from the axle. Slide out the axle.
5. Clean and inspect all parts as necessary. Replace any unserviceable components.
6. Inspect inner axle shaft seal (H) in front axle housing. Replace if necessary.

Installation

Installation is done in the reverse order of removal.

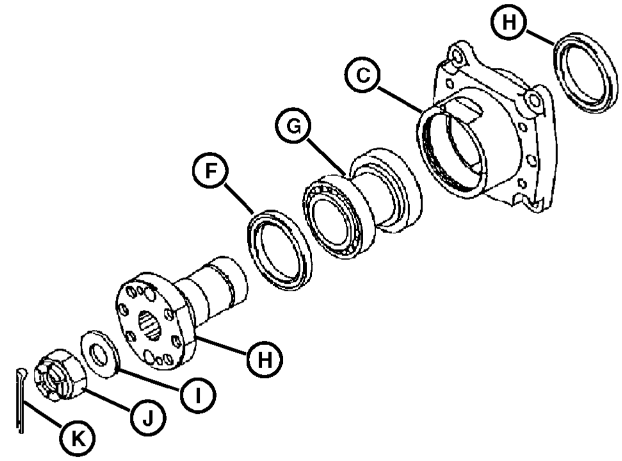
IMPORTANT: Use care not to damage inner shaft seal when installing axle shaft.

- The splines on the inner half of the axle shaft of the CV joint must align with the differential unit inside the differential housing. It may be necessary to rotate the axle shaft or input shaft to align the splines.
- Tighten the hub nut to specification.

Specification

Hub Nut—Torque.. 157-196 N·m (116-144 lb-ft)

- Tighten the bearing housing mounting screws to specification.



F—Bearing
G—Seal
H—Seal
I— Washer
J—Nut
K—Cotter Pin

Specification

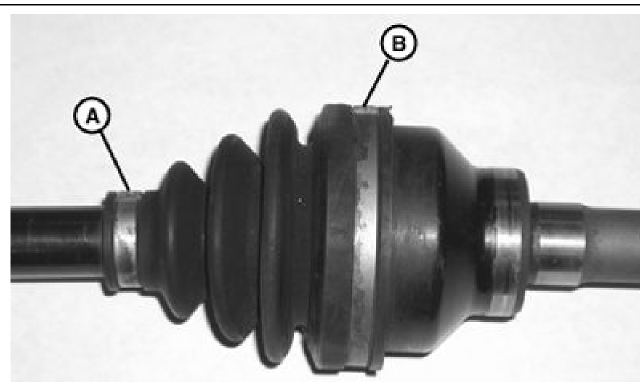
Bearing Housing-to-Steering Knuckle Cap Screw (M10)—Torque...44-59 N·m (33-43 lb-ft)

RB14256,00007B2 -19-18JUN12-2/2

CV Joint Boot Repair

Disassembly

1. Park machine on level surface and lock park brake.
2. Place wheels in a straight-ahead position. Raise and support the front of the vehicle.
3. Remove axle shaft. (See Remove and Install CV Joint with Axle Shaft (4WD).)
4. Remove metal straps (A and B) from CV boot.



A—Strap **B—Strap**

Continued on next page

RB14256,00007B3 -19-18JUN12-1/4

5. Using a utility blade, cut CV boot in half and remove.

NOTE: Should the grease be contaminated, the entire axle shaft assembly will need to be disassembled, cleaned and reassembled with fresh grease.

6. Inspect grease for contamination.

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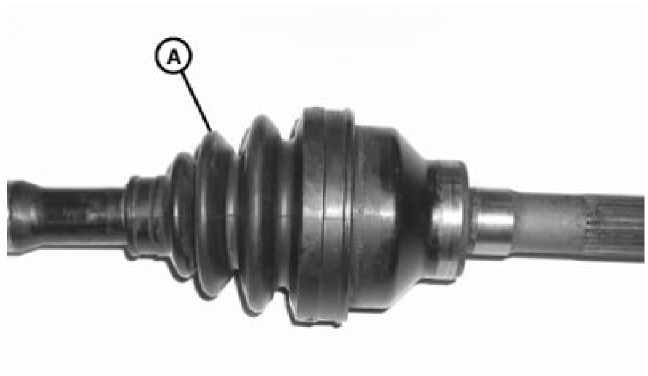
RB14256,00007B3 -19-18JUN12-2/4

Installation

1. Add grease as required.
2. Install new CV boot (A) over axle shaft.
3. Position CV boot ends in the grooves of the axle shaft.

A—CV Boot



TCAL26626 —UN—15JUN12

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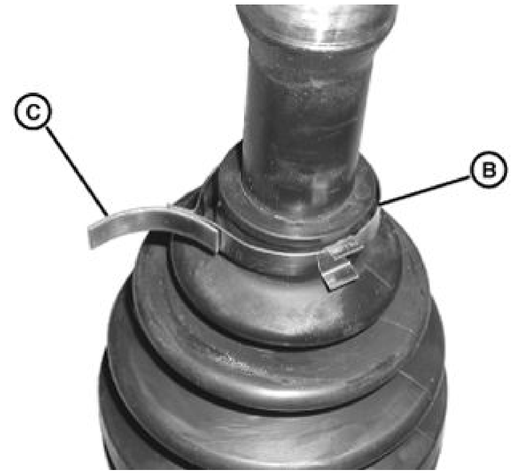
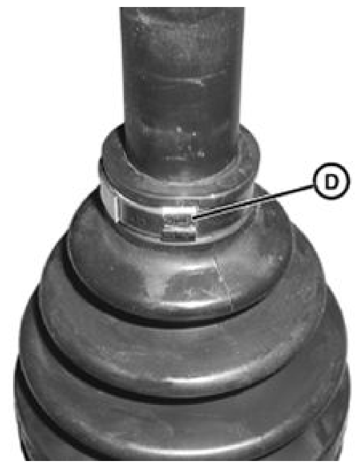
RB14256,00007B3 -19-18JUN12-3/4

4. Install metal strap (B) over boot end.
5. Fold over strap end (C) and lock down with tabs (D). Repeat procedure for the opposite end of the boot.
6. Install axle shaft. (See Remove and Install CV Joint with Axle Shaft (4WD).)
7. Lower vehicle and return to service.

D—Tabs



TCAL26627 —UN—15JUN12



TCAL26628 —UN—15JUN12

RB14256,00007B3 -19-18JUN12-4/4

Section 90
Brakes

Contents

General Specifications

Item	Measurement	Specification
Brake Specifications:		
Brake Type		Four Wheel Hydraulic Disk
Park Brake Type		Mechanical
Brake Fluid		DOT 3
Brake Friction Material Thickness (Minimum)		1 mm (0.04 in.)
Brake Pedal Arm to Stop Clearance		1 - 2 mm (0.039 - 0.079 in.)
Brake Rotor Thickness (Minimum)		6.22 mm (0.19 in.)

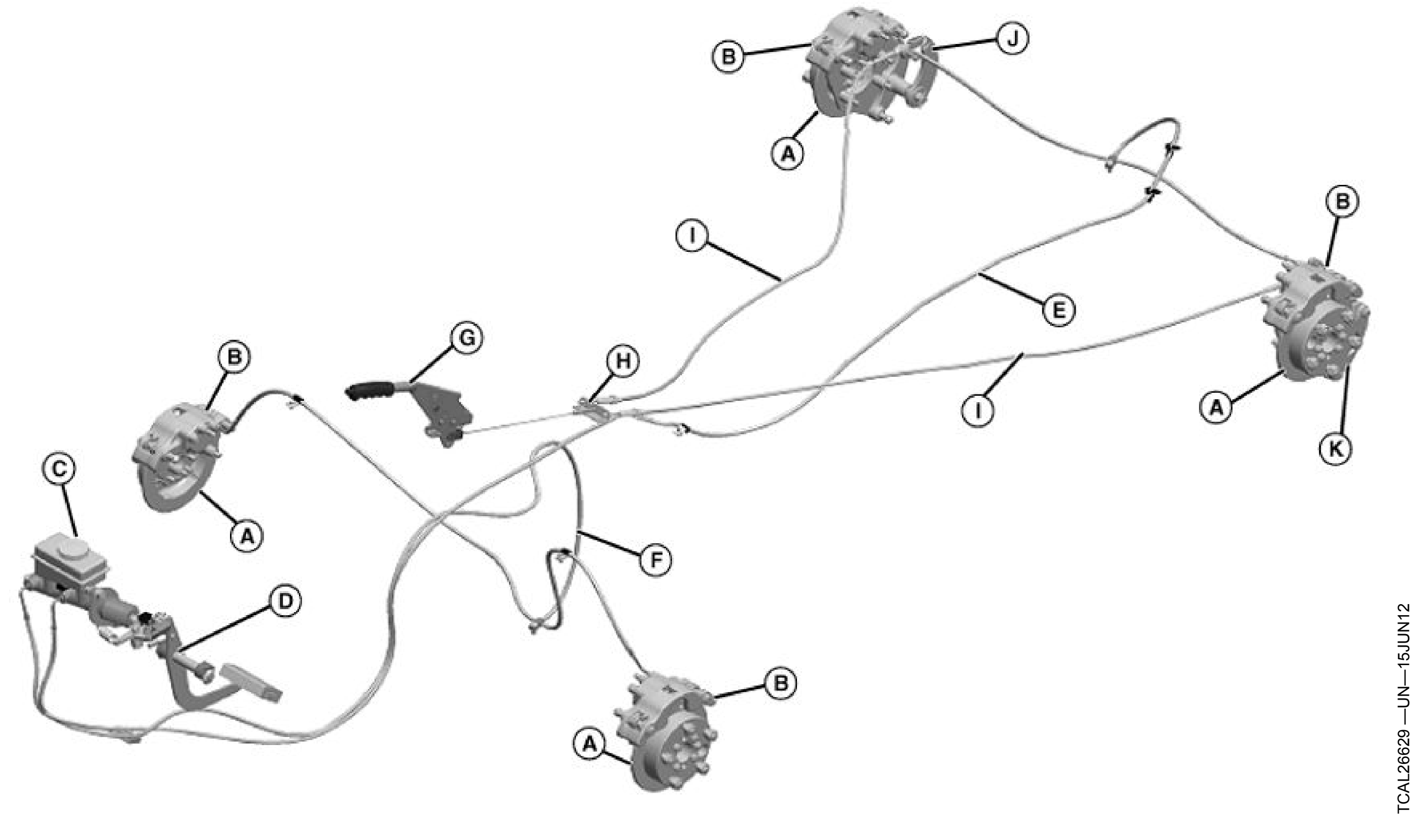
RB14256,0000779 -19-18JUN12-1/1

Torque Specifications

Item	Measurement	Specification
Hydraulic Brakes:		
Brake Line 3-Way Block Bolt		10.4 N·m (92 lb-in.)
Brake Line Flare Nut		15 N·m (133 lb-in.)
Master Cylinder Push Rod Jam Nut		20 N·m (15 lb-ft)
Brake Disc Mounting Bolt		81.5 N·m (60 lb-ft)
Wheel Lug Nut		115 N·m (85 lb-ft)
Brake Caliper Fitting Bolt		40.7 N·m (30 lb-ft)

RB14256,000077A -19-18JUN12-1/1

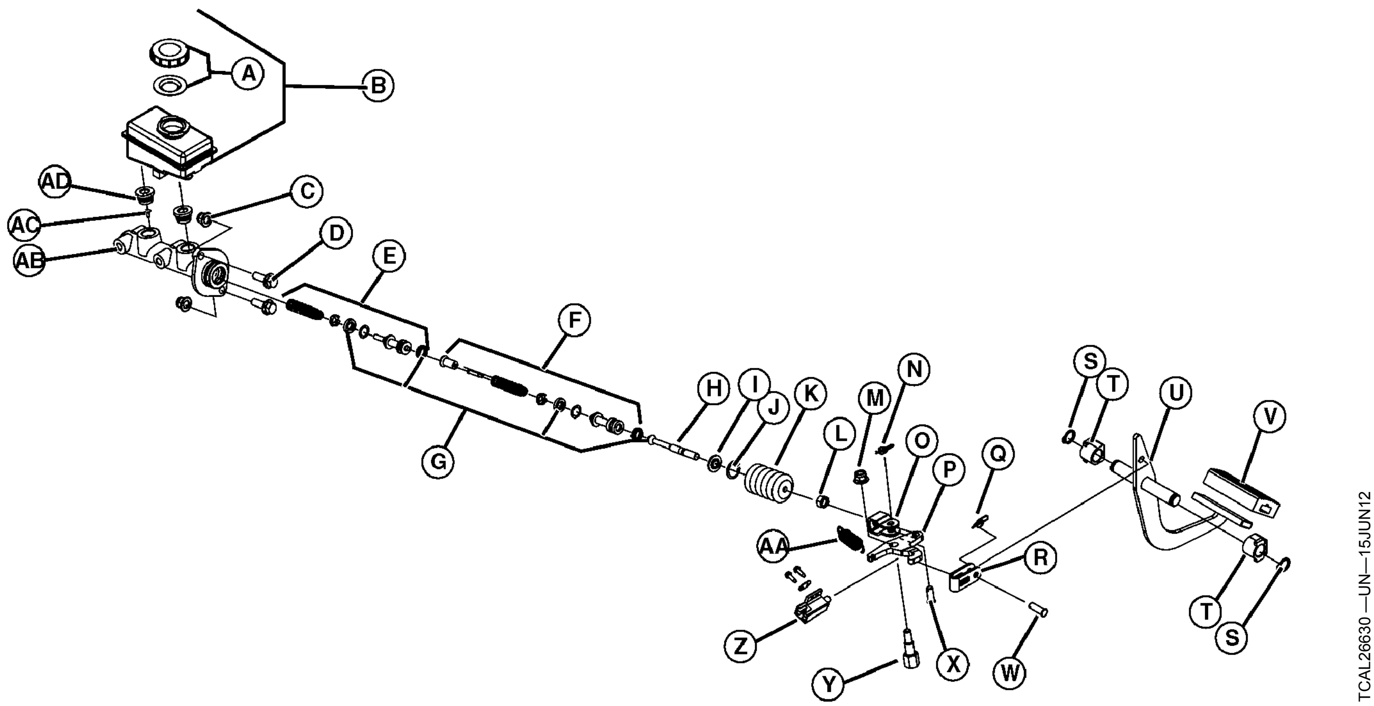
Brake System



A—Hub w/Brake Rotor (four used)
B—Brake Caliper (four used)
C—Master Cylinder
D—Brake Pedal Assembly
E—Rear Brakes Hydraulic Line
F—Front Brakes Hydraulic Line
G—Park Brake Handle
H—Park Brake Equalizer
I— Park Brake Cable (two used)
J— Park Brake Arm (two used)
K—Park Brake Caliper (two used)

RB14256,000077B -19-18JUN12-1/1

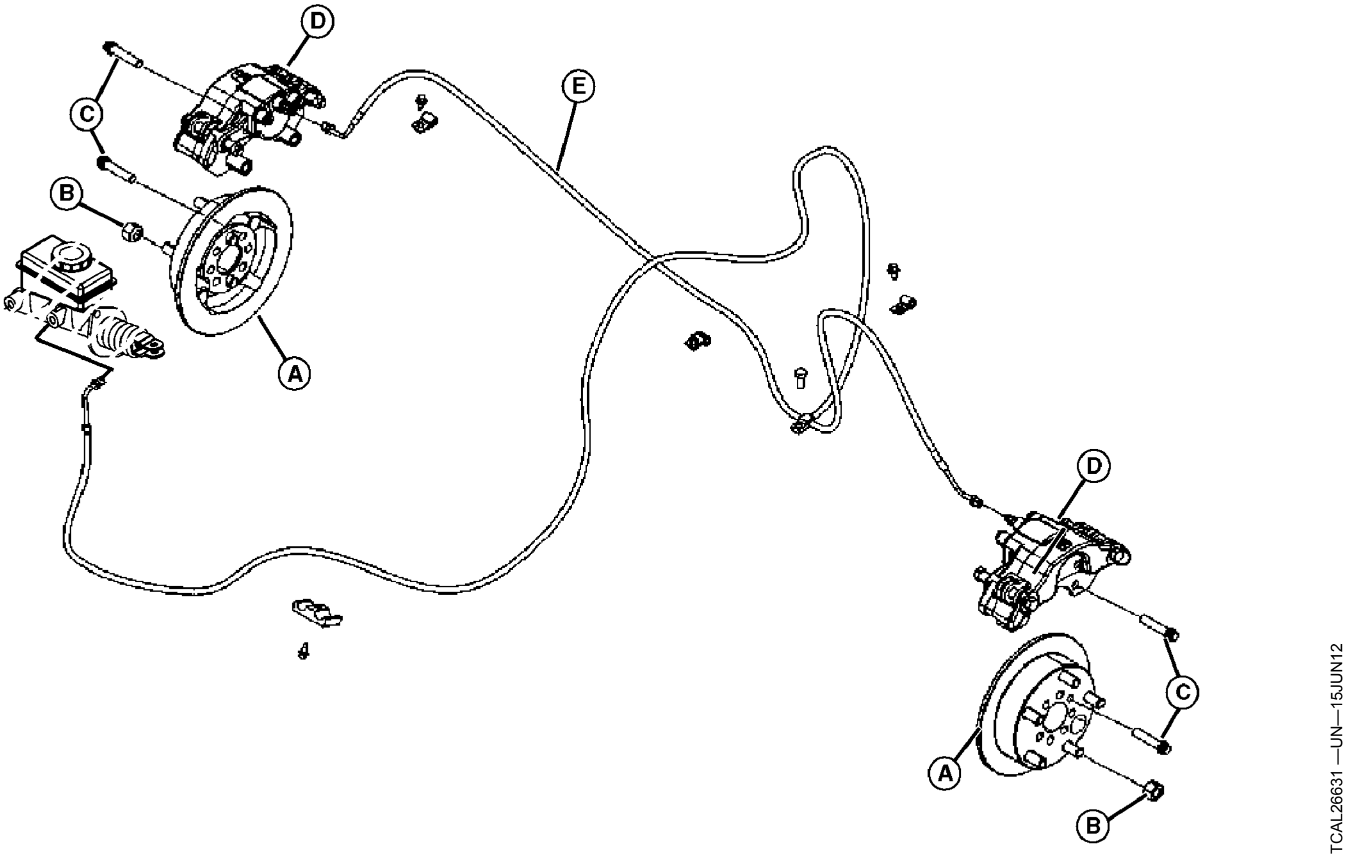
Brake System Components - Master Cylinder



A—Cap
B—Reservoir
C—Nut (2 Used)
D—Bolt (2 Used)
E—Piston, Rear
F—Piston, Front
G—Seal Kit
H—Push Rod
I— Washer
J— Ring, Retaining
K—Cover, Dust
L—Nut
M—Nut
N—Pin
O—Clevis
P—Pivot Arm
Q—Pin
R—Clevis
S—Snap Ring (2 Used)
T—Bearing (2 Used)
U—Brake Pedal
V—Pad
W—Pin, Drilled
X—Pin, Drilled
Y—Bolt
Z—Switch
AA—Spring, Return
AB—Master Cylinder Housing
AC—Stop Pin
AD—Seal (2 Used)

RB14256,000077C -19-18JUN12-1/1

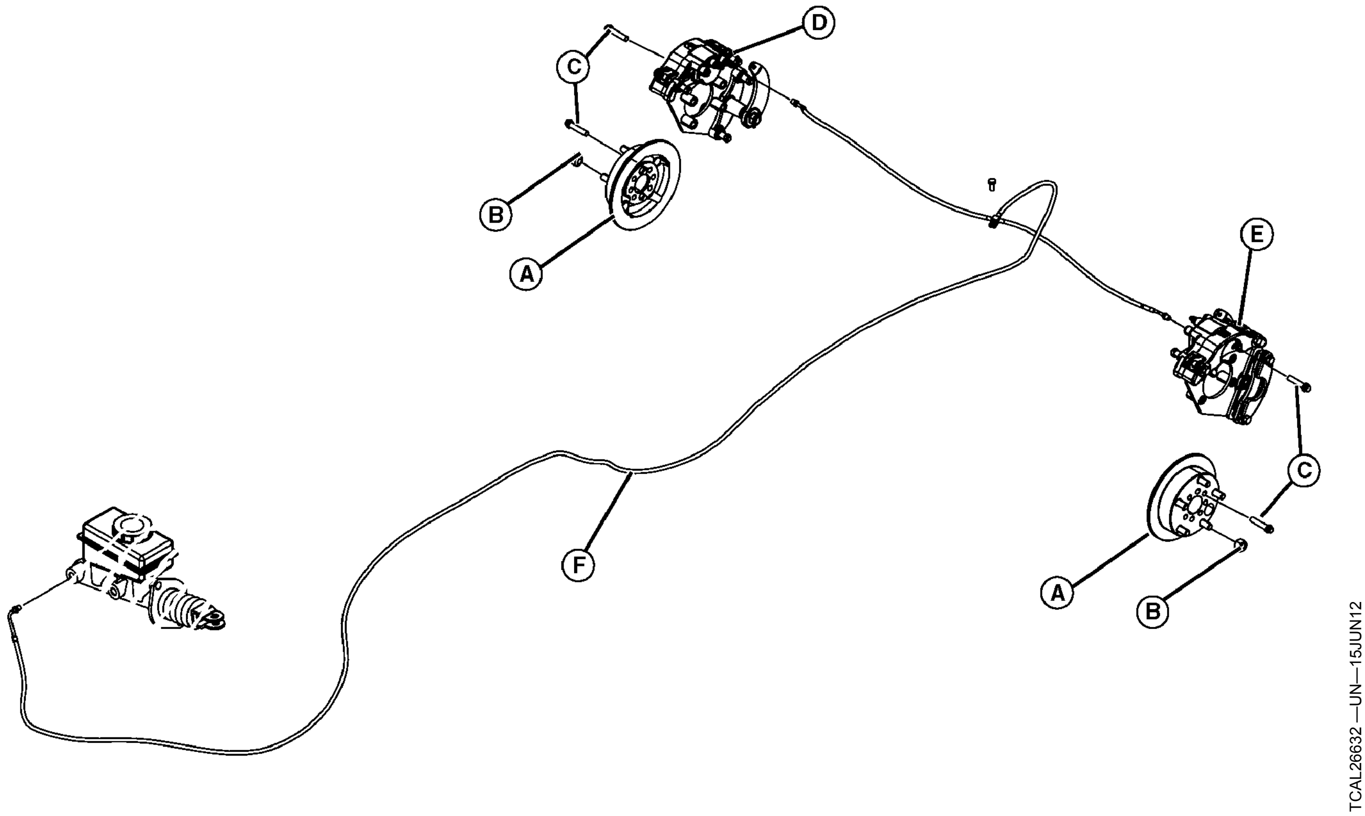
Brake System Components - Front



A—Hub w/Brake Rotor (2 used)
B—Lug Nut (10 Used)
C—Screw (16 Used)
D—Caliper (2 used)
E—Hose, Front Brake

RB14256,000077D -19-18JUN12-1/1

Brake System Components - Rear



A—Hub w/Brake Rotor (2 used)
B—Lug Nut (10 Used)
C—Screw (20 Used)
D—Caliper, Right Rear
E—Caliper, Left Rear
F—Hose, Rear Brake

RB14256,000077E -19-18JUN12-1/1

Brake System

Function:

The service brake system provides a means for the machine to be slowed or stopped, or temporarily held on a slope, while under the operator's control. The park brake system provides a means of preventing movement when the operator is not on the machine.

Theory of Operation:

The machine's service brake system is automotive style, with hydraulic disc brakes operating on all four wheels.

When the foot operated brake pedal is pressed, a clevis connected to the pedal arm operates on a rod at the brake master cylinder. The rod pushes a piston, applying pressure to brake fluid in the cylinder. Brake fluid flows from the master cylinder through brake lines and hoses to brake calipers at the wheels, where the fluid moves the caliper pistons. The pistons press opposing brake pads together to contact axle mounted brake rotors between them. Friction between the brake pads and brake rotors slows or stops wheel rotation.

The park brake system is cable operated. When the park brake lever is raised into its locked position, the front park brake cable pulls the rear park brake cables through an equalizer, which pulls on the park brake lever of each rear brake assembly. To release the park brake lever, raise the lever slightly, then depress the release button and lower the lever all the way.

A visual warning indicator on the instrument panel shows when the park brake control is in the applied position.

Brake pedal effort with the new brakes will be less than that of the old drum brake system. due to piston size increase.

RB14256,000077F -19-18JUN12-1/1

System: Diagnosis

RB14256,0000780 -19-18JUN12-1/5

Diagnosis

RB14256,0000780 -19-18JUN12-2/5

Step 1	Is the brake fluid level correct?	**YES:** Go to next step. **NO:** Add brake fluid. Check system for leaks.

RB14256,0000780 -19-18JUN12-3/5

Step 2	Do brake system components leak?	**YES:** Tighten, repair, or replace components as necessary. Bleed brake system.(See Bleeding Brakes.)

RB14256,0000780 -19-18JUN12-4/5

Step 3	Is there air in the brake system?	**YES:** Bleed the brake system. (See Bleeding Brakes.) **NO:** Go to next step.

RB14256,0000780 -19-18JUN12-5/5

Symptom: Brakes Will Not Engage or Show Poor Response

RB14256,0000781 -19-18JUN12-1/7

Brakes Will Not Engage or Show Poor Response

RB14256,0000781 -19-18JUN12-2/7

Step 1	Is the brake fluid level low?	**YES:** Add brake fluid. (See Check Brake Fluid Level.) **NO:** Go to next step.

RB14256,0000781 -19-18JUN12-3/7

Step 2	Do the master cylinder seal, brake lines or brake caliper seals leak?	**YES:** Repair or replace components. **NO:** Go to next step.

RB14256,0000781 -19-18JUN12-4/7

Step 3	Is there air in the brake system?	**YES:** Bleed brake lines. (See Bleeding Brakes.) **NO:** Go to next step.

RB14256,0000781 -19-18JUN12-5/7

Step 4	Is the master cylinder push rod adjusted correctly?	**NO:** Adjust push rod length. (See Adjust Master Cylinder Rod.) **YES:** Go to next step.

Continued on next page RB14256,0000781 -19-18JUN12-6/7

Step 5	Is the brake pedal or pivot bent, broken or worn?	**YES:** Repair or replace components as needed. **NO:** Go to next step.

RB14256,0000781 -19-18JUN12-7/7

Symptom: Brake Effort Excessive

RB14256,0000782 -19-18JUN12-1/7

Brake Effort Excessive

RB14256,0000782 -19-18JUN12-2/7

Step 1	Is the brake fluid level low?	**YES:** Add brake fluid. (See Check Brake Fluid Level.) **NO:** Go to next step.

RB14256,0000782 -19-18JUN12-3/7

Step 2	Does the master cylinder leak?	**YES:** Repair or replace components. **NO:** Go to next step.

RB14256,0000782 -19-18JUN12-4/7

Step 3	Is the master cylinder push rod adjusted correctly?	**NO:** Adjust push rod length. (See Adjust Master Cylinder Rod.) **YES:** Go to next step.

RB14256,0000782 -19-18JUN12-5/7

Step 4	Is the brake pedal or pivot bent, broken or worn?	**YES:** Repair or replace components as needed. **NO:** Go to next step.

RB14256,0000782 -19-18JUN12-6/7

Step 5	Are brake pads excessively worn?	**YES:** Replace brake pads. (See Service Brake Pad Replacement.)

RB14256,0000782 -19-18JUN12-7/7

Symptom: Brakes Will Not Release

RB14256,0000783 -19-18JUN12-1/4

Brakes Will Not Release

RB14256,0000783 -19-18JUN12-2/4

Step 1	Is the master cylinder push rod adjusted correctly?	**NO:** Adjust push rod length. (See Adjust Master Cylinder Rod.) **YES:** Go to next step.

Continued on next page RB14256,0000783 -19-18JUN12-3/4

Step 2	Is the brake pedal or pivot bent, broken or worn?	**YES:** Repair or replace components as needed.

RB14256,0000783 -19-18JUN12-4/4

Symptom: Brake Noisy or Chattering

RB14256,0000784 -19-18JUN12-1/5

Brake Noisy or Chattering

RB14256,0000784 -19-18JUN12-2/5

Step 1	Do the brake calipers leak?	**YES:** Repair or replace components. **NO:** Go to next step.

RB14256,0000784 -19-18JUN12-3/5

Step 2	Do the brake calipers have loose or missing hardware?	**YES:** Repair or replace hardware.

RB14256,0000784 -19-18JUN12-4/5

Step 3	Are brake pads excessively worn?	**YES:** Replace brake pads. (See Service Brake Pad Replacement.)

RB14256,0000784 -19-18JUN12-5/5

Symptom: Excessive Brake Pad Wear

RB14256,0000785 -19-18JUN12-1/5

Excessive Brake Pad Wear

RB14256,0000785 -19-18JUN12-2/5

Step 1	Is the brake pedal return spring stretched, broken or missing?	**YES:** Replace spring. **NO:** Go to next step.

RB14256,0000785 -19-18JUN12-3/5

Step 2	Is the master cylinder push rod adjusted correctly?	**NO:** Adjust push rod length. (See Adjust Master Cylinder Rod.) **YES:** Go to next step.

RB14256,0000785 -19-18JUN12-4/5

Step 3	Is the brake pedal or pivot bent, broken or worn?	**YES:** Repair or replace components as needed. **NO:** Go to next step.

RB14256,0000785 -19-18JUN12-5/5

Symptom: Excessive Brake Pedal Travel

RB14256,0000786 -19-18JUN12-1/5

Excessive Brake Pedal Travel

Continued on next page RB14256,0000786 -19-18JUN12-2/5

Step 1	Is the brake fluid level low?	**YES:** Add brake fluid. (See Check Brake Fluid Level.) **NO:** Go to next step.

RB14256,0000786 -19-18JUN12-3/5

Step 2	Do the master cylinder seal, brake lines or brake caliper seals leak?	**YES:** Repair or replace components. **NO:** Go to next step.

RB14256,0000786 -19-18JUN12-4/5

Step 3	Is there air in the brake system?	**YES:** Bleed brake lines. (See Bleeding Brakes.) **NO:** Go to next step.

RB14256,0000786 -19-18JUN12-5/5

Symptom: Brakes Pull Left or Right

RB14256,0000787 -19-18JUN12-1/5

Brakes Pull Left or Right

RB14256,0000787 -19-18JUN12-2/5

Step 1	Is the brake fluid level low?	**YES:** Add brake fluid. (See Check Brake Fluid Level.) **NO:** Go to next step.

RB14256,0000787 -19-18JUN12-3/5

Step 2	Do the brake lines or brake calipers leak?	**YES:** Repair or replace components. **NO:** Go to next step.

RB14256,0000787 -19-18JUN12-4/5

Step 3	Is there air in the brake system?	**YES:** Bleed brake lines. (See Bleeding Brakes.) **NO:** Go to next step.

RB14256,0000787 -19-18JUN12-5/5

Symptom: Pedal Feels Hard With Little Travel

RB14256,0000788 -19-18JUN12-1/4

Pedal Feels Hard With Little Travel

RB14256,0000788 -19-18JUN12-2/4

Step 1	Is the master cylinder push rod adjusted correctly?	**NO:** Adjust push rod length. (See Adjust Master Cylinder Rod.) **YES:** Go to next step.

Continued on next page

RB14256,0000788 -19-18JUN12-3/4

Step 2	Is the brake pedal or pivot bent, broken or worn?	**YES:** Repair or replace components as needed. **NO:** Go to next step.

RB14256,0000788 -19-18JUN12-4/4

Symptom: Park Brake Pedal Will Not Engage or Hold

RB14256,0000789 -19-18JUN12-1/8

Park Brake Pedal Will Not Engage or Hold

RB14256,0000789 -19-18JUN12-2/8

Step 1	Is the park brake cable broken?	**YES:** Replace cable. **NO:** Go on to next step.

RB14256,0000789 -19-18JUN12-3/8

Step 2	Is the park brake lever or locking pawl bent, broken, binding or worn?	**YES:** Replace park brake caliper assemblies. **NO:** Go to next step.

RB14256,0000789 -19-18JUN12-4/8

Step 3	Is the park brake cable stretched or binding?	**YES:** Replace brake cable. **NO:** Go to next step.

RB14256,0000789 -19-18JUN12-5/8

Step 4	Does the park brake mechanism have missing or worn components?	**YES:** Replace components.

RB14256,0000789 -19-18JUN12-6/8

Step 5	Are park brake friction disks worn below minimum thickness?	**YES:** Replace park brake caliper assembly. **NO:** Go on to next step

RB14256,0000789 -19-18JUN12-7/8

Step 6	Is park brake return spring completely depressed when lever is pulled up?	**YES:** Replace park brake caliper assembly. **NO:** Go on to next step

RB14256,0000789 -19-18JUN12-8/8

Symptom: Park Brake Will Not Release

RB14256,000078A -19-18JUN12-1/5

Park Brake Will Not Release

RB14256,000078A -19-18JUN12-2/5

Step 1	Is the park brake cable bent or frayed?	**YES:** Replace cable. **NO:** Go on to next step.

Continued on next page

RB14256,000078A -19-18JUN12-3/5

Step 2	Is the park brake cable binding?	**YES:** Repair or replace brake cable. **NO:** Go to next step.

RB14256,000078A -19-18JUN12-4/5

Step 3	Is the park brake lever or locking pawl bent, broken, binding or worn?	**YES:** Replace park brake caliper assembly.

RB14256,000078A -19-18JUN12-5/5

Symptom: Excessive Park Brake Pad Wear

RB14256,000078B -19-29MAY14-1/3

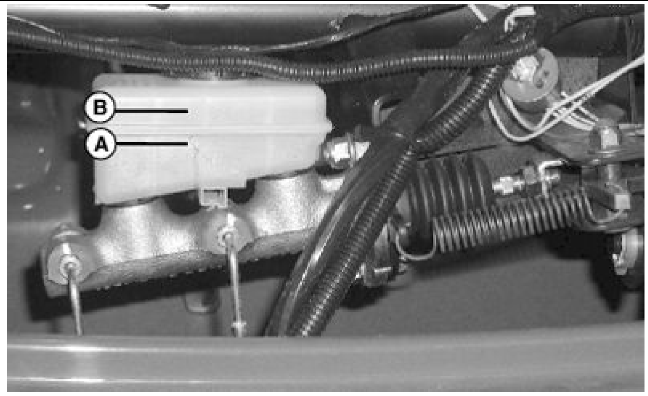
Excessive Park Brake Pad Wear

RB14256,000078B -19-29MAY14-2/3

Step 1	Is operator disengaging park brake prior to moving?	**YES:** Inspect pad clearances. **NO:** Replace caliper assemblies.

RB14256,000078B -19-29MAY14-3/3

Check Brake Fluid Level



TCAL26633 —UN—15JUN12

IMPORTANT: Avoid Damage! Avoid contamination of the brake fluid. Thoroughly clean area around the filler cap before removing. Do not open the brake fluid reservoir cap unless absolutely necessary.

Use extreme care when filling the reservoir. Fluid spilled on painted surfaces can cause damage.

Use only DOT 3 brake fluid from a sealed container.

1. Park machine safely on a level surface. See Park Machine Safely.

CAUTION: Avoid Injury! Allow the radiator to cool. Serious burns can result from contact with a hot radiator. Wear protective gloves when working around the radiator or center console. Injury can result from contact with sharp edges.

2. Remove the front access panel.
3. Visually check brake fluid level.

   a. Fluid level must be maintained between low (A) and high (B) level marks.

4. If fluid is low, carefully clean area around reservoir cap and remove cap:

   a. Add fluid as required to maintain within specified levels.

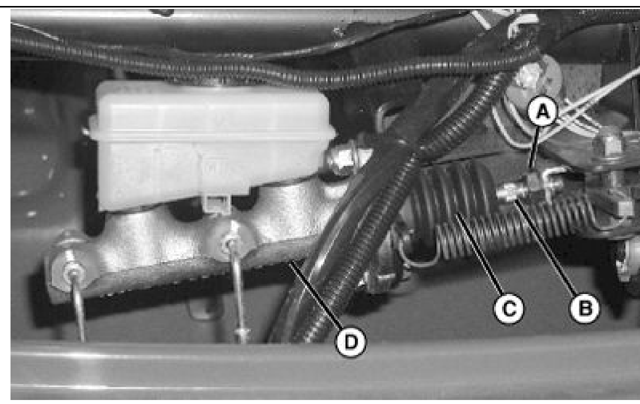
5. Install reservoir cap.
6. Replace the front access panel.

Specification:—Specification

Brake Fluid—Torque...DOT 3

RB14256,000078C -19-18JUN12-1/1

Adjust Master Cylinder Rod



TCAL26634 —UN—15JUN12

A—Jam Nut
B—Master Cylinder Rod
C—Rubber Boot
D—Master Cylinder

Reason

Master cylinder must be fully destroked when the pedal is against the backstop, or pressure will be maintained in the brake system.

Procedure

1. Park machine safely.
2. Remove the front access panel.
3. Loosen the jam nut (A) on the master cylinder rod (B).
4. Pull the rubber boot (C) off of the shoulder from the master cylinder (D).

NOTE: Adjustment is correct when the brake pedal has 6-16 mm travel before applying pressure on master cylinder push rod.

5. Turn the master cylinder rod to adjust brake pedal free play.
6. Attach boot back onto the master cylinder.
7. Tighten the jam nut, and verify brake pedal operation.
8. Install the front access panel.

Specifications:—Specification

Brake Pedal Arm to Stop
Clearance—Torque.......................................1 - 2 mm (0.039 - 0.079 in.)
Master Cylinder Push
Rod Jam Nut—Torque... 20 N·m (177 lb-in.)

RB14256,000078D -19-18JUN12-1/1

Adjust Park Brake Cable

Procedure

NOTE: Observe and make note of the routing of the park brake cable if the cable is to be replaced. Install the new cable to the machine in the same manner as the original installation.

1. The park brake cable is adjusted by removing the slack from the cable between the park brake lever and the park brake housing.
2. Adjust the nut on the front brake cable at the equalizer until the slack in the control cable slide rod and clevis has been removed.
3. Do not overtighten the cable, or the brakes will be preloaded.

RB14256,000078E -19-18JUN12-1/1

Bleeding Brakes

IMPORTANT: Avoid Damage! Avoid contamination of the brake fluid. Thoroughly clean area around the filler cap before removing.

Use extreme care when filling the reservoir. Fluid spilled on painted surfaces can cause damage.

Use only DOT 3 brake fluid from a sealed container.

NOTE: The brake hydraulic system must be bled any time a new component is installed, or any time the system has been opened. If only one component has been repaired or replaced it may only be necessary to bleed that component. If bleeding all four wheels, start at the wheel furthest away from the master cylinder and finish at the wheel closest to the master cylinder (right rear, left rear, right front, left front).

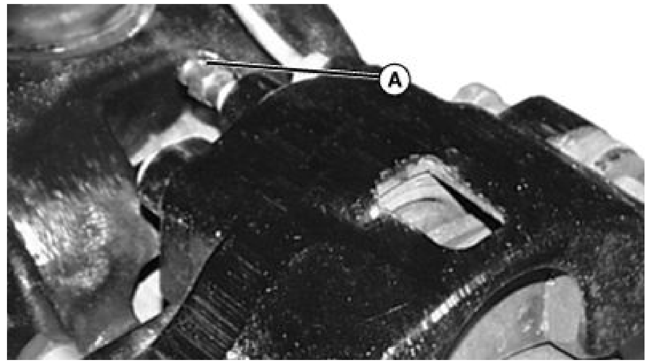
1. Park machine safely. See Park Machine Safely.

CAUTION: Avoid Injury! Allow the radiator to cool. Serious burns can result from contact with a hot radiator. Wear protective gloves when working around the radiator or center console. Injury can result from contact with sharp edges.

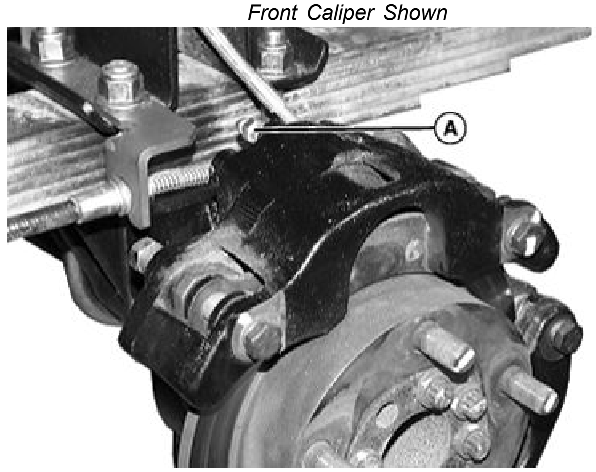
2. Remove the front access panel.
3. Lock park brake.
4. Remove wheels to provide access to brake calipers.
5. Protect painted surfaces from expelled brake fluid.
6. Attach one end of a clear piece of tubing to caliper bleeder screw (A). Submerge opposite end in approximately 13 mm (1/2 in.) of fresh brake fluid in a transparent container.

NOTE: Do not allow the fluid level in the master cylinder to fall below the indicated minimum level. Check the fluid level during the bleeding process, and add fluid as required.

7. Check master cylinder fluid level. Add clean fluid as required to maintain level between fill marks. Replace master cylinder cap before continuing bleeding process.
8. With the bleeder screw closed, have an assistant slowly pump the brake pedal to build pressure in the system.
9. After several pumps, have the assistant stop pumping but maintain pressure on the brake pedal.
10. Open the brake bleeder screw, allowing brake fluid and air to escape.
11. Close the bleeder screw before the end of the pedal stroke. The assistant can now release the pedal.



Front Caliper Shown



Rear caliper shown.

A—Caliper Bleeder Screw

12. Repeat bleeding process as required, until there is no evidence of air or bubbles in the expelled fluid.
13. Repeat bleeding process for remaining components as required.
14. Check brake pedal feel after completing bleeding process. The pedal should have a firm feel with bleed screws closed.

NOTE: New disk brakes are not as firm as drum brake system.

15. Ensure all bleeder screws are closed securely, and the master cylinder fluid level is correct.
16. Install the wheel(s).
17. Replace the front access panel.

Specifications:—Specification

Brake Fluid—Torque	DOT 3
Wheel Lug Nut—Torque	115 N·m (85 lb-ft)

RB14256,000078F -19-18JUN12-1/1

Bleeding Master Cylinder

NOTE: The master cylinder must be bled anytime it is replaced or allowed to run completely out of fluid.

1. Park machine safely on a level surface. See "Park Machine Safely" in the Safety section.
2. Set park brake.

CAUTION: Avoid Injury! Allow the radiator to cool. Serious burns can result from contact with a hot radiator. Wear protective gloves when working around the radiator or center console. Injury can result from contact with sharp edges.

CAUTION: Avoid Injury! Wear eye protection when bleeding brakes to avoid eye injury from escaping fluid.

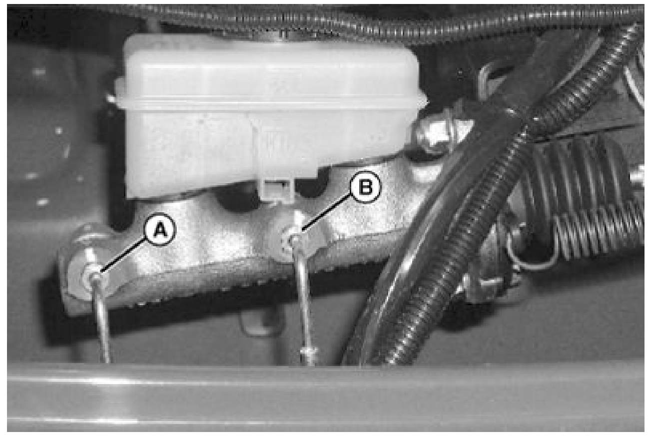
3. Remove the front access panel.

IMPORTANT: Avoid Damage! Avoid contamination of the brake fluid. Thoroughly clean area around the filler cap before removing.

Use extreme care when filling the reservoir. Fluid spilled on painted surfaces can cause damage.

Use only DOT 3 brake fluid from a sealed container.

4. Remove cap and check the level in the brake master cylinder. Top off to upper fill mark if necessary.
5. Place a suitable container below master cylinder brake line fittings to contain brake fluid.
6. Protect painted surfaces from expelled brake fluid.
7. Have an assistant maintain pressure on brake pedal. Loosen nut (A) securing master cylinder front brake fitting. Observe fluid flow for air bubbles at line connections. Secure brake fitting before pedal reaches full travel.



TCAL26637 —UN—15JUN12

Brake master cylinder viewed from front.

A—Master Cylinder Front Brake Fitting
B—Master Cylinder Rear Brake Fitting

8. Repeat procedure until air or bubbles no longer appear. Tighten fitting to specification.
9. Repeat procedure for rear fitting (B) until air or bubbles no longer appear. Tighten fitting to specification.
10. Top off reservoir as needed during and after procedure.
11. Bleed brake system. (See Bleeding Brakes.)
12. install Wheel(s).
13. Replace the front access panel.

Specifications:—Specification

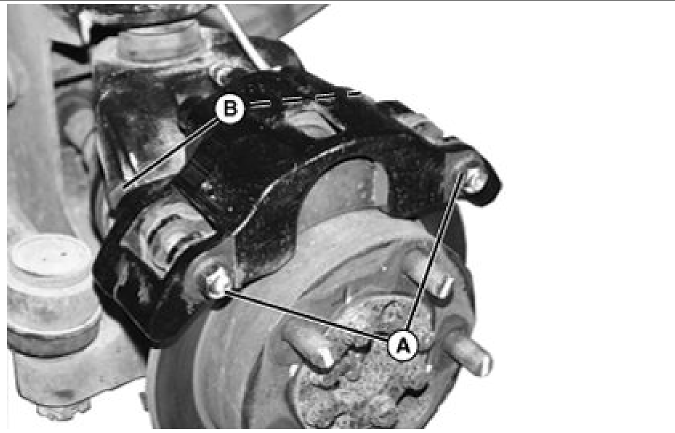
Brake Fluid—Torque	DOT 3
Brake Line Flare Nut—Torque	15 N·m (133 lb-in)

RB14256,0000790 -19-18JUN12-1/1

Service Brake Pad Replacement

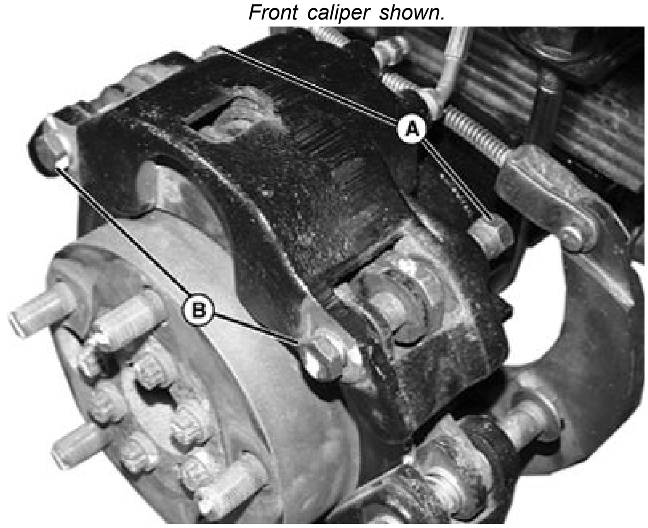
1. Park machine safely on a level surface. See Park Machine Safely.
2. Lock park brake.
3. Raise machine and support with jack stands.
4. Remove wheels. See Remove and Install Wheel.
5. Remove two nuts (A), two bolts (B) and four sleeves securing brake caliper.
6. Clean all dirt and corrosion off of brake hardware components.

A—Nuts **B—Bolts**



TCAL26638 —UN—15JUN12

Front caliper shown.



TCAL26639 —UN—15JUN12

Rear caliper shown.

Continued on next page RB14256,0000791 -19-06JUL12-1/5

NOTE: Sleeves should move freely in brake caliper housing bores.

7. Remove and support caliper (E). Ensure that there is no stress on brake line.

8. Measure brake pad (D) thickness. Replace pads if worn below minimum specification.

Specification

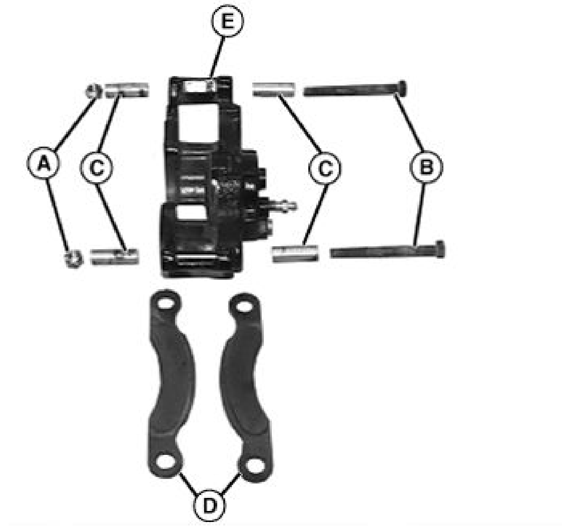
Brake Friction
Material—Thickness
(Minimum).. 1 mm (0.04 in.)

9. Measure brake rotor thickness at the wear area. Replace rotors if worn below minimum specification.

Specification

Brake Rotor—Thickness
(Minimum).. 6.35 mm (0.25 in.)

10. Install sleeves (C) into caliper bores.



TCAL26640 —UN—15JUN12

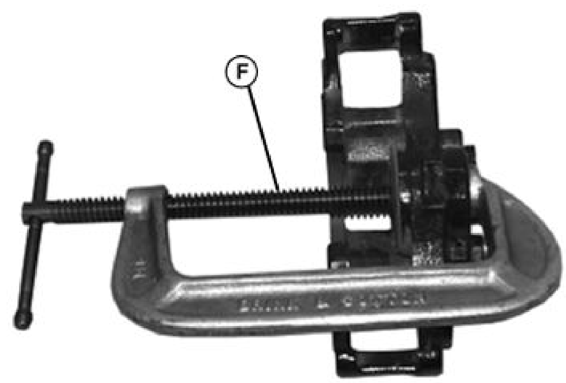
Caliper components shown.

A—Nuts
B—Bolts
C—Sleeves
D—Brake Pad
E—Caliper

RB14256,0000791 -19-06JUL12-2/5

11. Install brake calipers and pads to brake rotors. It may be necessary to press caliper piston(s) into bore with a C-clamp (F) to allow clearance for brake pads.

F— C-Clamp



TCAL26641 —UN—15JUN12

Continued on next page

RB14256,0000791 -19-06JUL12-3/5

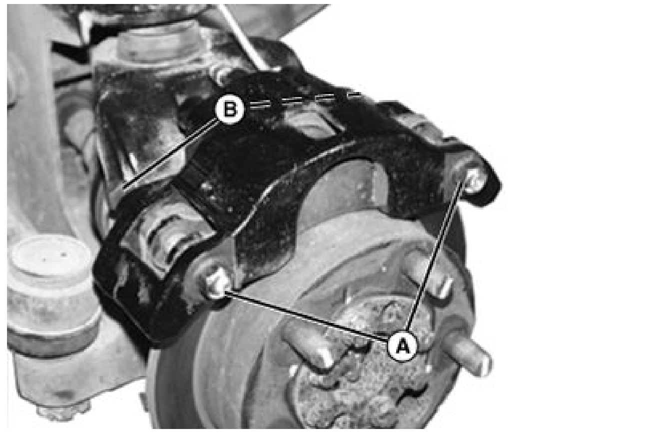
NOTE: Unscrew bleeder to relieve pressure in system.

12. Install two bolts (B) through friction pad tabs, steering knuckle mounts, four brake sleeves and front caliper bodies. Tighten two nuts (A) to specification.

Specification

Caliper Fitting
Bolt—Torque.. 41 N·m (30 lb-ft)

A—Nuts **B—Bolts**



TCAL26642 —UN—15JUN12

Front caliper shown.

RB14256,0000791 -19-06JUL12-4/5

13. Install two bolts (B) through friction pad tabs, four sleeves and rear caliper bodies. Tighten two nuts (A) to specification.

Specification

Caliper Fitting
Bolt—Torque.. 41 N·m (30 lb-ft)

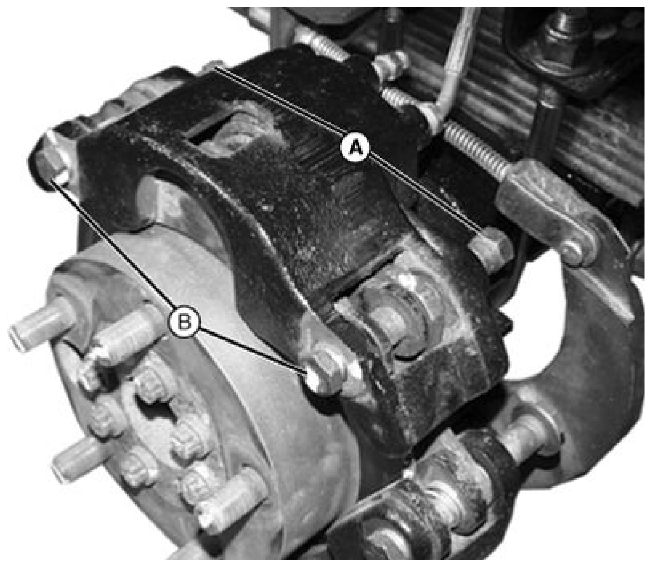
14. Bleed brake lines if necessary, using caliper bleed fittings. (See Bleeding Brakes.)

15. Install wheels. Tighten wheels lug nuts to specification.

Specification

Wheel Lug Nut—Torque...115 N·m (85 lb-ft)

A—Nuts **B—Bolts**



TCAL26643 —UN—15JUN12

Rear caliper shown.

RB14256,0000791 -19-06JUL12-5/5

Remove and Install Master Cylinder

Removal

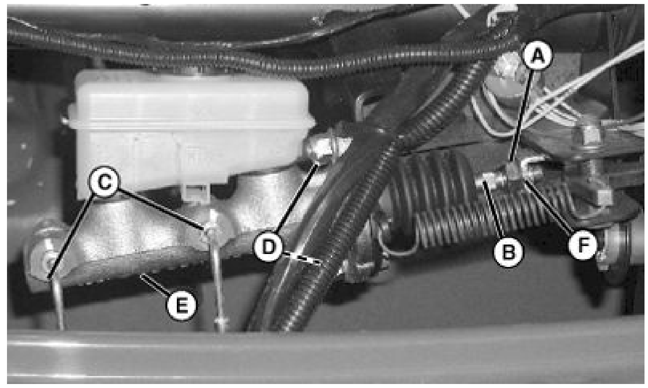
1. Park machine safely.
2. Remove the front access panel.
3. Loosen the jam nut (A) on the master cylinder rod (B).
4. Disconnect both brake lines (C) from the master cylinder.
5. Remove nuts (D) and remove the master cylinder (E).
6. Turn the master cylinder rod counterclockwise to remove it from the clevis (F).

Installation

1. Hold the master cylinder in position and thread the master cylinder rod into the clevis.
2. Install the master cylinder, and secure with cap screws and nuts.
3. Connect brake lines to the master cylinder. Tighten to specification.

Specification

Brake Line Flare Nut-to-Master Cylinder—Torque.. 15 N·m (133 lb-in)



TCAL26644 —UN—15JUN12

A—Jam Nut
B—Master Cylinder Rod
C—Brake Lines
D—Nuts
E—Master Cylinder
F—Clevis

4. Adjust the master cylinder rod length. (See Adjust Master Cylinder Rod.)
5. Bleed master cylinder. (See Bleeding Master Cylinder.)
6. Bleed brake system. (See Bleeding Brakes.)
7. Replace the front access panel.

RB14256,0000792 -19-18JUN12-1/1

Brake Line Removal and Replacement

IMPORTANT: Avoid Damage! Avoid contamination of the brake fluid. Thoroughly clean area around the filler cap and brake lines before removing. Do not open the brake fluid reservoir cap unless absolutely necessary.

Use extreme care when filling the reservoir. Fluid spilled on painted surfaces can cause damage.

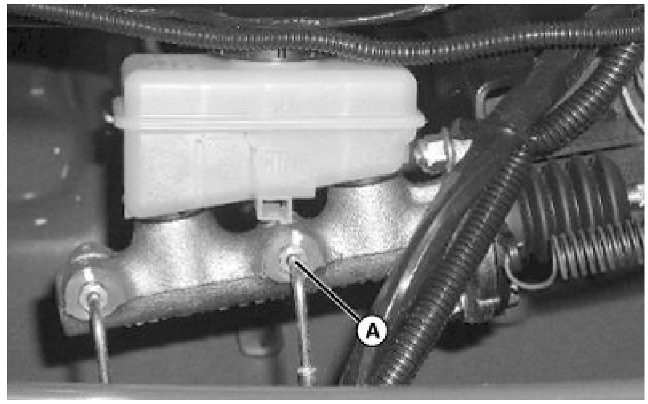
Use only DOT 3 brake fluid from a sealed container.

NOTE: The brake hydraulic system must be bled any time a new component is installed, or any time the system has been opened. If only one component has been repaired or replaced it may only be necessary to bleed that component. If bleeding all four wheels, start at the wheel furthest away from the master cylinder and finish at the wheel closest to the master cylinder (right rear, left rear, right front, left front).

1. Park machine safely. See Park Machine Safely.
2. Lock park brake.
3. Remove the front access panel.
4. Machine may be raised and wheels removed. (Brake line removal and installation procedure shown with wheels removed for clarity.)

Front Brake Line Removal

1. Place a suitable container below brake line fittings to contain brake fluid.
2. Protect painted surfaces from brake fluid.
3. Remove fitting (A) securing front brake line fitting to master cylinder front port.

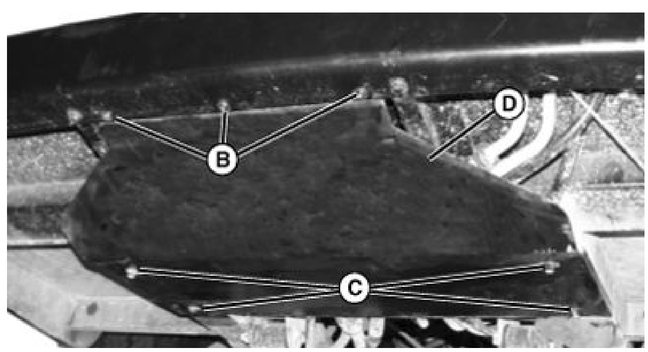


TCAL26645 —UN—15JUN12

A—Front Brake Line Fitting

RB14256,0000793 -19-18JUN12-1/23

4. Remove three socket head cap screws (B).
5. Remove four bolts (C).
6. Remove skid plate (D).



TCAL26646 —UN—15JUN12

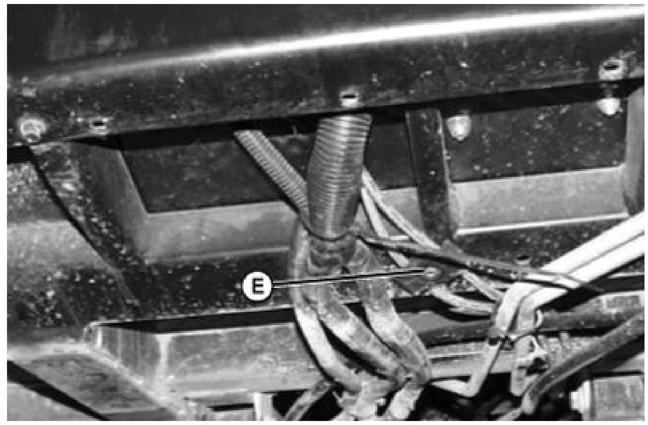
B—Socket Head Cap Screws
C—Bolts
D—Skid Plate

Continued on next page

RB14256,0000793 -19-18JUN12-2/23

7. Remove clamp (E).

E—Clamp

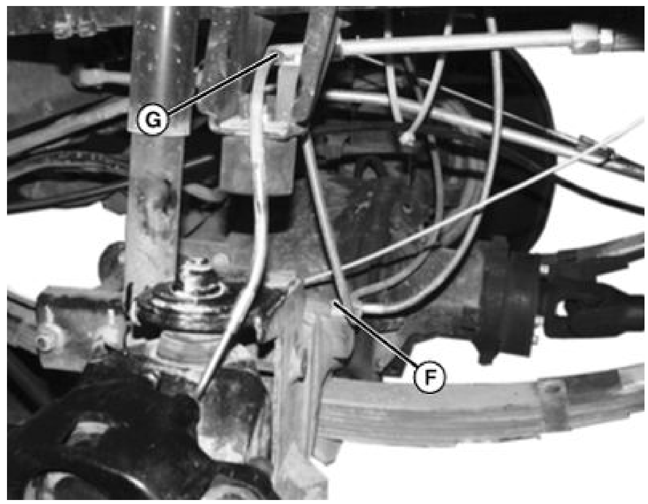


TCAL26647 —UN—15JUN12

RB14256,0000793 -19-18JUN12-3/23

8. Remove bolt (F) (drivers side shown).
9. Remove bolt and clamp (G).
10. Repeat steps eight and nine for passenger side.

F—Bolt **G—Clamp**

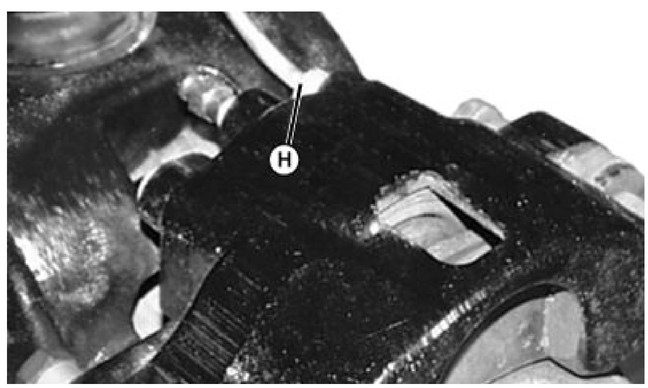


TCAL26648 —UN—15JUN12

RB14256,0000793 -19-18JUN12-4/23

11. Remove brake line from caliper (H).
12. Make note of brake line routing. Remove front brake line assembly from machine.

H—Caliper



TCAL26649 —UN—15JUN12

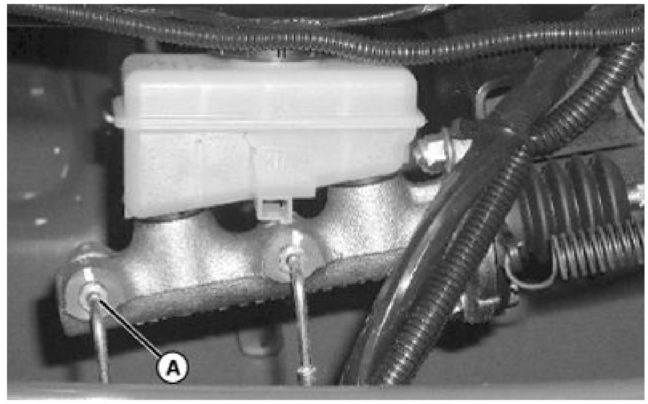
Continued on next page

RB14256,0000793 -19-18JUN12-5/23

Rear Brake Line Removal - Front Half

1. Place a suitable container below brake line fittings to contain brake fluid.
2. Protect painted surfaces from brake fluid.
3. Remove fitting (A) securing front brake line fitting to master cylinder front port.

A—Front Brake Line Fitting

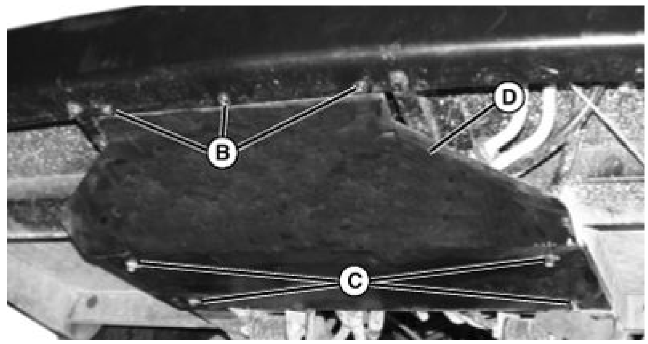


TCAL26650 —UN—15JUN12

RB14256,0000793 -19-18JUN12-6/23

4. Remove three socket head cap screws (B).
5. Remove four bolts (C).
6. Remove skid plate (D).

B—Socket Head Cap Screws
C—Bolts
D—Skid Plate

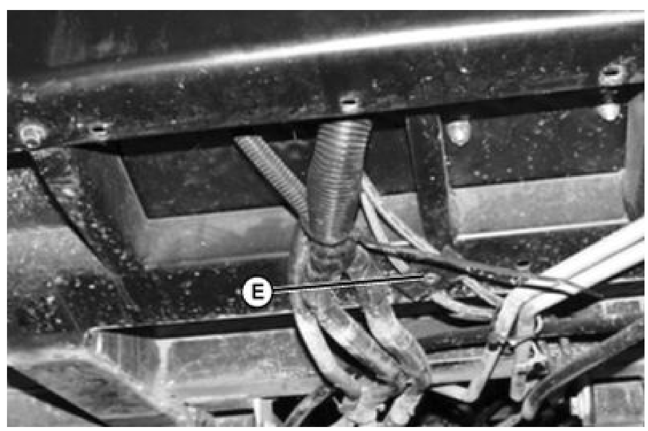


TCAL26651 —UN—15JUN12

RB14256,0000793 -19-18JUN12-7/23

7. Remove clamp (E).

E—Brake Line Clamp



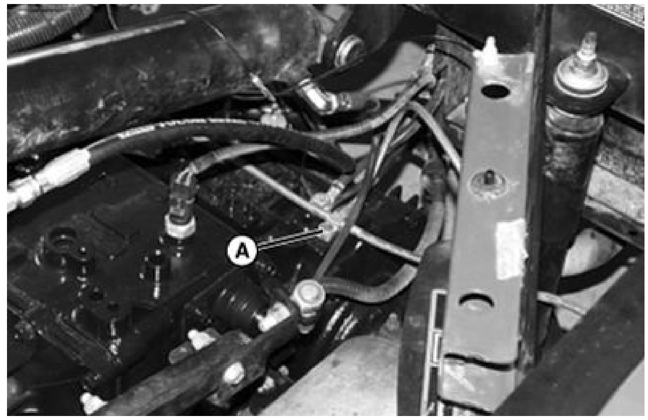
TCAL26652 —UN—15JUN12

Continued on next page

RB14256,0000793 -19-18JUN12-8/23

Rear Brake Line Removal - Rear Half

1. Place a suitable container below brake line fittings to contain brake fluid.
2. Remove bolt (A) securing brake hose to transaxle housing.

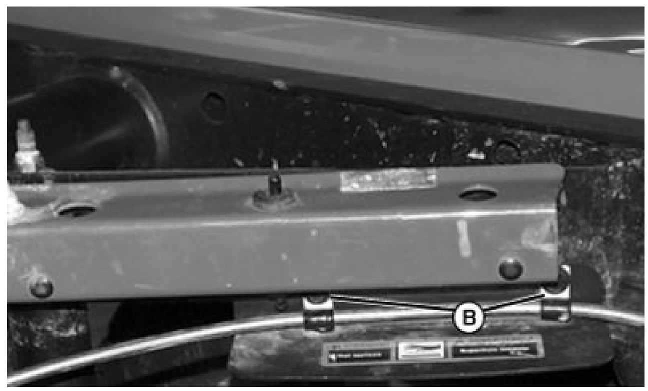


TCAL26653 —UN—15JUN12

A—Bolt

RB14256,0000793 -19-18JUN12-9/23

3. Remove two bolts and clamps (B).

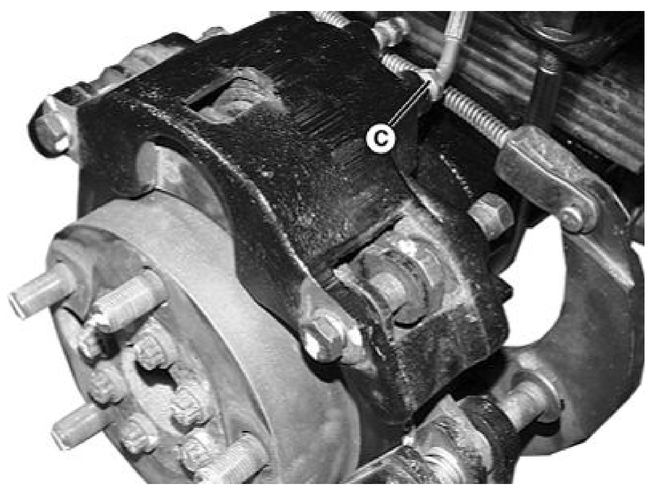


TCAL26654 —UN—15JUN12

B—Brake Line Clamps

RB14256,0000793 -19-18JUN12-10/23

4. Remove brake line (C) from caliper.
5. Note routing of brake hoses and orientation of caliper fittings as a guide for reassembly.



TCAL26655 —UN—15JUN12

C—Brake Line

Continued on next page

RB14256,0000793 -19-18JUN12-11/23

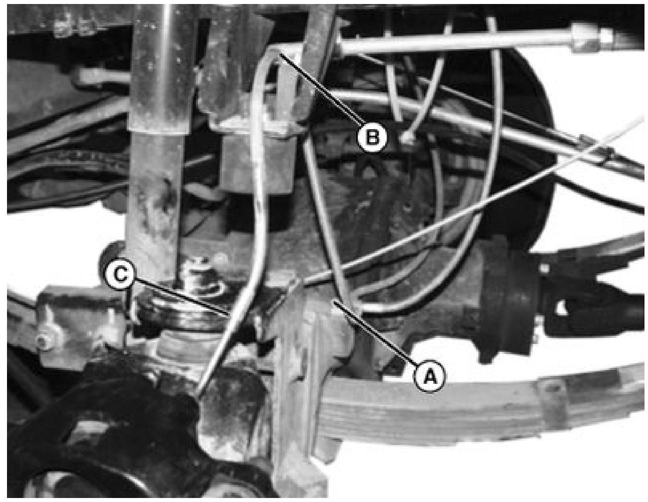
Front Brake Line Installation

IMPORTANT: Avoid Damage! Use all brake hose retainers as originally installed to secure brake hoses. Secure brake hose fittings to calipers at the specified angle. Brake hoses may be damaged from contact with frame, suspension, or drivetrain components if not properly installed and secured.

1. Install brake line and bolt (A) (drivers side shown).
2. Install brake line, clamp and bolt (B) on each side. Do not tighten clamp at this time.
3. Tighten clamp (B) on brake line, 235 ±3 mm (9.25 ±0.1 in.) from end of fitting at crimp (C) to specification.

Specification

Brake Line Block to Chassis—Torque... 10.4 N·m (92 lb-in.)

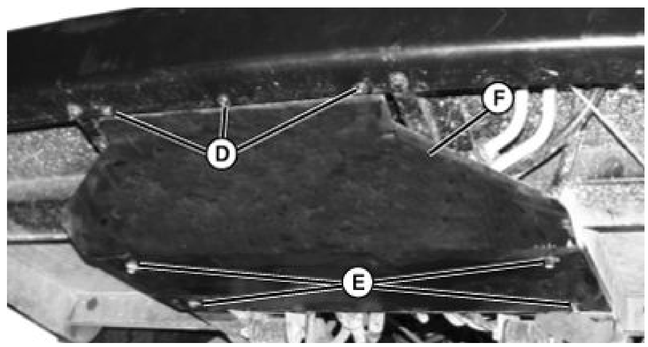


TCAL26656 —UN—15JUN12

A—Bolt
B—Bolt
C—Brake Line Clamp

RB14256,0000793 -19-18JUN12-12/23

4. Remove three socket head cap screws (D).
5. Remove four bolts (E).
6. Remove skid plate (F).



TCAL26657 —UN—15JUN12

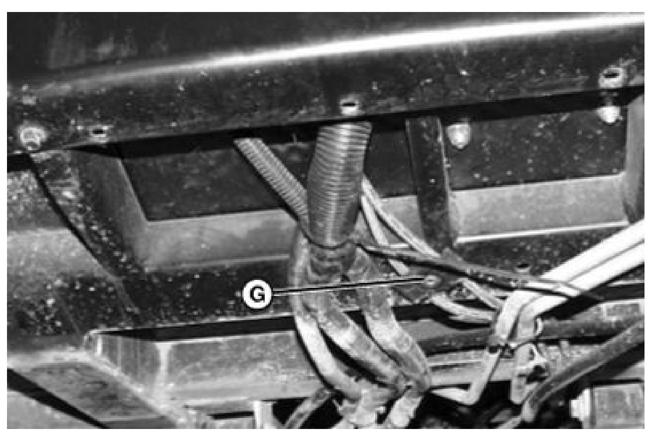
RB14256,0000793 -19-18JUN12-13/23

7. Install brake line and clamp (G). Tighten to specification.

Specification

Brake Line Retainer to Chassis—Torque... 10.4 N·m (92 lb-in.)

G—Brake Line and Clmap



TCAL26658 —UN—15JUN12

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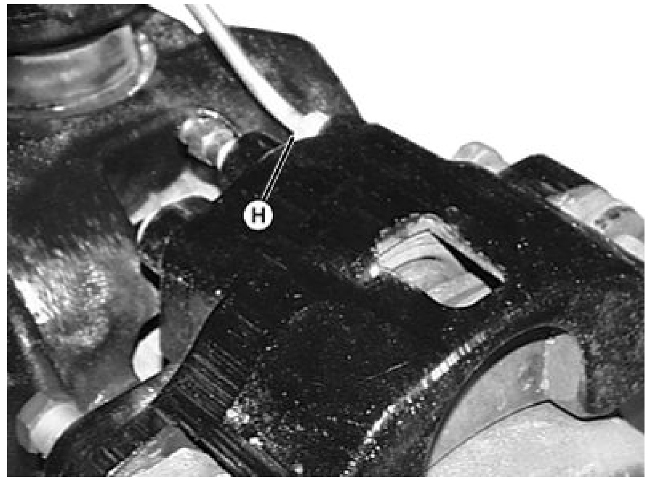
RB14256,0000793 -19-18JUN12-14/23

8. Install brake line (H) to caliper.



TCAL26659 —UN—15JUN12

H—Brake Line

RB14256,0000793 -19-18JUN12-15/23

9. Install fitting (I) securing front brake line fitting to master cylinder front port. Tighten brake line fitting to specification.

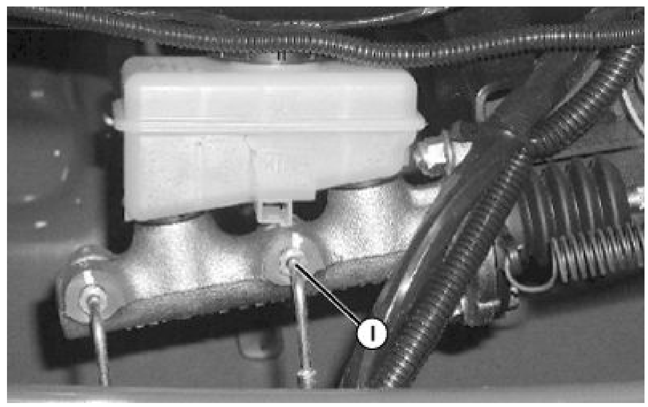
Specification

Brake Line Flare Nut—Torque.. 15 N·m (133 lb-in.)

10. Install skid plate.
11. Bleed brake system. See Bleeding Brakes.
12. Install wheels (if removed). Tighten wheel lug nuts specification.

Specification

Wheel Lug Nut—Torque...115 N·m (85 lb-ft)



TCAL26660 —UN—15JUN12

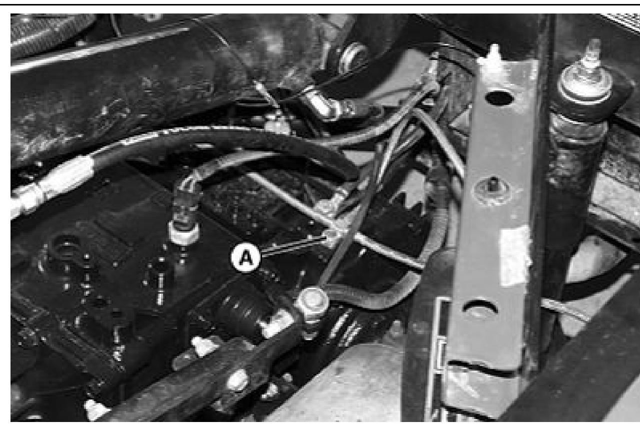
I— Fitting

RB14256,0000793 -19-18JUN12-16/23

Rear Brake Line Installation

IMPORTANT: Avoid Damage! Use all brake hose retainers as originally installed to secure brake hoses. Brake hoses may be damaged from contact with frame, suspension, or drivetrain components if not properly secured.

1. Install brake line and bolt (A) securing brake hose to transaxle housing.



TCAL26661 —UN—15JUN12

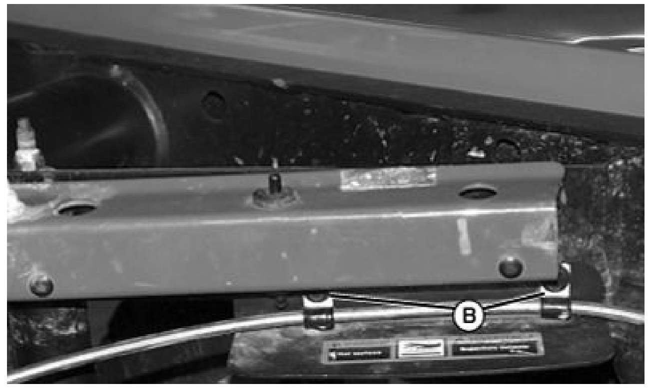
A—Brake Line and Bolt

Continued on next page

RB14256,0000793 -19-18JUN12-17/23

2. Install brake line, secure to frame with two clamps (B).
3. Route brake line along the bottom of the driver side frame rail.

B—Clamps (2 Used)

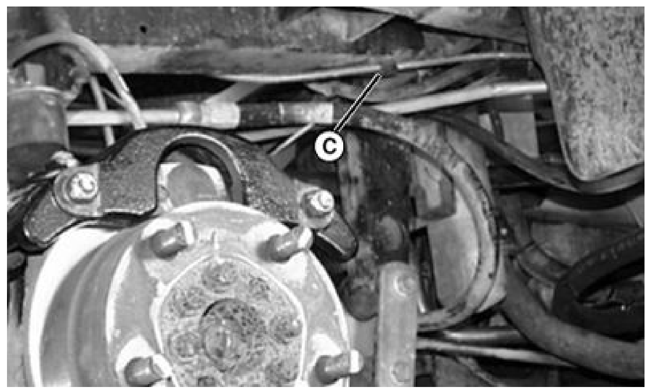


TCAL26662 —UN—15JUN12

RB14256,0000793 -19-18JUN12-18/23

4. Install brake line, secure with clamp (C) near front rotor.

C—Clamp

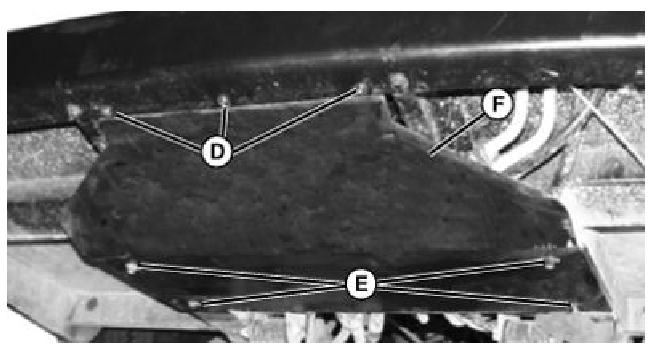


TCAL26663 —UN—15JUN12

RB14256,0000793 -19-18JUN12-19/23

5. Remove three socket head cap screws (D).
6. Remove four bolts (E).
7. Remove skid plate (F).

D—Socket Head Cap Screws (3 Used)
E—Bolts (4 Used)
F—Skind Plate



TCAL26664 —UN—15JUN12

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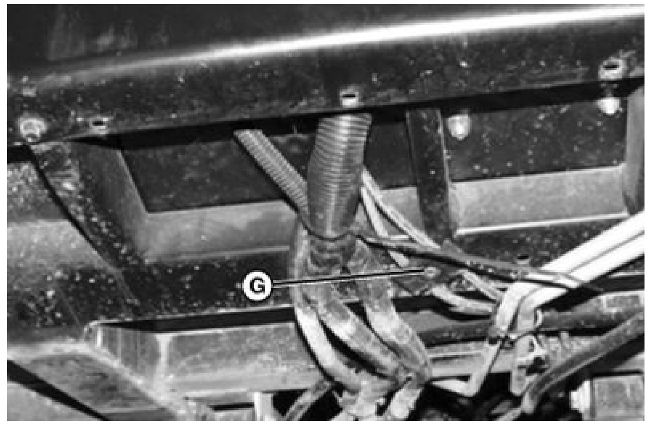
RB14256,0000793 -19-18JUN12-20/23

8. Install brake line and clamp (G). Tighten to specification.

Specification

Brake Line Block to Chassis—Torque... 10.4 N·m (92 lb-in.)

G—Brake Line and Clamp



TCAL26665 —UN—15JUN12

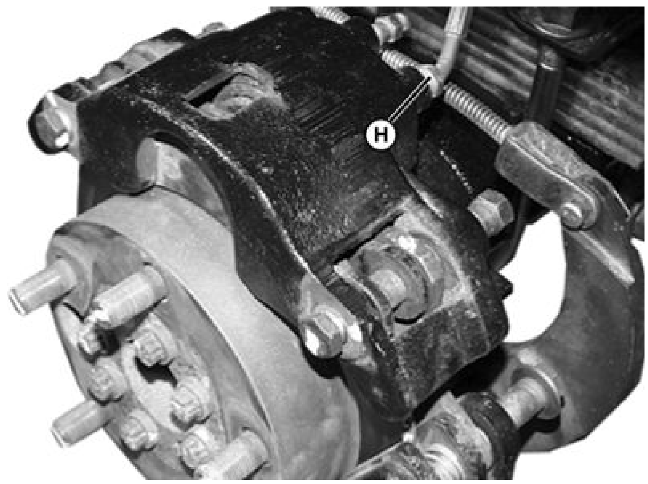
RB14256,0000793 -19-18JUN12-21/23

9. Install brake line (H) to calipers. Tighten brake line fitting to specification.

Specification

Brake Line Flare Nut to Caliper—Torque... 15 N·m (133 lb-in.)

H—Brake Line



TCAL26666 —UN—15JUN12

RB14256,0000793 -19-18JUN12-22/23

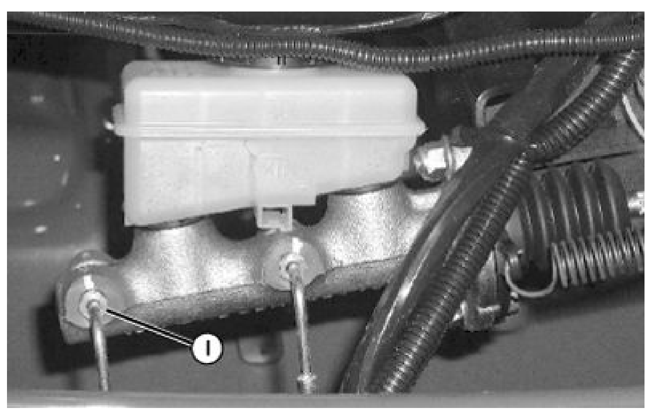
10. Install fitting (I) securing front brake line fitting to master cylinder front port. Tighten brake line fitting to specification.

Specification

Brake Line Flare Nut to Master Cylinder—Torque.. 15 N·m (133 lb-in.)

11. Bleed master cylinder if necessary. See Bleeding Master Cylinder.
12. Bleed brake system. See Bleeding Brakes.
13. Replace skid plate.

I— Fitting



TCAL26667 —UN—15JUN12

RB14256,0000793 -19-18JUN12-23/23

Service Brake Caliper Removal and Installation

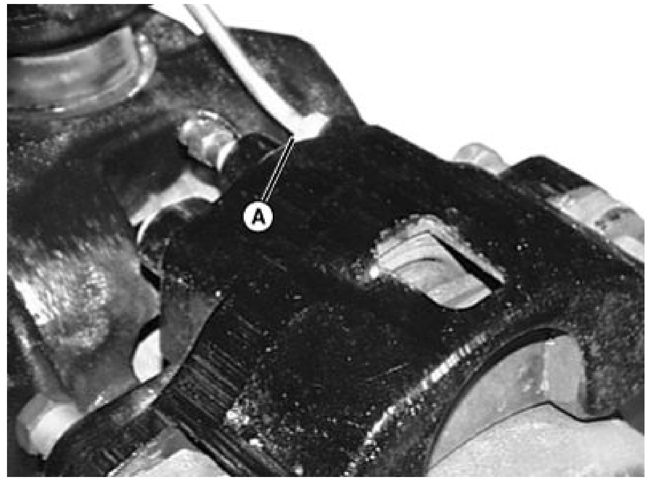
IMPORTANT: Avoid Damage! Avoid contamination of the brake fluid. Thoroughly clean area around the filler cap and brake lines before removing. Do not open the brake fluid reservoir cap unless absolutely necessary.

Use extreme care when filling the reservoir. Fluid spilled on painted surfaces can cause damage.

Use only DOT 3 brake fluid from a sealed container.

Removal:

1. Park machine safely on a level surface. See Park Machine Safely.
2. Raise and safely support machine.
3. Remove wheels. See Remove and Install Wheel.
4. Protect painted surfaces from brake fluid if brake hose is removed.
5. Place a suitable container below brake line fittings to contain brake fluid.
6. Remove brake line (A) from caliper.



TCAL26668 —UN—15JUN12

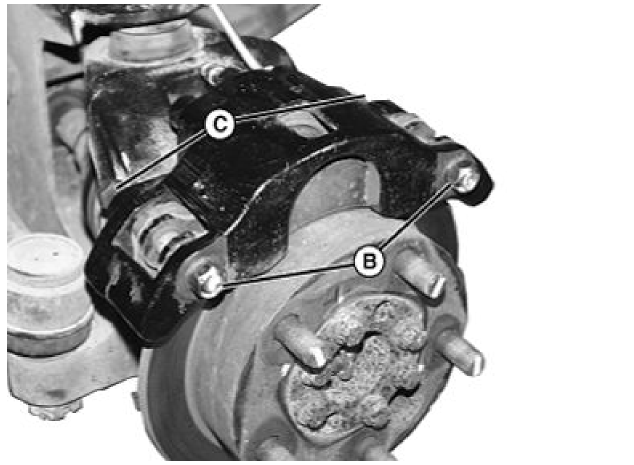
A—Brake Line

Continued on next page

RB14256,0000794 -19-06JUL12-1/6

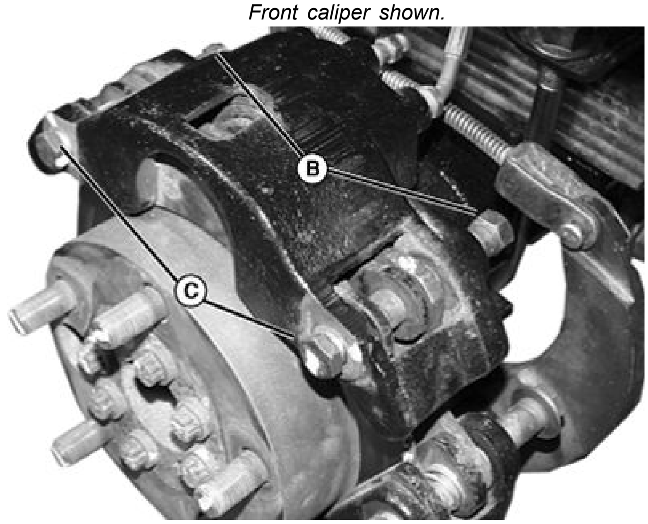
7. Remove two nuts (B), two bolts (C) and four sleeves securing brake caliper.
8. Remove caliper.
9. Remove brake pads from calipers.
10. Clean all dirt and corrosion from brake hardware components.

B—Nuts (2 Used) **C—Bolts (2 Used)**



TCAL26669 —UN—15JUN12

Front caliper shown.



TCAL26670 —UN—15JUN12

Rear caliper shown.

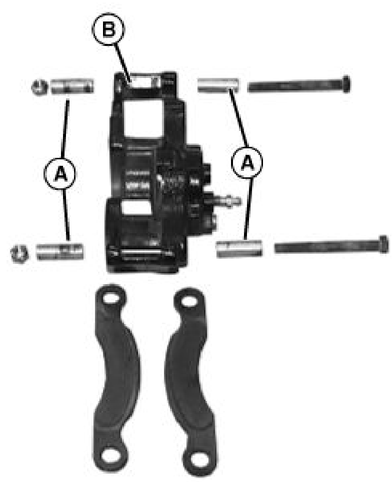
RB14256,0000794 -19-06JUL12-2/6

Installation:

NOTE: Sleeves should move freely in brake caliper housing.

1. Insert sleeves (A) into caliper (B).

A—Sleeves **B—Caliper**



TCAL26671 —UN—15JUN12

Continued on next page

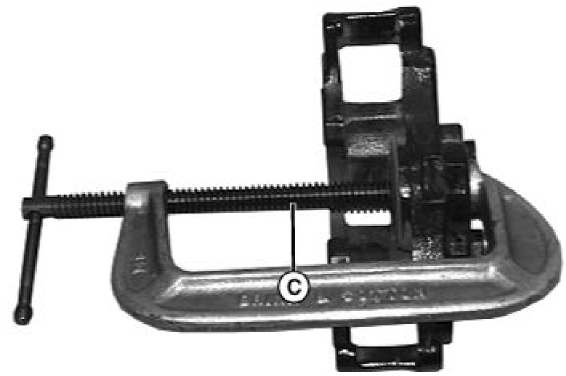
RB14256,0000794 -19-06JUL12-3/6

2. Install brake caliper to rotor. It may be necessary to press caliper pistons into bores with a C-clamp (C) to allow clearance for new brake pads.

NOTE: Unscrew bleeder to relieve pressure in system.

3. Insert new brake pads with friction material facing rotor.

C—C-Clamp



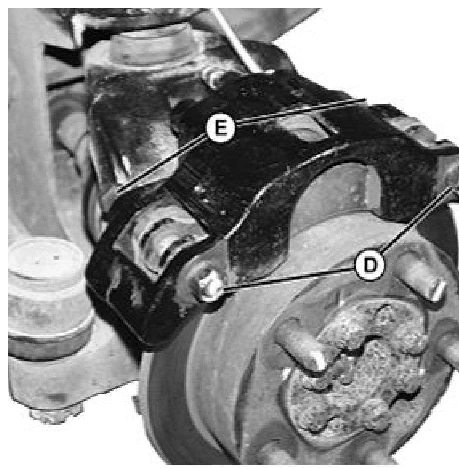
TCAL26672 —UN—15JUN12

RB14256,0000794 -19-06JUL12-4/6

4. Install two nuts (D), two bolts (E) and four sleeves securing brake caliper. Tighten bolts to specification.

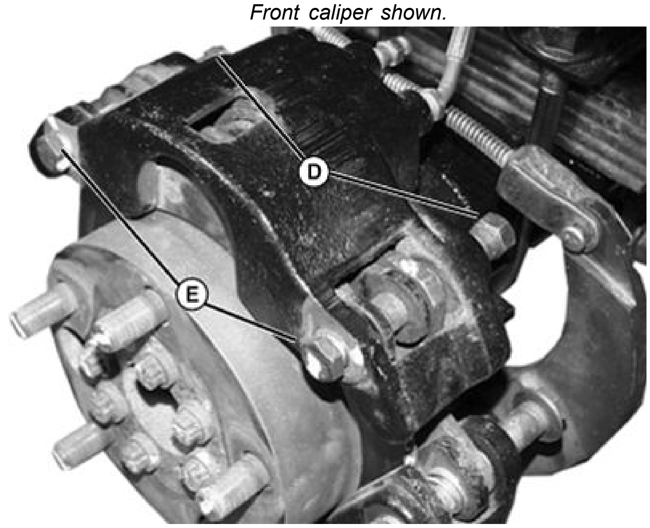
Specification	
Caliper Fitting Bolt—Torque	41 N·m (30 lb-ft)

D—Nuts (2 Used) **E—Bolts (2 Used)**



TCAL26673 —UN—15JUN12

Front caliper shown.



TCAL26674 —UN—15JUN12

Rear caliper shown.

Continued on next page

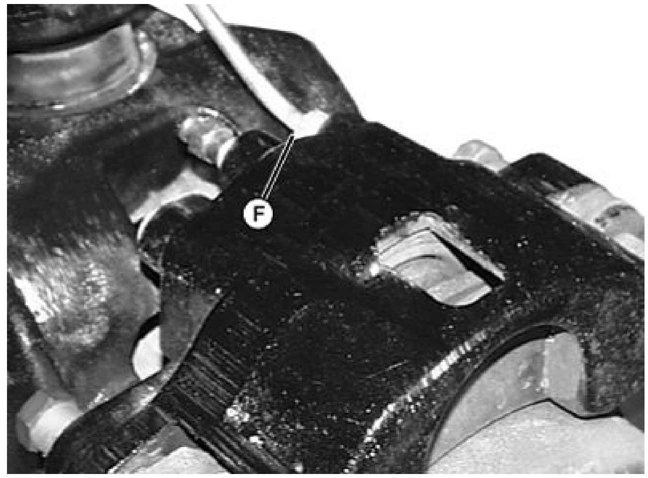
RB14256,0000794 -19-06JUL12-5/6

5. Install brake line (F) to caliper.
6. Bleed brake system. See Bleeding Brakes.
7. Install wheels. Tight wheel lug bolts to specification.

Specification

Wheel Lug Bolt—Torque...115 N·m (85 lb-ft)

F— Brake Line



TCAL26675 —UN—15JUN12

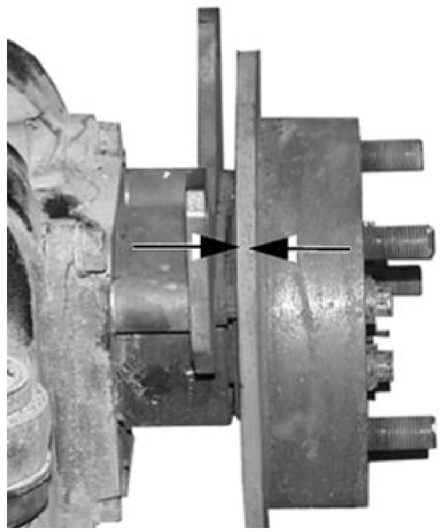
RB14256,0000794 -19-06JUL12-6/6

Brake Rotor Removal and Inspection

1. Park machine safely on a level surface. See Park Machine Safely.
2. Raise and safely support machine.
3. Remove wheel(s). See Remove and Install Wheel.
4. Remove brake caliper. See Service Brake Caliper Removal and Installation.
5. Secure caliper assembly so that there is no stress on brake hose.
6. Check brake rotor for deep grooves or scoring. Measure rotor thickness to see if minimum specification is met.

Specification

Brake Rotor—Thickness
(Minimum)..6.45 mm (0.254 in.)



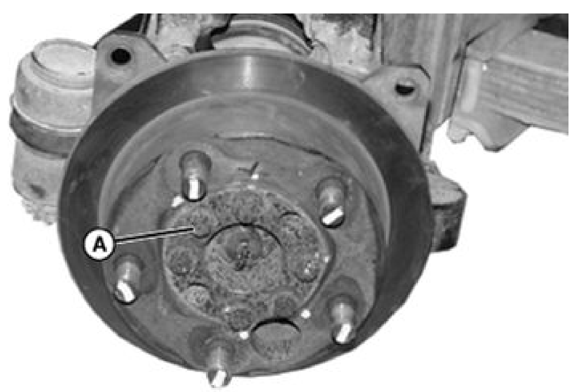
TCAL26676 —UN—15JUN12

RB14256,0000795 -19-06JUL12-1/5

NOTE: If rotor sticks, use a soft face hammer to loosen.

7. Remove six screws (A).

A—Screws (6 Used)



TCAL26677 —UN—15JUN12

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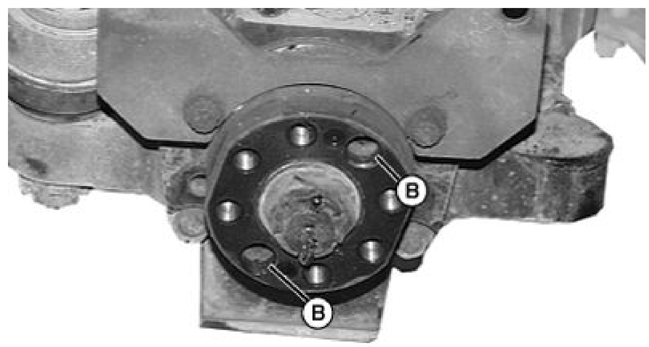
RB14256,0000795 -19-06JUL12-2/5

Installation:

RB14256,0000795 -19-06JUL12-3/5

1. Insert pins (A) into holes (B).

A—Pins **B—Holes in Hub**



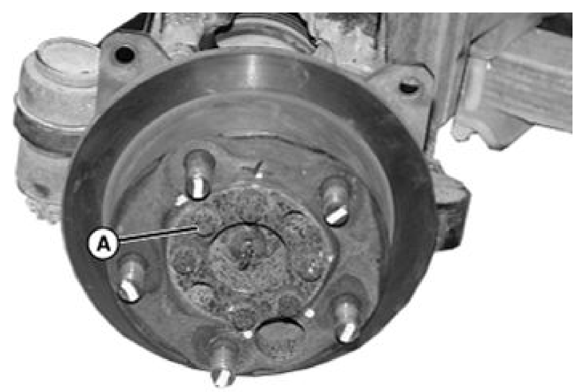
RB14256,0000795 -19-06JUL12-4/5

2. Install six screws (A).
3. Tighten wheel lug bolts to specification.

Specification

Wheel Lug Bolt—Torque..115 N·m (85 lb-ft)

A—Screws (6 Used)

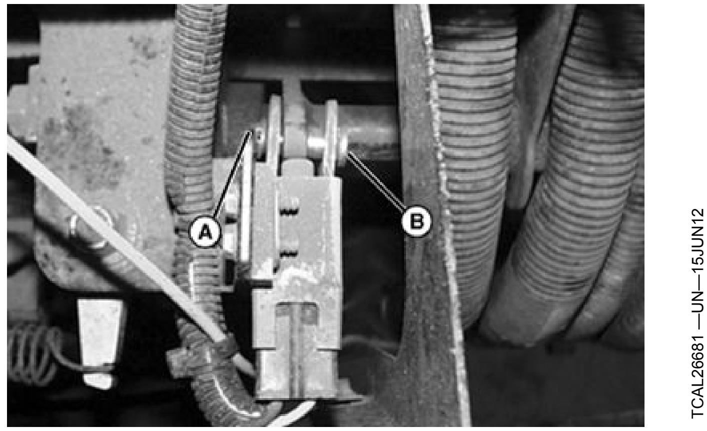


RB14256,0000795 -19-06JUL12-5/5

Brake Pedal Removal and Installation

1. Park machine safely. See Park Machine Safely.
2. Remove cotter pin (A) and drilled pin (B).

A—Cotter Pin **B—Drilled Pin**

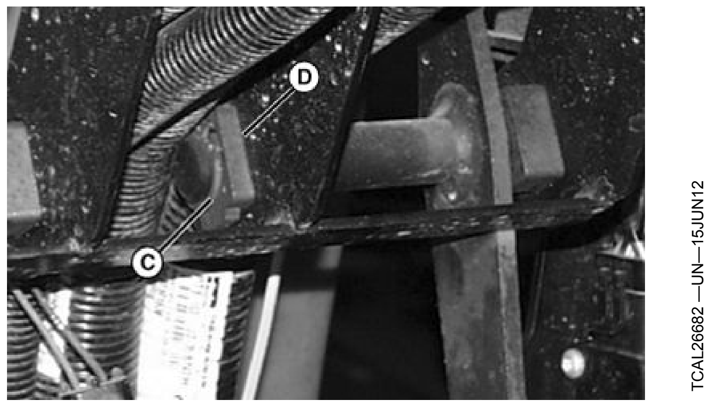


Brake Pedal—Top View

RB14256,0000796 -19-18JUN12-1/4

3. Remove outside snap rings (C) on brake pedal pivot shaft (one on each side).
4. Remove bushings (D) from brake pedal pivot shaft (one on each side).
5. Remove brake pedal from machine.

C—Snap Rings **D—Bushings**

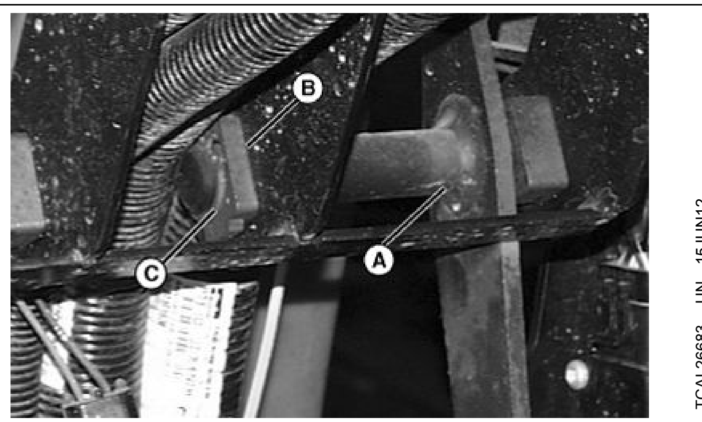


RB14256,0000796 -19-18JUN12-2/4

Installation:

1. Install brake pedal (A) in machine.
2. Install bushings (B) in frame on brake pedal pivot shaft (one on each side).
3. Install outside snap rings (C) on brake pedal pivot shaft (one on each side).

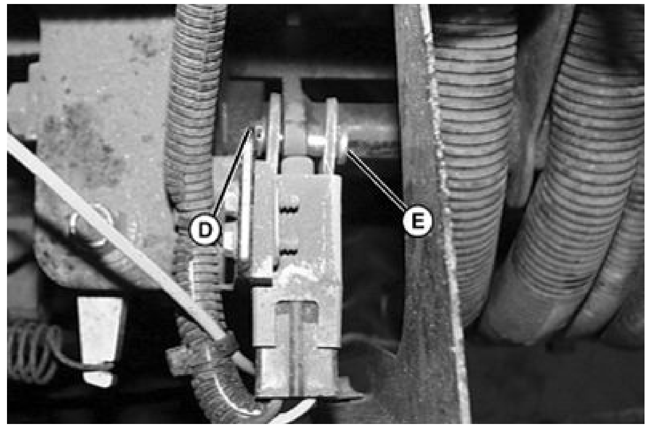
A—Brake Pedal
B—Bushings **C—Snap Rings**



Continued on next page RB14256,0000796 -19-18JUN12-3/4

4. Install cotter pin (D) and drilled pin (E).
5. Adjust master cylinder rod. (See Adjust Master Cylinder Rod.)

D—Cotter Pin **E—Drilled Pin**



TCAL26684 —UN—15JUN12

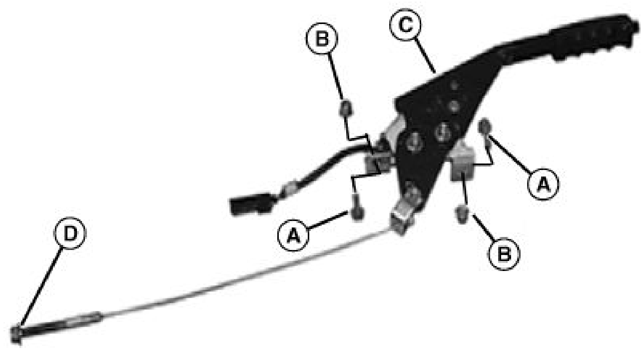
Brake Pedal—Top View

RB14256,0000796 -19-18JUN12-4/4

Park Brake Lever Removal and Installation

1. Park machine safely. See Park Machine Safely.
2. Block wheels to prevent machine from moving.
3. Release park brake.
4. Remove center control plate. (See Remove and Install Control Plate.)

A—Bolts (two used)
B—Locknuts (two used)
C—Park Brake Handle
D—Nut



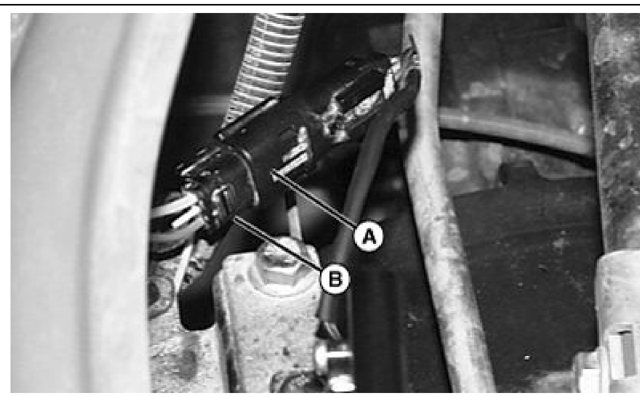
TCAL26685 —UN—15JUN12

RB14256,0000797 -19-18JUN12-1/7

Removal:

1. Disconnect switch wiring harness (A) from main wiring harness (B).

A—Switch Wiring Harness **B—Main Wiring Harness**



TCAL26686 —UN—15JUN12

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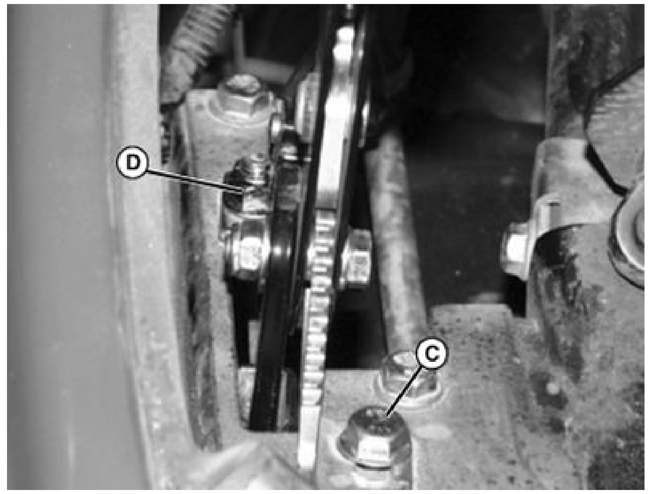
RB14256,0000797 -19-18JUN12-2/7

2. Remove two bolts (C) and two locknuts (D) securing park brake assembly to frame.

C—Bolts (2 Used) **D—Locknuts (2 Used)**



TCAL26687 —UN—15JUN12

RB14256,0000797 -19-18JUN12-3/7

3. Remove nut (E) on cable.

E—Nut

TCAL26688 —UN—15JUN12

RB14256,0000797 -19-18JUN12-4/7

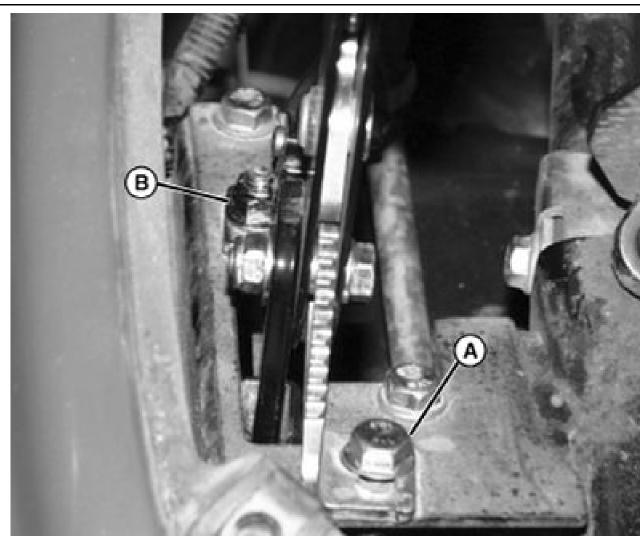
Installation:

1. Install two bolts (A) and two locknuts (B) securing park brake assembly to frame. Tighten nuts to specification.

Specification

Mounting Bracket to Frame Bolt and Nut—Torque.. 28 N·m (20 lb-ft)

A—Bolts (2 Used) **B—Locknuts (2 Used)**



TCAL26689 —UN—15JUN12

Continued on next page

RB14256,0000797 -19-18JUN12-5/7

2. Install nut (C) on cable. Adjust cable to remove slack. (See Adjust Park Brake Cable.)

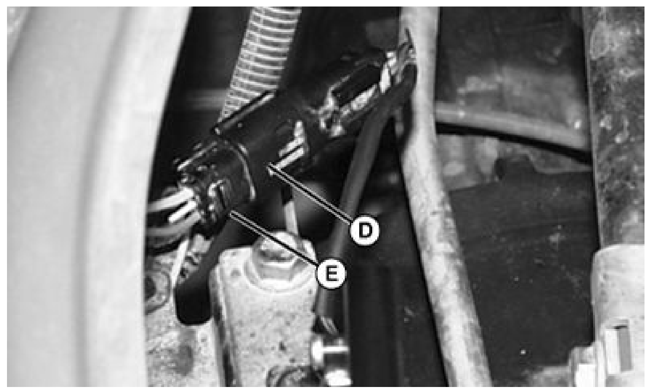
C—Nut

TCAL26690 —UN—15JUN12

RB14256,0000797 -19-18JUN12-6/7

3. Connect switch wiring harness (D) from main wiring harness (E).

D—Switch Wiring Harness **E—Main Wiring Harness**



TCAL26691 —UN—15JUN12

RB14256,0000797 -19-18JUN12-7/7

Park Brake Removal and Installation

Park Brake Removal

NOTE: Parking Brake subcomponents are not serviceable because the entire assembly is assembled, measured, and calibrated at the manufacturer. If the caliper is not functioning properly, it must be replaced.

Also this is a ball ramp style caliper. If the caliper is removed from the bracket and rotor, there must be a spacer, such as a piece of cardboard, placed between the pads to prevent over extension of the actuator arm. Over extension will free the ball bearings and require replacement of the unit.

1. Park machine safely on a level surface. See Park Machine Safely.
2. Place chocks at front wheels.
3. Lift and safely support left side of machine so that left rear tire is approximately 50 mm (2 in.) from surface.
4. Raise and secure cargo box.
5. Remove wheel assembly.

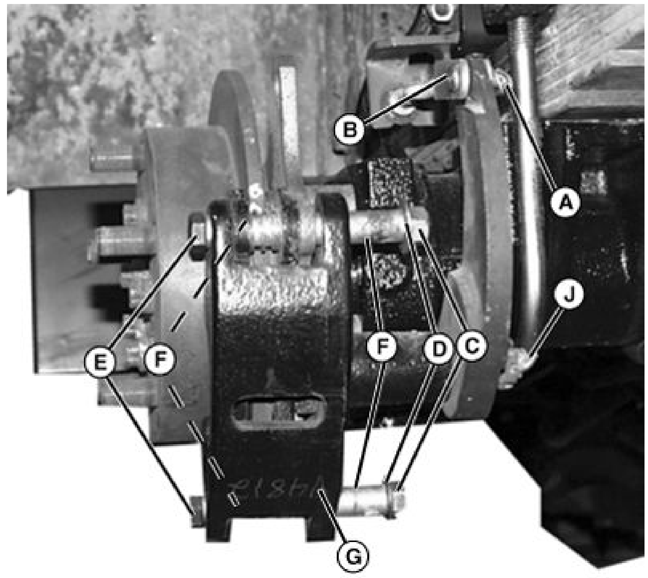
IMPORTANT: Avoid Damage! Do not disturb castle nut (J) on park brake actuator. If this nut is disturbed, the caliper must be discarded.

6. Release park brake.

NOTE: Observe and make note of the routing of the park brake cable if the cable is to be replaced. Install the new cable to the machine in the same manner as the original installation.

7. Disconnect park brake cable.

   a. Remove clip (A).



TCAL26692 —UN—15JUN12

A—Clip
B—Pin
C—Locknuts (2 Used)
D—Washers (2 Used)
E—Bolts (2 Used)
F—Sleeves (4 Used)
G—Housing
J—Castle Nut

   b. Remove pin (B).

8. Remove two locknuts (C).
9. Remove two washers (D).
10. Remove two bolts (E).
11. Remove four sleeves (F).
12. Remove housing (G).

Continued on next page

RB14256,0000798 -19-18JUN12-1/2

Park Brake Installation:

NOTE: Parking Brake subcomponents are not serviceable because the entire assembly is assembled, measured, and calibrated at the manufacturer. If the caliper is not functioning properly, it must be replaced.

Also this is a ball ramp style caliper. If the caliper is removed from the bracket and rotor, there must be a spacer, such as a piece of cardboard, placed between the pads to prevent over extension of the actuator arm. Over extension will free the ball bearings and require replacement of the unit.

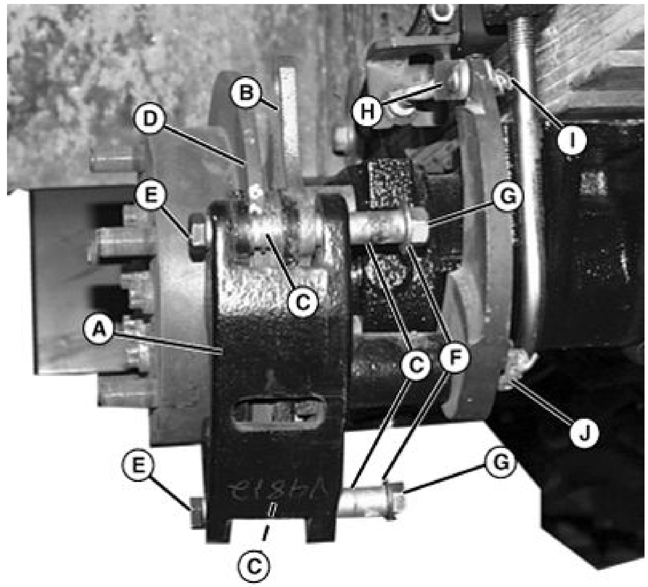
Do not disturb castle nut (J) on park brake actuator. If this nut is disturbed, the caliper must be discarded.

1. Install caliper assembly (A) onto backing plate (B) using four sleeves (C) as a guide, making sure brake pads fit over rotor (D).
2. Install two bolts (E) through housing and backing plate (B). Tighten bolts to specification.

Specification

Park Brake Mounting
Bolts—Torque.. 41 N·m (30 lb-ft.)

3. Insert two washers (F).
4. Install two nuts (G).
5. Install drilled pin (H) through park brake cable clevis and park brake arm.
6. Install pin (I) through drilled pin (H).



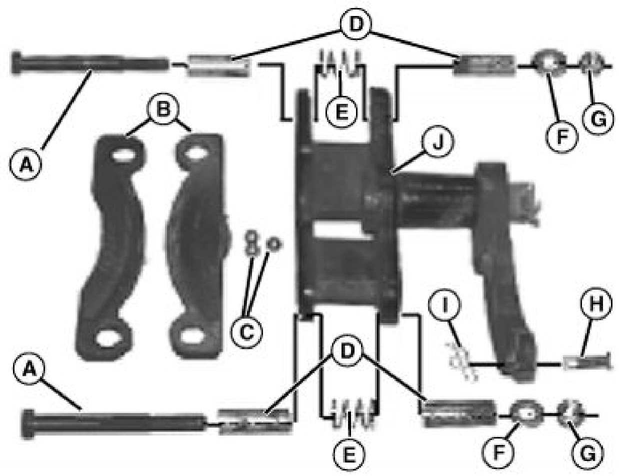
A—Caliper Assembly
B—Backing Plate
C—Sleeves (4 Used)
D—Rotor
E—Bolts (2 Used)
F—Washers (2 Used)
G—Nuts (2 Used)
H—Drilled Pin
I— Pin
J—Castle Nut

7. Replace wheel assembly.
8. Repeat on other side.

RB14256,0000798 -19-18JUN12-2/2

Park Brake Components

Replace the park brake assembly if damaged. Replace the control cable if the park brake does not hold with the control lever rotated to the top of its travel.



A—Bolts (two used)
B—Brake Pads.
C—Ball Bearing (three used)
D—Sleeves (four used)
E—Springs (two used)
F—Washers (two used)
G—Locknuts (two used)
H—Drilled Pin.
I— Clip.
J—Housing.

RB14256,0000799 -19-18JUN12-1/1

Section 100
Miscellaneous

Contents

Specifications

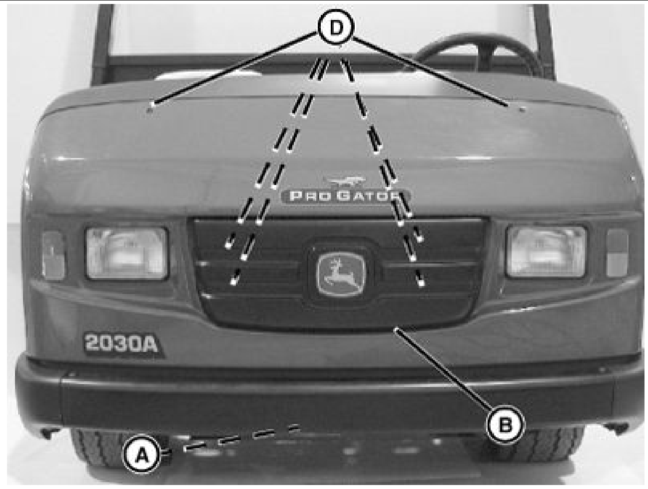
Item	Measurement	Specification
Specifications		
Tire Pressure with Max. Load (minimum)		83 kPa (12 psi)
Tire Pressure with HD300 Sprayer (minimum)		110 kPa (16 psi)
Control Cover Mounting Screw		6 N·m (54 lb-in.)
Brake Drum to Axle		102 N·m (75 lb-ft)
ROPS Mounting Bolts (SN -050000)	Torque	69 N·m (51 lb.-ft.)
ROPS Mounting Bolts (SN 050001-)	Torque	102 N·m (75 lb.-ft.)
Seat Mounting Cap Screw Torque	Torque	17 N·m (140 lb.-in.)
Wheel Lug Nut Torque	Torque	115 N·m (85 lb.-ft.)

RB14256,000076E -19-18JUN12-1/1

Remove and Install Hood

Removal

1. Park vehicle on level surface, turn key switch OFF, place shift lever in first gear or reverse, and lock park brake.
2. Remove three screws and four cap screws securing skid pan (A) and remove skid pan from under vehicle.
3. Remove the service panel (B) from the hood.



TCAL26695 —UN—15JUN12

A—Skid Pan
B—Service Panel
D—Screws and Nuts (8 each)

RB14256,000076F -19-18JUN12-1/2

4. Remove the four nuts and bolts securing the corner fenders (C).
5. Disconnect the wiring harness connectors to the left and right headlights and turn signals, if equipped.
6. Remove the eight screws and nuts (D) securing the hood.
7. Remove the hood.

Installation

Installation is done in the reverse order of removal.

TCAL26696 —UN—15JUN12

C—Corner Fenders
D—Screws And Nuts (8 Each)

RB14256,000076F -19-18JUN12-2/2

Remove and Install Dash

Removal

1. Remove hood. (See Remove and Install Hood.)
2. Disconnect electrical connections to control panel.
3. Remove steering wheel and boot.
4. Remove four cap screws securing steering control unit to dash.
5. Remove flange cap screws securing dash grab bar to frame. Slide grab bar out of frame.
6. Remove two screws securing dash to frame and remove dash.

Installation

Installation is done in the reverse order of removal.

RB14256,0000770 -19-18JUN12-1/1

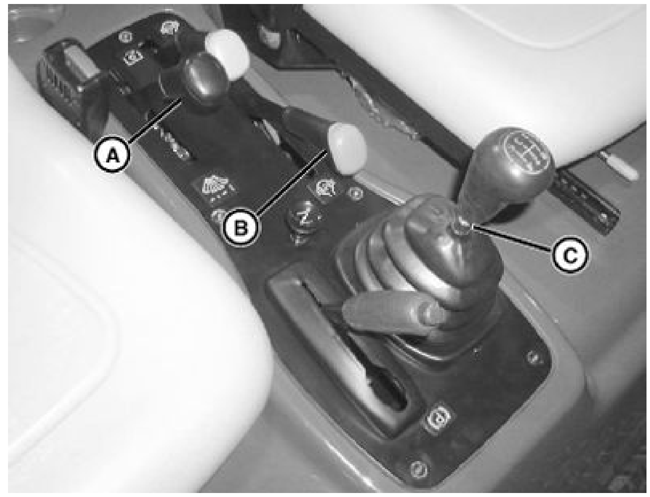
Remove and Install Control Plate

Removal

1. Park vehicle on level surface, turn key switch OFF, place shift lever in first gear or reverse, and lock park brake.
2. Remove the lever caps from the hydraulic control lever (A) and the differential lock lever (B). Remove the nuts securing the lever knobs and pull the knobs off the levers.
3. Loosen the jam nut (C) securing the shift knob and unscrew the knob from the shift lever. Remove the jam nut from the shift lever.
4. Remove screws securing the control plate and remove the plate from the vehicle.

Installation

Installation is done in the reverse order of removal.



TCAL26697 —UN—15JUN12

A—Hydraulic Control Lever
B—Differential Lock Lever
C—Jam Nut

RB14256,0000771 -19-18JUN12-1/1

Remove and Install Roll-Over Protective Structure (ROPS)

Removal

1. Park vehicle on level surface, turn key switch OFF, place shift lever in first gear or reverse, and lock park brake.
2. Disconnect wiring harness electrical connector from wiring inside ROPS (light connector if option is installed).
3. Remove two cap screws securing each side of ROPS to the frame.

CAUTION: The approximate weight of the ROPS is 57-61 kg (125-134 lb). Do not attempt to remove ROPS without an assistant or overhead crane.

NOTE: For removal, more working room is provided if the front wheels are turned to the right or left.

4. Using a hoist or assistance, lift the ROPS straight up and remove from vehicle.

Installation

Installation is done in the reverse order of removal.

- Tighten mounting bolts to specification.

Specification

ROPS Mounting Bolts
(SN -050000)—Torque.. 69 N·m (51 lb.-ft.)
ROPS Mounting Bolts
(SN 050001-)—Torque.. 102 N·m (75 lb.-ft.)

RB14256,0000772 -19-18JUN12-1/1

Remove and Install Seat

Removal

1. Park vehicle on level surface, turn key switch OFF, place shift lever in first gear or reverse, and lock park brake.

NOTE: If machine is equipped with flip up seats, flip seat forward to gain access to harness and hardware.

2. Disconnect the wiring harness from the driver-side seat switch (A) (under seat).
3. Slide the seat(s) forward and remove the two cap screws (B) securing the seat brackets to the vehicle.
4. Slide the seat(s) rearward and remove the two cap screws (C) securing the seat brackets to the vehicle.
5. Remove the seat(s).

Installation

1. Position the seat(s) on the vehicle and install the four cap screws securing the seat brackets.
2. Tighten cap screws to specification.

TCAL26698 —UN—15JUN12

A—Driver-Side Seat Switch
B—Cap Screws (2 Each)
C—Cap Screws (2 Each)

Specification

Seat Mounting Cap Screw Torque—Torque... 17 N·m (140 lb.-in.)

3. Connect the wiring harness to the driver-side seat switch.

RB14256,0000773 -19-11JUN14-1/1

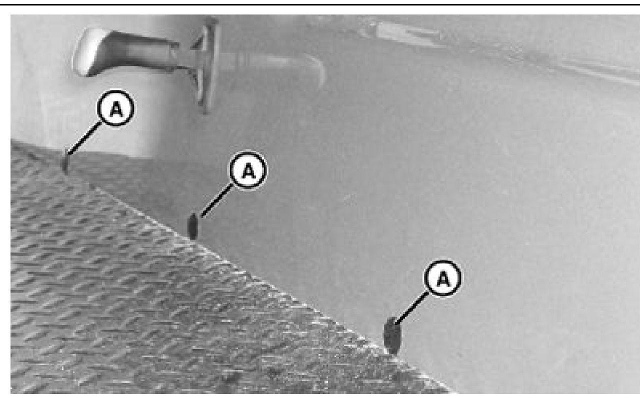
Remove and Install Seat Base Cover

Removal

1. Park vehicle on level surface, turn key switch OFF, place shift lever in first gear or reverse, and lock park brake.
2. Remove the control plate. (See Remove and Install Control Plate.)
3. Remove the ROPS. (See Remove and Install Roll-Over Protective Structure (ROPS).)
4. Remove the seats. (See Remove and Install Seat.)
5. Remove three plastic push-in fasteners (A) from front of seat base.
6. Remove the seat base cover.

Installation

Installation is done in the reverse order of removal.



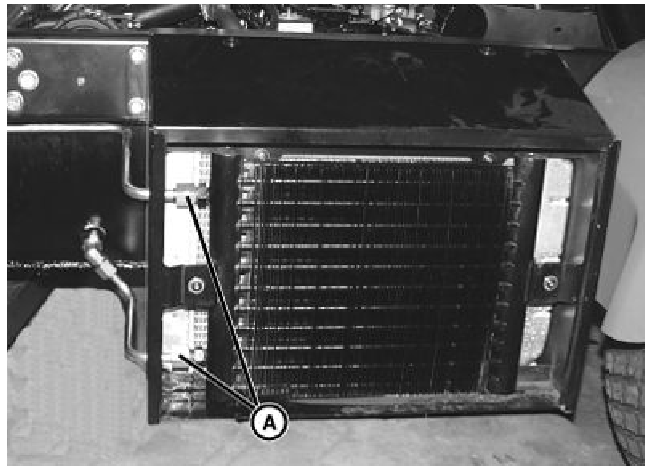
TCAL26699 —UN—15JUN12

A—Plastic Push-In Fasteners (3 Each)

RB14256,0000774 -19-18JUN12-1/1

Remove and Install Radiator (SN -80000)

CAUTION: Hot coolant under pressure can spray and burn unprotected skin and eyes. Allow the unit to cool down before performing this procedure. Dress appropriately and wear eye protection.



TCAL26700 —UN—15JUN12

A—Oil Cooler Lines

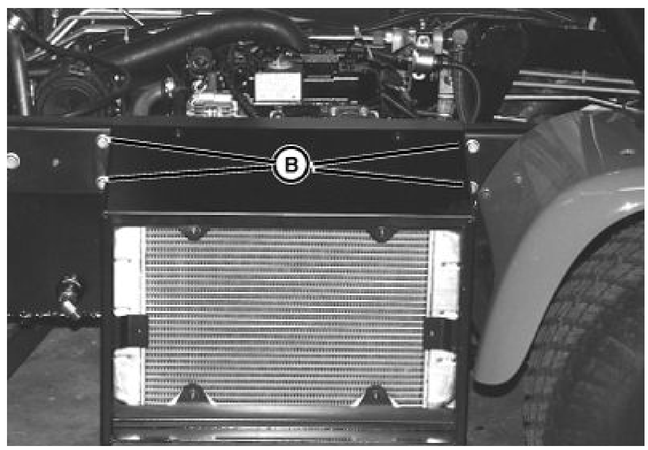
Removal

1. Park vehicle safely and allow to cool off.
2. Drain coolant.
3. Remove screen from front of radiator support.
4. If vehicle is equipped with hydraulic tank and cooler, drain oil from tank and remove lines (A) to oil cooler.
5. Disconnect wires to electric fan.
6. Remove the upper and lower radiator hoses from the radiator.

RB14256,0000775 -19-18JUN12-1/4

7. Remove cap screws (B) from radiator frame and remove unit from vehicle frame.

B—Cap Screws



TCAL26701 —UN—15JUN12

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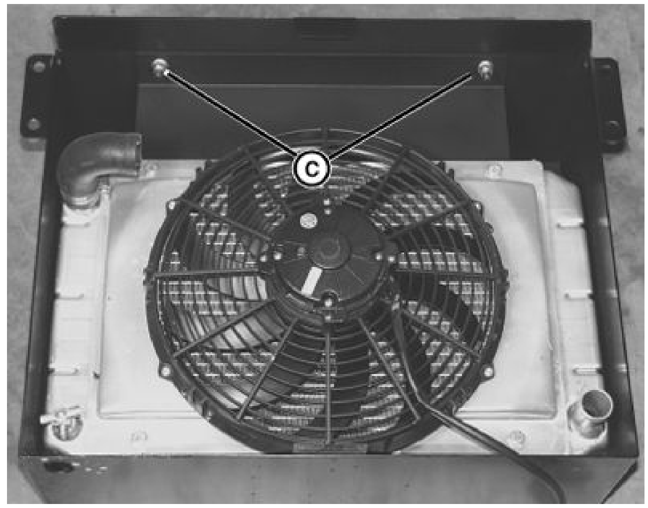
RB14256,0000775 -19-18JUN12-2/4

8. Remove cap screws (C) from radiator support.



TCAL26702 —UN—15JUN12

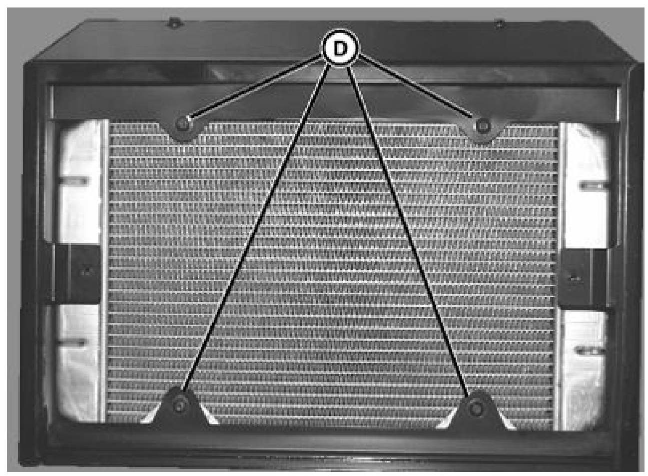
C—Cap Screws

RB14256,0000775 -19-18JUN12-3/4

9. Remove four cap screws (D) securing radiator to frame.
10. Lift and remove radiator from radiator frame.

Installation

1. Install the radiator to the frame.
2. Install radiator frame to vehicle frame.
3. Connect the radiator hoses and fan wiring.
4. If vehicle was equipped with hydraulic oil cooler, install cooler and lines. Fill hydraulic reservoir.
5. Fill cooling system and recovery tank with approved coolant.
6. Install the radiator cap.
7. Run the unit. Check the cooling system for leaks.



TCAL26703 —UN—15JUN12

D—Cap Screws (4 Each)

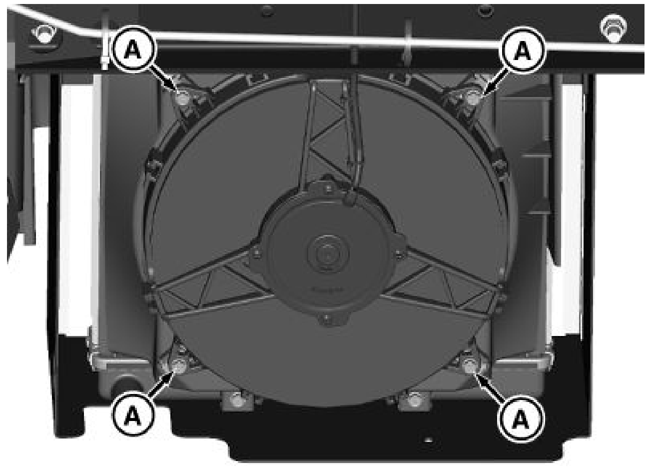
RB14256,0000775 -19-18JUN12-4/4

Remove and Install Radiator (SN 80001-)

Removal

CAUTION: Hot coolant under pressure can spray and burn unprotected skin and eyes. Allow the unit to cool down before performing this procedure. Dress appropriately and wear eye protection.

1. Park machine safely and allow to cool off. See the “Safety Section”.
2. Drain coolant.
3. Remove screen from front radiator support.
4. Remove hoses from radiator.
5. Disconnect wires to electric fan.
6. Remove bolts (A) securing fan to shroud.



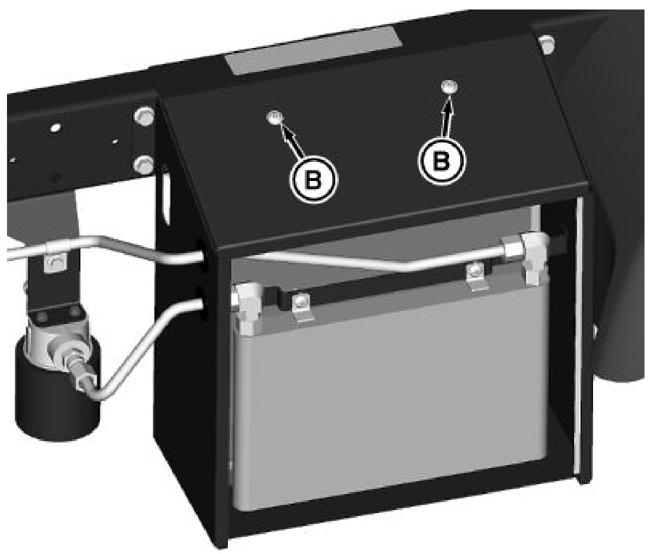
TCT011268 —UN—28MAY14

A—Bolts

BS62576,000178A -19-28MAY14-1/3

7. Remove nuts and bolts (B) securing cover to upper radiator support.

B—Bolts



TCT011269 —UN—28MAY14

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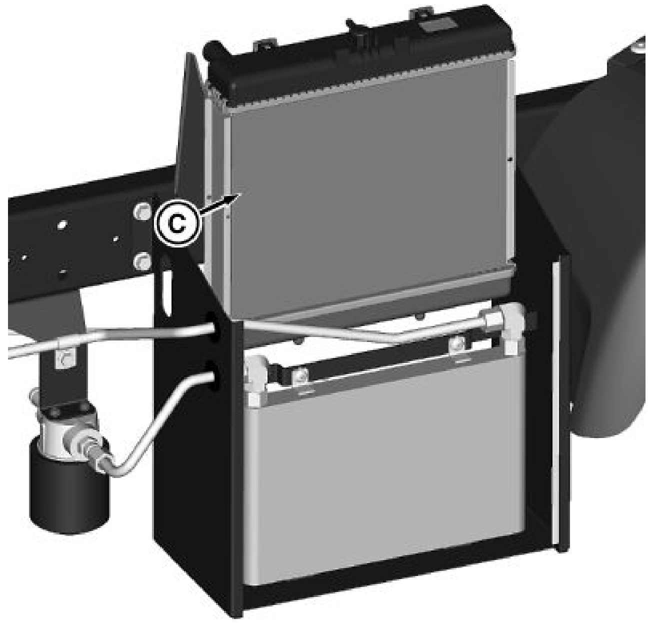
BS62576,000178A -19-28MAY14-2/3

8. Lift and remove radiator (C) from mounting position.
9. Inspect for damage.

Installation

1. Install radiator into mounting position.
2. Secure electric fan to shroud.
3. Connect fan wiring and radiator hoses.
4. Fill cooling system and recovery tank with approved coolant.
5. Install radiator cap.
6. Run the unit. Check cooling system for leaks.

C—Radiator



TCT011270 —UN—28MAY14

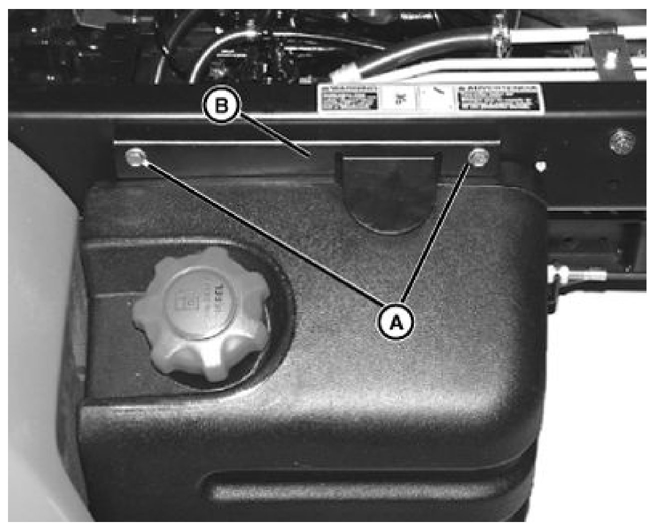
BS62576,000178A -19-28MAY14-3/3

Remove and Install Fuel Tank

Removal

1. Hold nuts behind frame rail and remove cap screws (A) and bracket (B).

A—Cap Screws **B—Bracket**



TCAL26704 —UN—15JUN12

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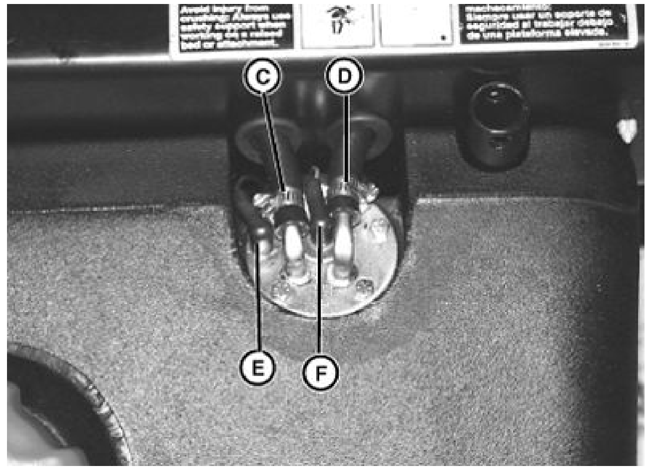
RB14256,0000776 -19-18JUN12-1/2

2. Loosen hose clamps and disconnect fuel return line (C) (diesel models) and fuel suction hose (D).
3. Disconnect black wire (E) and pink wire (F) from fuel level sensor.
4. Tip top of fuel tank away from frame and lift tank out of support bracket.

Installation

1. Set tank into lower bracket.
2. Connect hoses and wires to fuel level sensor.
3. Install bracket.



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C—Fuel Return Line
D—Fuel Suction Hose
E—Black Wire
F—Pink Wire

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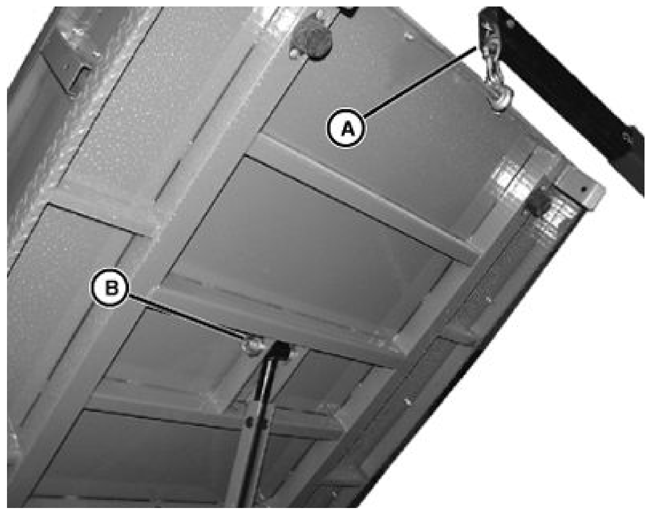
Remove and Install Cargo Box

Removal

CAUTION: The approximate weight of the cargo box is 137 kg (300 lb). Do not attempt to remove cargo box without several assistants or overhead crane.

1. Safely park vehicle and raise the cargo box.
2. Support the front of the box with an engine hoist or similar lifting device (A). Make sure the engine hoist is supporting enough weight that pin (B) is loose. Remove pin (B).
3. Lower cargo box with engine hoist.



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A—Lifting Device
B—Pin

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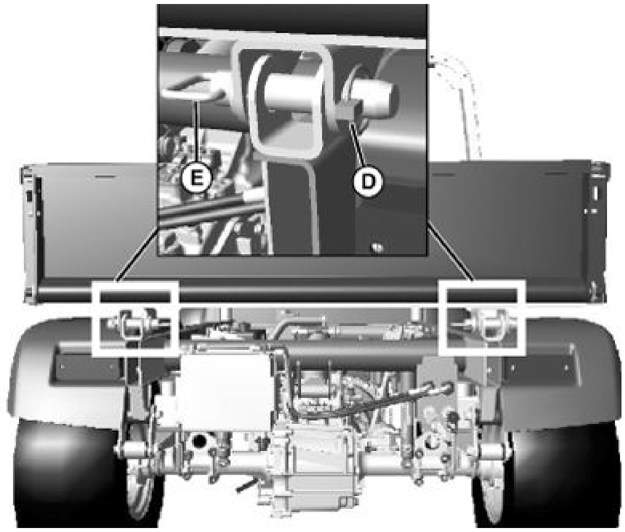
4. Remove retaining pins (D) and hinge pins (E).
5. Use an appropriate lifting device and lift box from vehicle.

Installation

Installation is done in the reverse order of removal.

D—Retaining Pins **E—Hinge Pins**



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Remove and Install Wheel

Removal

1. Park vehicle on level surface, turn key switch OFF, place shift lever in first gear or reverse, and lock park brake.
2. Loosen lug nuts on wheel(s) being removed.
3. Raise and support vehicle so that the wheel being removed is just off the ground.
4. Remove lug nuts and remove wheel.

Installation

Installation is done in the reverse order of removal.

- Install wheel(s) with stems toward outside of vehicle.
- Tighten lug nuts to specification.

Specification

Wheel Lug Nut
Torque—Torque..115 N·m (85 lb.-ft.)

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