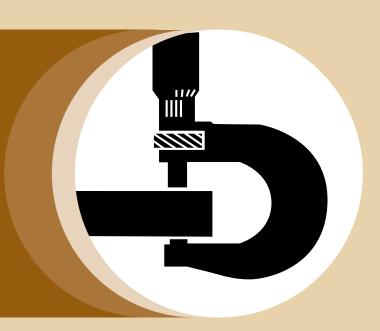
PowerTech® 4.5L & 6.8L Diesel Engines

Base Engine

COMPONENT TECHNICAL MANUAL



For complete service information also see:

POWERTECH® 4.5 L and 6.8 L Diesel

Engines—Level 4 Electronic Fuel Systems

with Bosch VP44 Pump CTM170

POWERTECH® 4.5 L and 6.8 L Diesel

Engines—Mechanical Fuel Systems..... CTM207

Alternators and Starting Motors CTM77

OEM Engine Accessories......... CTM67 (English Only)

Deere Power Systems Group CTM104 (19JUN00)

LITHO IN U.S.A.





Introduction

Forward

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.

This manual (CTM104) covers only the base engine. It is one of three volumes on 4.5 L and 6.8 L engines. The following two companion manuals cover fuel system repair, operation and diagnostics:

- CTM170—Level 4 Electronic Fuel Systems with Bosch VP44 Pump
- CTM207—Mechanical Fuel Systems

CTM207 covers the fuel systems formerly included in CTM104.

Other manuals will be added in the future to provide additional information on electronic fuel systems as needed.

A complete set of all three manuals covering the 4.5 L and 6.8 L engines can be procured by ordering CTM350 Binder Set.

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.

Use this component technical manual in conjunction with the machine technical manual. An application listing in Section 01, Group 001 identifies product-model/component type-model relationship. See

the machine technical manual for information on component removal and installation, and gaining access to the components.

Information is organized in sections and 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.

Before beginning repair on an engine, clean the engine and mount on a repair stand. (See Section 2, Group 010.)

This manual contains SI Metric units of measure followed immediately by the U.S. customary units of measure. Most hardware on these engines is metric sized.

Some components of this engine may be serviced without removing the engine from the machine. Refer to the specific machine technical manual for information on components that can be serviced without removing the engine from the machine and for engine removal and installation procedures.

Read each block of material completely before performing service to check for differences in procedures or specifications. Follow only the procedures that apply to the engine model number you are working on. If only one procedure is given, that procedure applies to all the engines in the manual.

CALIFORNIA PROPOSITION 65 WARNING
Diesel engine exhaust and some of its constituents are known to
the State of California to cause cancer, birth defects and other
reproductive harm.

DPSG,OUO1004,2767 -19-18MAY00-1/1

John Deere Dealers

The changes listed below make your CTM obsolete. Repair, operation and diagnostics on 4.5L and 6.8 L diesel engines is now covered in three manuals.

Discard CTM104 dated 12OCT98 and replace with the following new manuals:

- CTM104 4.5 L and 6.8 L Diesel Engines—Base Engine
- CTM207 4.5 L and 6.8 L Diesel Engines— Mechanical Fuel Systems
- CTM170 4.5 L and 6.8 L Diesel Engines—Level 4 Electronic Fuel System with Bosch VP44 Pump

Also, copy this page listing changes and route through your Service Department.

SECTION 01—GROUP 001 (Engine Identification)

- Updated engine model designation chart.
- Updated engine application charts.

SECTION 01—GROUP 002 (Fuels Lubricants and Coolants)

• Updated engine oil and coolant application guidelines.

SECTION 02—GROUP 010 (Engine Rebuild)

- Updated engine lifting procedure and safety precautions.
- Updated sealant application guidelines.
- Added engine break-in procedure.

SECTION 02—GROUP 020 (Cylinder Head and Valves)

Revised rocker arm support torque specifications.

SECTION 02—GROUP 030 (Cylinder Block, Liners, Pistons and Rods)

- Updated procedure for determining piston-to-liner clearance.
- Added sealant requirements and torque specifications for plugs and caps in cylinder block,

- located in procedure for inspection and cleaning of cylinder block.
- Revised procedure for measuring cylinder liner standout (height above block).
- Revised procedure for installing cylinder liners in block.

SECTION 02—GROUP 040 (Crankshaft, Main Bearings and Flywheel)

- Revised procedure and specifications for removal and installation of vibration damper.
- Revised procedure for removal and installation of front oil seal and wear sleeve.
- Revised procedure for installation of flywheel.
- Revised procedure and specifications for installation of flywheel housing.
- Added procedure for removal and installation of crankshaft timing wheel on engines with Bosch VP44 fuel injection pump.

SECTION 02—GROUP 050 (Camshaft, Balancer Shafts and Timing Gear Train)

- Revised idler gear end play specifications.
- Updated timing gear backlash specifications.
- Revised procedure for removal and installation of balancer shafts.
- Revised idler gear bushing and idler gear shaft specifications.
- Revised procedure for installation of upper idler shaft in front plate.
- Revised procedure for installation of camshaft.
- Revised procedure for installation of timing gear cover.
- Revised procedure for installation of crankshaft front wear sleeve and oil seal.

SECTION 02—GROUP 060 (Lubrication System)

- Revised procedure for removal and installation of oil filter base.
- Revised procedure for removal and installation of oil cooler assembly.
- Revised oil pan drain plug specifications.

SECTION 02—GROUP 070 (Cooling System)

- Added procedure for removal and installation of water manifold/thermostat cover on 6010 Series Tractors.
- Revised torque specification for water pump pulley.
- Revised procedure for installation of fan assembly.
- Revised procedure for installation of fan drive assembly.
- Added procedure for removal and installation of cold start advance switch.

SECTION 02—GROUP 080 (Air Intake and Exhaust System)

- Revised turbocharger lube line torque specifications.
- Added procedure for removal and installation of ether start aid.

SECTION 02—GROUP 090 (Fuel System)

NOTE: Repair procedures for fuel systems has been moved to Section 02, Group 090 in two other technical manuals: CTM207—Mechanical Fuel Systems and CTM170—Level 4 Electronic Fuel Systems with Bosch VP44 Pump.

SECTION 02—GROUP 100 (Starting and Charging Systems)

• Starting and charging systems are now covered in this new section/group.

SECTION 03—GROUP 120 (Base Engine Operation)

 Base engine theory of operation is covered in this new section/group. NOTE: Fuel system theory of operation has been moved to Section 03, Group 130 in two other technical manuals: CTM207—Mechanical Fuel Systems and CTM170—Level 4 Electronic Fuel Systems with Bosch VP44 Pump.

SECTION 04—GROUP 150 (Observable Diagnostics and Tests)

- Base engine observable tests and diagnostics is covered in this new section/group.
- Added dynamometer test procedure and specifications.

NOTE: Fuel system testing and diagnostics has been moved to Section 04, Group 150 in two other technical manuals: CTM207—Mechanical Fuel Systems and CTM170—Level 4 Electronic Fuel Systems with Bosch VP44 Pump.

SECTION 5 (Tools and Other Materials)

 All essential tools, service tools, dealer fabricated tools and other materials listed throughout this manual are consolidated in this section for ease of reference.

SECTION 6 (Specifications)

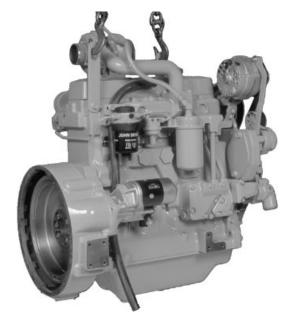
 All repair, test and diagnostic specifications listed throughout this manual are consolidated in this section for ease of reference.

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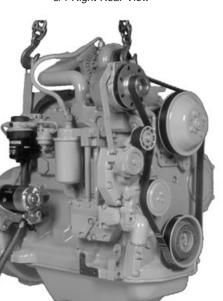
RG7636 -UN-23NOV97

RG7639 -UN-23NOV97

POWERTECH® 4.5 L Engine



3/4 Right Rear View



3/4 Right Front View



3/4 Left Rear View



3/4 Left Front View

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DPSG,OUO1004,129 -19-15MAY98-1/1

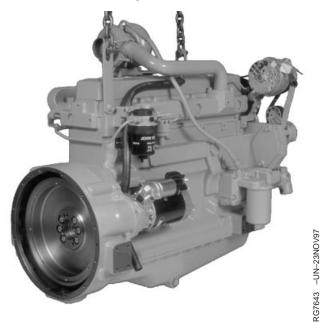
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RG7637 -UN-23NOV97

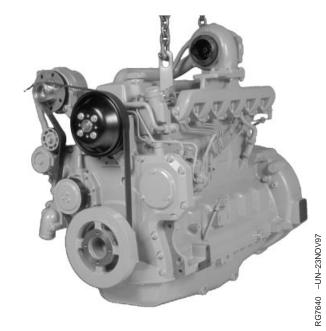
POWERTECH® 6.8 L Engine



3/4 Right Front View



3/4 Right Rear View



3/4 Left Front View



3/4 Left Rear View

POWERTECH is a registered trademark of Deere & Company

DPSG,OUO1004,130 -19-15MAY98-1/1

RG7642 -UN-23NOV97

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> 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.

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> > Previous Editions
> > Copyright © 1996, 1998

02

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INDX



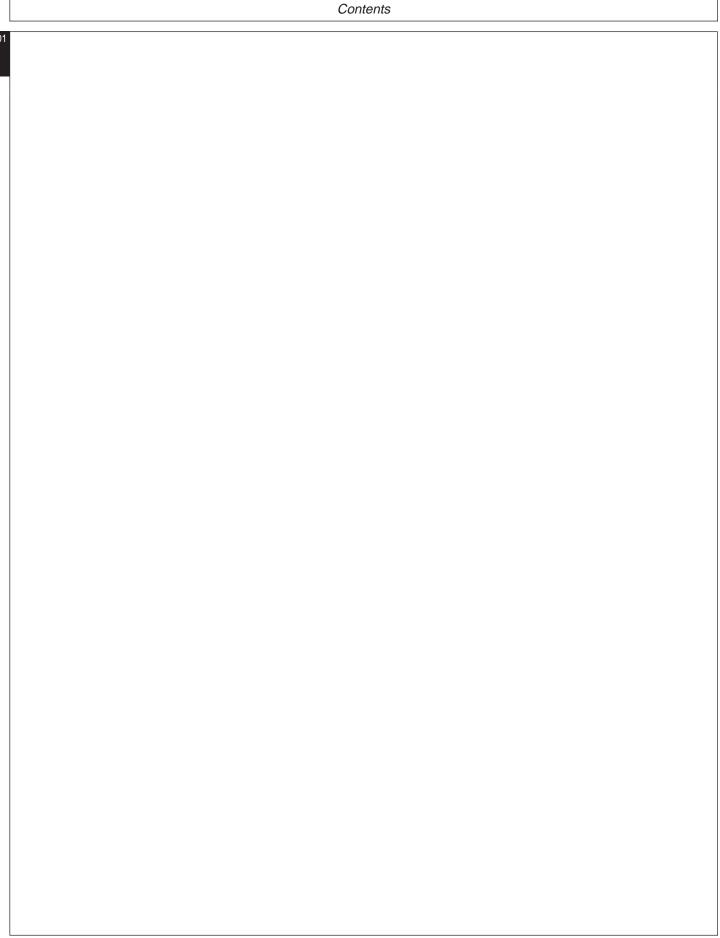
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Section 01 **General Information**

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CTM104 (19JUN00)



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.



Avoid Fires

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

Handle Starting Fluid Safely

Starting fluid is highly flammable.

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

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

Do not incinerate or puncture a starting fluid container.



Store Safely

356 -I IN-18N

DX,FIRE3 -19-16APR92-1/1



Service Cooling System Safely

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

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



Cooling System

81 -UN-

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

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 voltmeter or hydrometer.

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



Battery Explosions

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

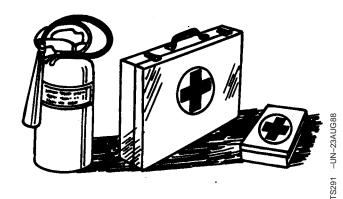
CTM104 (19JUN00)

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.



First Aid Kit

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

Handling Batteries Safely



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

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

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



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

Avoid the hazard by:

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

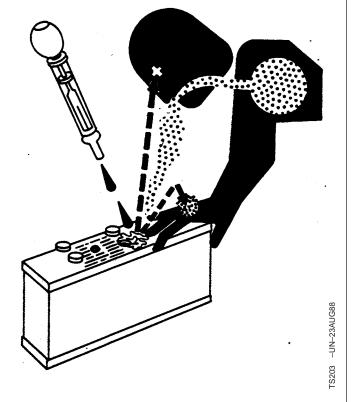
If acid is swallowed:

- 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.

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







-UN-23AUG88

Avoid High-Pressure Fluids

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.



High-Pressure Fluids

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

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.

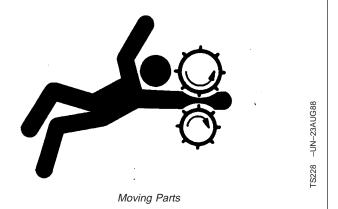


DX,WEAR -19-10SEP90-1/1

Service Machines Safely

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

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

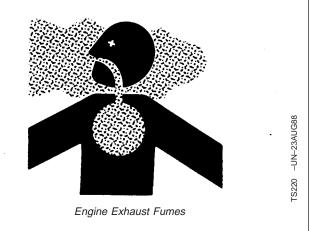


DX,LOOSE -19-04JUN90-1/1

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

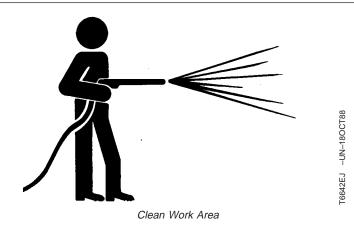


DX,AIR -19-17FEB99-1/1

Work in Clean Area

Before starting a job:

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



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

Remove Paint Before Welding or Heating

Avoid potentially toxic fumes and dust.

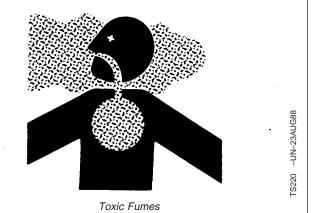
Hazardous fumes can be generated when paint is heated by welding, soldering, or using a torch.

Do all work outside or in a well ventilated area. Dispose of paint and solvent properly.

Remove paint before welding or heating:

CTM104 (19JUN00)

- 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.



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

Avoid Heating Near Pressurized Fluid Lines

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



Flammable Spray

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

Illuminate Work Area Safely

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

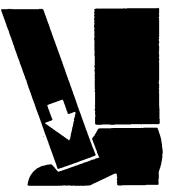


Illuminate Work Area Safely

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

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

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



Use Proper Lifting Equipment

S226 -UN-23AUG88

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

Construct Dealer-Made Tools Safely

Faulty or broken tools can result in serious injury. When constructing tools, use proper, quality materials and good workmanship.

Do not weld tools unless you have the proper equipment and experience to perform the job.



John Lace Board Made Toole Carely

DPSG,OUO1004,899 -19-19MAY99-1/1

Practice Safe Maintenance

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

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

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

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

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

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



Keep Area Clean

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

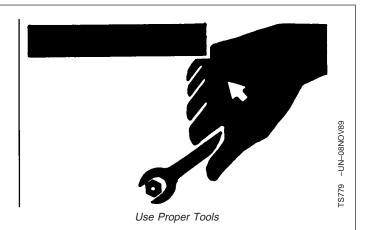
Use Proper Tools

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.



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

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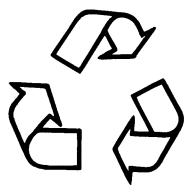
Improperly disposing of waste can threaten the environment and ecology. Potentially harmful waste used with John Deere equipment include such items as oil, fuel, coolant, brake fluid, filters, and batteries.

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.



Recycle Waste

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

Live With Safety

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



Safety Systems

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

31 -19-070CT88

CTM104 (19JUN00)

Engine Model Designation

John Deere Engine Model—4045 and 6068 Engines

John Deere engine model designation includes number of cylinders, displacement in liters, aspiration, user code, and applicable code. For example:

| 4045TF150 Engine | |
|--------------------------|--|
| 4 | Number of cylinders |
| 4.5 | Liter displacement |
| T | Aspiration code |
| F | User code |
| 1 | Internal engine configuration type |
| 50 | PowerTech® application code |
| Aspiration Code | топ 2002 година принамент обще |
| D | Naturally aspirated |
| T | Turbocharged and Air-to-Coolant Aftercooled |
| H | Turbocharged and Air-to-Air Aftercooled |
| User Factory Code | ransconargea and ran to ran ratercoolea |
| AP | Saltillo (Mexico) |
| CQ | S.L.C. Horizontina (Brazil) |
| DW | John Deere Davenport Works |
| E | John Deere Ottumwa Works |
| F | OEM (Outside Equipment Manufacturers) |
| FF | Kernersville Deere-Hitachi (North Carolina) |
| FG | Goldoni (Italy) |
| FM | Marine Engines |
| H | John Deere Harvester Works |
| KV | John Deere Knoxville (Tennesee) |
| L | John Deere Werke Mannheim (Germany) |
| LA | John Deere Werke Mannheim (Germany) |
| | (Engines with Bosch VP44 Injection Pump) |
| LV | John Deere Augusta, Georgia |
| N | John Deere Des Moines Works |
| P | Saltillo/Monterrey (Mexico) |
| RW | John Deere Waterloo Tractor Works |
| Τ | John Deere Dubuque Works |
| T8 | Cameco (Deere) (Louisiana) |
| YC | John Deere Jialian Harvester Co. Limited |
| | (China) |
| Z | John Deere WERKE Zweibrucken (Germany) |
| Model Designation | , , , , , |
| 1 or 2 | Indicates different internal engine components |
| Application Code | ů l |
| 50 or above | PowerTech® code for specific application |
| | |

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RG,01,DT7028 -19-08OCT99-1/1

Engine Serial Number Plate Information

IMPORTANT: The engine serial number plate (A) can be easily destroyed. Before "hot tank" cleaning the block, remove the plate.

Engine Serial Number (B)

Each engine has a 13-digit John Deere engine serial number identifying the producing factory, engine model designation, and a 6-digit sequential number. The following is an example:

| | T04045T000000 | | | |
|------------------------------------|-------------------|--|--|--|
| | T0 | Factory producing engine | | |
| | 4045T | Engine model designation | | |
| | 000000 | Sequential serial number | | |
| Factory Code (Engine Manufacturer) | | | | |
| | T0 | Dubuque, Iowa | | |
| | CD | Saran, France | | |
| | PE | Torreon, Mexico | | |
| Engine Model Designation | | | | |
| | 4045T | Definition explained previously. (See ENGINE | | |
| | | MODEL DESIGNATION earlier in this group. | | |
| | Sequential Number | | | |
| | 000000 | 6-digit sequential serial number | | |
| | | | | |

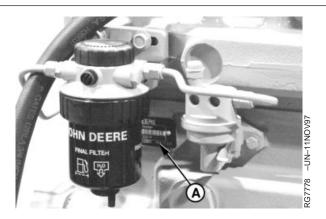
Engine Application Data (C)

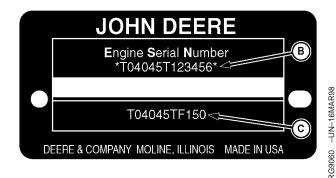
The second line of information on the serial number plate identifies the engine/machine or OEM relationship. See ENGINE APPLICATION CHARTS later in this group.

Coefficient of Absorption (D) — (Saran-Built Engines Only)

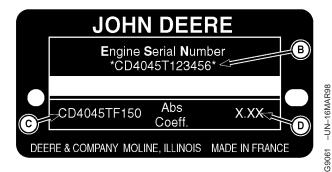
The second line of information on Saran serial number plate also contains the coefficient of absorption value for smoke emissions.

- A—Engine Serial Number Plate
- **B**—Engine Serial Number
- **C**—Engine Application Data
- D—Coefficient of Absorption (Saran Engines Only)

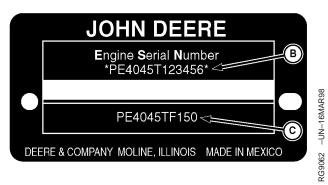




Dubuque Engine Serial Number Plate



Saran Engine Serial Number Plate



Torreon Engine Serial Number Plate

RG,01,DT7029 -19-26APR00-1/1

OEM Engine Option Code Label

An option code label is secured to the top of the valve cover and identifies the factory installed options on each OEM engine to ensure correct parts acquisition.

Always provide option code information and engine base code when ordering repair parts. A listing of option codes is given in Parts Catalogs and Operator's Manuals.

NOTE: Before "hot tank" cleaning, ensure that option codes are recorded elsewhere.



DPSG,OUO1004,482 -19-07NOV98-1/1

Engine Application Charts

| JOHN DEERE AGRICULTURAL EQUIPMENT | | | |
|-------------------------------------|---------------------------------------|--|--|
| Machine Model | Engine Model | | |
| Des Moines, Iowa | | | |
| 4700 Sprayer (138 kW) | PE6068TN050, PE6068TN053, T06068TN050 | | |
| 4700 Sprayer (149 kW) | PE6068TN052 | | |
| 6700/6700S Sprayer | PE4045TN050, T04045TN050 | | |
| 9935 Cotton Picker | T06068TN051 | | |
| 7455 Cotton Stripper | T06068TN051 | | |
| East Moline, Illinois | | | |
| 9400 Combine | T06068HH050 | | |
| 9410 Combine | T06068HH051 | | |
| 9450 Combine | T06068HH052 | | |
| Horizontina, Brazil | | | |
| 1170 Combine | CD6068TCQ50 | | |
| Zweibrucken, Germany | | | |
| 2254 Combine | CD6068HZ050 | | |
| 3200/3400 Telescopic Handler | CD4045TZ250 | | |
| Ottumwa, Iowa | | | |
| 4890 Windrower | T04045TE050 | | |
| 4990 Windrower | T06068TE050 | | |
| Waterloo, Iowa | | | |
| 7210 (SyncroPlus) Tractor | T06068TRW53 | | |
| 7210 (PowerQuad) Tractor | T06068TRW50 | | |
| 7410 (SyncroPlus) Tractor | T06068TRW54 | | |
| 7410 (PowerQuad) Tractor | T06068TRW51 | | |
| 7510 (PowerQuad) Tractor | T06068TRW70 | | |
| 7610 Tractor | T06068TRW52, T06068TRW72 | | |
| Mannheim, Germany (European Market) | | | |
| 6010 Tractor | CD4045DL050 | | |
| 6110 Tractor (Direct Fan Drive) | CD4045TL058 | | |
| 6110 Tractor (Viscous Fan Drive) | CD4045TL050 | | |
| 6205 Tractor (Classic) | CD4045TL064 | | |
| 6210 Tractor (Direct Fan Drive) | CD4045TL059 | | |
| 6210 Tractor (Viscous Fan Drive) | CD4045TL051 | | |
| 6310 Tractor (Direct Fan Drive) | CD4045TL060 | | |
| 6310 Tractor (Viscous Fan Drive) | CD4045TL052 | | |
| 6310 Tractor (ECU Level 4) | CD4045TLA50 | | |
| 6410 Tractor (Direct Fan Drive) | CD4045TL061 | | |
| 6410 Tractor (Viscous Fan Drive) | CD4045TL053 | | |

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| JOHN DEERE AGRICULTURAL EQUIPMENT | | |
|---|--------------------------|--|
| Machine Model | Engine Model | |
| 6410 Tractor (ECU Level 4) | CD4045TLA51 | |
| 6505 Tractor (Classic) | CD6068DL051 | |
| 6510 Tractor | CD6068DL050 | |
| 6610 Tractor | CD6068TL050 | |
| 6610 Tractor (ECU Level 4) | CD6068TLA50 | |
| 6810 Tractor | CD6068TL051 | |
| 6810 Tractor (ECU Level 4) | CD6068TLA51 | |
| 6910 Tractor | CD6068TL052 | |
| 6910 Tractor (107 kW) | CD6068TL054 | |
| 6910 Tractor (ECU Level 4) | CD6068TLA52 | |
| 6910S Tractor (ECU Level 4, Boost) | CD6068TLA53 | |
| Mannheim, Germany (North American Market) | | |
| 6110/6110L Tractor | CD4045TL063 | |
| 6210/6210L Tractor | CD4045TL054 | |
| 6310/6310L/6310S Tractor | CD4045TL055 | |
| 6405 Tractor | CD4045TL062 | |
| 6410/6410L/6410S Tractor | CD4045TL056 | |
| 6510L/6510S Tractor | CD4045TL057 | |
| 6605 Tractor | CD6068TL053 | |
| Saltillo, Mexico | | |
| 5415 Tractor | PE4045DP050, PE4045DP052 | |
| 5615 Tractor | PE4045DP051, PE4045DP053 | |
| 5715 Tractor | PE4045TP050, PE4045TP059 | |
| 7410 Tractor | CD6068TP052 | |
| 7405 Tractor | CD6068TP051, PE6068TP051 | |
| 7500 Tractor | PE6068TP052 | |
| 6400 Tractor | PE4045TP054 | |
| Tekirdag, Turkey | | |
| 5615 Tractor | CD4045DTK20 | |
| 5715 Tractor | CD4045TTK20 | |
| Cameco | | |
| 404 Veg Sprayer | T04045TT850 | |
| SP1800 & SP3000 Cane Loader/S30 Harvester/215 4WD Tractor | PE6068DT850 | |
| SP2252 Cane Loader/Kanaf 100 Loader/Kanaf Harvester/220 4WD Tractor/Pineapple Harvester/Sprayer | PE6068TT850 | |

| JOHN DEERE CONSTRUCTION EQUIPMENT | | |
|---|--------------------------|--|
| Machine Model | Engine Model | |
| Davenport, Iowa | | |
| 210LE Landscape Loader | T04045DT050, PE4045DT050 | |
| 344H Loader | CD4045TF152 | |
| 444H Loader, TC 44H Tool Carrier | T04045TDW50 | |
| 544H Loader, TC 54H Tool Carrier | T06068TDW50 | |
| 624H Loader, TC 62H Tool Carrier | T06068HDW50 | |
| LX100 Loader (Hitachi Construction Machine) | T06068TDW53 | |
| LX120 Loader (Hitachi Construction Machine) | T06068HDW70 | |
| 540G Cable Skidder, 548G Grapple Skidder (558205—) | T06068TDW51 | |
| 540G-II Cable Skidder, 548G-II Grapple Skidder | T06068TDW54 | |
| 640G/648GX Skidder (558325—) | T06068TDW52 | |
| 640G-II Cable Skidder | T06068TDW55 | |
| 648G-II Grapple Skidder | T06068TDW55 | |
| 670C Motor Grader | T06068HDW53 | |
| 670CH/672CH Motor Grader | T06068HDW55 | |
| 690E LC Excavator (559603—) | T06068TDW56 | |
| Dubuque, Iowa | | |
| 310E Backhoe Loader (Alt Comp) | T04045TT056 | |
| 310E Backhoe Loader | T04045DT055 | |
| 310SE Backhoe Loader | T04045TT050 | |
| 315SE Backhoe Loader | T04045TT060 | |
| 324H Loader | CD4045DF153 | |
| 410E Backhoe Loader | T04045TT053 | |
| 710D Backhoe Loader (—834729) | T06068TT050 | |
| 710D Backhoe Loader (834730—) | T06068TT055 | |
| 450G Series IV Crawler Dozer (840461—) | T04045TT061 | |
| 450GTC Series IV Crawler Dozer (840461—)/455GTC Crawler Loader (840461—) | T04045TT067 | |
| 455G Series IV Crawler Loader (840461—) | T04045TT061 | |
| 550G Crawler Dozer (840461—) | T04045TT062 | |
| 550GTC Crawler Dozer (840461—) | T04045TT068 | |
| 555G Crawler Loader (840461—) | T04045TT063 | |
| 650G Crawler Dozer (840461—) | T04045TT063 | |
| 650GTC Crawler Dozer (840461—)/555GTC Crawler Loader | T04045TT069 | |
| 450H LGP Crawler Dozer | T04045TT058 | |
| 450H/STD, LT Crawler Dozer | T04045DT053 | |
| 450H Alt Comp Crawler Dozer | T04045TT057 | |
| 550H Crawler Dozer | T04045TT064 | |
| 550H LGP Crawler Dozer | T04045TT065 | |

| JOHN DEERE CONSTRUCTION EQUIPMENT | | |
|--|--------------------------|--|
| Machine Model | Engine Model | |
| 650H Crawler Dozer | T04045TT066 | |
| 750C Crawler Dozer (831372—) | T06068TT052 | |
| 643G Feller Buncher | T06068TT053 | |
| 643H Feller Buncher | PE6068TT058 | |
| 653E Feller Buncher | T06068TT053 (751314—) | |
| 653G Feller Buncher (120 kW) | T06068TT053, PE6068TT059 | |
| 653G Feller Buncher (140 kW) | PE6068HT057 | |
| 843G Feller Buncher | T06068HT050, PE6068HT050 | |
| 843H Feller Buncher | PE6068HT056 | |
| 485E, 486E, 488E Forklift/210LE Landscape Loader | T04045DT050, PE4045DT050 | |
| DX75 Crawler Dozer (Japan) | T04045DT052 | |
| DX75 HST Crawler Dozer (Japan) | T04045TT070 | |
| 650H Forest Fire Plow | T04045TT083 | |
| Saltillo (Mexico) | | |
| 110 Excavator | T04045TT054, PE4045TP052 | |
| 120 Excavator | T04045TT052, PE4045TP051 | |
| 160LC Excavator | T04045TT055, PE4045TP053 | |
| Kernersville (Deere-Hitachi) | | |
| 200LC Excavator | T06068TT051, PE6068TT051 | |
| 230LC Excavator | T06068HT051, PE6068HT051 | |
| 270LC Excavator | T06068HT052 | |

| JOHN DEERE COMMERCIAL AND CONSUMER EQUIPMENT | | |
|--|--------------------------|--|
| Machine Model | Engine Model | |
| Augusta, Georgia | | |
| 5410 Tractor | CD4045DLV50, PE4045DLV50 | |
| 5410 Tractor (No Engine Air Heater Option) | PE4045DLV51 | |
| 5510/5510N Tractor | CD4045TLV50, PE4045TLV50 | |
| 5510 Tractor (No Engine Air Heater Option) | PE4045TLV51 | |

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| Naturally Aspirated | Turbocharged | Turbocharged, Air-to-Air Aftercooled |
|---------------------|--------------|--------------------------------------|
| CD4045DF120 | CD4045TF150 | CD4045HF150 |
| CD4045DF150 | CD4045TF152 | CD4045HF157 |
| CD4045DF151 | CD4045TF154 | CD4045HF158 |
| CD4045DF152 | CD4045TF155 | CD6068HF150 |
| CD4045DF153 | CD4045TF157 | CD6068HF157 |
| CD4045DF154 | CD4045TF158 | CD6068HF158 |
| CD4045DF157 | CD4045TF220 | CD6068HF250 |
| CD4045DF158 | CD4045TF250 | PE4045HF120 |
| CD6068DF150 | CD4045TF251 | PE4045HF150 |
| PE4045DF150 | CD4045TF257 | PE6068HF150 |
| PE6068DF150 | CD4045TF258 | PE6068HF250 |
| T04045DF150 | CD6068TF150 | T04045HF120 |
| T04045DF151 | CD6068TF151 | T04045HF150 |
| T04045DF152 | CD6068TF152 | T06068HF150 |
| T04045DF153 | CD6068TF157 | T06068HF250 |
| T06068DF150 | CD6068TF158 | |
| T04045DFM50 | CD6068TF159 | |
| | CD6068TF220 | |
| | CD6068TF250 | |
| | CD6068TF251 | |
| | CD6068TF257 | |
| | CD6068TF258 | |
| | PE4045TF120 | |
| | PE4045TF150 | |
| | PE4045TF250 | |
| | PE6068TF120 | |
| | PE6068TF150 | |
| | PE6068TF220 | |
| | PE6068TF250 | |
| | T04045TF120 | |
| | T04045TF150 | |
| | T04045TF151 | |
| | T04045TF152 | |
| | T04045TF250 | |
| | T04045TF251 | |
| | T04045TFM50 | |
| | T06068TF120 | |
| | T06068TF150 | |
| | T06068TF151 | |
| | T06068TF220 | |

Engine Identification

| JOHN DEERE OEM (OUTSIDE EQUIPMENT MANUFACTURERS) | | |
|--|--------------|---|
| Naturally Aspirated | Turbocharged | Turbocharged, Air-to-Air Aftercooled |
| | T06068TF250 | |
| | T06068TFM50 | |

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CTM104 (19JUN00)

Diesel Fuel

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

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

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

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

- Cetane Number of 40 minimum. Cetane number greater than 50 is preferred, especially for temperatures below —20°C (—4°F) or elevations above 1500 m (5000 ft).
- Cold Filter Plugging Point (CFPP) below the expected low temperature OR Cloud Point at least 5°C (9°F) below the expected low temperature.

- Fuel Lubricity should pass a minimum of 3100 gram load level as measured by the BOCLE scuffing test.
- Sulfur Content
 - Sulfur content should not exceed 0.5%. Sulfur content less than 0.05% is preferred.
 - If diesel fuel with sulfur content greater than 0.5% is used, reduce the service interval for engine oil and filter by 50%.
 - DO NOT use diesel fuel with sulfur content greater than 1.0%.

Bio-diesel fuels with properties meeting DIN 51606 or equivalent specification may be used.

DO NOT mix used engine oil or any other type of lubricant with diesel fuel.

RG,02,DT7324 -19-08OCT99-1/1

Lubricity of Diesel Fuel

Diesel fuel must have adequate lubricity to ensure proper operation and durability of fuel injection system components.

Diesel fuels for highway use in the United States, Canada, and the European Union require sulfur content less than 0.05%.

Experience shows that some low sulfur diesel fuels may have inadequate lubricity and their use may reduce performance in fuel injection systems due to inadequate lubrication of injection pump components. The lower concentration of aromatic compounds in these fuels also adversely affects injection pump seals and may result in leaks.

Use of low lubricity diesel fuels may also cause accelerated wear, injection nozzle erosion or corrosion, engine speed instability, hard starting, low power, and engine smoke.

Fuel lubricity should pass a minimum of 3100 gram load level as measured by the BOCLE scuffing test.

ASTM D975 and EN 590 specifications do not require fuels to pass a fuel lubricity test.

If fuel of low or unknown lubricity is used, add John Deere PREMIUM DIESEL FUEL CONDITIONER (or equivalent) at the specified concentration.

Engine Break-In Oil

The engine is ready for normal operation. However, extra care during the first 100 hours of operation will result in more satisfactory long-term engine performance and life. New engines are filled at the factory with John Deere ENGINE BREAK-IN OIL. During the break-in period, add John Deere ENGINE BREAK-IN OIL as needed to maintain the specified oil level. DO NOT exceed 100 hours of operation with break-in oil.

IMPORTANT: DO NOT add makeup oil until the oil is BELOW the ADD mark on dipstick.

John Deere ENGINE BREAK-IN OIL (TY22041) should be used to make up any oil consumed during the break-in period.

The engine should be operated at heavy loads with minimal idling during the break-in period. If the engine has significant operating time at idle, constant speeds, and/or light load usage, or makeup oil is required in the first 100 hour period, a longer break-in period may be required. In these situations, an additional 100 hour break-in period is recommended using a new change of John Deere ENGINE BREAK-IN OIL and a new John Deere oil filter.

Change the oil and filter after the first 100 hours of operation of a new or rebuilt engine.

After engine overhaul, fill the engine with John Deere ENGINE BREAK-IN OIL.

If John Deere ENGINE BREAK-IN OIL is not available, use a diesel engine oil meeting one of the following during the first 100 hours of operation:

- API Service Classification CE
- ACEA Specification E1

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

IMPORTANT: Do not use John Deere PLUS-50® oil or engine oils meeting API CG4, API CF4, ACEA E3, or ACEA E2 performance levels during the first 100 hours of operation of a new or rebuilt engine. These oils will not allow the engine to break in properly.

PLUS-50 is a registered trademark of Deere & Company.

RG,02,DT7326 -19-22JUL99-1/1

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Diesel Engine Oil

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

The following oil is preferred:

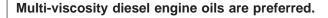
• John Deere PLUS-50®

The following oil is also recommended:

John Deere TORQ-GARD SUPREME®

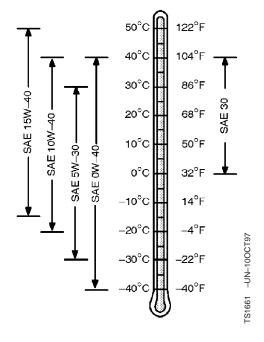
Other oils may be used if they meet one or more of the following:

- API Service Classification CH-4
- API Service Classification CG-4
- API Service Classification CF-4
- ACEA Specification E3
- ACEA Specification E2



If diesel fuel with sulfur content greater than 0.5% is used, reduce the service interval by 50%.

Extended service intervals may apply when John Deere preferred engine oils are used. Consult your John Deere dealer for more information.



PLUS-50 is a registered trademark of Deere & Company.
TORQ-GARD SUPREME is a registered trademark of Deere & Company

DX,ENOIL -19-24JAN00-1/1

Extended Diesel Engine Oil Service Intervals

When John Deere PLUS-50® oil and the specified John Deere filter are used, the service interval for engine oil and filter changes may be increased by 50%.

If other than PLUS-50® oil and the specified John Deere filter are used, change the engine oil and filter at the normal service interval.

PLUS-50 is a registered trademark of Deere & Company.

RG,RG34710,1031 -19-23OCT97-1/1



Alternative and Synthetic Lubricants

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

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

Consult your John Deere dealer to obtain information and recommendations.

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

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

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

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

Mixing of Lubricants

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

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

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

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

OILSCAN®, OILSCAN Plus® and COOLSCAN™



OILSCAN®, OILSCAN Plus® and COOLSCAN™ are John Deere sampling fluid programs to help you monitor machine maintenance and system condition. The objective of a fluid sampling program is to ensure machine availability when you need it and to reduce repair costs by identifying potential problems before they become critical.

Oil and coolant samples should be taken from each system prior to its recommended change interval.

Check with your John Deere dealer on a maintenance program for your specific application. Your dealer has the sampling products and expertise to assist you in lowering your overall operating costs through fluid sampling.

OILSCAN is a registered trademark of Deere & Company.
OILSCAN Plus is a registered trademark of Deere & Company.
COOLSCAN is a trademark of Deere & Company.

RG,01,DT7040 -19-05JAN00-1/1

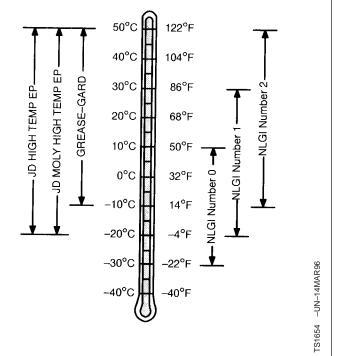
Grease

Use grease based on NLGI consistency numbers and the expected air temperature range during the service interval.

The following greases are preferred:

- John Deere HIGH TEMPERATURE EP GREASE
- John Deere MOLY HIGH TEMPERATURE EP GREASE
- John Deere GREASE-GARD™

Other greases may be used if they meet NLGI Performance Classification GC-LB.



GREASE-GARD is a trademark of Deere & Company.

DX,GREA1 -19-18MAR96-1/1

Diesel Engine Coolant Recommendations

Contact your engine distributor or servicing dealer to determine what the cooling system of this engine is filled with and the winter freeze protection level.

Solutions of antifreeze and supplemental coolant additives MUST be used year-round for freeze protection, boil-over protection, and to provide a stable, noncorrosive environment for seals, hoses, and metal engine parts.

The following engine coolant is preferred for service:

- John Deere PREDILUTED ANTIFREEZE/SUMMER COOLANT
- John Deere COOL-GARD™, where available.

John Deere ANTIFREEZE/SUMMER COOLANT CONCENTRATE in a 40 to 60 percent mixture of concentrate with quality water is also recommended.

John Deere Prediluted Antifreeze/Summer Coolant

This product contains all the necessary ingredients that make up the proper coolant solution: chemically pure water, ethylene glycol (low silicate antifreeze), and supplemental coolant additives (SCAs). It is ready to use; no mixing is required.

John Deere Prediluted Antifreeze/Summer Coolant permits extended service life to 3000 hours or 36 months of operation.

John Deere COOL-GARD™

In certain geographical areas, John Deere COOL-GARD™ is marketed for use in the engine

cooling system. This product contains all the necessary ingredients that make up the proper coolant solution: chemically pure water, ethylene glycol (low silicate antifreeze), and supplemental coolant additives (SCAs). It is ready to add to cooling system as is; no mixing or supplemental coolant additives required. Contact your John Deere Parts Network for local availability.

John Deere COOL-GARD™ has a service life of 2000 hours or 24 months of operation.

John Deere Antifreeze/Summer Coolant Concentrate

This product contains ethylene glycol (low silicate antifreeze) and supplemental coolant additives (SCAs). It must be mixed with quality water, as described later in this section, before adding to the engine cooling system. The proportion of water to be used depends upon the lowest freeze protection temperature desired according to the following table:

| % CONCENTRATE | FREEZE PROTECTION LIMIT |
|---------------|-------------------------|
| 40 | -24° C (-12° F) |
| 50 | -37° C (-34° F) |
| 60 | -52° C (-62° F) |

John Deere Antifreeze/Summer Coolant Concentrate has a service life of 2000 hours or 24 months of operation.

COOL-GARD is a trademark of Deere & Company.

RG,02,JW7721 -19-01DEC97-1/1

Engine Coolant Specifications

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

Coolant solutions of quality water, ethylene glycol concentrate (antifreeze), and supplemental coolant additives (SCAs) MUST be used year-round to protect against freezing, boil-over, liner erosion or pitting, and to provide a stable, noncorrosive environment for seals, hoses, and metal engine parts.

Some products, including John Deere PREDILUTED ANTIFREEZE/SUMMER COOLANT, are fully formulated coolants that contain all three components in their correct concentrations. Do not add an initial charge of supplemental coolant additives to these fully formulated products.

Some coolant concentrates, including John Deere ANTIFREEZE/SUMMER COOLANT CONCENTRATE, contain both ethylene glycol antifreeze and inhibiting coolant additives. Mix these products and quality water, but do not add an initial charge of supplemental coolant additives.

Coolants meeting ASTM D5345 (prediluted coolant) or ASTM D4985 (coolant concentrate) require an initial charge of supplemental coolant additives.

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

| Water Quality Specifications | | |
|----------------------------------|-----------|-------------------|
| Item | Parts Per | Grains Per |
| | Million | U.S. Gallon |
| Chlorides (maximum) | 40 | 2.5 |
| Sulfates (maximum) | 100 | 5.9 |
| Total Dissolved Solids (maximum) | 340 | 20 |
| Total Hardness (maximum) | 170 | 10 |
| pH Level | 5.5—9.0 | |

Ethylene Glycol Concentrate (Antifreeze):

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

The use of John Deere coolant products, as outlined on the previous page, is strongly recommended.

If John Deere coolant products are not used, other low silicate ethylene glycol base coolants for heavy-duty engines may be used when mixed with quality water and supplemental coolant additives (SCAs), if they meet one of the following specifications:

- ASTM D5345 (prediluted coolant)
- ASTM D4985 (coolant concentrate) in a 40% to 60% mixture of concentrate with quality water.

Coolants meeting these specifications require addition of supplemental coolant additives (SCAs), formulated for heavy-duty diesel engines, for protection against corrosion and cylinder liner erosion and pitting.

Continued on next page

RG,02,DT7036 -19-29OCT97-1/3

IMPORTANT: Never use automotive-type coolants (such as those meeting ASTM D3306 or ASTM D4656). These coolants do not contain the correct additives to protect heavy-duty engines. They often contain a high concentration of silicates and may damage the engine or cooling system.

Supplemental Coolant Additives (SCAs):

IMPORTANT: DO NOT over-inhibit antifreeze

solutions, as this can cause silicate-dropout. When this happens, a gel-type deposit is created which retards heat transfer and coolant flow

causing engine to overheat.

NOTE: John Deere Prediluted Antifreeze/Summer Coolant, and John Deere Antifreeze/Summer Coolant Concentrate contain supplemental coolant additives (SCAs). However, as the coolant solution loses its effectiveness, additives will need to be added.

Operating without proper coolant additive will result in increased corrosion, cylinder liner erosion and pitting, and other damage to the engine and cooling system. A simple mixture of ethylene glycol and water WILL NOT give adequate protection.

The use of supplemental coolant additives reduces corrosion, erosion, and pitting. These chemicals reduce the number of vapor bubbles in the coolant and help form a protective film on cylinder liner surfaces. This film acts as a barrier against the harmful effects of collapsing vapor bubbles.

Inhibit the antifreeze-coolant mix with a non-chromate inhibitor. John Deere Liquid Coolant Conditioner is recommended as a supplemental coolant additive in John Deere engines.



John Deere Liquid Coolant Conditioner



IMPORTANT: Check inhibitors between drain intervals every 600 hours or 12 months of operation. Replenish inhibitors by the addition of a supplemental coolant additive as necessary.

DO NOT use soluble oil.

Additives eventually lose their effectiveness and must be recharged with additional supplemental coolant additives available in the form of liquid coolant conditioner. See TESTING DIESEL ENGINE COOLANT and REPLENISHING SUPPLEMENTAL COOLANT ADDITIVES (SCAs) BETWEEN COOLANT CHANGES, as described later in this group.

RG,02,DT7036 -19-29OCT97-3/3

Testing Diesel Engine Coolant

Maintaining adequate concentrations of glycol and inhibiting additives in the coolant is critical to protect the engine and cooling system against freezing, corrosion, and cylinder liner erosion and pitting.

Test the coolant solution at 600 hours or 12 months of operation and whenever excessive coolant is lost through leaks or overheating to ensure the necessary protection.



Coolant test strips are available from your engine servicing dealer. These test strips provide a simple, effective method to check the freeze point and additive levels of your engine coolant.

Compare the results to the supplemental coolant additive (SCA) chart to determine the amount of inhibiting additives in your coolant and whether more John Deere Liquid Coolant Conditioner should be added.

COOLSCANTM

For a more thorough evaluation of your coolant, perform a COOLSCAN™ analysis. See your engine servicing dealer for information about COOLSCAN™.

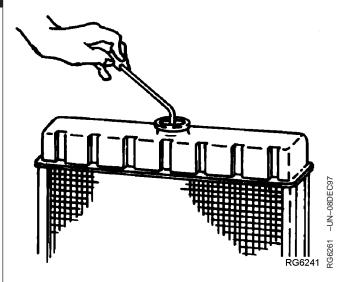




COOLSCAN is a trademark of Deere & Company.

RG,02,JW7722 -19-01DEC97-1/1

Replenishing Supplemental Coolant Additives (SCAs) Between Coolant Changes



IMPORTANT: Do not add supplemental coolant additives when the cooling system is drained and refilled with John Deere ANTIFREEZE/SUMMER COOLANT or John Deere COOL-GARD™.

NOTE: If a system is to be filled with coolant that does not contain SCAs, the coolant must be precharged. Determine the total system capacity and premix with 3% John Deere Coolant Conditioner.

Through time and use, the concentration of coolant additives is gradually depleted during engine operation. Periodic replenishment of inhibitors is required, even when John Deere ANTIFREEZE/SUMMER COOLANT is used. The cooling system must be recharged with additional supplemental coolant additives available in the form of liquid coolant conditioner.



Maintaining the correct coolant conditioner concentration (SCAs) and freeze point is essential in your cooling system to protect against rust, liner pitting and corrosion, and freeze-ups due to incorrect coolant dilution.

John Deere LIQUID COOLANT CONDITIONER is recommended as a supplemental coolant additive in John Deere engines.

Do Not mix one brand of SCA with a different brand.

Test the coolant solution at 600 hours or 12 months of operation using either John Deere coolant test strips or a COOLSCAN™ analysis. If a COOLSCAN™ analysis is not available, recharge system per instructions printed on label of John Deere Liquid Coolant Conditioner.

COOL-GARD is a trademark of Deere & Company. COOLSCAN is a trademark of Deere & Company.

Continued on next page

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IMPORTANT: ALWAYS maintain coolant at correct level and concentration. DO NOT operate engine without coolant for even a few minutes.

> If frequent coolant makeup is required, the glycol concentration should be checked with JT05460 Refractometer to assure that the desired freeze point is maintained. Follow manufacturer's instructions provided with refractometer.

Add the manufacturer's recommended concentration of supplemental coolant additive. DO NOT add more than the recommended amount.

The use of non-recommended supplemental coolant additives may result in additive drop-out and gelation of the coolant.

If other coolants are used, consult the coolant supplier and follow the manufacturer's recommendation for use of supplemental coolant additives.

See ENGINE COOLANT SPECIFICATIONS earlier in this group for proper mixing of coolant ingredients before adding to the cooling system.

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Operating in Warm Temperature Climates

John Deere engines are designed to operate using glycol base engine coolants.

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

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

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

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

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Flush and Service Cooling System



CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns. Shut off engine. Only remove filler cap when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing cap completely.

IMPORTANT: Air must be expelled from cooling system when system is refilled. Follow procedure given in your operator's manual.

> Whenever the aluminum timing gear cover or water pump are replaced, the cooling system should be completely drained. In addition to opening petcock on radiator, remove lower radiator hose when draining cooling system.

The ethylene glycol base (antifreeze) can become depleted of SCAs, allowing various acids to form that will damage engine components. In addition, heavy metals, such as lead, copper and zinc, accumulate in the ethylene glycol base. The heavy metals come from corrosion that occurs to some degree within a cooling system. When a coolant is saturated to the point where it can no longer hold heavy metals and other dissolved solids, they settle out and act as abrasives on engine parts.

NOTE: Refer to your operator's manual for a specific service interval.

Flush cooling system as described in your operator's manual. Clean cooling system with clean water and TY15979 John Deere Heavy-Duty Cooling System Cleaner or an equivalent cleaner such as FLEETGUARD® RESTORE™ or RESTORE PLUS™. Follow the instructions provided with the cleaner. Refill cooling system with the appropriate coolant solution. See ENGINE COOLANT SPECIFICATIONS, earlier in this group.



FLEETGUARD is a registered trademark of the Cummins Engine Company.

RESTORE is a trademark of FLEETGUARD. RESTORE PLUS is a trademark of FLEETGUARD.

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IMPORTANT: NEVER overfill the system. A pressurized system needs space for heat expansion without overflowing at the top of the radiator. Coolant level should be at bottom of radiator filler neck.

> Air must be expelled from cooling system when system is refilled. Loosen plug in side of thermostat housing to allow air to escape when filling system. Retighten plug when all the air has been expelled.

After adding new coolant solution, run engine until it reaches operating temperature. This mixes the coolant solution uniformly and circulates it through the entire system. After running engine, check coolant level and entire cooling system for leaks.

Contact your engine servicing dealer, if there are further questions.

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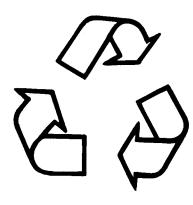
Disposing of Coolant

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

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

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

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



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02

Section 02 **Repair and Adjustments**

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CTM104 (19JUN00)

Engine Overhaul Guidelines

Engine life and performance will vary depending on operating conditions and the level of regular engine maintenance. Engines can be brought back to original performance standards through proper overhaul procedure and replacement of parts with genuine John Deere service parts. Overhauling the engine prior to failure can avoid costly repairs and downtime.

Consider installing a John Deere overhaul kit when:

- The engine begins to experience power loss and there are no known engine component failures.
- The engine is hard to start due to low cranking compression.
- The engine begins to smoke and there are no known engine component failures.
- The engine begins to use oil. Refer to Section 04 for acceptable oil consumption.
- The engine has high usage hours and the owner wants to take preventive measure to avoid high-cost repairs and costly downtime.

John Deere overhaul kits have a 1500-hour or 12-month warranty, whichever comes first. Installation labor is covered by warranty if an authorized John Deere dealer installed the overhaul kit and the replacement parts.

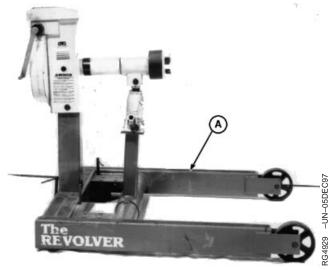
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Engine Repair Stand

NOTE: Only the 2722 kg (6000 lb) heavy duty engine repair stand (A) No. D05223ST manufactured by Owatonna Tool Co., Owatonna, Minnesota, is referenced in this manual. When any other repair stand is used, consult the manufacturer's instructions for mounting the engine.

Refer to machine technical manual for steps to remove engine from machine.

A-Engine Repair Stand



Engine Repair Stand

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Engine Stand Safety Precautions

The engine repair stand should be used only by qualified service technicians familiar with this equipment.

To maintain shear strength specifications, alloy steel Class 12.9 or SAE Grade 8 or higher cap screws must be used to mount adapters and engine to repair stand. Use LOCTITE® 242 Thread Lock and Sealer on cap screws when installing lifting straps on engine. Tighten cap screws to specifications given.

For full thread engagement, be certain that tapped holes in adapters and engine blocks are clean and not damaged. A thread length engagement equal to 1-1/2 screw diameters minimum is required to maintain strength requirements.

To avoid structural or personal injury, do not exceed the maximum capacity rating of 2722 kg (6000 lb). Maximum capacity is determined with the center of the engine located not more than 330 mm (13 in.) from the mounting hub surface of the engine stand.

The center of balance of an engine must be located within 51 mm (2 in.) of the engine stand rotating shaft.

Engine center of balance is generally located a few millimeters above the crankshaft.

To prevent possible personal injury due to engine slippage, recheck to make sure engine is solidly mounted before releasing support from engine lifting device.

Never permit any part of the body to be positioned under a load being lifted or suspended. Accidental slippage may result in personal injury.

The lifting jack is to be used when it is necessary to lift the engine for rotation. When working on the engine, the jack should be at its lowest position to keep the center of gravity and the possibility of tipping low.

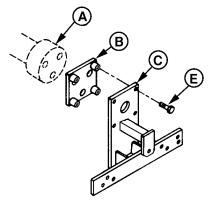
To prevent possible personal injury due to sudden engine movement, lower the engine by operating jack release valve slowly. Do not unscrew release valve knob more than two turns from its closed position.

LOCTITE is a registered trademark of Loctite Corp.

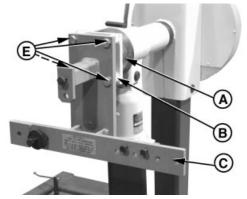
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Install Adapters on Engine Repair Stand

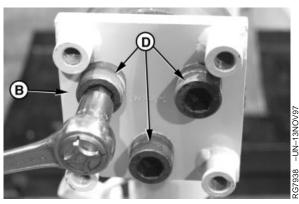
- Attach the D05226ST Special Adapter (B) to mounting hub (A) of the engine repair stand using SAE Grade 8 socket-head screws (D). Tighten screws to 135 N•m (100 lb-ft).
- 2. Attach the 62835¹ Engine Adapter (C) to the special adapter, using four 5/8—11 x 2 in. SAE Grade 8 cap screws (E). Tighten screws to 135 N•m (100 lb-ft).
 - **A**—Mounting Hub
 - B-D05226ST Special Adapter
 - C-62835 Engine Adapter
 - D—Socket Head Cap Screws
 - E—Cap Screws



Engine Repair Stand Adapters



Engine Repair Stand Adapters



Engine Repair Stand Adapters

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¹ Part of JT07268 Engine Adapter Kit

Engine Lifting Procedure



CAUTION: The only recommended method for lifting the engine is with JDG23 Engine Lifting Sling and safety approved lifting straps that come with engine. Use extreme caution when lifting and NEVER permit any part of the body to be positioned under an engine being lifted or suspended.

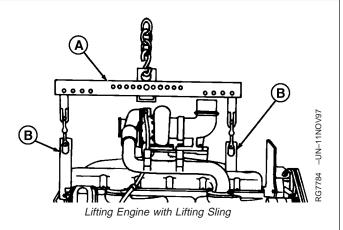
Lift engine with longitudinal loading on lift sling and lifting brackets only. Angular loading greatly reduces lifting capacity of sling and brackets.

 Apply TY9370 LOCTITE® 242 Thread Lock and Sealer to lift strap cap screws. Install lift straps and tighten cap screws to the following specifications.

Specification

NOTE: Lift spacing on sling is adjustable. Position each lifting point so that engine hangs level when lifted.

2. Attach the JDG23 Engine Lifting Sling (A) to engine lifting straps (B) and overhead hoist or floor crane.



A—Lifting Sling B—Lifting Straps

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Continued on next page

RG,03,JW7723 -19-26APR00-1/2

NOTE: If engine lifting straps are misplaced, they should be procured through service parts. Use of an engine lifting sling (as shown) is the ONLY APPROVED method for lifting engine.

IMPORTANT: Lifting straps are designed to lift the engine and small accessories, such as hydraulic pumps and air compressors

mounted to the engine auxiliary gear drive, or belt-driven components, such as air conditioning compressors and alternators. If larger components, such as PTOs, transmissions, generators or air compressors, are attached to other locations on the engine, the lift straps provided with the engine are not intended for this purpose. Technician is responsible for providing adequate lifting devices under these situations.

See machine technical manual for additional information on removing

3. Carefully lift engine and slowly lower to desired location.

engine from machine.

RG,03,JW7723 -19-26APR00-2/2

Clean Engine

- 1. Cap or plug all openings (air intake, exhaust, fuel, coolant, etc.).
- Remove electrical components (starter, alternator, etc.). Cover electrical components that are not removed with plastic and tape securely to prevent moisture damage.
- 3. Thoroughly steam clean engine.

IMPORTANT: Never steam clean or pour cold water on an injection pump while it is still warm. To do so may cause seizure of pump parts.

RG,RG34710,49 -19-13AUG99-1/1

Disconnect Turbocharger Oil Inlet Line

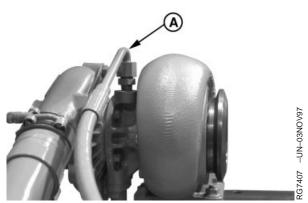
1. Drain all engine oil and coolant, if not previously done.

IMPORTANT: When servicing turbocharged engines on a rollover stand, disconnect turbocharger oil inlet line (A) from oil filter housing or turbocharger before rolling engine over. Failure to do so may cause a hydraulic lock upon starting engine. Hydraulic lock may cause possible engine failure.

> Hydraulic lock occurs when trapped oil in the oil filter housing drains through the turbocharger, the exhaust and intake manifolds, and then into the cylinder head.

After starting the engine, the trapped oil in the manifold and head is released into the cylinder(s), filling them with oil, causing hydraulic lock and possible engine failure.

2. Disconnect turbocharger oil inlet line at turbocharger or oil filter housing.



Turbocharger Oil Inlet Line

A-Oil Inlet Line

RG,01,DT7046 -19-29OCT97-1/1

RG9058 -UN-16MAR98

Mount Engine on Repair Stand



CAUTION: NEVER remove the overhead lifting equipment until the engine is securely mounted onto the repair stand and all mounting hardware is tightened to specified torque. Always release the overhead lifting equipment slowly.

On engines equipped with a low-profile turbocharger, remove turbocharger before attaching engine to repair stand.

On engines with a left-hand oil fill tube, remove tube before mounting engine to repair stand.

NOTE: See next module for illustration of an engine that has been mounted on repair stand.

Mount the engine to 62835¹ Engine Adapter as described below. A label (H) is affixed to the engine adapter for aid in explaining spacer used for each engine model.

NOTE: No. 221668¹ Spacer (G) is used on the outside of the engine adapter for the 4045 Engines and on the inside (next to engine) on 6068 Engines.

4045 Engines

Hole A—(2) No. 2144901 (M12 x 1.75 x 35 mm)

Hole B—(1) No. 2216641 (M14 x 2.00 x 35 mm)

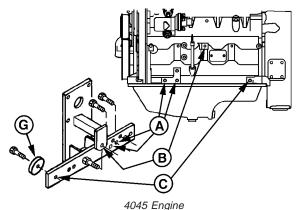
Hole C—(1) No. 221665^1 (M14 x 2.00 x 60 mm) with No. 221668^1 Spacer

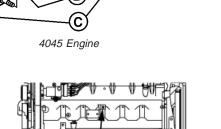
6068 Engines

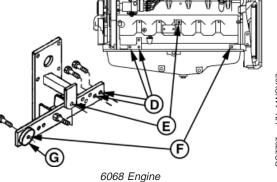
Hole D—(2) No. 214490¹ (M12 x 1.75 x 35 mm)

Hole E—(1) No. 221664¹ (M14 x 2.00 x 35 mm)

Hole F—(1) No. 221665^{1} (M14 x 2.00 x 60 mm) with No. 221668^{1} Spacer









Engine Mounting Label

G—Spacer H—Label

¹ Part of JT07268 Engine Adapter Kit

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RG,03,JW7724 -19-18MAY00-1/2

NOTE: Four threaded holes in engine mounting adapter are for storing mounting hardware.

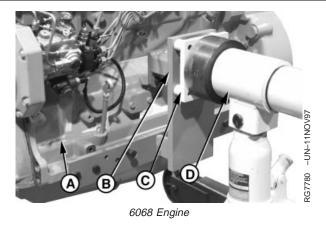
Specification

| Engine Repair Stand M12 Cap | 140 N•m (105 lb-ft) |
|-----------------------------|---------------------|
| Screws Torque | |
| Engine Repair Stand M14 Cap | 225 Nem (165 lb-ft) |
| Screws Torque | |

RG,03,JW7724 -19-18MAY00-2/2

Engine Mounted on Repair Stand

- A—Engine
- B-62835 Engine Adapter
- C—D05226ST Special Adapter
- D-Engine Repair Stand



RG,03,DT7334 -19-11NOV97-1/1

Engine Disassembly Sequence

The following sequence is suggested when complete disassembly for overhaul is required. Refer to the appropriate repair group for removal, inspection and repair of individual engine components.

- Mount engine on a safety approved repair stand. (See MOUNT ENGINE ON REPAIR STAND in this group.)
- Drain coolant and oil. Perform John Deere OILSCAN Plus[®] and COOLSCAN Plus[™] analysis. (See OILSCAN Plus[®] and COOLSCAN Plus[™] in Section 01, Group 002.)
- 3. Remove fan belts, fan, and belt tensioner. (See REMOVE AND INSTALL AUTOMATIC SPRING BELT TENSIONER in Group 070.)
- 4. Remove alternator. (See REMOVE AND INSTALL ALTERNATOR in Group 100.)
- Remove turbocharger (if equipped). (See REMOVE TURBOCHARGER in Group 080.) Remove exhaust manifold. (See REMOVE, INSPECT AND INSTALL EXHAUST MANIFOLD in Group 080.)
- Remove rocker arm cover and vent tube. If option code label is located on rocker arm cover, be careful not to damage label. (See REMOVE CYLINDER HEAD in Group 020.)
- On applications where the water manifold is not an integral part of cylinder head, remove water manifold or thermostat housing. (See REMOVE AND INSTALL WATER MANIFOLD/THERMOSTAT COVER AND THERMOSTAT in Group 070.)
- 8. Remove oil cooler piping and water pump. (See REMOVE WATER PUMP in Group 070.)
- Remove dipstick, oil filter, oil cooler, and adapter housing (if equipped). (See REMOVE, INSPECT AND INSTALL OIL COOLER in Group 060.)

- Remove oil pressure regulating valve assembly. (See REMOVE AND INSTALL OIL PRESSURE REGULATING VALVE AND SEAT in Group 060.)
- 11. Remove fuel filter. See REMOVE AND INSTALL FINAL FUEL FILTER AND/OR PRIMARY FUEL FILTER/WATER SEPARATOR BASE in Section 02, Group 090 of CTM207 (Mechanical Fuel Systems) or CTM170 (Electronic Fuel Systems). Remove fuel supply pump. See REMOVE FUEL SUPPLY PUMP in Section 02, Group 090 of CTM207 (Mechanical Fuel Systems) or CTM170 (Electronic Fuel Systems). Remove fuel lines.
- Remove injection lines and injection pump. Remove injection nozzles. See REMOVE FUEL INJECTION NOZZLES in Section 02, Group 090 of CTM207 (Mechanical Fuel Systems) or CTM170 (Electronic Fuel Systems).
- 13. Remove starter motor. (See REMOVE AND INSTALL STARTER in Group 100.)
- 14. Remove rocker arm assembly and push rods. Keep rods in order. (See REMOVE CYLINDER HEAD in Group 020.) Check for bent push rods and condition of wear pad contact surfaces on rockers.
- Remove cylinder head. (See REMOVE CYLINDER HEAD in Group 020.) Check piston protrusion. (See MEASURE PISTON PROTRUSION in Group 030.)
- Remove camshaft followers. Keep followers in order. (See INSPECT CAMSHAFT FOLLOWERS in Group 050.)
- Remove flywheel. (See REMOVE FLYWHEEL in Group 040.) Remove flywheel housing. (See REMOVE FLYWHEEL HOUSING in Group 040.)
- 18. Remove oil pan.

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RG,04,JW7725 -19-19NOV99-1/2

- Remove crankshaft pulley. (See REMOVE PULLEY OR VIBRATION DAMPER AND PULLEY in Group 040.)
- 20. Remove timing gear cover. (See REMOVE TIMING GEAR COVER in Group 050.)
- 21. Remove oil pump drive gear, outlet tube, and pump body. (See REMOVE ENGINE OIL PUMP in Group 060.)
- Remove timing gears and camshaft. Perform wear checks. (See REMOVE CAMSHAFT in Group 050.)
- 23. Remove balancer shafts (4045 engines). (See REMOVE BALANCER SHAFTS in Group 050.)
- 24. Remove engine front plate. (See REMOVE CYLINDER BLOCK FRONT PLATE in Group 050.)
- Remove oil bypass valve. (See REMOVE, INSPECT AND INSTALL OIL BYPASS VALVE in Group 060.)
- 26. Stamp cylinder number on connecting rod. Remove pistons and rods. Perform wear checks

- with PLASTIGAGE®. (See INSPECT AND MEASURE CONNECTING ROD BEARINGS in Group 030.)
- 27. Remove crankshaft and main bearings. Perform wear checks with PLASTIGAGE®. (See REMOVE CRANKSHAFT in Group 040.)
- 28. Remove cylinder liners and mark each one with cylinder number. (See REMOVE CYLINDER LINERS in Group 030.)
- Remove piston cooling orifices. (See REMOVE, INSPECT AND INSTALL PISTON COOLING ORIFICES in Group 030.)
- 30. Remove balancer shaft bushings (4045 engines) and camshaft bushing.
- 31. Remove cylinder block plugs and serial number plate when block is to be put in a "hot tank".
- 32. Clean upper and lower liner bores with nylon brush. (See CLEAN CYLINDER LINERS in Group 030.)
- 33. Measure cylinder block. (Groups 030, 040 and 050.)

PLASTIGAGE is a registered trademark of the DANA Corp.

RG,04,JW7725 -19-19NOV99-2/2

02 010 11

Sealant Application Guidelines

Listed below are sealants which have been tested and are used by the John Deere factory to control leakage and ensure hardware retention. ALWAYS use the following recommended sealants when assembling your John Deere Engine to ensure quality performance.

LOCTITE® thread sealants are designed to perform to sealing standards with machine oil residue present. If excessive machine oil or poor cleanliness quality exist, clean with solvent. Refer to John Deere Merchandise and Parts Sales Manual for ordering information.

IMPORTANT: LOCTITE® gasket materials are NOT designed to work with oil residue present. Oil residues must be cleaned from surfaces before applying gasket material.

LOCTITE® 242—Thread Lock and Sealer (Medium Strength) (blue):

TY9370, 6 ml tube/T43512, 50 ml tube

- Plugs and fittings: fuel filter base, fuel transfer pump, and oil filter base housing, cylinder block oil galleries.
- Cap screws: injection pump access cover, electronic tachometer cover, oil filler inlet, flywheel, fuel transfer pump, oil cooler housing-to-cylinder block (open holes only) and timing hole cover.
- Oil pressure sending unit.

LOCTITE® 271—Thread Lock and Sealer (High Strength) (clear):

TY9371, 6 ml tube/T43513, 50 ml bottle

• Studs: water pump-to-cylinder block, injection pump-to-front plate.

- Oil filter nipple.
- Oil dipstick tube and fitting.

LOCTITE® 277—Rigid Form-In-Place Gasket (High Strength) (red):

T43514, 50 ml bottle

- Steel cap plugs: cylinder block and cylinder head.
- O-ring adapter for oil pump outlet tube.
- Nipples and elbows which are pressed into place, water pump housing, and oil cooler cover.
- Torque converter access hole plug.

LOCTITE® 515—Flexible Form-In-Place Gasket (General Purpose) (purple):

TY6304, 50 ml bottle

- Flywheel housing-to-cylinder block.
- Flywheel housing-to-oil pan.
- Front and rear face of cylinder block.
- Front plate/timing gear cover-to-oil pan.

LOCTITE® 592—Pipe Sealant with TEFLON® (white):

TY9374, 6 ml tube/TY9375, 50 ml tube

- Pipe plugs: cylinder block (water manifold), thermostat housing, water pump, flywheel housing (drain).
- Injection pump governor cover fitting (fuel return).
- Temperature sending unit.
- Oil pan (drain hose, drain valve, and elbow drain fitting).
- Connectors: turbo line, turbo drain, and water return-to-cylinder block.
- Adapter fitting and plug for turbo lube on dual oil filter base.
- · Air heater.

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Engine Rebuild

010

LOCTITE® 680 Maximum Strength Retaining Compound:

- Crankshaft wear sleeve.
- · Camshaft nose.

RTV Silicone Sealant Form-In-Place Gasket (Clear):1

TY16021, 1.7 oz. tube

NEVER-SEEZ is a registered trademark of the Emhart Chemical Group.

¹ Use DD15664 LOCTITE 515 Flexible Sealant when servicing an engine within the European Market/Service Area. Follow manufacturer's directions on package when using and storing sealant.

Injection pump timing gear cover ONLY when traditional gasket is not available.

PT569 NEVER-SEEZ® Compound:

PT569, 227 g brush/PT506, 453 g spray

Cap screws: exhaust manifold and turbine housing-to-center housing.

RG,04,JW7726 -19-30NOV99-2/2

Engine Assembly Sequence

The following assembly sequence is suggested when engine has been completely disassembled. Be sure to check run-out specifications, clearance tolerances, torques, etc., as engine is assembled. Refer to the appropriate repair group when assembling engine components.

- Install all plugs and serial number plate in cylinder block (if removed). (See INSPECT AND CLEAN CYLINDER BLOCK in Group 030.)
- Install piston cooling orifices. (See REMOVE, INSPECT AND INSTALL PISTON COOLING ORIFICES in Group 030.)
- 3. Install new balancer shaft bushings (4045 engines) and a new camshaft bushing.
- Install cylinder liners without O-rings. Measure liner height. Install liners with O-rings. (See INSTALL CYLINDER LINER IN BLOCK in Group 030.)
- Install main bearings and crankshaft.
 PLASTIGAGE® bearings. (See INSTALL CRANKSHAFT in Group 040.)
- Install flywheel housing. (See INSTALL FLYWHEEL HOUSING in Group 040.) Install rear oil seal. (See INSTALL CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE in Group 040.) Install flywheel. (See INSTALL FLYWHEEL in Group 040.)
- 7. Install pistons and rods. Measure piston protrusion. (See INSTALL PISTON AND CONNECTING ROD ASSEMBLY in Group 030.)
- 8. Install oil bypass valve. (See REMOVE, INSPECT AND INSTALL OIL BYPASS VALVE in Group 060.)
- 9. Install front plate. (See INSTALL CYLINDER BLOCK FRONT PLATE in Group 050.)

- Install balancer shafts (4045 engines). Check end play. (See INSTALL AND TIME BALANCER SHAFTS in Group 050.)
- 11. Install oil outlet tube, O-ring in block, and oil pump. (See INSTALL ENGINE OIL PUMP in Group 060.)
- Install injection pump. See Section 02, Group 090 of CTM207 (Mechanical Fuel Systems) or CTM170 (Electronic Fuel Systems).
- 13. Install camshaft and timing gears. (See INSTALL CAMSHAFT in Group 050.) Time all gears with No. 1 cylinder at TDC compression stroke.
- 14. Install timing gear cover. (See INSTALL TIMING GEAR COVER in Group 050.) Install new front seal. (See REPLACE FRONT CRANKSHAFT OIL SEAL AND WEAR SLEEVE in Group 040.)
- 15. Install oil pan. (See INSTALL OIL PAN in Group 060.)
- Install oil pressure regulating valve. (See REMOVE AND INSTALL OIL PRESSURE REGULATING VALVE AND SEAT in Group 060.)
- Install camshaft followers in same order as removed.
- Install cylinder head gasket and cylinder head. (See INSTALL CYLINDER HEAD in Group 020.) Install push rods and rocker arm assembly. (See INSTALL ROCKER ARM ASSEMBLY in Group 020.)
- Install starter motor. (See REMOVE AND INSTALL STARTER in Group 100.)

- Install injection nozzles (with new seals) and injection lines. See INSTALL FUEL INJECTION NOZZLES in Section 02, Group 090 of CTM207 (Mechanical Fuel Systems) or CTM170 (Electronic Fuel Systems).
- 21. Install fuel filter. See REMOVE AND INSTALL FINAL FUEL FILTER AND/OR PRIMARY FUEL FILTER/WATER SEPARATOR BASE in Section 02, Group 090 of CTM207 (Mechanical Fuel Systems) or CTM170 (Electronic Fuel Systems). Install fuel supply pump, and fuel lines. See INSTALL FUEL SUPPLY PUMP in Section 02, Group 090 of CTM207 (Mechanical Fuel Systems) or CTM170 (Electronic Fuel Systems).
- 22. Install oil cooler, new oil filter, and dipstick. (See REMOVE, INSPECT AND INSTALL OIL COOLER in Group 060.)
- 23. Install water manifold or thermostat housing and thermostats. (See REMOVE AND INSTALL WATER MANIFOLD/THERMOSTAT COVER AND THERMOSTAT in Group 070.)
- 24. Install exhaust manifold. (See REMOVE, INSPECT AND INSTALL EXHAUST MANIFOLD in Group 080.) Install turbocharger. Prelube the turbocharger. (See INSTALL TURBOCHARGER in Group 080.)

- 25. Install water pump and hoses. (See INSTALL WATER PUMP in Group 070.)
- Install crankshaft pulley or vibration damper (use new damper). (See INSTALL PULLEY OR VIBRATION DAMPER AND PULLEY in Group 040.)
- 27. Install alternator. (See REMOVE AND INSTALL ALTERNATOR in Group 100.)
- 28. Install belt tensioner, fan, and fan belts. (See REMOVE AND INSTALL AUTOMATIC BELT TENSIONER in Group 070.)
- Adjust valves. (See CHECK AND ADJUST VALVE CLEARANCE in Group 020.) Install rocker arm cover. (See INSTALL ROCKER ARM COVER in Group 020.)
- 30. Install vent tube.
- 31. Fill engine with clean oil. (Section 01, Group 002.)
- 32. Flush cooling system and refill with proper coolant. (Section 01, Group 002.)
- 33. Perform engine break-in and standard performance checks. (See PERFORM ENGINE BREAK-IN in this group.)

RG,04,DT7335 -19-11NOV97-2/2

Engine Break-In Guidelines

Engine break-in should be performed after overhaul or when the following repairs have been made:

- Main bearings, rod bearings, crankshaft, or any combination of these parts have been replaced.
- Pistons, rings, or liners have been replaced.
- Rear crankshaft oil seal and wear sleeve have been replaced. (Primary objective is to see if oil seal still leaks.)
- Cylinder head has been removed.
- Injection pump has been removed or critical adjustments have been made while it is on the engine. (Primary objective is to check power.)

RG,RG34710,1053 -19-03NOV99-1/1

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Perform Engine Break-In

IMPORTANT: If engine has a PTO, break-in can be performed at the PTO if it is done as specified below. To prevent possible damage to the PTO gearbox, DO NOT apply full load through the PTO for any longer than the specified 10 minutes below.

Use a dynamometer to perform the following preliminary break-in procedure. If necessary, preliminary engine break-in can be performed without a dynamometer if under controlled operating conditions.

IMPORTANT: DO NOT use John Deere PLUS-50 oil or engine oils meeting API CG4, API CF4, ACEA E3 or ACEA E2, performance levels during break-in period of an engine that has had a major overhaul. These oils will not allow an overhauled engine to properly wear during the break-in period.

> Do not add makeup oil until the oil level is BELOW the add mark. John Deere Engine Break-In Oil should be used to make up any oil consumed during break-in period.

DO NOT fill above the crosshatch pattern or FULL mark. Oil levels anywhere within the crosshatch are acceptable.

1. Fill engine crankcase to proper level with John Deere Engine Break-In Oil during break-in operation. Use break-in oil regardless of ambient temperature. This oil is specifically formulated to enhance break-in of John Deere diesel engines. Under normal conditions, do not exceed 100 hours with break-in oil.

If John Deere Engine Break-In Oil is not available, use diesel engine oil meeting API Service Classification CE or ACEA Specification E1.

IMPORTANT: During preliminary break-in, periodically check engine oil pressure and coolant temperature. Also check for signs of fuel, oil, or coolant leaks.

> Do not run engine at full load for more than 10 minutes at one time.

2. Start engine, run at loads and speeds shown in following chart for time limits given.

PRELIMINARY ENGINE BREAK-IN AFTER MAJOR OVERHAUL

| Load | Engine Speed |
|--------------|------------------------------------|
| No load | 850 rpm |
| No load | Fast Idle |
| 1/2-3/4 load | 2000 rpm to rated |
| | speed |
| Full load | Rated speed |
| | No load No load 1/2—3/4 load |

- 3. After preliminary break-in, run engine 1—2 minutes at 1500 rpm, with no load before shut-down.
- 4. Check and readjust valve clearance as necessary. Cylinder head retorque is not required.

NOTE: During the first 20 hours, avoid prolonged periods of engine idling or sustained maximum load operation. If engine will idle longer than 5 minutes, stop engine.

5. Operate the engine at heavy loads with minimal idling during the break-in period.

If the engine has significant operating time at idle, constant speeds, and/or light load usage, an additional 100 hour break-in period is recommended using a new change of John Deere Engine Break-In Oil and new John Deere oil filter.

Engine Rebuild

Check engine oil level more frequently during engine break-in period. As a general rule, makeup oil should not need to be added during 100-hour break-in period. However, if makeup oil is required in the first 100-hour break-in, an additional 100-hour break-in period is required. Use a new change of John Deere Engine Break-In Oil and a new John Deere oil filter.

After 100 hours maximum, drain break-in oil and change oil filter. Fill crankcase with John Deere TORQ-GARD SUPREME® or PLUS-50® or other

heavy-duty diesel engine oil within the same service classification as recommended in this manual. See DIESEL ENGINE OIL in Section 01, Group 002, Fuels, Lubricants, and Coolants.

NOTE: Some increase in oil consumption may be expected when low viscosity oils are used. Check oil levels more frequently.

If air temperature is below —10°C (14°F), use an engine block heater.

RG,100,JW7645 -19-05NOV99-2/2

TORQ-GARD SUPREME is a registered trademark of Deere & Company.

PLUS-50 is a registered trademark of Deere & Company.

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3G7408 -UN-06AUG96

Check and Adjust Valve Clearance



CAUTION: To prevent accidental starting of engine while performing valve adjustments, always disconnect NEGATIVE (—) battery terminal.

IMPORTANT: Valve clearance MUST BE checked and adjusted with engine COLD.

 Remove rocker arm cover and crankcase ventilator tube.

IMPORTANT: Visually inspect contact surfaces of valve tips and rocker arm wear pads.

Check all parts for excessive wear, breakage, or cracks. Replace parts that show visible damage.

Rocker arms that exhibit excessive valve clearance should be inspected more thoroughly to identify damaged parts.

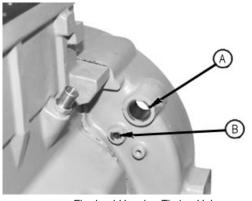
2. Remove plastic plugs or cover plate from engine timing/rotation hole (A) and timing pin hole (B).

NOTE: Some engines are equipped with flywheel housings which do not allow use of an engine flywheel rotation tool. These engines may be rotated from front nose of engine, using JDG966 Crankshaft Front/Rear Rotation Adapter.

3. Using JDE83 or JDG820 Flywheel Turning Tool, rotate engine flywheel in running direction (clockwise viewed from front) until No. 1 cylinder is at TDC compression stroke. Insert JDE81-4 Timing Pin in flywheel.

If No.1 cylinder rocker arms are loose, the engine is at No. 1 TDC compression.

If No. 1 cylinder rocker arms are not loose, rotate engine one full revolution (360°) to No. 1 TDC compression.



Flywheel Housing Timing Holes

A—Timing/Rotation Hole B—Timing Pin Hole

Continued on next page

RG,05,DT7375 -19-11NOV97-1/5

 With engine lock-pinned at TDC of No. 1 piston's compression stroke, check valve clearance to following specifications. (Use sequence for 4-cylinder or 6-cylinder engines as outlined on next page.)

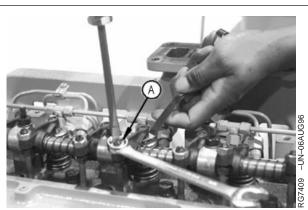
Specification

| Intake Valve Clearance Checking | 0.31—0.38 mm |
|---------------------------------|-------------------|
| (Rocker Arm-to-Valve Tip) | (0.012—0.015 in.) |
| (Engine Cold) Clearance | |
| Exhaust Valve Clearance | 0.41—0.48 mm |
| Checking (Rocker Arm-to-Valve | (0.016—0.019 in.) |
| Tip) (Engine Cold) Clearance | |

RG,05,DT7375 -19-11NOV97-2/5

5. If valves need adjusting, use the appropriate valve clearance adjustment procedure on the next page and adjust to specifications below. Loosen the jam nut (A) on rocker arm adjusting screw. Turn adjusting screw until feeler gauge slips with a slight drag. Hold the adjusting screw from turning with screwdriver and tighten jam nut to specifications. Recheck clearance again after tightening jam nut. Readjust clearance as necessary.

Specification



Adjusting Valves

A—Adjusting Screw Jam Nut

Specification

6. Replace rocker arm cover and crankcase ventilator tube.

Continued on next page

RG,05,DT7375 -19-11NOV97-3/5

4-Cylinder Engine:

NOTE: Firing order is 1-3-4-2.

- 1. Using JDE81-4 Timing Pin, lock No. 1 piston at TDC compression stroke (B).
- 2. Adjust valve clearance on No. 1 and 3 exhaust valves and No. 1 and 2 intake valves.
- 3. Turn crankshaft 360°. Lock No. 4 piston at TDC compression stroke (C).
- 4. Adjust valve clearance on No. 2 and 4 exhaust valves and No. 3 and 4 intake valves.

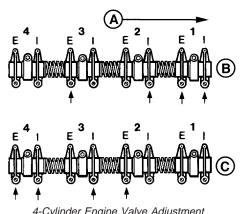
A-Front of Engine

B-No. 1 Piston TDC Compression

C—No. 4 Piston TDC Compression

E-Exhaust Valve

I-Intake Valve



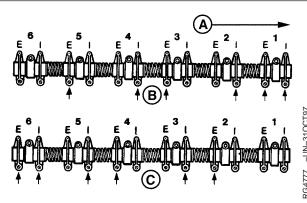
4-Cylinder Engine Valve Adjustment

RG,05,DT7375 -19-11NOV97-4/5

6-Cylinder Engine:

NOTE: Firing order is 1-5-3-6-2-4.

- 1. Lock No. 1 piston at TDC compression stroke (B).
- 2. Adjust valve clearance on No. 1, 3 and 5 exhaust valves and No. 1, 2, and 4 intake valves.
- 3. Turn crankshaft 360°. Lock No. 6 piston at TDC compression stroke (C).
- 4. Adjust valve clearance on No. 2, 4 and 6 exhaust valves and No. 3, 5, and 6 intake valves.



6-Cylinder Engine Valve Adjustment

A-Front of Engine

B—No. 1 Piston TDC Compression

C-No. 6 Piston TDC Compression

E-Exhaust Valve

I-Intake Valve

RG,05,DT7375 -19-11NOV97-5/5

Measure Valve Lift

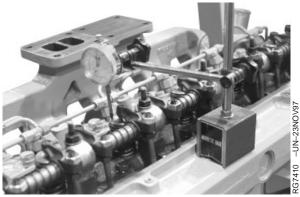
IMPORTANT: For a more accurate measurement, measure valve lift at 0.00 mm (0.00 in.) rocker arm-to-valve tip clearance and with engine COLD.

NOTE: Measuring valve lift provides an indication of wear on camshaft lobes and camshaft followers or push rods.

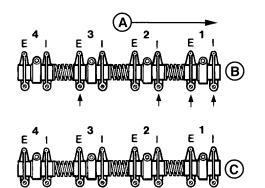
- 1. Remove rocker arm cover.
- 2. Set No. 1 piston at TDC compression stroke and install JDE81-4 Timing Pin in flywheel.
- 3. Set rocker arm-to-valve tip clearance to 0.00 mm (0.00 in.) for:
 - No. 1 and 3 exhaust and No. 1 and 2 intake valves on 4-cylinder engines.
 - No. 1, 3, and 5 exhaust and No. 1, 2, and 4 intake valves on 6-cylinder engines.
- Place dial indicator tip on top of valve spring cap (retainer) or rotator. Preload indicator tip and set dial at 0.0 mm (0.0 in.).
- 5. Remove timing pin from flywheel and manually rotate engine one full revolution (360°) in running direction using appropriate flywheel turning tool.
- Observe dial indicator reading as valve is moved to full open. Record maximum reading and compare with specifications given below.

| Specification | | |
|---------------------|----------------------|--|
| Intake Valves Lift | 11.77—12.21 mm | |
| | (0.463—0.481 in.) | |
| Wear Limit | 11.34 mm (0.447 in.) | |
| Exhaust Valves Lift | 11.51—11.94 mm | |
| | (0.453—0.470 in.) | |
| Wear Limit | 11.08 mm (0.436 in.) | |

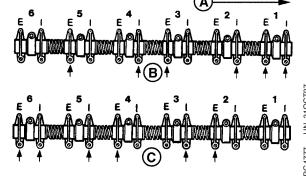
7. Follow same procedure for all remaining valves and record readings.



Measuring Valve Lift



4-Cylinder Engine



6-Cylinder Engine

- A—Front of Engine
- B—No. 1 Piston TDC Compression
- C—No. 4 Piston or No. 6 Piston TDC Compression
- E-Exhaust Valve
- I-Intake Valve

Continued on next page

RG,05,DT7374 -19-11NOV97-1/2

PN=72

If valve lift on all valves is within specifications, adjust valve lash to specified clearance. (See CHECK AND ADJUST VALVE CLEARANCE earlier in this group.)

If valve lift on one or more valves is not within specification, remove and inspect entire valve train and camshaft.

- 8. Rotate engine one full revolution (360°). Lock engine at:
 - TDC No. 4 compression stroke for 4-cylinder engines.
 - TDC No. 6 compression stroke for 6-cylinder engines.
- 9. Set rocker arm-to-valve tip clearance to 0.0 mm (0.0 in.) for:
 - No. 2 and 4 exhaust and No. 3 and 4 intake valves on 4-cylinder engines.
 - No. 2, 4, and 6 exhaust and No. 3, 5, and 6 intake valves on 6-cylinder engines.
- 10. Repeat steps 4—7.

RG,05,DT7374 -19-11NOV97-2/2

02 020 5

Remove Cylinder Head

In some applications, it may be necessary to remove engine from machine to service cylinder head. Refer to your Machine Technical Manual for engine removal procedure.



CAUTION: After operating engine, allow exhaust system to cool before working on engine.

Do NOT drain coolant until the coolant temperature is below operating temperature. Remove radiator filler cap only when the cap is cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing completely.

1. Drain engine oil and coolant.

NOTE: On engines equipped with a low-profile turbocharger, remove turbocharger before attaching engine to repair stand.

2. Remove air inlet elbow. (See REMOVE AND INSTALL AIR INTAKE PIPE in Group 080.)

Continued on next page

RG,05,DT7373 -19-11NOV97-1/12

02 020 7

NOTE: Turbocharger and exhaust elbow may be removed from engine while assembled to exhaust manifold, if desired.

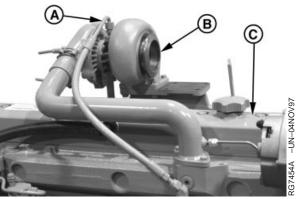
 On turbocharged engines, disconnect turbocharger oil inlet line (A) at turbocharger (B). Remove turbocharger and exhaust elbow (shown removed). (See REMOVE TURBOCHARGER in Group 080.)

IMPORTANT: Rocker arm cover sealing ring (D) can be reused if there is no evidence of physical damage. Remove sealing ring from groove for replacement only.

4. Remove hex nuts and O-rings from rocker arm cover (C).

Lift off cover. Save O-rings for reassembly or replace as necessary.

- A-Turbocharger Oil Inlet Line
- **B**—Turbocharger
- C—Rocker Arm Cover
- D—Rocker Arm Cover Sealing Ring



Turbocharger and Rocker Arm Cover



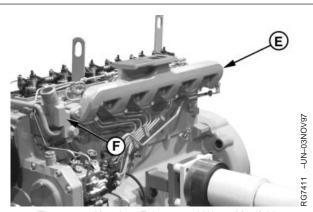
Rocker Arm Cover Sealing Ring

RG,05,DT7373 -19-11NOV97-2/12

5. Using guide studs, remove exhaust manifold (E).

NOTE: On some engines, the thermostat housing/water manifold (F) is part of the cylinder head.

- 6. Remove thermostat housing/water manifold (F).
 - E—Exhaust Manifold
 - F—Thermostat Housing/Water Manifold



Thermostat Housing, Exhaust and Water Manifold

Continued on next page

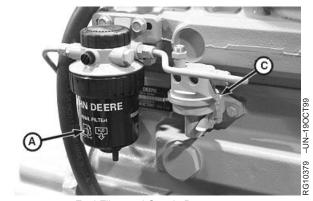
RG,05,DT7373 -19-11NOV97-3/12

NOTE: Position of fuel filters (A) and (B) and supply pump (C) vary by engine and injection pump applications. See Section 02, Group 090 of CTM207 (Mechanical Fuel Systems) or CTM170 (Electronic Fuel Systems) for procedures to remove filter(s) and/or supply pump as required.

- 7. Disconnect fuel lines and remove fuel filter(s) (A) and (B) and mounting brackets as required.
- 8. Remove fuel supply pump (C), if equipped. Inspect face of pump lever for wear. If worn flat or concave, replace supply pump.
- Remove alternator, if desired. (See REMOVE AND INSTALL ALTERNATOR in Group 100.)
 - A-Final Fuel Filter
 - **B—Primary Fuel Filter/Water Separator**
 - C-Fuel Supply Pump



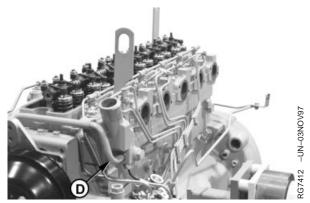
Fuel Filters



Fuel Filter and Supply Pump

RG,05,DT7373 -19-11NOV97-4/12

- 10. Remove thermostat housing-to-water pump tube (D).
 - D—Thermostat Housing-to-Water Pump Tube

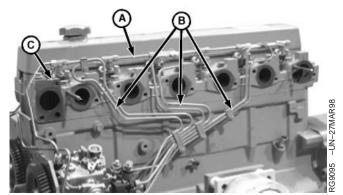


Thermostat Housing-to-Water Pump Tube

Continued on next page

RG,05,DT7373 -19-11NOV97-5/12

- Remove fuel leakoff line (A) and fuel delivery lines (B) as an assembly. Remove fuel injection nozzles (C).
 See REMOVE FUEL INJECTION NOZZLES in Section 02, Group 090 of CTM207 (Mechanical Fuel Systems) or CTM170 (Electronic Fuel Systems).
 - A-Fuel Leakoff Line
 - **B**—Fuel Delivery Lines
 - **C—Injection Nozzles**

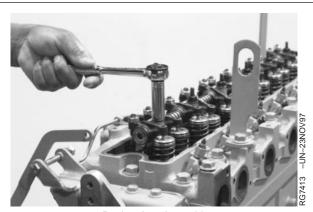


Fuel Lines and Injection Nozzles

RG,05,DT7373 -19-11NOV97-6/12

NOTE: Loosen all rocker arm adjusting screws prior to removing assembly.

12. Remove rocker arm assembly.



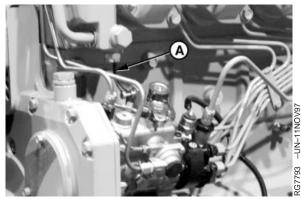
Rocker Arm Assembly

Continued on next page

RG,05,DT7373 -19-11NOV97-7/12

13. Disconnect coolant temperature connector (A) from injection pump wiring harness.

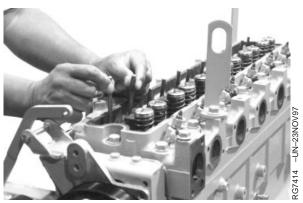
A—Coolant Temperature Connector



Coolant Temperature Connector

RG,05,DT7373 -19-11NOV97-8/12

14. Remove all push rods and identify for reassembly in the same location. Clean and inspect push rods.



Valve Push Rods

Continued on next page

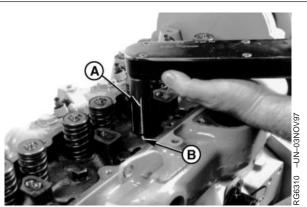
RG,05,DT7373 -19-11NOV97-9/12

02 020 11

15. If a cylinder head gasket failure has occurred, check and record torque on each cylinder head cap screw before removing.

To check cylinder head cap screw torque:

- a. Make a reference mark (in-line) on socket (A) and cylinder head surface (B).
- b. Loosen cap screw at least 1/2 turn.
- c. Retighten cap screw (using a torque wrench) until reference marks align and record torque.
- 16. Remove all cylinder head cap screws.



Cylinder Head Cap Screws

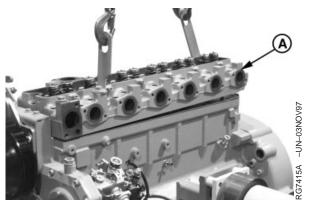
A—Mark on Socket B—Mark on Head Surface

RG,05,DT7373 -19-11NOV97-10/12

IMPORTANT: DO NOT use screwdrivers or pry bars between cylinder block and head to loosen head gasket seal. Screwdrivers or pry bars can damage cylinder head and block gasket surfaces.

17. Lift cylinder head (A) from block. If cylinder head sticks, use a soft hammer to tap cylinder head.

A—Cylinder Head



Cylinder Head

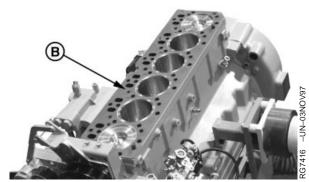
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RG,05,DT7373 -19-11NOV97-11/12

 Remove cylinder head gasket (B). Inspect for possible oil, coolant, or combustion chamber leaks. Also, check for evidence of incorrect head gasket being used.

NOTE: Do not rotate crankshaft with cylinder head removed unless cylinder liners are secured with cap screws and large flat washers. (See MEASURE CYLINDER LINER STANDOUT [HEIGHT ABOVE BLOCK], later in this group.)

B—Head Gasket



Cylinder Head Gasket

RG,05,DT7373 -19-11NOV97-12/12

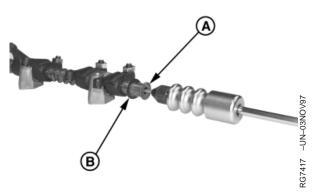
Disassemble and Inspect Rocker Arm Shaft **Assembly**

- 1. Remove plugs (A) and bowed washers (B) from rocker arm shaft.
- 2. Disassemble and inspect all parts for wear or damage. Replace any parts that are damaged or not within specifications.

Rocker Arm Assembly—Specification

A—Plug B-Washer

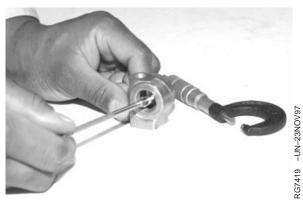
CTM104 (19JUN00)



Rocker Arm Shaft



Rocker Arm Shaft OD



Rocker Shaft Support ID



Rocker Arm Bore ID

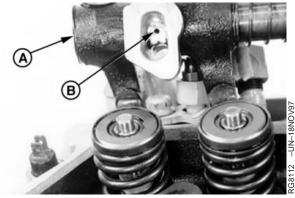
RG,05,DT7372 -19-11NOV97-1/1

Assemble Rocker Arm Assembly

1. Lubricate shaft OD, rocker arm bores, and rocker arm supports with clean engine oil.

IMPORTANT: The oil supply hole (B) on the rocker arm shaft must be toward the flywheel end of the engine.

- 2. Assemble springs, rocker arms, and rocker arm supports onto shaft in the same location as removed from.
- 3. Install bowed washers and new end plugs (A) firmly in end of shaft.



Rocker Arm Oil Supply Hole and Plugs

A—End Plugs B—Oil Supply Hole

RG,05,DT7371 -19-11NOV97-1/1

Inspect, Measure, and Install Fuel Supply Pump Push Rod—If Applicable

1. Remove and clean push rod (A). Label end(s) for reassembly in same orientation.

A-Push Rod



Fuel Supply Pump Push Rod

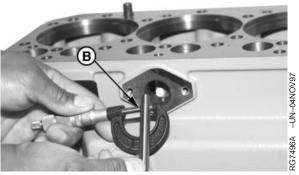
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RG,05,DT7370 -19-11NOV97-1/4

2. Measure push rod OD (B). If OD is less than specification, install a new push rod.

Specification

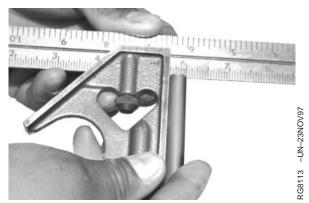
B-Push Rod OD



Push Rod OD Wear

RG,05,DT7370 -19-11NOV97-2/4

 Check crown on push rod ends. If flat or concave, replace push rod and check camshaft lobe for wear. (See MEASURE CAMSHAFT LOBE HEIGHT in Group 050.)



Push Rod and Crown Wear

Continued on next page

RG,05,DT7370 -19-11NOV97-3/4

4. Measure push rod bore ID (C) in block.

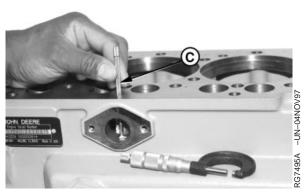
Specification

Bore in Block ID (0.3937—0.3957 in.)

Repair or replace block as necessary.

5. Lubricate push rod with clean engine oil and install in bore with same end orientation as removed.

C-Bore ID



Push Rod Bore in Block Wear

RG,05,DT7370 -19-11NOV97-4/4

Inspect, Measure, and Assemble Camshaft **Followers**

1. Remove and clean camshaft followers. Label for reassembly in same location.



Camshaft Followers

Continued on next page

RG,05,DT7369 -19-11NOV97-1/3

2. Measure camshaft follower OD. If camshaft follower OD is less than specified, install a new follower.

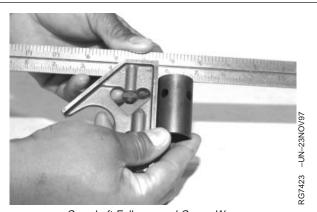
Specification



Camshaft Follower Wear

RG,05,DT7369 -19-11NOV97-2/3

- Check crown on follower face. If flat or concave, replace follower and check camshaft lobes for wear. (See VISUALLY INSPECT CAMSHAFT in Group 050.)
- Measure camshaft follower bore in block and determine if clearance is within specification. (See MEASURE CAMSHAFT FOLLOWER MACHINED BORE IN BLOCK in Group 030.)
- 5. Lubricate camshaft followers in clean engine oil and install in same bore from which removed.



Camshaft Follower and Crown Wear

RG,05,DT7369 -19-11NOV97-3/3

Measure Valve Recess in Cylinder Head

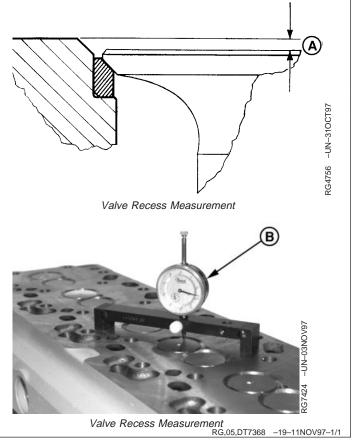
Measure and record valve recess (A) using a depth micrometer, magnetic base dial indicator or a dial indicator with JDG451 Height Gauge (B). Measurements must be made a maximum of 3.0 mm (0.12 in.) in from edge of valve head.

Specification

| Intake Valves Recess in Cylinder | 0.61—1.11 mm |
|----------------------------------|---------------------|
| Head | (0.024—0.044 in.) |
| Wear Limit | 1.63 mm (0.064 in.) |
| Exhaust Valve Recess in Cylinder | 1.22—1.72 mm |
| Head | (0.048—0.068 in.) |
| Wear Limit | 2.26 mm (0.089 in.) |

Install new valves and inserts, or grind existing valves and inserts, as necessary, to obtain proper valve recess. Grind valve seat inserts as required. (See REMOVE VALVE SEAT INSERTS later in this group.)

> A-Valve Recess **B**—Dial Indicator



Preliminary Cylinder Head and Valve Checks

Make preliminary inspection of cylinder head and valve assembly during disassembly.

Look for the following conditions:

Sticking Valves:

- · Carbon deposits on valve stem.
- Worn valve guides.
- · Scored valve stems.
- Warped valve stems.
- Misaligned or broken valve springs.
- Worn or distorted valve seats.
- Insufficient lubrication.

Warped, Worn, or Distorted Valve Guides:

- Lack of lubrication.
- Cylinder head distortion.
- Excessive heat.
- Unevenly tightened cylinder head cap screws.

Distorted Cylinder Head and Gasket Leakage:

- Loss of cylinder head cap screw torque.
- Broken cylinder head cap screw(s).
- Overheating from low coolant level operation.
- Insufficient liner standout.
- Coolant leakage into cylinder causing hydraulic failure of gasket.
- · Leaking aftercooler.
- · Cracked cylinder head.
- Cracked cylinder liner.
- Damaged or incorrect gasket.
- Overpowering or overfueling.
- Damaged cylinder head or block surfaces.
- Improper surface finish on cylinder head.
- Improperly tightened cylinder head cap screws.
- Faulty gasket installation (misaligned).

Worn or Broken Valve Seats:

Misaligned valves.

CTM104 (19JUN00)

- Distorted cylinder head.
- Carbon deposits on seats due to incomplete combustion.
- Valve spring tension too weak.
- Excessive heat.
- Improper valve clearance.
- Improper valve timing.
- Incorrect valve or seat installed.

Burned, Pitted, Worn, or Broken Valves:

- · Worn or distorted valve seats.
- Loose valve seats.
- Worn valve guides.
- Insufficient cooling.
- · Cocked or broken valve springs.
- Improper engine operation.
- Improper valve train timing.
- · Faulty valve rotators.
- Warped or distorted valve stems.
- "Stretched" valves due to excessive spring tension.
- Warped cylinder head.
- Bent push rods.
- · Carbon build-up on valve seats.
- Rocker arm failure.
- Incorrect valve or seat installed.
- Incorrect piston-to-valve clearance.

Improper Valve Clearance:

- Inefficient use of fuel.
- · Engine starts harder.
- Maximum engine power will not be achieved.
- Shorter service life of valve train.
- · Greater chance for engine to overheat.

Excessive Recession:

- · Worn valve guides.
- Bent valves.
- Debris passed through valve train.

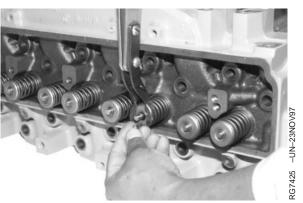
Remove Valve Assembly

NOTE: A small magnet may be used to aid removal of valve retainer locks.

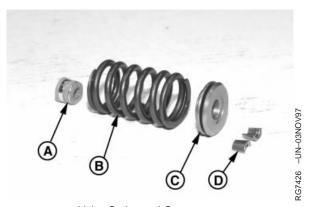
- 1. Using JDE138 Valve Spring Compressor, compress valve springs far enough to remove retainer locks (D).
- 2. Release spring tension and remove valve rotator (C) and valve spring (B).
- 3. Remove valves from cylinder head.

NOTE: Identify all parts for assembly in same location.

- 4. Remove valve stem seals (A) (if equipped) from valve guide tower.
 - A-Valve Stem Seal
 - **B**—Valve Spring
 - C—Valve Rotator
 - **D**—Retainer Locks



Valve Spring Removal Tool



Valve Spring and Components

RG,05,DT7366 -19-11NOV97-1/1

Inspect and Measure Valve Springs

- 1. Inspect valve springs for alignment, wear, and damage.
- Using D01168AA Spring Compression Tester, check valve spring tension. Compressed height must be within specification given below.

Valve Springs—Specification

| Spring Free Length 0 N (0 | 54.0 mm (2.125 in.) |
|-------------------------------|---------------------|
| lb-force) ¹ Height | |
| Spring Compressed 240—280 N | |
| (54—62 lb-force) Height | |
| Spring Compressed 590—680 N | |
| (133—153 lb-force) Height | |



Valve Spring



Valve Spring Compression Tester

RG,05,DT7365 -19-11NOV97-1/1

¹ Free length may vary slightly between valve springs.

02-020-20

Inspect Valve Rotators

Valve rotators cannot be repaired. Replace valve rotators when valves are replaced or reground.

Ensure that valve rotators turn freely in both directions. Replace if defective.



Valve Rotator

RG7428 -UN-23NOV97

020

RG,05,DT7364 -19-11NOV97-1/1

Clean Valves

1. Hold each valve firmly against a soft wire wheel on a bench grinder.

IMPORTANT: Any carbon left on the stem will affect alignment in valve refacer. DO NOT use a wire wheel on plated portion of valve stem. Polish the valve stem with steel wool or crocus cloth to remove any scratch marks left by the wire brush.

2. Make sure all carbon is removed from valve head, face and unplated portion of stem.

RG,05,DT7363 -19-11NOV97-1/1

Inspect and Measure Valves

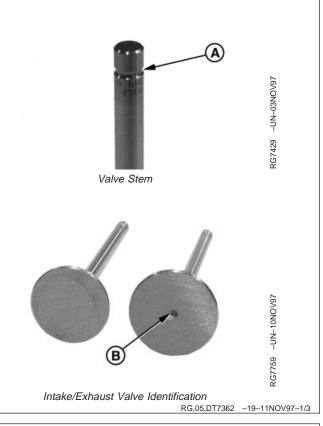
 Clean and inspect valves, valve stems, stem tips, and retainer lock groove (A). Replace valves that are worn or damaged.

| Specification | | |
|-----------------------|-------------------|--|
| Intake Valve Head OD | 46.47—46.73 mm | |
| | (1.830—1.840 in.) | |
| Exhaust Valve Head OD | 42.37—42.63 mm | |
| | (1.668—1.678 in.) | |

NOTE: Intake valve has a larger head OD and is also identified with a dimple (B) on valve head.

A—Retainer Lock Groove

B—Dimple



2. Measure valve stem OD. Record measurements and compare with valve guide ID. (See MEASURE VALVE GUIDES later in this group.)

| Intake Valve Stem OD | 7.864—7.884 mm |
|-----------------------|---------------------|
| | (0.3096—0.3104 in.) |
| Exhaust Valve Stem OD | 7.848—7.874 mm |
| | (0.3090—0.3100 in.) |



Valve Stem Measurement

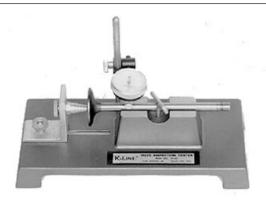
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RG,05,DT7362 -19-11NOV97-2/3

RG4234 -UN-05DEC97

3. Using a valve inspection center, determine if valves are out of round, bent, or warped.

Specification



Valve Inspection Center

RG,05,DT7362 -19-11NOV97-3/3

RG4755 -UN-310CT97

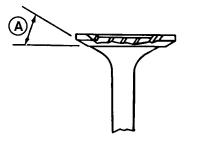
Grind Valves

IMPORTANT: DO NOT nick valve head-to-stem radius when grinding valves. A nick could cause the valve to break. Break all sharp edges after grinding.

Reface serviceable valves to specified angle (A).

Specification

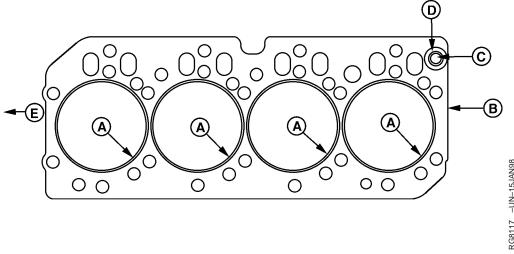
A-Valve Face Angle



Checking Valve Face Angle

RG,05,DT7361 -19-11NOV97-1/1

Head Gasket Inspection and Repair Sequence



Head Gasket Inspection

A—Combustion Seals (Flanges)

B—Gasket Body C—Rocker Arm Oil Port D—Elastomer Beading Strip

E-Front of Engine

The following inspection procedures are recommended whenever a head gasket joint failure occurs, or when joint disassembly takes place.

- Review historical data relating to machine operation, maintenance and repair, along with diagnostic observations. Note all areas requiring further inspection and analysis.
- 2. Remove rocker arm cover and check for presence of coolant in the oil.
- 3. Record head cap screw torques prior to removal. Upon removal, check cap screw length differences.
- Remove cylinder head using appropriate lifting devices to prevent handling damage to head gasket. (See REMOVE CYLINDER HEAD in Group 020.)
- 5. Observe surfaces of removed head gasket.

Examine combustion seals (A) for the following:

- Flange severed/expanded/cracked/deformed.
- Adjacent body area burned/eroded.

- Fire ring severed/displaced/missing.
- Flange sealing pattern eccentric/contains voids.
- Discoloration of flange and adjacent body areas.
- Flange surfaces rough/abraided/channelled.

Examine gasket body (B) for the following:

- Combustion gas erosion paths or soot deposits originating at combustion seals.
- Extreme discoloration/hardening/embrittlement in localized areas.
- O-ring seal missing/damaged in port area (C).
- Elastomer missing/damaged in port area (D).
- Oil or coolant paths from port areas.
- · Localized areas of low compression.
- Before cleaning components, inspect head, block, and liners for evidence of combustion gas and fluid leakage. Inspect cylinders and valve ports for unusual deposits.
- 7. Clean block, head, liners, and cap screws. (See groups 020 and 030.)
- 8. Proceed with the following dimensional checks and visual inspections:

Continued on next page

RG,105,JW7656 -19-24MAY00-1/2

Cylinder Head (See Group 020.)

- · Check surface flatness/finish.
- Inspect for surface damage.
- Check cylinder head thickness, if resurfacing.

Cylinder Block and Liners (Assembled and Clamped) (See Group 030.)

- Check liner standout at four places on each liner.
- Check liner standout difference between cylinders.

Cylinder Block (See Group 030.)

- Check surface flatness/finish.
- Inspect for surface damage.
- Check liner counterbore depth (if liner is removed).
- Check top deck to crankshaft centerline dimension.
- Inspect cap screw bosses; must be clean/intact.

Cylinder Liner (See Group 030.)

- · Check liner flange flatness/finish.
- Check liner flange thickness (if liner is removed).
- Inspect flange for damage.

Cylinder Head Cap Screws (See Group 020.)

- Inspect for corrosion damage.
- · Inspect condition of threads.
- Inspect for straightness.
- Check length.
- When inspections and measurements have been completed, determine most probable causes of joint failure. Make all necessary repairs to joint components, cooling system, and fuel injection system.
- Reassemble the engine according to procedures and specifications in the repair groups of this manual.

RG,105,JW7656 -19-24MAY00-2/2

020

25

Inspect and Clean Cylinder Head

- Inspect combustion face for evidence of physical damage, oil or coolant leakage, or gasket failure prior to cleaning the cylinder head. Repair or replace cylinder head if there is evidence of physical damage, such as cracking, abrasion, distortion, or valve seat "torching". Inspect all cylinder head passages for restrictions.
- 2. Scrape gasket material, oil, carbon, and rust from head. Use a powered wire brush to clean sealing surfaces.

IMPORTANT: Be sure to remove all plugs before cleaning head, as parts can be damaged or destroyed by hot tank solutions.

- 3. Clean cylinder head in a chemical hot tank, or with solvent and a brush.
- 4. Dry with compressed air and blow out all passages.

RG,05,DT7360 -19-11NOV97-1/1

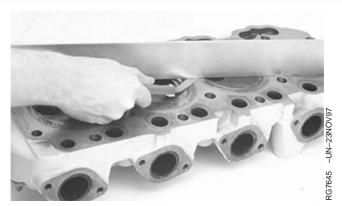
Check Cylinder Head Flatness

Check cylinder head flatness using D05012ST Precision "Bevelled Edge" Straightedge and feeler gauge. Check lengthwise, crosswise, and diagonally in several places.

Specification

| Cylinder Head Flatness Maximum | 0.08 mm (0.003 in.) |
|-----------------------------------|---------------------|
| Acceptable Out-of-Flat for Entire | |
| Length or Width | |
| Maximum Acceptable Out-of-Flat | 0.03 mm (0.001 in.) |
| for Every 150 mm (5.90 in.) | |

If out-of-flat exceeds specifications, the cylinder head must be reconditioned or replaced. (See MEASURE CYLINDER HEAD THICKNESS later in this group.)



Cylinder Head Flatness Check

RG,05,DT7359 -19-11NOV97-1/1

Measure Cylinder Head Thickness

Measure head thickness from valve cover gasket rail-to-combustion face.

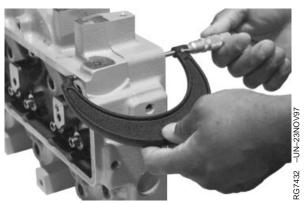
If cylinder head thickness is less than minimum allowable thickness, DO NOT attempt to resurface. Install a new cylinder head.

When resurfacing cylinder head, remove ONLY what is necessary to restore flatness.

| New Cylinder Head Thickness | 104.87—105.13 mm |
|--------------------------------|-----------------------|
| | (4.129—4.139 in.) |
| Minimum Acceptable Thickness | 104.24 mm (4.104 in.) |
| Combustion Face Surface Finish | 0.7—3.2 micrometers |
| (Surface Grind Only) (AA) | (31-125 micro-in.) |
| Maximum Wave Depth | 0.012 mm (0.0005 in.) |
| Maximum Material Removal for | 0.76 mm (0.030 in.) |
| Resurfacing | |

IMPORTANT: After resurfacing cylinder head, check for flatness as described earlier. Also check surface finish on combustion face of head.

Measure and record valve recess in cylinder head. (See MEASURE VALVE RECESS IN CYLINDER HEAD earlier in this group.)



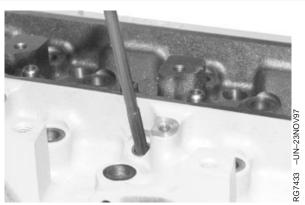
Cylinder Head Thickness Check

RG,05,DT7358 -19-11NOV97-1/1

Clean Injection Nozzle Bores

IMPORTANT: Always turn the tool clockwise through the bore, even when pulling back. This will prevent premature wear on the tool.

Clean carbon deposits from nozzle bores with JDE39 Nozzle Bore Cleaning Tool. Blow debris from bore with compressed air.



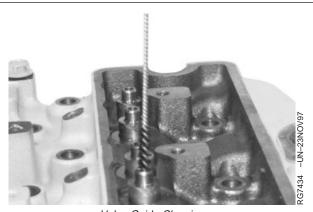
Fuel Injection Nozzle Bore Cleaning

RG,05,DT7357 -19-11NOV97-1/1

Clean Valve Guides

Clean valve guides with a plastic brush before inspection or repair.

NOTE: A few drops of light oil or kerosene will help clean the guides.



Valve Guide Cleaning

RG,05,DT7356 -19-11NOV97-1/1

Measure Valve Guides

Using a telescopic gauge, measure valve guide wear.

Specification

| -p | |
|---------------------------------|---------------------|
| Valve Guide Bore (New) ID | 7.912-7.938 mm |
| | (0.312-0.313 in.) |
| Valve Guide-to-Valve Stem (New) | 0.05-0.10 mm |
| Clearance | (0.002-0.004 in.) |
| Wear Limit | 0.15 mm (0.006 in.) |
| | |

NOTE: Valves are available with 0.38 mm (0.015 in.) and 0.76 mm (0.030 in.) oversize stems.

If valve guide-to-stem oil clearance exceeds the wear limit, oversize valve stems are available. Have a qualified machine shop ream valve guides to assure guide-to-stem clearance is within specification.

If valve guide-to-stem oil clearance exceeds the wear limit, but is less than 0.20 mm (0.008 in.), it is acceptable to knurl guides and ream to size. However, installing oversize valve stems is preferred. (See KNURL VALVE GUIDES, later in this group.)

IMPORTANT: Production valve guides have a 5/6-24NF modified internal thread the entire length of guide with major diameter of 8.052—8.128 mm (0.3170—0.3199 in.). Have qualified machine shop thread valve guides accordingly after reaming for oversize valve stems.



Valve Guide Wear

RG,05,DT7355 -19-11NOV97-1/1

Knurl Valve Guides

IMPORTANT: Valve guide knurling should only be done by experienced personnel familiar

with equipment and capable of maintaining required specification.

ALWAYS knurl valve guides before reaming to assure proper valve guide-to-stem clearance.

- Use JT05949 Valve Guide Knurler Kit to knurl valve guides. Use kit exactly as directed by the manufacturer.
- 2. After knurling, ream valve guide to finished size to provide specified stem-to-guide clearance.



Knurling Valve Guides

RG,05,DT7354 -19-11NOV97-1/1

Clean and Inspect Valve Seats

- 1. Use an electric hand drill with D17024BR End Brush to remove all carbon on valve seats.
- 2. Inspect seats for excessive wear, cracks, or damage.
- 3. Check entire combustion face for rust, scoring, pitting, or cracks.



Valve Seat Cleaning and Inspection

RG,05,DT7379 -19-11NOV97-1/1

Grind Valve Seats

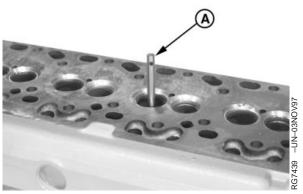
IMPORTANT: Valve seat grinding should only be done by experienced personnel familiar with equipment and capable of maintaining required specifications. ALWAYS keep valve guides and work area clean when grinding valve seats to maintain valve guide bore-to-seat runout.

> **Grinding valve seats increases seat** width and valve recess in cylinder head. DO NOT grind excessively. Only a few seconds are required to recondition the average valve seat. Dress grinding stone as necessary to maintain specified seat angle.

Support the weight of grinder to avoid excessive pressure on the stone.

Blend or radius all sharp edges after grinding valve seats for a more effective valve face-to-seat seal.

1. Install appropriate pilot (A) in valve guide bore.



Valve Seat Grinding Pilot

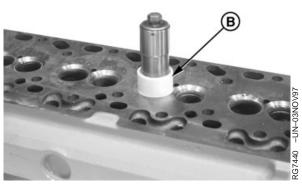
A—Pilot

Continued on next page

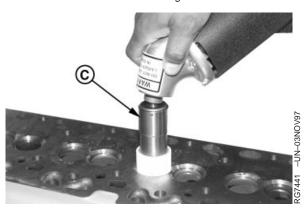
RG,05,DT7353 -19-11NOV97-1/4

2. Install appropriate grinding stone (B) on arbor (C) and position onto valve seat.

> **B**—Grinding Stone C—Arbor



Valve Seat Grinding Stone



Valve Seat Grinding Arbor

RG,05,DT7353 -19-11NOV97-2/4

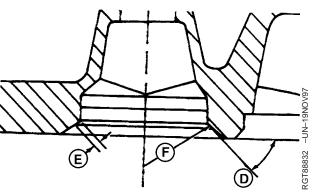
3. Using drill from JT05893 Heavy Duty Seat Grinder Set, grind valve seats to the following specifications:

Specification

Valve Seat Width (E)...... 1.50—2.00 mm (0.059—0.079 in.) Maximum Valve Seat Runout (F)...... 0.08 mm (0.003 in.)

4. Use a vernier caliper or scale to measure seat width. If valve seat is too wide, reduce the width with a narrowing stone.

NOTE: A narrowing stone will change the top angle of the seat and reduce the outer diameter of the valve seating area. Varying the width changes the fine contact between valve face and seat. If seat width is too narrow, valve may burn or erode.



Valve Seat Grinding Specifications

D-Valve Seat Angle E-Valve Seat Width F-Valve Seat Runout

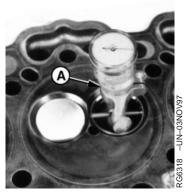
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RG,05,DT7353 -19-11NOV97-3/4

Cylinder Head and Valves

- 5. If valve does not seat properly, use an eccentrimeter (A) to check valve seat runout. Use a new or refaced valve and blueing to check contact between valve seat and face. If necessary, lap the valve onto its seat using a lapping tool and lapping compound. Replace valves and inserts as necessary.
- Install new or refaced valve and check valve recess in cylinder head after grinding. (See MEASURE VALVE RECESS IN CYLINDER HEAD earlier in this group.)

A-Eccentrimeter



Eccentrimeter

RG,05,DT7353 -19-11NOV97-4/4

Remove Valve Seat Inserts

IMPORTANT: Be careful not to damage cylinder head

when removing valve seats. Valve seat removal should only be done by experienced personnel familiar with

procedures.

DO NOT use an oxy-acetylene torch to remove valve seat inserts, as it alters the hardness of the cylinder head.

Valve seat inserts are made of sintered (powdered) metal. Remove inserts by one of the following methods:

Continued on next page

RG,05,DT7352 -19-11NOV97-1/4

02 020

Raising Burr on Valve Seat Insert

- 1. Using a carbide deburring tool (A), raise a burr (B) on bottom of valve seat insert.
 - A—Deburring Tool
 - B—Burr



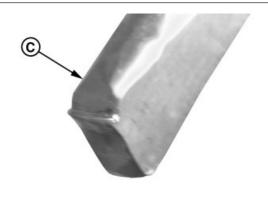
Carbide Deburring Tool



Valve Seat

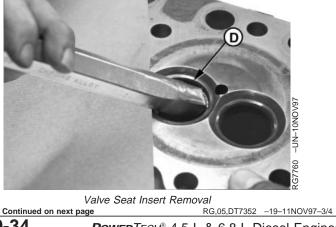
RG,05,DT7352 -19-11NOV97-2/4

- 2. Protect surface of cylinder head with cardboard or cloth. Using a chisel with special ground end (C), tap handle of chisel with hammer until valve seat insert (D) comes loose.
 - C—Special Ground Chisel
 - D-Valve Seat Insert



RG7818 -UN-13NOV97

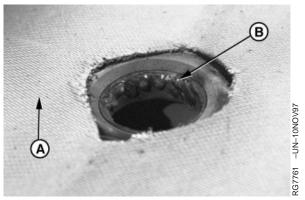
Chisel for Valve Seat Insert Removal



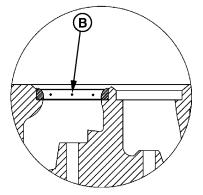
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Using an Arc Welder

- 1. Protect the valve guide by installing a cap screw or dowel in guide to protect from weld spatter.
- Protect the cylinder head surface with a non-flammable welder's cloth (A). Apply a thin bead of weld (B) around ID of valve seat insert. Allow insert to cool and use a screwdriver (C) or similar tool and carefully pry insert from bore.
- After removal of inserts, thoroughly clean area around valve seat bore and inspect for damage or cracks. Replace cylinder head as necessary.
 - A-Welders Cloth
 - B-Weld Bead
 - C—Screwdriver



Weld Bead for Valve Seat Insert Removal



Weld Bead Location



Valve Seat Insert Removal

RG,05,DT7352 -19-11NOV97-4/4

RG7813 -UN-13NOV97

Measure Valve Seat Bore in Cylinder Head

If bore dimensions are not within specification, machine head to the following specifications:

Exhaust Valve Seat Insert Bore Specifications:

| A | 42.987—43.013 mm (1.6924—1.6934 in.) |
|------------------------|--------------------------------------|
| В | 3.82 mm (0.150 in.) Reference |
| C | 9.936—10.064 mm (0.3912—0.3962 in.) |
| D | 38—42° |
| E | Maximum Radius 0.5 mm (0.019 in.) |
| | |
| Maximum surface finish | 0.00158 mm |

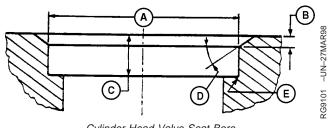
Intake Valve Seat Insert Bore Specifications:

of bore "A" (0.000062 in.)

| A | 47.104—47.130 mm (1.8545—1.8555 in.) |
|------------------------|--------------------------------------|
| В | 3.45 mm (0.136 in.) Reference |
| C | 9.936—10.064 mm (0.3912—0.3962 in.) |
| D | 38—42° |
| E | Maximum Radius 0.5 mm (0.019 in.) |
| | |
| Maximum surface finish | 0.00158 mm |
| of bore "A" | (0.000062 in.) |

Replacement Valve Seat Insert OD:

| Intake | 47.155—47.181 mm (1.8565—1.8575 in.) |
|---------|--------------------------------------|
| Exhaust | 43.038—43.064 mm (1.6944—1.6954 in.) |



Cylinder Head Valve Seat Bore

RG,05,DT7351 -19-11NOV97-1/1

02 020 37

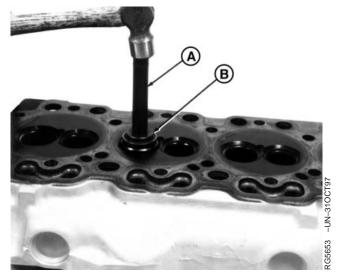
Install Valve Seat Inserts

 Use JDG676 Valve Seat Driver (A) and JDG675 Valve Seat Insert Installing Adapter (B) to install valve seat inserts in cylinder head.

Use one end of JDG675 Adapter to install intake valve seat inserts and the other end to install exhaust valve seat inserts.

- Install valves and measure valve recess. (See MEASURE VALVE RECESS IN CYLINDER HEAD, earlier in this group.)
- Grind valve seats as required to maintain correct valve recess and valve face-to-seat seal. (See GRIND VALVE SEATS, earlier in this group.)

A—Valve Seat Driver B—Adapter



Valve Seat Insert in Cylinder Head Installation

RG,05,DT7350 -19-11NOV97-1/1

Install Valves

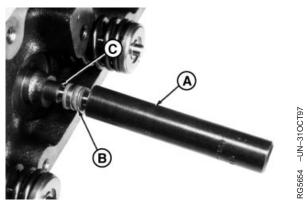
1. Lubricate valve stems and guides with AR44402 Valve Stem Lubricant or clean engine oil.

NOTE: Valves must move freely in guide and seat properly in head to form an effective seal.

- 2. Insert valves in head (if valves are reused, install in same location from which removed).
- 3. Use JDG678 Valve Stem Seal Installer (A) to slide valve stem seals (B) over valve stems and onto valve guide tower (C).

NOTE: JDG678 Installer may also be used to install oversize valve stem seals on oversize valve stems.

4. Install valve springs and rotators.



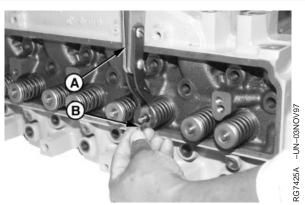
Valve Stem Seal Installation Tool

- A—Seal Installer
- B—Valve Stem Seals
- C—Valve Guide Tower

Continued on next page

RG,05,DT7349 -19-11NOV97-1/2

- Compress valve springs using JDE138 Valve Spring Compressor (A) and install retainer locks (B) on valve stems.
- Strike end of each valve three or four times with a soft mallet (non-metallic) to insure proper positioning of the retainer locks.
- 7. Recheck valve recess. (See MEASURE VALVE RECESS IN CYLINDER HEAD, earlier in this group.)
 - A—Spring Compressor
 - **B**—Retainer Locks



Valve Spring Compressor and Retainer Lock

RG,05,DT7349 -19-11NOV97-2/2

Clean and Inspect Cylinder Head Cap Screws

- 1. Clean entire length of cap screws. Use a wire brush and solvent to remove rust and scale. Dry cap screws with compressed air.
- Inspect cap screws for corrosion damage and overall condition of threads. CAP SCREWS WITH CORROSION OR OTHER IMPERFECTIONS MUST BE REPLACED.



Cylinder Head Cap Screw

RG,05,DT7348 -19-11NOV97-1/1

Inspect and Clean Exhaust Manifold

- 1. Thoroughly clean all passages and gasket surfaces in exhaust manifold and exhaust elbow.
- 2. Inspect entire exhaust manifold for cracks or damage. Replace parts as necessary.

RG,05,DT7347 -19-11NOV97-1/1

Clean and Inspect Top Deck of Cylinder Block

- Remove gasket material, rust, carbon, and other foreign material from top deck. Gasket surface must be clean.
- Clean threaded holes in cylinder block using JDG680
 Tap or any 1/2-13 UNC-2A tap about 76 mm (3.0 in.)
 long. Use compressed air to remove debris and fluids
 from the cap screw holes. Replace block if there is
 evidence of damage.
- 3. Use compressed air to remove all loose foreign material from cylinders and top deck.

IMPORTANT: All debris must be cleaned from the camshaft followers before assembling the engine.

- 4. If not previously done, remove camshaft followers from block and wash in solvent. Lubricate with clean engine oil and install in the same bore.
- Inspect top deck for flatness and serviceability. (See MEASURE CYLINDER BLOCK TOP DECK FLATNESS in Group 030.)



Cleaning Threaded Holes in Cylinder Block



Clean and Lube Camshaft Followers

RG,05,DT7346 -19-11NOV97-1/1

Measure Cylinder Liner Standout (Height above Block)

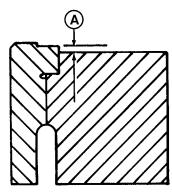
- Secure liners using cap screws and flat washers. Flat washers should be at least 3.18 mm (1/8 in.) thick. Tighten cap screws to 68 N•m (50 lb-ft).
- Using JDG451 or KJD10123 Gauge (B) and D17526CI or D17527CI Dial Indicator (C), measure liner height (A) at 1, 5, 7, and 11 o'clock positions as viewed from flywheel end of engine. Record all measurements by cylinder number.

| Specification | |
|-----------------------------------|---------------------|
| Cylinder Liner Height above Block | . 0.030—0.100 mm |
| | (0.001—0.004 in.) |
| Maximum Permissible Height | 0.05 mm (0.002 in.) |
| Difference at Nearest Point of | |
| Two Adjacent Liners, or Within a | |
| Single Liner | |
| | |

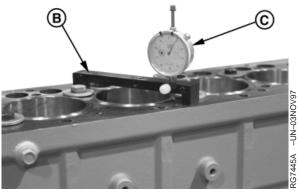
IMPORTANT: ONE LINER SHIM ONLY may be installed under each liner flange.

Remove and shim, or replace, any liner that does not meet height specifications. (See REMOVE CYLINDER LINERS in Group 030.)

NOTE: Two sizes of shims are available: 0.05 mm (0.002 in.) and 0.10 mm (0.004 in.).



Cylinder Liner Standout (Above Block)



Measure Cylinder Standout (Above Block)

- A-Liner Height
- B—Gauge
- C—Dial Indicator

RG,05,DT7345 -19-26APR00-1/1

Install Cylinder Head

1. Dip fuel supply pump push rod (A) (if equipped) in clean engine oil and carefully install in cylinder block before installing cylinder head.

A-Fuel Supply Pump Push Rod



Fuel Supply Pump Push Rod

Continued on next page

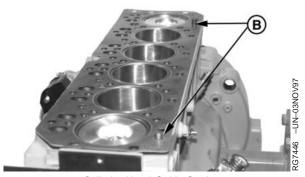
RG,05,DT7344 -19-26APR00-1/4

IMPORTANT: The O-ring seals in head gasket can be damaged if head is repositioned while resting on engine block. Use guide studs to position cylinder head on block.

2. Install two guide studs (B) in cylinder block at locating holes.

IMPORTANT: ALWAYS thoroughly inspect cylinder head gasket for possible manufacturing imperfections. Return any gasket that does not pass inspection.

3. Place new head gasket on cylinder block. Do not use sealant; install dry.

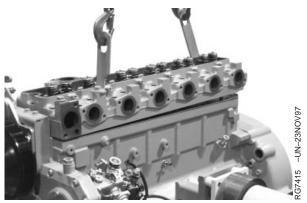


Cylinder Head Guide Studs

B—Guide Studs

RG,05,DT7344 -19-26APR00-2/4

4. Position cylinder head over guide studs and lower onto cylinder block.



Cylinder Head to Block Installation

Continued on next page

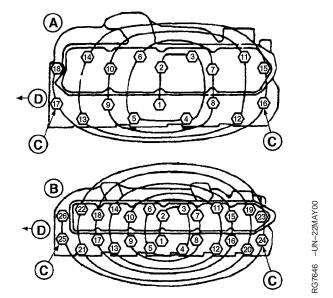
RG,05,DT7344 -19-26APR00-3/4

- 5. Dip entire cap screw in clean engine oil. Remove excess oil from screw.
- 6. Remove guide studs. Install flanged-head cylinder head cap screws.
- 7. Tighten all cap screws to specified torques (in sequence shown, beginning with No. 1), following steps 1—4 below. Then, torque-turn cap screws following procedure on next page.

| Cylinder | Head | Cap | Screws— | Specification |
|----------|------|-----|---------|---------------|
|----------|------|-----|---------|---------------|

| Step 1—Initial Torque | 100 N•m (75 lb-ft) |
|---------------------------------|--|
| Step 2—Second Torque | 150 N•m (110 lb-ft) |
| Step 3—Verify (After 5 Minutes) | 150 N•m (110 lb-ft) |
| Torque | |
| Step 4—Final Torque-Turn | Tighten each screw an additional |
| | $60^{\circ} \pm 10^{\circ}$ (See TORQUE-TURN |
| | METHOD FOR PROPER |
| | TORQUE next in this group.) |

Retorque of cylinder head cap screws after engine break-in is not required when using the recommended torque procedure along with flanged-head cap screw.



Cylinder Head Bolt Tightening Sequence

- A—4-Cylinder Engine
- B-6-Cylinder Engine
- C—Locating Holes (Guide Stud Locations)
- D—Arrow Toward Front of Engine

RG,05,DT7344 -19-26APR00-4/4

Torque-Turn Method for Proper Torque

After tightening cap screws to 150 Nem (110 lb-ft), use JT05993 Torque Angle Gauge or the line scribe method below to tighten each cap screw an additional 60°.

Line scribe method:

CTM104 (19JUN00)

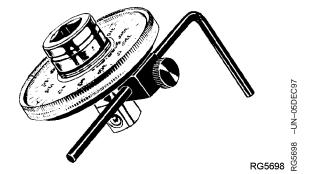
Step A—Make two marks on socket 1/6 turn $(60^{\circ} \pm 10^{\circ})$ apart.

Step B-Make a mark on cylinder head next to each cap screw.

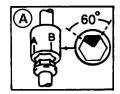
Step C—Place socket on cap screw so first mark aligns with mark on cylinder head.

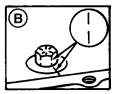
Step D—Tighten all cap screws (in sequence shown on previous page) until second mark on socket aligns with mark on cylinder head.

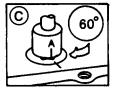
Retorque of cylinder head cap screws after engine break-in is not required when using the recommended torque procedure along with flanged-head cap screws.

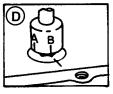


Torque Angle Gauge









-UN-310CT97

Torque-Turn Tightening Procedure

RG,05,DT7343 -19-11NOV97-1/1

Install Rocker Arm Assembly

1. Install push rods in same location from which removed.

NOTE: Valve stem tips are specially hardened; wear caps are not required.

IMPORTANT: Relieve tension on rocker arm adjusting screw to avoid damaging rocker arm shaft during installation.

2. Position rocker arm assembly on engine.

IMPORTANT: Oil supply hole in rocker arm shaft must be positioned at the flywheel end of engine and facing downward when rocker shaft is installed.

3. Lubricate all rocker arms with engine oil and make sure they move freely. Tighten rocker arm support studs in a criss-cross sequence to specifications.

Specification

4. Adjust valve clearance. (See CHECK AND ADJUST VALVE CLEARANCE earlier in this group.)



Rocker Arm Assembly Installation

RG,05,DT7342 -19-24NOV99-1/1

Inspect and Clean Ventilator Outlet Hose

NOTE: If ventilator hose or tube is crimped or restricted in any way, high oil pressure or possible loss of oil could result in engine damage.

- 1. Check ventilator outlet hose (A) on rocker arm cover for bent or damaged condition. Replace if necessary.
- 2. Clean ventilator hose and tube if they are restricted.

A-Ventilator Outlet Hose



Ventilator Outlet Hose Inspection

Install Rocker Arm Cover

IMPORTANT: Dispose of sealing ring (A) if there is evidence of damage. Otherwise, do NOT remove sealing ring from groove.

If the sealing ring is defective, the following procedure should be used to install a new sealing ring:

- Carefully remove the old sealing ring from rocker arm cover. Do not use any cutting tool that could damage the cover.
- Clean the groove with acetone. Dry with compressed air
- When installing new sealing ring in groove, start at ends and work toward the center of the cover. Do not use sealant on sealing ring.
- 1. Install rocker arm cover with sealing ring.



Rocker Arm Cover Sealing Ring

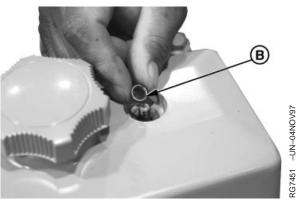
A-Sealing Ring

RG,05,DT7340 -19-11NOV97-1/3

- 2. Install O-rings (B) and nuts.
- Tighten all nuts to specifications, starting at the center and alternating sides until reaching the ends. DO NOT OVERTIGHTEN.

Specification

B—O-Rings



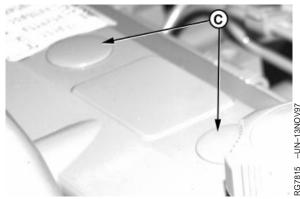
Rocker Arm Cover O-Rings

Continued on next page

RG,05,DT7340 -19-11NOV97-2/3

4. Install rocker arm cover button plugs (C).

C—Plugs

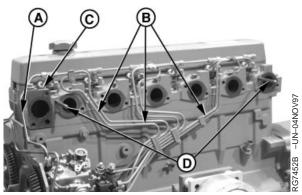


Rocker Arm Cover Button Plugs

RG,05,DT7340 -19-11NOV97-3/3

Complete Final Assembly

- Install injection nozzles (C). Install injection lines (B) as an assembly. See INSTALL FUEL INJECTION NOZZLES in Section 02, Group 090 of CTM207 (Mechanical Fuel Systems) or CTM170 (Electronic Fuel Systems).
- Install fuel leak-off line (A). See Section 02, Group 090 of CTM207 (Mechanical Fuel Systems) or CTM170 (Electronic Fuel Systems).
- 3. Install guide pins (D) in cylinder head to aid in installation of exhaust manifold.



Fuel Lines and Injection Nozzles

- A-Fuel Leak-Off Line
- **B**—Injection Lines
- C—Injection Nozzles
- **D**—Guide Pins

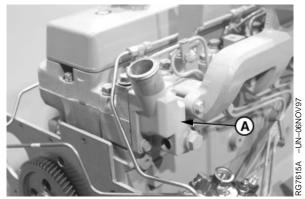
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RG,05,DT7339 -19-11NOV97-1/6

NOTE: On some engines, the thermostat housing/water manifold is part of the cylinder head.

4. Install thermostat housing/water manifold (A). (See INSTALL WATER MANIFOLD, THERMOSTAT COVER AND THERMOSTAT in Group 070.)

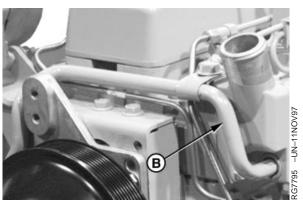
A—Thermostat Housing/Water Manifold



Thermostat Housing/Water Manifold

RG,05,DT7339 -19-11NOV97-2/6

- 5. Install thermostat housing-to-water pump tube (B).
 - B—Thermostat Housing to Water Pump Tube



Thermostat Housing to Water Pump Tube

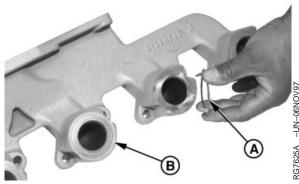
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RG,05,DT7339 -19-11NOV97-3/6

6. Using guide studs, install exhaust manifold (B) with gasket(s) (A). (See REMOVE, INSPECT AND INSTALL EXHAUST MANIFOLD in Group 080.)

A-Stainless Steel Gasket Shown

B—Exhaust Manifold



Exhaust Manifold Steel Gaskets

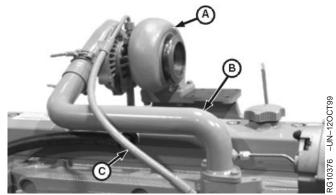
RG,05,DT7339 -19-11NOV97-4/6

 Install turbocharger (A) if equipped, exhaust elbow (shown removed) and lube line (C). (See INSTALL TURBOCHARGER in Group 080.). Install air intake pipe (B). (See REMOVE AND INSTALL AIR INTAKE PIPE in Group 080.)

A—Turbocharger

B—Air Intake Pipe

C—Lube Line



Turbocharger

Continued on next page

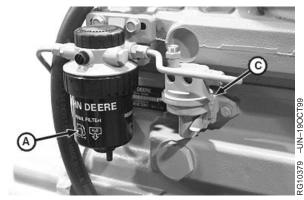
RG,05,DT7339 -19-11NOV97-5/6

NOTE: Position of fuel filters (A) and (B) and supply pump (C) vary by engine and injection pump applications. See Section 02, Group 090 of CTM207 (Mechanical Fuel Systems) or CTM170 (Electronic Fuel Systems) for procedures to remove filter(s) and/or supply pump as required.

- 8. Install fuel filter base and fuel filters (A) and (B) as required. See Section 02, Group 090 of CTM207 (Mechanical Fuel Systems) or CTM170 (Electronic Fuel Systems) for procedures to install fuel filters.
- Install fuel supply pump (C). See INSTALL FUEL SUPPLY PUMP in Section 02, Group 090 of CTM207 (Mechanical Fuel Systems) or CTM170 (Electronic Fuel Systems).
- 10. Install alternator if removed. (See REMOVE AND INSTALL ALTERNATOR in Group 100.)
- 11. If engine oil was drained from crankcase, install new oil filter and fill engine with clean oil of correct grade and viscosity. (See Section 01, Group 002.)
- 12. Fill cooling system with clean coolant. (See Section 01, Group 002.)
- 13. Perform engine break-in. (See PERFORM ENGINE BREAK-IN in Group 010.)



Fuel Filters



Fuel Filters and Supply Pump

- A—Final Fuel Filter
- B—Primary Fuel Filter/Water Separator
- C-Fuel Supply Pump

RG,05,DT7339 -19-11NOV97-6/6



Connecting Rods—General Information

Earlier engines have the traditional tongue-and-groove between the connecting rod and cap (A). Later engines have the PRECISION JOINT $^{\text{TM}}$ rod and cap (B).

PRECISION JOINT™ rods and caps were introduced as follows:

| Dubuc | que E | 3uilt |
|-------|-------|-------|
|-------|-------|-------|

| 4.5 L Engines | (793938—) |
|---------------|------------|
| 6.8 L Engines | (794055—) |

Saran Built

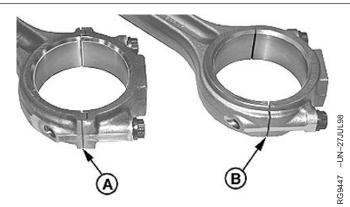
| RE500002 Rod | (554036—) |
|--------------|-----------|
| RE500608 Rod | (553937—) |

Torreon Built

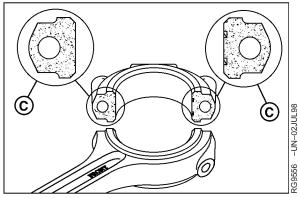
| RE500002 Rod | (039708— |
|--------------|----------|
| RE500608 Rod | (036628— |

To create the PRECISION JOINT™, the connecting rod is notched with a laser beam. Then a precision mandrel in the rod bore is powered to separate the cap from the rod at the joints (C).

Both types of rods provide a strong joint and torque on cap screws is the same. Removal and installation is similar, with differences noted. See INSPECT ROD AND CAP and INSTALL PISTON AND CONNECTING ROD ASSEMBLY later in this group.



Connecting Rod (Machined)



Connecting Rod (Non-Machined)

- A—Tongue-and-Groove Rod (Early Engines)
- **B—PRECISION JOINT™ Rod (Later Engines)**
- C—PRECISION JOINT™ Details

PRECISION JOINT is a trademark of Deere & Company

DPSG,OUO1004,165 -19-28SEP99-1/1

Remove Pistons and Connecting Rods

If engine is to be removed from the machine, see your machine technical manual.

CAUTION: Do not drain engine coolant until it cools below operating temperature. Then slowly loosen block drain valve to relieve any pressure.

1. Drain coolant and engine oil.

NOTE: If engine is to be completely disassembled, see ENGINE DISASSEMBLY SEQUENCE in Group 010.

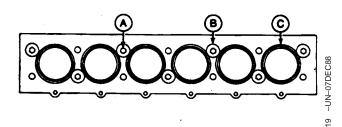
- 2. Remove cylinder head. (See REMOVE CYLINDER HEAD in Group 020.)
- 3. Remove camshaft followers and keep in order for reassembly in same position.
- 4. Clean all foreign material from cylinder block top deck.

RG,10,DT7421 -19-12NOV97-1/5

IMPORTANT: Cap screws and washers must be tightened to the correct specification to achieve an accurate reading when checking liner standout (height above block), as detailed later in this group.

5. Use short cap screws (A) and 3 mm (1/8 in.) thick washers (B) to bolt down cylinder liners (C). Fasten each liner in two locations. Tighten cap screws to 68 N•m (50 lb-ft).

NOTE: Do not rotate crankshaft with cylinder head removed unless liners are fastened down.



Cylinder Liner Hold-Down

A—Cap Screws

B—Washers

C-Liners

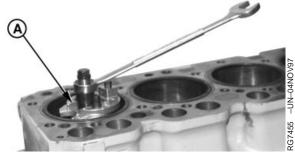
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RG,10,DT7421 -19-12NOV97-2/5

NOTE: Always follow manufacturer's directions provided with ridge reamer.

 Remove carbon from liner bore with a scraper or ridge reamer (A). Use compressed air to remove loose material from cylinders.

A-Ridge Reamer



Using Ridge Reamer in Cylinder Bore

RG,10,DT7421 -19-12NOV97-3/5

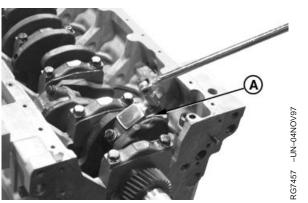
- Remove oil pan, oil pump, and pick-up tube. (See REMOVE, INSPECT AND INSTALL OIL PUMP PICK-UP TUBE ASSEMBLY in Group 060.) (See REMOVE ENGINE OIL PUMP in Group 060.)
- 8. Mark rods, pistons, and caps to ensure correct assembly in same location.

IMPORTANT: Keep inserts with their respective caps for rod and main bearings.

- 9. Remove all rod caps (A) with bearings.
- Measure rod bearing-to-journal oil clearance with PLASTIGAGE® before removing piston and rod assembly. Record measurements. (See INSPECT AND MEASURE CONNECTING ROD BEARINGS, later in this group.)

NOTE: Use PLASTIGAGE® as directed by the manufacturer. PLASTIGAGE® will determine bearing-to-journal oil clearance, but will not indicate the condition of either surface.

A—Rod Caps



Bearing and Rod Cap Removal



Measure Bearing Clearance

PLASTIGAGE is a registered trademark of the DANA Corp.

Continued on next page

RG,10,DT7421 -19-12NOV97-4/5

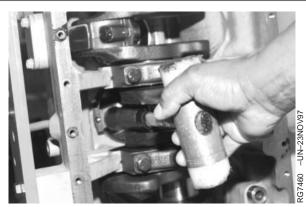
IMPORTANT: Hold onto piston to prevent piston from dropping. Piston will drop once piston rings have cleared cylinder liner.

If liners are to be reused, be extremely careful not to let connecting rod hit liner bore when removing piston and rod assembly.

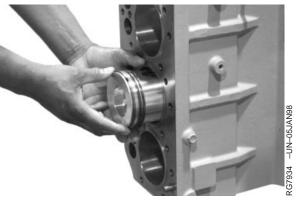
- 11. Gently tap piston through top of cylinder block from the bottom.
- 12. Remove pistons and rods from engine.
- 13. If piston rings are to be reused, measure piston ring end gap and compare to the following specifications:

| Specification | | | | |
|-------------------------------|--------------------------------|--|--|--|
| Piston Rings—4045DF, TF150 | 0.33—0.58 mm (0.013—0.023 in.) | | | |
| and 6068DF, TF150 Engines End | | | | |
| Gap (No. 1 Compression) | | | | |
| End Gap (No. 2 Compression) | 1.24—1.49 mm (0.049—0.059 in.) | | | |
| End Gap (No. 3 Oil Control) | 0.30—0.56 mm (0.011—0.022 in.) | | | |
| Piston Rings—4045TF250 and | 0.33—0.64 mm (0.013—0.025 in.) | | | |
| 6068TF250 Engines End Gap | | | | |
| (No. 1 Compression) | | | | |
| End Gap (No. 2 Compression) | 0.75—1.00 mm (0.030—0.039 in.) | | | |
| End Gap (No. 3 Oil Control) | 0.33—0.64 mm (0.013—0.025 in.) | | | |

14. Remove all main bearing caps with bearings. Remove crankshaft from engine.



Piston Removal



Piston Removal

RG,10,DT7421 -19-12NOV97-5/5

Remove Cylinder Liners

IMPORTANT: Cap screws and washers must be tight to achieve an accurate liner height reading.

1. Using D17526CI (or D17527CI) Dial Indicator and JDG451 (or KJD10123) Gauge, measure height (A) of each liner at 1, 5, 7, and 11 o'clock positions as viewed from rear of engine. Record all measurements.

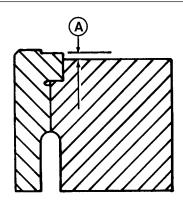
| | | ca | | |
|--|--|----|--|--|
| | | | | |
| | | | | |
| | | | | |

| Cylinder Liner Height above Block | 0.030—0.100 mm |
|-----------------------------------|---------------------|
| | (0.001—0.004 in.) |
| Maximum Permissible Difference | 0.05 mm (0.002 in.) |
| between Readings within One | |
| Cylinder or between Adjacent | |
| Cylinders | |

2. Remove cap screws and washers securing liners to cylinder block.

IMPORTANT: DO NOT stamp top of piston. Piston may be damaged.

Number cylinder liners and pistons. Stamp front of liner to assure correct assembly. Do not stamp liner flange; stamp on fire dam only.



Liner Standout



Marking Cylinder Liner Location/Position

A-Liner Height

Continued on next page

RG,10,DT7420 -19-12NOV97-1/3

IMPORTANT: Keep matched pistons and liners together. Liners must be reinstalled in same cylinder bore.

4. Pull liners out of cylinder block with D01062AA, D01073AA, KCD10001 or JDG1145 Puller.

NOTE: If the KCD10001 Puller is used, secure puller with two cylinder head cap screws.

IMPORTANT: When using D01062AA (or D01073AA) Cylinder Liner Puller (B) to remove liners (A), be sure jaw (C) of puller is correctly positioned before attempting to remove liner. DO NOT over-tighten liner puller to remove liners. Doing so could easily break liners.

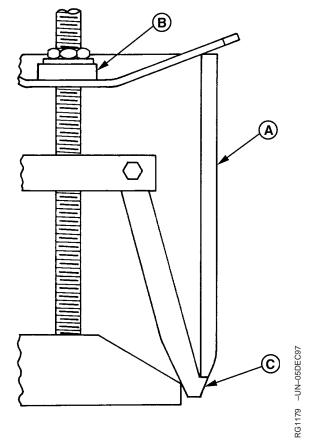
A-Liners

B—Cylinder Liner Puller

C-Jaw



Pulling Cylinder Liners Out of Block



Cylinder Liner Puller

Continued on next page

RG,10,DT7420 -19-12NOV97-2/3

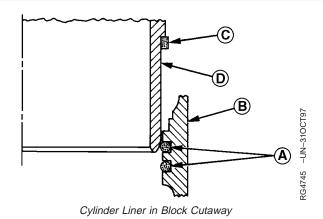
5. Remove cylinder liner O-rings (A) from grooves in cylinder block (B). Also remove packing (C) from cylinder liner (D).

A—O-Rings

B—Cylinder Block

C-Packing

D-Cylinder Liner



RG,10,DT7420 -19-12NOV97-3/3

Complete Disassembly of Cylinder Block (If Required)

If not previously removed, also remove:

- Crankshaft pulley. (See REMOVE PULLEY OR VIBRATION DAMPER AND PULLEY in Group 040.)
- Oil pressure regulating plug, valve, and spring in timing gear cover. (See REMOVE AND INSTALL OIL PRESSURE REGULATING VALVE AND SEAT in Group 060.)
- 3. Timing gear cover, timing gears, and camshaft. (See REMOVE CAMSHAFT in Group 050.)
- 4. Camshaft bushing. (See REMOVE AND INSTALL CAMSHAFT BUSHING in Group 050.)
- Balancer shafts and balancer shaft bushings (if equipped). (See REMOVE AND INSTALL BALANCER SHAFT BUSHINGS in Group 050.)

- 6. Front plate. (See REMOVE CYLINDER BLOCK FRONT PLATE in Group 050.)
- 7. Oil bypass valve. (See REMOVE, INSPECT AND INSTALL OIL BYPASS VALVE in Group 060.)
- 8. Main bearings. (See REMOVE CRANKSHAFT MAIN BEARINGS in Group 040.)
- 9. Crankshaft. (See REMOVE CRANKSHAFT in Group 040.)
- Piston cooling orifices. (See REMOVE, INSPECT AND INSTALL PISTON COOLING ORIFICES in this group.)
- 11. Remove water gallery plugs.
- 12. If necessary to "Hot Tank" the block, also remove screw-in type oil gallery plugs and the engine serial number plate.

RG,10,DT7419 -19-29NOV99-1/1

Preliminary Liner, Piston and Rod Checks

Scuffed or Scored Pistons:

- Insufficient lubrication.
- Insufficient cooling.
- Improper piston-to-liner clearance.
- Coolant leakage in crankcase.
- Misaligned or bent connecting rod.
- Improperly installed piston.
- Low oil level.
- Improper operation.
- Incorrect connecting rod bearing clearance.
- Carbon build-up in ring groove.
- Improper break-in.
- Worn piston.
- · Contaminated oil.
- Distorted cylinder liner.

Worn or Broken Compression Rings:

- Insufficient lubrication.
- Insufficient cooling.
- Improper ring installation.
- Improper combustion.
- · Improper timing.
- Abrasives in combustion chamber.

Clogged Oil Control Ring:

- · Improper oil.
- Excessive blow-by.
- Contaminated oil.
- Improper periodic service.
- Low operating temperature.

Dull Satin Finish and Fine Vertical Scratches on Rings:

Dirt and abrasive in air intake system.

Stuck Rings:

- Improper oil classification.
- Improper periodic service.
- Poor operating conditions.
- Coolant leakage in crankcase.
- Excessive cylinder liner taper.

Cylinder Liner Wear and Distortion:

- · Incorrectly installed compression rings.
- Insufficient lubrication.
- Uneven cooling around liner.
- Improper piston-to-liner clearance.
- Liner bore damage.

Warped Cylinder Block:

Insufficient cooling.

Broken Connecting Rod:

- Inadequate piston-to-liner clearance.
- Worn connecting rod bearing.
- Distorted cylinder liner.
- Piston pin failure.

Piston Pin and Snap Ring Failure:

- Misaligned connecting rod.
- Excessive crankshaft end play.
- Incorrect snap rings.

Mottled, Grayish or Pitted Compression Rings:

Internal coolant leaks.

RG,10,DT7418 -19-12NOV97-1/1

Disassemble Piston and Rod Assembly

IMPORTANT: DO NOT reuse piston rings.

1. Remove piston rings using the JDE135 (shown), JDE85, or KJD10140 Piston Ring Expander.



Piston Ring Removal from Piston

RG,10,DT7417 -19-12NOV97-1/2

- 2. Remove and discard piston pin snap rings.
- 3. Separate piston and rod. Keep these parts in place with their respective cylinder liner.



Piston Pin Snap Ring Removal

RG,10,DT7417 -19-12NOV97-2/2

Clean Pistons



CAUTION: Always follow manufacturer's instructions and safety steps exactly.

 Clean piston ring grooves using a piston ring groove cleaning tool.

IMPORTANT: When washing pistons, always use a stiff bristle brush—NOT A WIRE BRUSH—to loosen carbon residue.

DO NOT bead blast ring groove areas.

- 2. Clean pistons by any of the following methods:
 - Immersion-Solvent "D-Part".
 - Hydra-Jet Rinse Gun.
 - Hot water with liquid detergent soap.

If cleaning with hot water and liquid detergent, soak pistons in a 50 percent solution of liquid household detergent and hot water for 30 to 60 minutes. Use a stiff bristle brush—NOT A WIRE BRUSH—to loosen carbon residue. Dry with compressed air.



Cleaning Piston Ring Grooves

RG,10,DT7424 -19-12NOV97-1/1

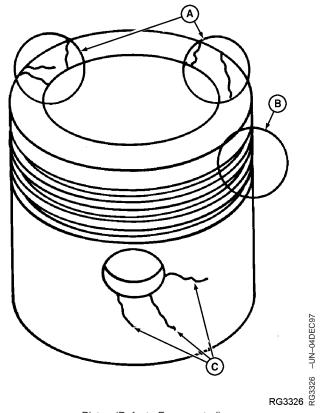
Visually Inspect Pistons

Carefully inspect pistons under magnification. Check for:

- · signs of fatigue
- fine cracks in the piston head (A)
- bent or broken ring lands (B)
- cracks in the skirt (C) at inner and outer ends of piston pin bore
- excessive piston skirt wear (original machining marks must be visible)

If any imperfections are found, replace the piston and liner as a set.

- A-Piston Head
- **B**—Ring Lands
- C—Piston Pin Bore



Piston (Defects Exaggerated)

RG,10,DT7416 -19-12NOV97-1/1

Clean Cylinder Liners

 Use a stiff bristle brush to remove all debris, rust, and scale from OD of liners, under liner flange, and in O-ring packing areas. Make certain there are no nicks or burrs in areas where packings will seat.

IMPORTANT: Do not use gasoline, kerosene or commercial solvents to clean liners.

Solvents will not remove all abrasives from liner walls.

- 2. Thoroughly clean liner ID with a 50 percent solution of hot water and liquid detergent.
- 3. Rinse thoroughly and wipe dry with a clean rag.
- Swab out liner as often as necessary with clean SAE 10W oil. Clean liner until a clean, white rag shows no discoloration.

RG,10,DT7425 -19-12NOV97-1/1

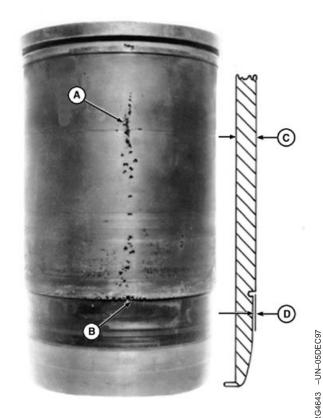
Visually Inspect Cylinder Liners

IMPORTANT: If liner pitting has occurred, check condition of coolant.

NOTE: When installing reusable liners, rotate 90° from original position. The liners should be deglazed and ring sets installed in pistons.

- 1. Inspect exterior length of liner for pitting (A). Check packing step for erosion (B). If pitting or erosion is observed, measure depth of pits with a fine wire or needle. Replace piston and liner if:
 - Depth of any pit is one-half or more of liner thickness
 - · Depth of erosion is one-half or more of the packing step (D).

| | Specification |
|-----------------------------|-----------------------|
| Cylinder Liner Thickness | 5.875—6.375 mm |
| | (0.2313—0.2510 in.) |
| Cylinder Liner Packing Step | 2.0185—2.2865 mm |
| Dimension | (0.07947—0.09002 in.) |
| | |



Cylinder Liner Inspection

A—Liner Pitting

B—Liner Erosion

C—Liner Thickness

D—Packing Step

Continued on next page

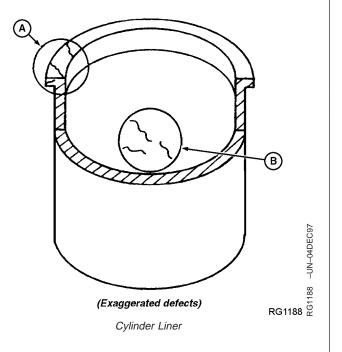
RG,10,DT7415 -19-12NOV97-1/2

030 13

- 2. Visually inspect liner ID. Replace piston and liner if:
 - The crosshatch honing pattern is not visible immediately below the top ring turn-around area for turbocharged engines.
 - The hone pattern is not visible all the way around the liner in over 75 percent of the ring travel area for naturally aspirated engines.
 - Liners are pitted or contain deep vertical scratches that can be detected by the fingernail.
- 3. Carefully examine liner for signs of fatigue, such as fine cracks in the flange area (A) and cracks in the ring travel area (B).

NOTE: Inspect block for cracks or erosion in the O-ring packing areas. (See INSPECT AND CLEAN CYLINDER BLOCK later in this group.)

> A—Flange Area B-Ring Travel Area



RG,10,DT7415 -19-12NOV97-2/2

-UN-04NOV9

RG9059 -UN-16MAR98

Check Piston Ring Groove Wear

Pistons with tapered rods will use JDE62 Ring Groove Wear Gauge and pistons with straight rods will use JDG957 Ring Groove Wear Gauge.

 Use the appropriate ring groove wear gauge (C) to check wear of keystone ring groove (top groove). Check grooves at several locations around the circumference of piston.

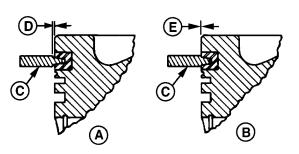
Gauge shoulders should not contact ring land. Clearance (D) between shoulders of tool and ring land indicate ring groove is good.

If ring groove is worn, replace piston and liner as a matched set. If ring groove is good, proceed to next step.

- A-Piston with Good Keystone Ring Groove
- B—Piston with Worn Keystone Ring Groove
- C-Ring Groove Wear Gauge
- D—Clearance (Normal)
- E—No Clearance (Replace)



Piston Ring Groove Wear Gauge



Piston Ring Grooves

RG,10,DT7414 -19-12NOV97-1/2

Check second and third ring grooves using a new piston ring and a feeler gauge. Measure clearance at several points. Compare measurements with specifications.

Specification

3. Replace piston and liner (as a set) if clearance exceeds specification.



Piston Ring Groove Wear

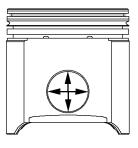
RG,10,DT7414 -19-12NOV97-2/2

Measure Piston Pin Bore

Measure piston pin bore. If bore is not within specification, replace piston and liner set.

Specification

| Piston Pin Bore (Small Pin) ID | 34.935—34.945 mm |
|--------------------------------|---------------------|
| | (1.3754—1.3758 in.) |
| Piston Pin Bore (Large Pin) ID | 41.285—41.295 mm |
| | (1 6254—1 6258 in) |



Piston Pin Bore

RG7402 -UN-23NOV97

RG,10,DT7413 -19-12NOV97-1/1

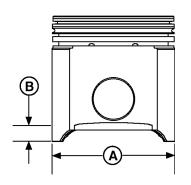
RG7403 -UN-03NOV97

Measure Piston Skirt

 Measure piston skirt (A) 90° to piston pin bore and 28 mm (1.1 in.) from bottom of piston (B). Record measurement.

Specification

- 2. Measure cylinder liner as directed later in this group and compare with piston measurement.
 - A—Piston Skirt B—Measurement Area



Piston Skirt Wear

RG,10,DT7412 -19-12NOV97-1/1

Measure Piston Height

Measure piston height from center of piston pin bore-to-top of piston.

Specification

DPSG,OUO1004,212 -19-09JUL98-1/1

RG7403 -UN-03NOV97

Determine Piston-to-Liner Clearance

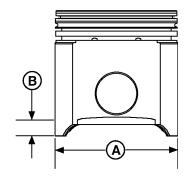
- 1. Measure skirt OD (A) at right angles to piston pin bore, 28 mm (1.1 in.) from the bottom of the piston (B).
- 2. Record measurement and compare measurement obtained from matching liner.

Specification

Piston Skirt OD 28 mm (1.1 in.)...... 106.38—106.40 mm from Bottom of Piston (4.188—4.189 in.)

A—Skirt OD

B—Bottom of Piston Dimension



Measuring Piston Skirt

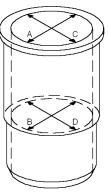
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DPSG,OUO1004,1169 -19-23NOV99-1/2

IMPORTANT: ALWAYS measure liners at room temperature.

- 3. Measure liner bore parallel to piston pin at top end of ring travel (A).
- 4. Measure bore in same position at bottom end of ring travel (B).
- 5. Measure bore at right angle to piston pin at top end of ring travel (C).
- 6. Measure bore in same position at bottom end of ring travel (D).
- 7. Compare measurements A, B, C, and D to determine if liner is tapered or out-of-round.
- Compare liner ID with matched piston OD. Replace piston and liners (as a set) if they exceed wear specifications given.

| Specification | | |
|--------------------------------|---------------------|--|
| Cylinder Liner ID | 106.48—106.52 mm | |
| | (4.192—4.194 in.) | |
| Cylinder Liner (Top or Bottom) | 0.05 mm (0.002 in.) | |
| Maximum Out-of-Round | | |
| Cylinder Liner Maximum Taper | | |
| Piston-to-Liner Clearance | 0.08—0.14 mm | |
| (Measured at Bottom of Piston | (0.003—0.005 in.) | |
| Skirt) (Naturally Aspirated | | |
| Engines) Clearance | | |
| Piston-to-Liner Clearance | 0.08—0.15 mm | |
| (Measured at Bottom of Piston | (0.003—0.006 in.) | |
| Skirt) (Turbocharged Engines) | | |
| Clearance | | |



Measuring Liner ID

RG10049 -UN-25MAY99

DPSG,OUO1004,1169 -19-23NOV99-2/2

- 1. Secure cylinder liner in a holding fixture. (See Dealer Fabricated Service Tools, Section 05, Group 190 for assembly of holding fixture.)
- 2. Use D17004BR Flexible Cylinder Hone to deglaze cylinder liner.

NOTE: Use honing oil along with flex hone when deglazing liners.



Cylinder Liner Deglazing

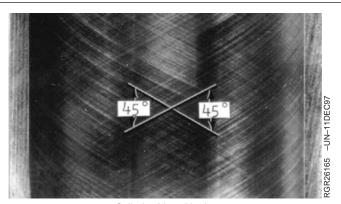
RGR26164 -UN-11DEC97

030

RG,10,DT7410 -19-12NOV97-1/2

3. Use D17004BR Hone according to instructions supplied with tool to obtain a 45° cross-hatch pattern.

Thoroughly clean liners after deglazing. See CLEAN CYLINDER LINERS earlier in this group for proper cleaning procedures.



Cylinder Liner Honing

RG,10,DT7410 -19-12NOV97-2/2

Replace Piston and Liner Sets

IMPORTANT: ALWAYS install a new (matched set) liner when replacing a piston. DO NOT stamp top of piston. Piston may be damaged.

Mark matched piston and liner for placement in the same cylinder location.

RG,10,DT7426 -19-12NOV97-1/1

Inspect and Measure Connecting Rod Bearings (Rods Removed from Engine)

- 1. Inspect rod bearings for damage or wear.
- 2. Measure crankshaft rod journal OD at several points.

Specification

 Assemble connecting rod, cap, and bearings with OLD cap screws. Tighten cap screws to 58 N•m (43 lb-ft). Tighten cap screw an additional 90—100°. (See TORQUE-TURN CONNECTING ROD CAP SCREWS later in this group.)



Measure Crankshaft Rod Journal

RG,10,DT7409 -19-12NOV97-1/2

4. Measure assembled rod bearing ID.

Specification

5. Subtract crankshaft journal OD from rod bearing ID to determine oil clearance. Replace bearings if oil clearance is out of specification.

Specification

| Connecting Rod | 0.050—0.127 mm |
|--------------------------------|-----------------------|
| Bearing-to-Journal (New Parts) | (0.0020—0.0050 in.) |
| Oil Clearance | |
| Wear Limit | 0.152 mm (0.0600 in.) |



Measuring Rod Bearing ID

RG,10,DT7409 -19-12NOV97-2/2

Inspect and Measure Connecting Rod Bearings (Rod and Crankshaft in Engine)

IMPORTANT: Use hand wrenches. Pneumatic wrenches may cause thread damage.

NOTE: Use PLASTIGAGE® as directed by manufacturer. PLASTIGAGE® will determine oil clearance, but will not indicate condition of either surface.

- Remove rod cap. Place a piece of PLASTIGAGE® in center of bearing. Install rod cap using OLD cap screws. Tighten cap screws to 58 N•m (43 lb-ft). Tighten cap screw an additional 90—100°. (See TORQUE-TURN CONNECTING ROD CAP SCREWS later in this group.)
- 2. Remove rod cap. Compare width of PLASTIGAGE® with scale provided on package to determine clearance. Replace bearings if oil clearance is out of specification.



Measure Rod Oil Clearance

PLASTIGAGE is a registered trademark of the DANA Corp.

DPSG,OUO1004,52 -19-16APR98-1/1

Inspect Rod and Cap

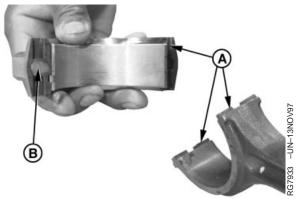
1. Inspect rod and cap for wear or damage, such as chips or nicks in the joint area (A).

IMPORTANT: Do not nick the joint surfaces of the rod and cap. This is very critical on PRECISION JOINT™ rods to ensure proper seating. Never scrape these surfaces (C) with a wire brush or other tool. The interlocking mating surfaces must be preserved.

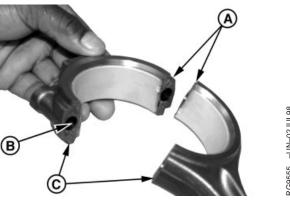
- 2. Inspect in and around cap screw holes (B) in cap. If any imperfections are found, replace rod and cap.
- 3. Carefully clamp rod in a soft-jawed vise (cap end upward).

IMPORTANT: Never use new connecting rod cap screws when checking rod bore ID. Use new cap screws only for final assembly of connecting rods.

- 4. Install cap WITHOUT bearing inserts. Use old cap screws.
- 5. Tighten cap screws to 58 N•m (43 lb-ft). Turn cap screws an additional 90—100°. See TORQUE-TURN CONNECTING ROD CAP SCREWS later in this group.



Tongue-and-Groove Rod and Cap



PRECISION JOINT™ Rod and Cap

- A—Joint Area
- B—Cap Holes
- **C—PRECISION JOINT™ Surfaces**

PRECISION JOINT is a trademark of Deere & Company

Continued on next page

RG,10,DT7408 -19-12NOV97-1/2

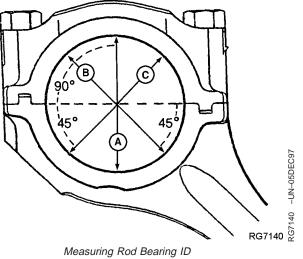
- 6. Using an inside micrometer, measure rod bore at center of bore and record measurements as follows:
 - At right angle to rod-to-cap joint (A).
 - At 45 degrees left of measurement step "A" (B).
 - At 45 degrees right of measurement step "A" (C).
- 7. Compare measurements to specifications.

Specification

8. If difference between the greatest and least measurement exceeds out-of-round specification, replace connecting rod.

Specification

Connecting Rod Bore Maximum 0.038 mm (0.0015 in.) Permissible Out-of-Round



RG,10,DT7408 -19-12NOV97-2/2

Inspect Piston Pins and Bushings

1. Visually inspect piston pin. Pin must be in good condition with no visible wear.

IMPORTANT: Do not attempt to polish or refinish piston pin. Pin has a highly polished surface.

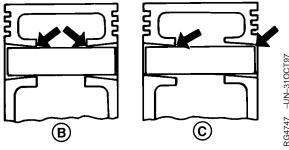
- 2. Dip piston pin in clean engine oil.
- 3. Install pin (A) through piston. Pin should pass through piston using only light thumb pressure.
- 4. Insert pin from both sides. If pin enters freely, but binds in the center, the bore could be tapered (B).
- 5. Insert pin to check for bore alignment (C). Pin should not "click" or need to be forced into bore on opposite side.
- 6. Measure piston pin OD. Replace if not within specification.

| Specification | | |
|-----------------------|------------------------|--|
| Piston Pin (Small) OD | 34.920—34.930 mm | |
| | (1.3748—1.3752 in.) | |
| Wear Limit | 34.907 mm (1.3743 in.) | |
| Piston Pin (Large) OD | 41.270—41.280 mm | |
| | (1.6248—1.6252 in.) | |
| Wear Limit | 41.257 mm (1.6243 in.) | |
| Piston Pin Length | 71.51—72.11 mm | |
| | (2.815—2.839 in.) | |

- A—Piston Pin
- **B**—Tapered Bore
- C—Bore Alignment



Piston Pin and Bushing



Piston Pin Wear Points



Measuring Piston Pin OD

RG7473 -UN-23NOV97

Continued on next page

RG,10,DT7407 -19-12NOV97-1/2

NOTE: Straight-end rods have an oil hole; tapered-end rods do not.

- 7. Lubrication hole must be open.
- 8. Measure pin bushing ID and compare to pin OD to determine oil clearance.

| Specification | ۱ |
|---------------|---|
|---------------|---|

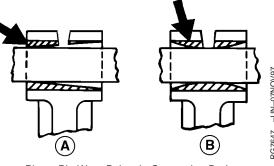
| Piston Pin Bushing Installed | 34.950—34.976 mm |
|------------------------------|------------------------|
| (Small Pin) ID | (1.3760—1.3770 in.) |
| Wear Limit | 35.026 mm (1.3790 in.) |
| Piston Pin Bushing Installed | 41.300—41.326 mm |
| (Large Pin) ID | (1.6260—1.6270 in.) |
| Wear Limit | 41.376 mm (1.6290 in.) |
| Piston Pin-to-Bushing Oil | 0.020—0.056 mm |
| Clearance | (0.0008—0.0022 in.) |
| Wear Limit | 0.102 mm (0.0040 in.) |
| | |

 Insert pin from either side of rod bushing. If pin is free on one end, but tight on the other, the bore could be tapered (A). If pin enters freely from both sides, but is tight in the center, bore is bell mouthed (B).

> A—Tapered Bore B—Bell Mouthed Bore



Measuring Connect Rod Pin Bore ID



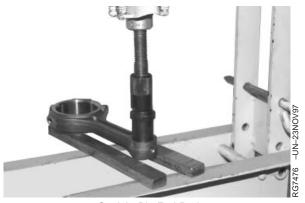
Piston Pin Wear Points in Connecting Rod

RG,10,DT7407 -19-12NOV97-2/2

Remove Piston Pin Bushing

Removing Piston Pin Bushing on Straight Pin-End Rod

Use JD286 (JD-286) Piston Pin Bushing Remover and Installer for 41 mm (1.6 in.) pin, or JDE88 Piston Pin Bushing Remover and Installer for 35 mm (1.3 in.) pin to remove bushing.



Straight Pin-End Rod

Continued on next page

RG,10,DT7406 -19-12NOV97-1/2

Removing Piston Pin Bushing on Tapered Pin-End Rod

- Select JDG953-1 Driver (A) and JDG953-2 Receiver Cup (B) from JDG953 Connecting Rod Bushing Service Set to remove bushing (C) from tapered rod.
- 2. Slide driver into one side of rod bushing. Turn driver until taper on driver flange matches up with taper on the bushing.
- 3. Install receiver cup onto opposite side of rod bushing.

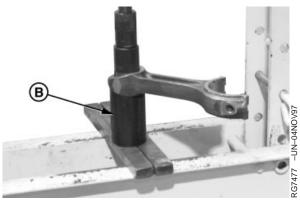
NOTE: Stud in cup keeps rod properly located on the cup.

IMPORTANT: If bushing is heavily worn, the driver may contact the ID of the rod bore. Be careful not to damage the rod bore.

- 4. Using hydraulic press, press bushing out of the rod until driver and bushing fall into receiver cup.
- 5. Clean, inspect, and measure ID of rod pin bore, as described later in this group.



Tapered Pin-End Rod



Tapered Pin-End Rod

A—JDG953-1 Driver B—JDG953-2 Receiver Cup C—Bushing

RG,10,DT7406 -19-12NOV97-2/2

-UN-04NOV97

Clean and Inspect Connecting Rod Pin Bore

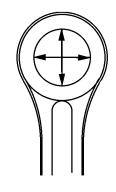
- 1. Clean bore of rod with medium grit emery cloth.
- 2. Inspect for cracks or other damage. Make sure that lube oil hole in top of straight pin-end rod is open.

IMPORTANT: If bushing has spun in rod, replace connecting rod.

3. Measure bore diameter in two places, 90° apart. Replace rod if not within specification.

Specification

| Connecting Rod Small Pin Bore | 38.087—38.113 mm |
|-------------------------------|---------------------|
| (Bushing Removed) ID | (1.4995—1.5005 in.) |
| Connecting Rod Large Pin Bore | 46.025—46.051 mm |
| (Bushing Removed) ID | (1.8120—1.8130 in.) |



Connecting Rod Pin Bore

RG7478 -UN-23NOV97

030

RG,10,DT7405 -19-12NOV97-1/1

Install Piston Pin Bushing in Connecting Rod

Carefully file a slight chamfer on edge of rod pin bore. Remove any burrs or sharp edges from edge of bushing bore.

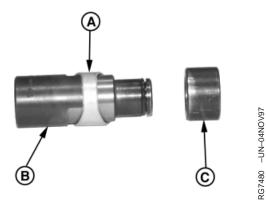
NOTE: Tapered pin-end rods do not have a lubrication hole in the rod or bushing.

Installing Piston Pin Bushing in Tapered Pin-End Rod

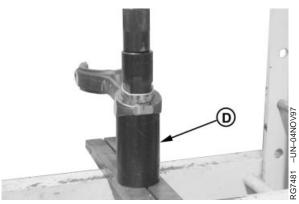
- 1. Slide bushing (A) onto JDG953-1 Driver (B) and install JDG738-2 Installer Pilot (C) onto O-ring end of driver. Apply clean engine oil or grease to OD of new bushing, OD of pilot ring, and ID of rod pin bore.
- 2. Insert driver into rod pin bore so pilot ring pilots in rod bore, and bushing taper aligns with taper on driver flange.
- 3. Install JDG953-2 Receiver Cup (D) onto the opposite side of rod.
- 4. Press bushing into rod bore until edge of bushing is flush or just slightly below rod face.
- 5. If necessary, have the new bushing reamed by a specialized machine shop to obtain specified oil clearance with piston pin.

Specification

Connecting Rod Pin-to-Bushing...... 0.020—0.056 mm (Tapered Pin-End) Oil Clearance (0.0008—0.0022 in.)



Piston Pin Bushing in Installation Tool



Receiver Cup on Connecting Rod

A-Piston Pin Bushing

B-JDG953-1 Driver

C—JDG738-2 Installer Pilot

D-JDG953-2 Receiver Cup

Continued on next page

RG,10,DT7404 -19-12NOV97-1/2

CTM104 (19JUN00)

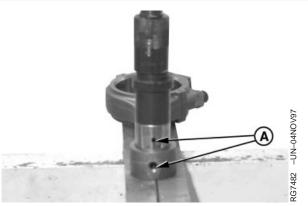
Installing Piston Pin Bushing in Straight Pin-End Rod

IMPORTANT: Oil holes (A) MUST be aligned. If holes are not aligned, remove and discard bushing. Install a new bushing. DO NOT attempt to reuse the bushing. Install bushing in rod.

- Use JD286 (JD-286) Piston Pin Bushing Remover and Installer for 41 mm (1.6 in.) pin or JDE88 Piston Pin Bushing Remover and Installer for 35 mm (1.3 in.) pin to install bushing.
- 2. Press bushing into rod bore until edge of bushing is flush or just slightly below machined surface on face of rod.
- 3. Remove rod from press.
- 4. ID of new bushing must be precision bored by specialized machine shop to specifications.

Specification

| Connecting Rod Pin-to-Bushing | 0.020—0.056 mm |
|----------------------------------|-----------------------|
| (Straight Pin-End) Oil Clearance | (0.0008-0.0022 in.) |
| Wear Limit | 0.102 mm (0.0040 in.) |



Piston Pin Bushing and Rod Oil Holes

A-Oil Holes

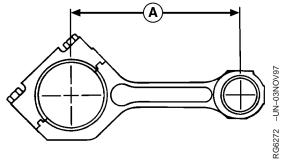
RG,10,DT7404 -19-12NOV97-2/2

Measure Rod Center-to-Center Bores

Measure rod center-to-center bores (A) (with bushings removed). Compare to specifications given below. Replace rod if necessary.

Specification

A-Center-to-Center Measurement



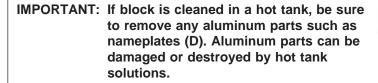
Measure Rod Center-to-Center Bores

RG,10,DT7403 -19-12NOV97-1/1

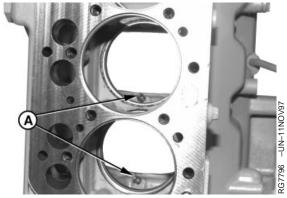
Inspect and Clean Cylinder Block

Before inspecting and cleaning cylinder block, remove all of the following:

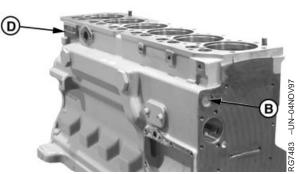
- piston cooling orifices (A) (see REMOVE, INSPECT AND INSTALL PISTON COOLING ORIFICES later in this group)
- soft plugs (B)
- oil gallery plugs (C) (using JDG782 Oil Gallery Plug Tool)
- all external and internal mounted components (refer to the proper group for removal procedures)



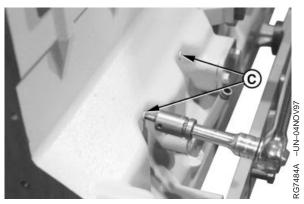
- 1. Clean block thoroughly using cleaning solvent, pressure steam, or a hot tank.
- 2. All passages and crevices must be clear of sludge, and grease.
- 3. All coolant passages must be clear of lime deposits and scale.
 - A—Piston Cooling Orifice
 - **B—Soft Plug**
 - C-Oil Gallery Plug
 - D-Nameplate



Cylinder Block Piston Cooling Orifice



Cylinder Block Plug and Nameplate



Cylinder Block Oil Gallery Plug

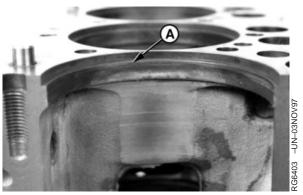
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RG,10,DT7402 -19-29NOV99-1/3

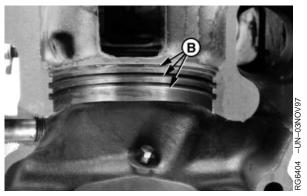
IMPORTANT: DO NOT file liner support flange excessively. Excess filing can damage liner support flange and allow an improper liner fit. Thoroughly clean all filings from cylinder block.

- 4. Inspect liner support flange (A) for burrs. If burrs are present, use a small half-moon file and LIGHTLY file (in a circular motion) burr off at a 60° angle. DO NOT let file hit top of cylinder block while filing.
- 5. Carefully inspect block for cracks or damage. If a cracked block is suspected, pressure-test the block. A procedure for pressure testing is outlined in FOS (Fundamentals of Service) Manual—ENGINES. Check for erosion or cracks in the liner O-ring/packing area (B). Replace cracked or damaged blocks.
- 6. If cylinder block is serviceable, clean out all threaded holes for cylinder head mounting cap screws in top deck of cylinder block, using JDG680 Tap (C) or an equivalent 1/2-13 UNC-2A x 76 mm (3.0 in.) long tap. Remove debris or fluid from tapped holes with compressed air.
- After service of cylinder block, reinstall piston cooling orifices. (See REMOVE, INSPECT AND INSTALL PISTON COOLING ORIFICES later in this group.)

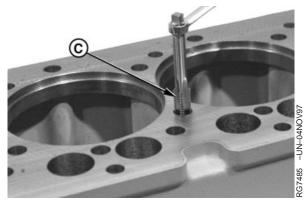
A—Liner Support Flange B—O-Ring/Packing Area C—JDG680 Tap



Liner Support Flange



Liner O-Ring/Packing Area



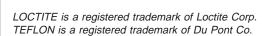
Cleaning Threaded Holes in Cylinder Block

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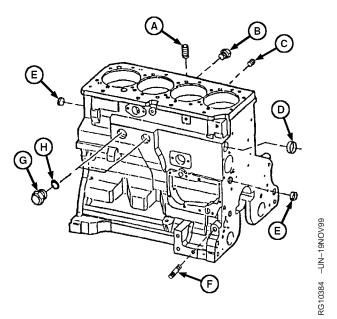
RG,10,DT7402 -19-29NOV99-2/3

- 8. Apply LOCTITE® 277 Rigid Form-in-Place Gasket to steel caps/soft plugs and install caps in block.
- Apply LOCTITE® 242 Thread Lock and Sealer to oil gallery plugs. Install plugs and tighten to specifications below.
- Apply LOCTITE® 592 Pipe Sealant with TEFLON® to coolant gallery plugs. Install plugs and tighten to specifications.

| Cylinder Block Oil and Coolant Gallery Plugs- | -Specification |
|---|-------------------|
| 1/2 in. Plug (W/O Turbocharger, | 45 Nem (33 lb-ft) |
| Return Port) Torque | |
| 1/4 in. Plug (Coolant Gallery) | 17 N•m (13 lb-ft) |
| Torque | |
| 1/8 in. Plug (Oil Gallery) Torque | 17 Nem (13 lb-ft) |
| 3/8 in. Plug (Oil Gallery) Torque | 45 Nem (33 lb-ft) |
| 1-5/8 in. Steel Plug (Coolant | 60 N•M (44 lb-ft) |
| Gallery) ¹ Torque | |
| 1-5/8 in. Composite Plug (Coolant | 30 Nem (22 lb-ft) |
| Gallery) ² Torque | |



¹ (Saran "CD" engines —540458)



Cylinder Block Plugs and Caps

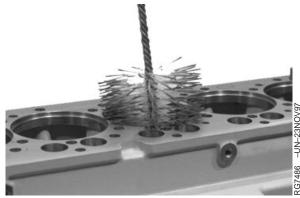
- A—1/2 in. Plug (W/O Turbocharger, Return Port)
- B—1/4 in. Plug (Coolant Gallery)
- C—1/8 in. Plug (Oil Gallery)
- D—Cap
- E—Cap
- F-3/8 in. Plug (Oil Gallery)
- G-1-5/8 in. Plug (Coolant Gallery)
- H-O-Ring

RG,10,DT7402 -19-29NOV99-3/3

Clean Cylinder Liner O-Ring Bore

Use D17015BR O-Ring Groove Cleaning Brush to thoroughly clean lower liner O-ring bore.

NOTE: Use brush exactly as directed by the manufacturer.



O-Ring Groove Cleaning Brush

² (Saran "CD" engines 540459—)

Measure Cylinder Block Main Bearing Bore

Measure main bearing bore diameter.

Specification

If bearing caps are damaged, or bore is not within specification, replace caps and line bore to specifications. (See MEASURE ASSEMBLED ID OF MAIN BEARING CAPS in Group 040.)



Measuring Cylinder Block Main Bearing Bore

RG,10,DT7427 -19-12NOV97-1/1

Measure Camshaft Follower Machined Bore in Block

Measure camshaft follower bore diameter at all bore locations.

Specification

| Camshaft Follower Bore in Block | 31.70—31.75 mm |
|---------------------------------|-------------------|
| ID | (1.248—1.250 in.) |
| Camshaft Follower (New) OD | 31.61—31.64 mm |
| | (1.245—1.246 in.) |
| Camshaft Follower-to-Bore | 0.06—0.13 mm |
| Clearance | (0.002—0.005 in.) |

If any one camshaft follower bore ID and follower-to-bore clearance exceed specified maximum, install a new cylinder block.



Measuring Camshaft Follower Bore

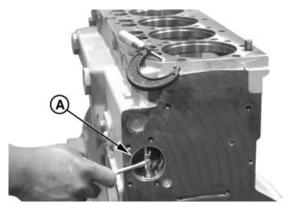
RG,10,DT7400 -19-11NOV97-1/1

Measure Camshaft Bushing Bores in Block

Replaceable bushings (A) are installed in front camshaft bore only. Remaining bores in cylinder block act as camshaft bushings.

 Visually inspect and measure front camshaft bushing ID. If bushing is worn or not within specification, install new bushings. (See REMOVE AND INSTALL CAMSHAFT BUSHING in Group 050.)

A—Bushings



Measuring Camshaft Bushing Bores

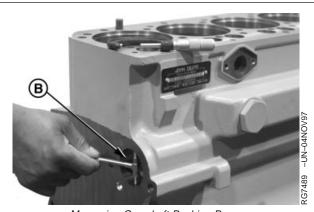
RG,10,DT7399 -19-11NOV97-1/2

-UN-05JAN98

- If necessary to replace bushing, remove bushing and measure bore diameter in block. If bushing bore (B) in block is not within specification, repair or replace cylinder block as required.
- 3. Measure remaining camshaft bores in block and compare with specification given. Repair or replace cylinder block as required.

Specification

| Camshaft Bore in Block, Front | 59.961—59.987 mm |
|---|---------------------|
| No. 1 (Without Bushing) ID | (2.3607—2.3617 in.) |
| Camshaft Bore in Block, Front | 55.961—55.987 mm |
| No. 1 (With Bushing) ID | (2.2031—2.2042 in.) |
| Camshaft Bore in Block (All | 55.986—56.012 mm |
| Except No. 1) ID | (2.2042—2.2052 in.) |
| Camshaft Journal-to-Bushing (No | 0.063—0.115 mm |
| 1 Bore With Bushing) Oil | (0.0025—0.0045 in.) |
| Clearance | |
| Camshaft Journal-to-Bushing (All | 0.088—0.140 mm |
| Except No. 1) Oil Clearance | (0.0035—0.0055 in.) |
| , | (, |



Measuring Camshaft Bushing Bores

A—Bushing Bore

RG,10,DT7399 -19-11NOV97-2/2

Measure Balancer Shaft Bushing ID in **Block—4-Cylinder Engines**

1. Visually inspect and measure balancer shaft bushing ID with bushing removed (A) and with bushing installed

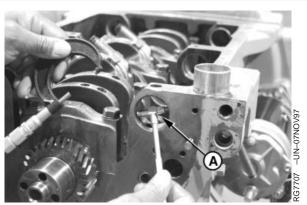
If bushing is worn or not within specification, install new bushings. (See REMOVE AND INSTALL BALANCER SHAFT BUSHINGS in Group 050.)

2. If necessary to replace bushing, remove bushing and measure bore diameter in block.

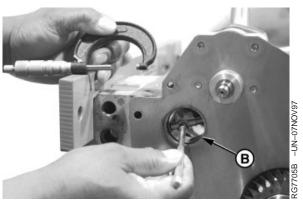
If bore diameter in block is not within specification, install a new cylinder block.

Specification

A-Bore without Bushing B-Bore with Bushing



Balancer Shaft Bore ID (Bushing Removed)



Balancer Shaft Bore ID (Bushing Installed)

RG,10,DT7398 -19-18MAY00-1/1

Measure Cylinder Liners and Block Bores

Measure cylinder liners and block bores. Replace liners not within specifications.

Specification

| Lower Block Bore for Seating | 115.75—115.80 mm |
|-----------------------------------|---------------------|
| Liner ID | (4.557—4.559 in.) |
| Upper Block Bore for Seating | 120.70—120.75 mm |
| Liner ID | (4.752-4.754 in.) |
| Liner Flange in Block ID | 126.33—126.35 mm |
| | (4.973-4.974 in.) |
| Liner at Upper Bore OD | 120.61—120.69 mm |
| | (4.7484—4.7516 in.) |
| Liner-to-Cylinder Block Clearance | 0.035—0.100 mm |
| at Lower Bore | (0.001—0.004 in.) |
| Liner-to-Cylinder Block Clearance | 0.10—0.14 mm |
| at Upper Bore | (0.004—0.005 in.) |
| Cylinder Liner ID | 106.48—106.52 mm |
| | (4.192—4.194 in.) |
| Cylinder Maximum Wear | 0.10 mm (0.004 in.) |
| Cylinder Maximum Taper | 0.05 mm (0.002 in.) |
| Cylinder Maximum Out-of-Round | 0.05 mm (0.002 in.) |

DPSG,OUO1004,213 -19-09JUL98-1/1

Measure Liner Flange Counterbore Depth in **Block**

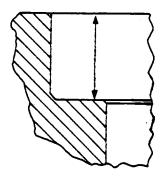
Measure liner flange counterbore depth in block and compare to specification given below. If depth is not within specification, liner shims are available.

Specification

| Cylinder Liner Flange | 5.952- | -5.988 | mm |
|-------------------------------|--------|---------|--------|
| Counterbore Depth in Block (0 | .2343- | -0.2357 | ' in.) |



Measure Liner Flange Counterbore Depth



Liner Flange Counterbore Depth

RG,10,DT7397 -19-11NOV97-1/1

Measure Liner Flange Thickness

Measure cylinder liner flange thickness at several locations. If liner flange is not within specifications, liner shims are available or replace piston and liner set.

Specification

(0.2371—0.2385 in.)



Measuring Liner Flange Thickness

RG,10,DT7396 -19-11NOV97-1/1

Measure Cylinder Block Top Deck Flatness

IMPORTANT: When cylinder block top deck or main bearing bores are machined, the dimension from crankshaft centerline to top deck will be changed. Make sure this dimension is within specifications, otherwise piston may contact cylinder head.

Measure cylinder block top deck flatness using D05012ST Precision Straightedge and feeler gauge. If flatness is not as specified, clean up top deck of cylinder block.

Cylinder Block Top Deck—Specification

| Maximum Acceptable Out-of-Flat, 0.08 mm (0.003 in.) |
|--|
| Entire Length or Width (Used) |
| Measurement |
| Maximum Acceptable Out-of-Flat 0.025 mm (0.001 in.) |
| (Any 150 mm [5.90 in.] Length) |
| Measurement |
| Top Deck (Surface Grind Only) 0.8—3.2 micrometers |
| (AA) Surface Finish (32—125 micro-in.) |
| Top Deck Surface Finish 0.012 mm (0.0005 in.) |
| Maximum Wave Depth |
| Main Bearing Bore |
| Centerline-to-Cylinder Block Top (13.3029—13.3059 in.) |
| Deck Distance |



Measuring Cylinder Block Top Deck Flatness

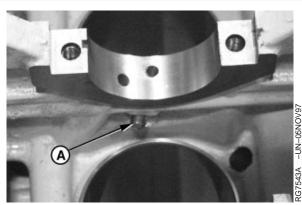
RG,10,DT7395 -19-11NOV97-1/1

Remove, Inspect, and Install Piston Cooling Orifices

IMPORTANT: A piston cooling orifice failure could cause damage to pistons, piston pins, rod pin bushings and liners. If a piston cooling orifice is left out, low or no oil pressure will result.

 Remove and clean each piston cooling orifice (A) to make sure it is not plugged or damaged. Replace if questionable.





Piston Cooling Orifice

RG,10,DT7394 -19-11NOV97-1/2

NOTE: If equipped with early design orifice (B), add a punch mark (C) to each orifice as shown. This is not necessary on later design orifice (D) because of its different shape. Adding a punch mark to orifice (B) will also prevent cooling jets from being mistakenly used on 300-Series Engines.

POWERTECH® Engines use a larger orifice diameter cooling jet for proper lubrication and cooling of piston skirts.

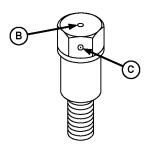
2. Install and tighten orifices.

Specification

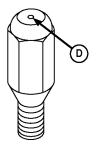
B—Early Design Orifice

C-Punch Mark

D-Later Design Orifice



Early Design Orifice



Later Design Orifice

RG,10,DT7394 -19-11NOV97-2/2

3G9066 -UN-16MAR98

3G9065 -UN-16MAR98

CTM104 (19JUN00)

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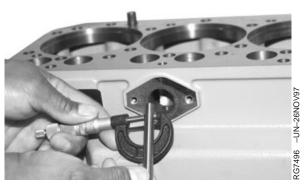
Measure Fuel Supply Pump Push Rod Bore and Push Rod OD

- 1. Visually inspect and measure fuel supply pump push rod OD.
- 2. If rod is worn or not within specification, install a new rod.

| Specification | | |
|---------------------------|---------------------|--|
| Push Rod OD | 9.891—9.917 mm | |
| | (0.3894—0.3904 in.) | |
| Push Rod Bore in Block ID | 10.00—10.05 mm | |
| | (0.3937—0.3957 in.) | |



Fuel Supply Pump Push Rod Bore



Fuel Supply Pump Push Rod OD RG,10,DT7393 -19-11NOV97-1/1

Measure Cylinder Liner Standout (Height above Block)

NOTE: If a new liner assembly is being installed in a new or used cylinder block, liner height must be checked.

1. Be sure liner bore in cylinder block and top deck of block are clean.

IMPORTANT: Liner should rotate smoothly by hand when installed without O-rings or packing. If not, remove liner and clean block.

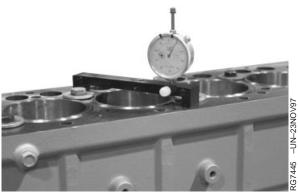
Install liner without O-rings and packing. If liner does
not rotate smoothly by hand, remove liner and polish
lower pilot bore in block with emery cloth or D17015BR
Brush. Use a shop towel or other suitable means to
collect debris when polishing bore.

Locate liner mark toward the front of the engine. Secure with cap screws and washers (approximately 3 mm [1/8 in.] thick). Tighten screws to 68 N•m (50 lb-ft).

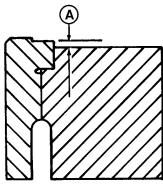
3. Using JDG451 or KJD10123 Gauge and D17526Cl or D17527Cl Dial Indicator, measure height (A) of liner at 1, 5, 7, and 11 o'clock positions as viewed from flywheel end of engine.

Specification

| Specification | |
|-----------------------------------|---------------------|
| Cylinder Liner Height above Block | 0.030—0.100 mm |
| | (0.001—0.004 in.) |
| Maximum Permissible Height | 0.05 mm (0.002 in.) |
| Difference at Nearest Point of | |
| Two Adjacent Liners, or Within a | |
| Single Liner | |
| | |



Cylinder Liner Standout



RG6439 -UN-03NOV97

Cylinder Liner Standout

A-Liner Height

Continued on next page

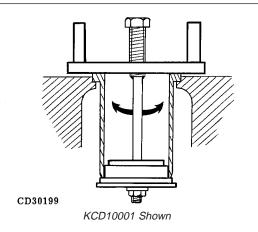
RG,10,DT7392 -19-11NOV99-1/2

4. If liner height is above specification, check cylinder block for burrs on liner support flange or incorrect counterbore depth. If burrs are present, apply lapping compound to liner flange shoulder in the block, then install liner and turn to left and right using KCD10001 or JDG1145 Cylinder Liner Puller to rub off enough material to seat liner as necessary.

IMPORTANT: ONE LINER SHIM ONLY may be installed under each liner flange. If liner requires more than one shim, install a new liner or cylinder block.

5. If liner height is no more than 0.08 mm (0.003 in.) below top deck of block, install one liner shim under liner flange.

NOTE: Two shim sizes are available; 0.05 mm (0.002 in.) CD15466 liner shim and 0.10 mm (0.004 in.) R65833 liner shim.

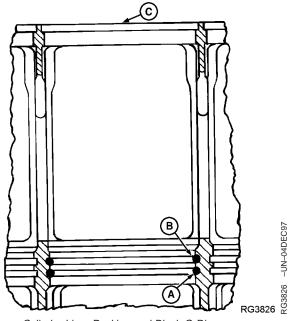


RG,10,DT7392 -19-11NOV99-2/2

Install Packing on Cylinder Liner and O-Rings in Block

IMPORTANT: DO NOT use oil or hand cleaner soap on cylinder liner packing or O-rings. Petroleum products will cause the red (or white) O-ring to swell, which may result in O-ring damage during liner installation.

- Pour AR54749 Soap Lubricant into a suitable container.
- 2. Dip O-rings in AR54749 Soap Lubricant.
- 3. Install the black O-ring (A) in the lower O-ring groove in the cylinder block (C).
- 4. Install the red (or white) O-ring (B) in the upper O-ring groove in the cylinder block.



Cylinder Liner Packing and Block O-Rings

A—Black O-Ring

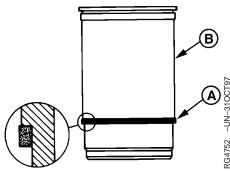
B-Red or White O-Ring

C—Cylinder Block

Continued on next page

RG,10,DT7391 -19-11NOV97-1/2

- 5. Turn cylinder liner (B) upside-down. Dip square packing (A) in soap lubricant and install over outside of liner.
- 6. Slide packing down firmly against shoulder on liner. Make sure packing is not twisted.
- 7. Coat the liner packing sealing area of the cylinder liner and block O-rings with soap lubricant.
 - A—Square Packing
 - B—Cylinder Liner



Cylinder Liner Packings and O-Rings

RG,10,DT7391 -19-11NOV97-2/2

RG10370 -UN-30SEP99

Install Cylinder Liner in Block

IMPORTANT: There are different manufacturers/part

numbers for piston and liner sets. These sets are not interchangeable. DO NOT intermix piston/liner sets on the same engine. Check parts catalog for correct applications.

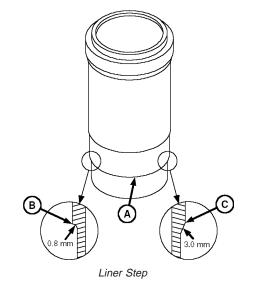
IMPORTANT: Install cylinder liners into same cylinder block bore as removed. DO NOT scuff the liner packing across the upper counterbore.

> Pitted or eroded liners that meet reuse guidelines should be rotated 90° from their removed position. (See VISUALLY **INSPECT CYLINDER LINERS earlier in** this group for reuse guidelines.)

> Early liners were machined with an 0.8 mm step radius which could cause damage to seals during liner installation. On these liners, blunt the sharp edge (B) of step to a 45° chamfer with a honing stone or emery cloth. Newer liners have a 3.0 mm step radius (C) allowing for installation of liners without damage to seals.

1. Install liner in block bore with mark (made during disassembly) toward front of engine, unless liner OD is pitted or eroded.

If liner OD is pitted or eroded, but still within acceptable service limits, rotate liner 90° from its removed position. Pitted sections of the liner should be facing the front or rear of engine.



A-Liner Step

B-0.8 mm Step Radius

C-3.0 mm Step Radius

Continued on next page

RG,10,DT7390 -19-06JAN00-1/2

NOTE: Using KCD10001 (A) or JDG1145 Puller is the preferred method for seating cylinder liners.

 A resistance will be felt when cylinder liner is aligned in pilot bore. Finish seating liners using KCD10001 (A) or JDG1145 Puller.

A clean, hardwood block and mallet may be used if puller is not available. Gently tap hardwood block over top of cylinder liner with mallet.

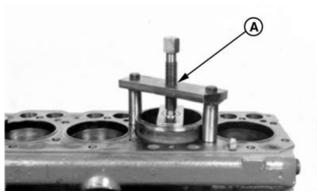
NOTE: Cylinder liner will protrude over top of cylinder block more than normal due to uncompressed packings and O-rings.

IMPORTANT: If you suspect a packing may have sheared or been displaced during liner installation, remove and examine the liner and packing assembly. If no damage is found, check packings for proper position. Resoap packings and reinstall liner assembly.

- 3. Hold liners in place with large flat washers and cap screws. Turn cap screws snug but do not tighten.
- 4. Clean cylinder liner bores with waterless hand cleaner after installation. Wipe dry with clean towels.
- 5. Apply clean engine oil to liner bores immediately to prevent corrosion.



Install Cylinder Liner in Block



Install Cylinder Liner in Block (Preferred Method)

A-KCD10001 Liner Puller

RG,10,DT7390 -19-06JAN00-2/2

3 CCD6373 -UN-31OCT97

Assemble Piston and Connecting Rod

IMPORTANT: There are different manufacturers/part numbers for piston and liner sets.

These sets are not interchangeable. DO NOT intermix piston/liner sets on the same engine. Check parts catalog for

correct applications.

IMPORTANT: If a new piston and liner assembly is to be installed, DO NOT remove piston from liner. Push piston out of liner bottom only far enough to install piston

pin.

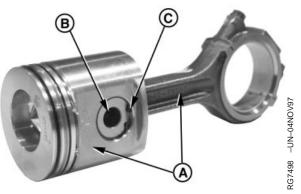
1. Lubricate piston pin and bushing with clean engine oil.

IMPORTANT: Pistons must be installed on connecting rods from which they were removed, and new piston pin snap rings must be used. Piston and connecting rod must be assembled so combustion bowl in piston is offset toward fuel injection pump side of engine when long side of connecting rod is toward the camshaft side of engine.

- Assemble pistons and connecting rods, making sure the word "FRONT" (A) on side of piston and side of connecting rod are facing same direction.
- 3. Insert piston pin (B) into piston pin bore.

NOTE: Some piston pin snap rings have sharp edges on both sides. These rings are reversible.

4. Install NEW piston pin snap rings (C) with sharp edge of ring facing away from piston pin. Make sure snap rings are seated in grooves of piston pin bore.



Assembly Piston and Connecting Rod

A-Stamped "Front"

B—Piston Pin

C-Snap Rings

RG,10,DT7389 -19-06JAN00-1/1

Install Piston Rings

IMPORTANT: Piston rings can be damaged if expanded too far. Expand piston rings only as far as necessary to install rings on piston.

- When installing new piston rings, use JDE85, JDE135, or KJD10140 Piston Ring Expander. Install oil ring expander in bottom ring groove. Position end gap toward either side of piston pin.
- 2. Install oil control ring (C) in bottom ring groove over ring expander. Install with end gap on opposite side of piston from ring expander gap.

NOTE: If standard-duty top piston ring is used, identify top as follows: hold ring with gap facing you and turn ring so that paint strip is to the left side of gap.

If heavy-duty top ring is used, the depression ("pip") mark should be on top as shown (A).

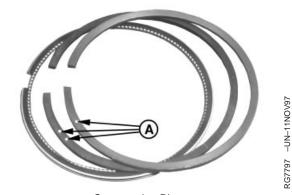
 Identify top side of compression rings. Top side of rectangular and keystone compression rings will be identified by depression marks (A) on the top side of two rings.

NOTE: Rectangular compression ring with two depression marks goes in the second groove.

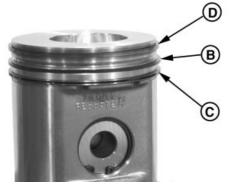
- 4. Install rectangular compression ring (B) in center ring groove with top of ring toward top of piston.
- 5. Position gap in rectangular compression ring on opposite side of piston from oil control ring (C) gap.
- 6. Install keystone compression ring (D) in top ring groove with top of ring toward top of piston.
- 7. Position gap in keystone compression ring on opposite side of piston from rectangular compression ring gap.



Piston Ring Expander Tool



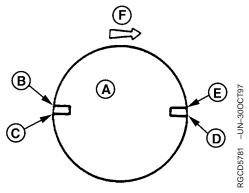
Compression Rings



Piston Ring Locations

- A—Depression Marks
- **B**—Rectangular Compression Ring
- C—Oil Control Ring
- **D**—Keystone Compression Ring

- 8. Stagger ring gaps on pistons as shown.
- 9. Coat pistons, liners and inside of JDE84 Ring Compressor with clean engine oil.
 - A-Piston Head
 - **B—Top Compression Ring**
 - C—Oil Control Ring Gap
 - D—Expander Ring Gap
 - E—Bottom Compression Ring Gap
 - F—Front of Engine



Piston Ring Gap Stagger Pattern

RG,10,DT7388 -19-11NOV97-2/2

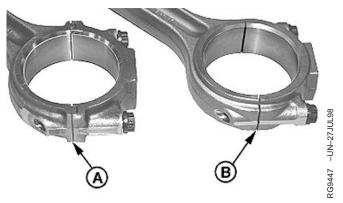
Install Piston and Connecting Rod Assembly

IMPORTANT: There are different manufacturers/part numbers for piston and liner sets.

These sets are not interchangeable. DO NOT intermix piston/liner sets on the same engine. Check parts catalog for

correct applications.

Earlier engines have the traditional tongue-and-groove between the connecting rod and cap (A). Later engines have the PRECISION JOINT™ rod and cap (B). Installation of each rod is similar, with differences noted in the following procedure.



Connecting Rods

A—Tongue-and-Groove Rod and Cap B—PRECISION JOINT™ Rod and Cap

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RG,10,DT7387 -19-06JAN00-1/5

PN=165

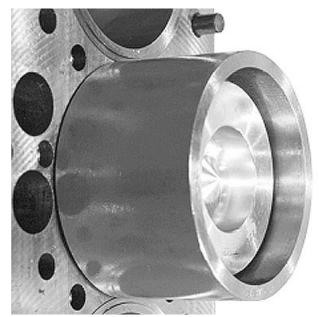
CTM104 (19JUN00)

IMPORTANT: Be careful so crankshaft journals and liner walls are not damaged by connecting rod when installing piston and rod in liner.

 Carefully place JDE84 Piston Ring Compressor with piston and rod over liner so the word "FRONT" on side of rod and on the side of piston faces toward the front of the engine.

NOTE: If arrow indicating "FRONT" is not visible on top of pistons, install piston and rod so combustion bowl in piston is offset toward fuel injection pump side of engine, and the long side of the connecting rod is toward camshaft side of engine.

2. With piston centered in ring compressor and rings staggered correctly, push piston into liner.



Install Piston

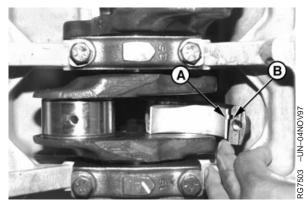
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-UN-07JUL98

RG,10,DT7387 -19-06JAN00-2/5

- 3. Install bearing insert in connecting rod with tang (A) in groove (B).
- Apply clean engine oil on insert and crankshaft journal. Carefully pull connecting rod and insert against crankshaft journal.

A—Tang B—Groove



Tongue-and-Groove Rod Shown

Continued on next page

RG,10,DT7387 -19-06JAN00-3/5

NOTE: Due to the manufacturing process, PRECISION JOINT™ rod and cap both have a groove, while the bearing insert has a single tang. Only the groove in the cap is used for the bearing tang.

5. Install bearing insert in connecting rod cap with tang (A) in groove (B).

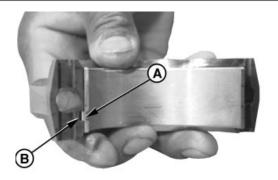
IMPORTANT: On PRECISION JOINT™ connecting rods, make sure cap is properly aligned on rod with edges flush and interlocking surfaces sealed tightly.

6. Apply clean engine oil to bearing insert. Install cap on connecting rod with tangs to same side.

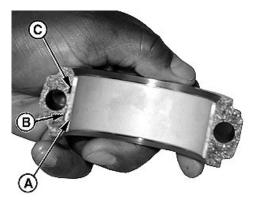
A—Tang

B—Groove

C—Extra Groove (Not Used)



Tongue-and-Groove Rod



-UN-27JUL98

RG7504 -UN-04NOV97

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PRECISION JOINT™ Rod

RG,10,DT7387 -19-06JAN00-4/5 Continued on next page

IMPORTANT: NEVER use connecting rod cap screws more than once for final engine assembly. Once rod cap screws have been tightened to final torque-turn specification, they must not be reused for another final assembly.

Cap screws for PRECISION JOINT™ rod and cap are 3 mm shorter than tongue-and-groove cap screws. DO NOT mix hardware.

- 7. Dip NEW connecting rod cap screws in clean oil and install.
- 8. Tighten cap screws alternately to initial torque specification.



 Second, torque-turn all cap screws to 90—100 degrees. (See TORQUE-TURN CONNECTING ROD CAP SCREWS next in this group.)



Connecting Rod Cap Screws

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RG,10,DT7387 -19-06JAN00-5/5

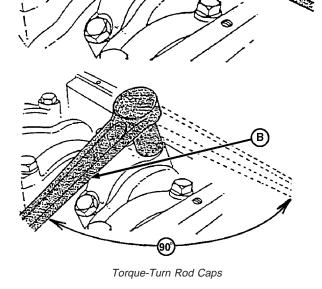
Torque-Turn Connecting Rod Cap Screws

Using Engine Axis Method to Torque-Turn Connecting Rod Cap Screws

- 1. After tightening cap screws to initial torque values, mark connecting rod cap and socket.
- 2. Position handle of wrench parallel to centerline of engine crankshaft axis (A).
- Tighten 1/4 turn (90—100°) clockwise until handle of wrench is perpendicular to centerline of engine crankshaft axis (B) as shown.

Specification

A—Parallel to Centerline Crankshaft B—Perpendicular to Centerline Crankshaft

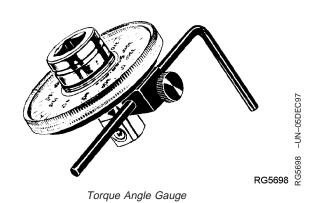


RG,10,DT7386 -19-11NOV97-1/2

RG9102 -UN-27MAR98

Using JT05993 Torque Angle Gauge to Torque-Turn Connecting Rod Cap Screws

After tightening cap screws to initial torque values provided earlier, follow directions provided with JT05993 Gauge and torque-turn each cap screw 90°—100°.



RG,10,DT7386 -19-11NOV97-2/2

Check Engine Rotation for Excessive Tightness

- 1. Rotate crankshaft several revolutions to be sure engine rotates without excessive tightness.
- 2. Check liners for deep scratches caused by an improperly installed or broken piston ring.
- 3. Check side clearance of rods. Must have slight side-to-side movement.

RG,10,DT7385 -19-11NOV97-1/1

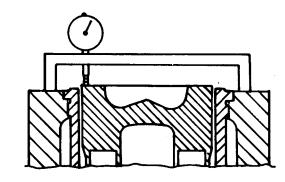
RG6440 -UN-22SEP92

Measure Piston Protrusion

- 1. Press down on top of piston to remove oil clearances before measuring piston protrusion.
- NOTE: If JDG451 or KJD10123 are not available, a dial indicator with magnetic base can be used to measure piston protrusion; however, specifications will be different.
- Use JDG451 or KJD10123 Gauge (or use a magnetic base dial indicator) to measure piston protrusion. Place gauge on top of cylinder block so dial indicator can be set to "zero" with top of block.
- Position gauge across piston. While pressing gauge downward, rotate crankshaft until piston is at TDC position. Measure piston height at several positions around the piston. If using JDG451 Gauge, piston height must be checked at outermost diameter of piston.
- 4. Piston protrusion must be within specifications to prevent piston-to-exhaust valve contact.
- Measure piston protrusion and compare to the following specifications. If protrusion does not meet specifications, check dimensions of piston, connecting rod, cylinder block, crankshaft, and bearings to determine the cause.

Piston Protrusion (Using JDG451 or KJD10123 Gauge)— Specification

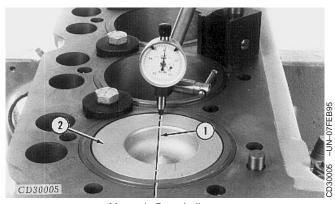
| 4-Cyl. Standard Duty | 0.08—0.31 mm |
|--------------------------|-------------------|
| Codes 4801, 4803, 4809. | (0.003—0.012 in.) |
| 6-Cyl. Standard Duty | |
| Codes 4805, 4807. Piston | |
| Protrusion | |
| 4-Cyl. Heavy Duty | 0.08—0.25 mm |
| Code 4804. | (0.003—0.010 in.) |
| 6-Cyl. Heavy Duty | |
| Codes 4808, 4810. Piston | |



Piston Protrusion above Block Deck



Piston Protrusion above Block Deck



Magnetic Base Indicator

- 1—Centerline of Cylinder Liner Bore
- 2—Position at TDC

Continued on next page

RG,10,DT7384 -19-11NOV97-1/2

Protrusion

Piston Protrusion (Using Magnetic Base Dial Indicator)— Specification

4-Cyl. Standard Duty...... 0.15—0.38 mm Codes 4801, 4803, 4809. (0.006—0.015 in.)

6-Cyl. Standard Duty Codes 4805, 4807. Piston

Protrusion

4-Cyl. Heavy Duty 0.15—0.33 mm (0.006—0.013 in.) Code 4804.

6-Cyl. Heavy Duty Codes 4808, 4810. Piston

Protrusion

RG,10,DT7384 -19-11NOV97-2/2

Complete Final Assembly

- 1. Install oil pump outlet tube O-ring in cylinder block. Install oil pump and outlet tube. (See INSTALL ENGINE OIL PUMP in Group 060.)
- 2. Install balancer shaft bushings (4-cylinder engines). (See REMOVE AND INSTALL BALANCER SHAFT BUSHINGS in Group 050.)
- 3. Install camshaft bushings. (See REMOVE AND INSTALL CAMSHAFT BUSHINGS in Group 050.)
- 4. Install oil bypass valve (in front of block) and front plate. (See INSTALL CYLINDER BLOCK FRONT PLATE in Group 050.)
- 5. Install balancer shafts (if equipped). (See INSTALL AND TIME BALANCER SHAFTS in Group 050.)
- 6. Install camshaft and timing gears. (See INSTALL CAMSHAFT in Group 050.)
- 7. Install timing gear cover. (See INSTALL TIMING GEAR COVER in Group 050.)

CTM104 (19JUN00)

- 8. Install oil pressure regulator valve, spring, and plug in timing gear cover. (See REMOVE AND INSTALL OIL PRESSURE REGULATING VALVE AND SEAT in Group 060.)
- 9. Install oil pan. (See INSTALL OIL PAN in Group 060.)
- 10. Install crankshaft pulley. (See INSTALL PULLEY OR VIBRATION DAMPER PULLEY in Group 040.)
- 11. Install camshaft followers. (See INSPECT, MEASURE AND ASSEMBLE CAMSHAFT FOLLOWERS in Group 050.)
- 12. Install cylinder head with new gasket. (See INSTALL CYLINDER HEAD in Group 020.)
- 13. Fill engine with clean oil and proper coolant.
- 14. Perform engine break-in. (See PERFORM ENGINE BREAK-IN in Group 010.).

RG,10,DT7383 -19-11NOV99-1/1

Crankshaft and Main Bearing Failure Analysis

Scored Main Bearing (Diagnosis also applies to connecting rod bearing.):

- Oil starvation.
- · Contaminated oil.
- Engine parts failure.
- · Excessive heat.
- Poor periodic service.

Galled or "Wiped" Bearings:

- Fuel in lubricating oil (incomplete combustion).
- Coolant in lubrication system (cracked block, liner seal failure, or leaking water pump seal with plugged hole).
- Insufficient bearing oil clearance.
- Parts not lubricated prior to engine operation.
- Wrong bearing size.

Inconsistent Wear Pattern:

- Misaligned or bent connecting rod.
- Warped or bowed crankshaft.
- Distorted cylinder block.

Broken Main Bearing Caps:

- Improper installation.
- Dirt between bearing and crankshaft journal.
- Low oil pressure.
- Oil pump failure.

Cracked, Chipped or Broken Bearings:

- · Overspeeding.
- · Excessive idling.
- Lugging.
- Excessive oil clearance.
- Improper installation.

040

RG,15,DT7461 -19-18MAY00-1/1

Inspect Vibration Damper

hammer.

IMPORTANT: Do not immerse the vibration damper in cleaning solvent or any petroleum product. Rubber portion of damper may

be damaged. Use a steam cleaner, soap solution or water only.

Never apply thrust on outer ring.

Damper is sensitive to impact damage, such as being dropped or struck with a

The damper assembly is not repairable. Replace damper every 5 years or 4500 hours, whichever occurs first. Also, replace damper whenever crankshaft is replaced or after major engine overhaul.

 Grasp outer ring of damper and attempt to turn it in both directions. If rotation is felt, damper is defective and should be replaced. Also, if rubber is separated, partially missing, or displaced, replace damper.



Vibration Damper—6-Cylinder Engine

RG,15,DT7460 -19-09NOV99-1/3

- Check vibration damper radial runout (concentricity) by positioning D17526CI (English, in.) or D17527CI (Metric, mm) dial indicator so probe contacts damper OD.
- 3. With engine at operating temperature, rotate crankshaft using JDG820 or JDE83 Flywheel Turning Tool.
- 4. Note dial indicator reading. If runout (concentricity) exceeds specifications given below, replace vibration damper.

Specification



Vibration Damper Radial (Concentricity)

Continued on next page

RG,15,DT7460 -19-09NOV99-2/3

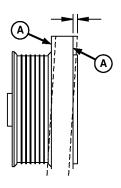
-UN-16MAR98

- Check vibration damper wobble using a dial indicator.
 Measure wobble at the outer edges of damper face (A).
- Rotate crankshaft one complete revolution using engine rotation tool, and note total dial indicator movement. Compare readings with specifications below.

| Sna | cific | ation |
|-----|-------|-------|
| Ope | CITIC | ation |

| Damper Pulley Outer Ring | 1.50 mm (0.060 in.) |
|--------------------------|----------------------|
| Wobble (Maximum) | |
| Damper Pulley Inner Ring | . 0.5 mm (0.020 in.) |
| Wobble (Maximum) | |

IMPORTANT: Replace damper after 4500 hours or every five years, whichever occurs first.



Damper Wobble

A—Vibration Damper Wobble

RG,15,DT7460 -19-09NOV99-3/3

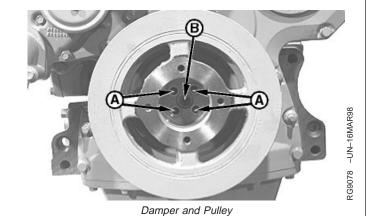
Remove Pulley or Vibration Damper and Pulley

IMPORTANT: Never apply thrust on outer ring of damper. Do not drop or hammer on damper.

- 1. Remove four cap screws (A) from vibration damper.
- 2. If equipped, remove center cap screw (B).
- 3. Grasp damper and remove from crankshaft.

A—Cap Screws

B—Center Cap Screw



Continued on next page

RG,15,DT7459 -19-29SEP99-1/2

4. Remove belt pulley (C).

C—Pulley



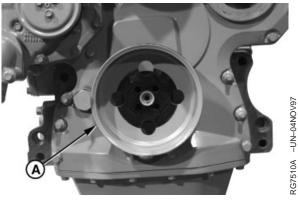
Crankshaft Belt Pulley

RG,15,DT7459 -19-29SEP99-2/2

Install Pulley or Vibration Damper and Pulley

- 1. Install belt pulley (A).
- 2. Position damper on crankshaft. Handle vibration damper with care to avoid impact damage.

A—Pulley



Crankshaft Belt Pulley

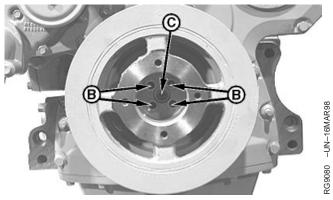
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RG,15,DT7458 -19-29SEP99-1/2

IMPORTANT: Damper or pulley-to-crankshaft cap screw must be SAE Grade 8 or higher.

- 3. Dip cap screws (B) in clean SAE30 engine oil.
- 4. Install cap screws (B) and tighten in a cross sequence to 20 N•m (15 lb-ft).
- 5. If equipped, install cap screw (C).
- 6. Tighten all cap screws to specifications. Use a criss-cross sequence to tighten outer cap screws (B).

| Clarikanan Damper Fulley Cap acrews—apecinication | |
|---|------|
| Five Cap Screw Mounted Damper | ·ft) |
| (4 Outer Cap Screws) Torque | |
| Five Cap Screw Mounted Damper 150 Nem (111 lb-ft | ·ft) |
| (Center Cap Screw) Torque | |
| Four Cap Screw Mounted | ·ft) |
| Damper Torque | |



Damper and Pulley

- **B—Cap Screws**
- C-Center Cap Screw

RG,15,DT7458 -19-29SEP99-2/2

040

Replace Front Crankshaft Oil Seal and Wear Sleeve

NOTE: This procedure is for removing seal and wear sleeve with timing gear cover installed.

Later production engines are not equipped with front wear sleeve; however, wear sleeve is recommended for service whenever front oil seal is replaced.

Remove Front Crankshaft Oil Seal

- 1. Remove poly-vee belts.
- 2. Remove vibration damper/pulley or pulley from crankshaft as previously instructed in this group.

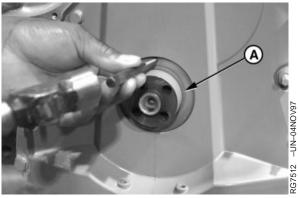
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RG,15,DT7455 -19-15NOV99-1/10

IMPORTANT: Whenever front oil seal is replaced, the wear sleeve must also be replaced.

- 3. Check oil seal (A) for wear, damage, or leakage.
- 4. Center punch seal casing at 12 o'clock position and drill 1/8 in. hole in casing.

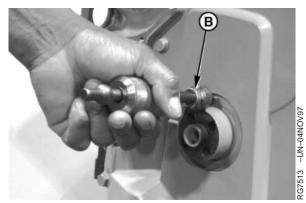
A-Oil Seal



Crankshaft Oil Seal/Wear Sleeve

RG,15,DT7455 -19-15NOV99-2/10

- Remove seal from timing gear cover using JDG22 Seal Remover or JDG719 Seal Puller Adapter along with JDE38-2 Shank and JDE38-3 Slide Hammer (B). Be careful not to damage seal bore in timing gear cover.
 - **B—Seal Removing Tool**



Slide Hammer Installed Oil Seal

Continued on next page

RG,15,DT7455 -19-15NOV99-3/10

Remove Crankshaft Wear Sleeve

- Rotate crankshaft using JDG820 or JDE83 Flywheel Turning Tool and lock flywheel with JDE81-4 Timing Pin.
- 2. Back out forcing screw and position collet from JDG992-1 Front Wear Sleeve Puller onto crankshaft flange until threaded ID contacts wear sleeve.

NOTE: You may want to apply inward pressure on collet as it is threaded onto wear sleeve.

- 3. Thread collet onto wear sleeve and tighten securely. Use a long breaker bar and tighten collet until wear sleeve spins on crank flange.
- 4. Lubricate threads of forcing screw. Tighten forcing screw until flange on wear sleeve is at least 3.2 mm (0.13 in.) from crankshaft gear.
- 5. Loosen forcing screw and remove threaded collet from wear sleeve.



Crankshaft Wear Sleeve Removal Tool



Crankshaft Wear Sleeve Removal Tool



Crankshaft Wear Sleeve Removal Tool

Continued on next page

RG,15,DT7455 -19-15NOV99-4/10

Position three 313727 Split Collets from JDG992-2
 Front Wear Sleeve Puller (using narrower lip) around OD of wear sleeve flange with 221761 End Cap and 311099 Forcing Screw.



Front Wear Sleeve Removal Tool

RG,15,DT7455 -19-15NOV99-5/10

7. Slide 221760 Sleeve over collets to secure puller assembly.



Front Wear Sleeve Removal Tool

Continued on next page

RG,15,DT7455 -19-15NOV99-6/10

040

NOTE: If wear sleeve flange begins to roll during removal, remove puller assembly and use the wider lip of collets to grasp wear sleeve.

- 8. Tighten forcing screw until wear sleeve is removed from crankshaft flange.
- 9. Clean crankshaft flange using Brake Kleen, Ignition Cleaner, or equivalent.



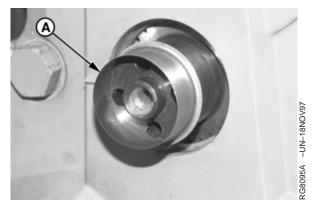
Front Wear Sleeve Removal Tool

RG,15,DT7455 -19-15NOV99-7/10

Install Crankshaft Wear Sleeve

- 1. Coat ID of new wear sleeve with LOCTITE® 680 Retaining Compound.
- 2. Install wear sleeve (A) on nose of crankshaft with flange of sleeve toward crankshaft.

A-Wear Sleeve



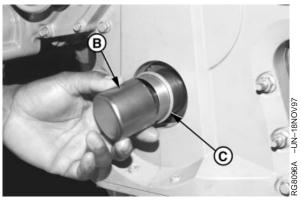
Crankshaft Wear Sleeve

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RG,15,DT7455 -19-15NOV99-8/10

- Position installation tool (B) provided in front wear sleeve kit over wear sleeve. Install wear sleeve until tool bottoms on nose of crankshaft, using a dead blow hammer. Flange on wear sleeve should contact crankshaft gear.
- 4. Clean any sealant from OD of crankshaft flange (C) and wear sleeve.
 - B—Installation Tool
 - C—Crankshaft Flange



Crankshaft Wear Sleeve



Crankshaft Wear Sleeve

Continued on next page

RG,15,DT7455 -19-15NOV99-9/10

Install Front Crankshaft Oil Seal

 Inspect and clean seal bore in timing gear cover. Check for nicks or burrs. Use a medium-grit emery cloth to smooth rough areas.

IMPORTANT: To ensure proper sealing, the OD of the crankshaft and wear sleeve MUST BE cleaned with Brake Kleen, Ignition Cleaner, or equivalent and dried prior to installing seal (C).

2. Slide JDG954A-2 Adapter (A) on nose of crankshaft and tighten cap screws.

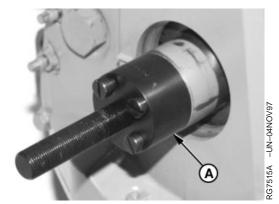
IMPORTANT: DO NOT allow oil to contact coating on OD of seal.

- Apply a light coating of clean engine oil to lips of seal and position seal on crankshaft flange. (The spring-loaded side of seal goes into timing gear cover first.)
- 4. Place JDG954A-1 Installer (B) over adapter. Tighten screw until seal is properly seated in timing gear cover.
- 5. Install vibration damper/pulley or pulley on crankshaft as previously instructed in this group.
- 6. Install poly-vee belts.

A-Adapter

B—Installer

C—Seal



Front Crankshaft Oil Seal Tool



Front Crankshaft Oil Seal Tool



Front Crankshaft Oil Seal

RG,15,DT7455 -19-15NOV99-10/10

Check Crankshaft End Play

Measure end play prior to removing crankshaft to determine condition of thrust bearings.

1. Position dial indicator on contact face of flywheel, on front crankshaft nose, on damper, or front pulley assembly if installed.



Check Crankshaft End Play w/Dial Indicator

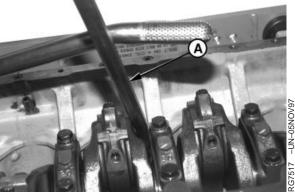
RG,15,DT7454 -19-15NOV99-1/2

IMPORTANT: Do not apply too much pressure with pry bar (A), as this could damage bearings.

- 2. Using a pry bar, gently push crankshaft as far to rear of engine as possible.
- 3. Zero the dial indicator.
- 4. Gently pry the crankshaft as far forward as possible. Note indicator reading. If end play is not within specifications, install new thrust bearing.

Specification

Crankshaft End Play 0.05-0.25 mm (0.002-0.010 in.)



Prying Crankshaft Toward Rear of Engine

A-Pry Bar

RG,15,DT7454 -19-15NOV99-2/2

Inspect Flywheel

- 1. Inspect the clutch contact face for scoring, overheating, or cracks. Replace or resurface flywheel if defective.
- 2. Examine flywheel ring gear for worn or broken teeth. Replace ring gear if defective, as described later in this group.

RG,15,DT7465 -19-14NOV97-1/1

CTM104 (19JUN00)

02 040

R22213 -UN-14DEC88

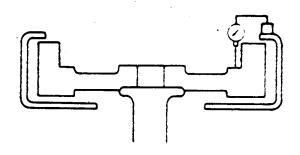
Check Flywheel Face Flatness

 Mount dial indicator base on flywheel housing. Position pointer to contact driving ring mounting surface. Do not allow pointer to contact driving ring mounting holes.

IMPORTANT: Maintain constant end pressure on crankshaft to hold shaft against thrust bearing when measuring flywheel face runout.

Rotate flywheel by turning crankshaft. Read total indicator movement. Resurface flywheel face or replace as required.





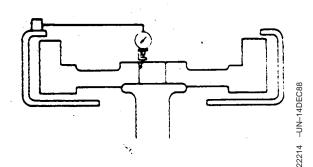
Flywheel Face Flatness Check

RG,15,DT7453 -19-14NOV97-1/1

Check Pilot Bearing Bore Concentricity

- Mount dial indicator on flywheel housing face and position pointer to contact ID of pilot bearing bore in flywheel.
- 2. Rotate flywheel by turning crankshaft. Read total dial indicator movement.

Specification



Flywheel Bearing Bore Concentricity

DPSG,OUO1004,69 -19-21APR98-1/1

(1.0 in.) of Travel

Remove Flywheel

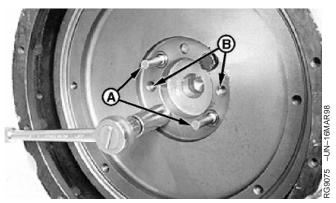


CAUTION: Flywheel is heavy. Plan a proper lifting procedure to avoid personal injury.

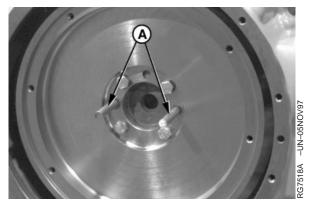
- 1. Remove two cap screws and install guide studs (A) in their place. Remove the remaining cap screws.
- On flywheels secured with threaded jack screw holes (B): Install two jack screws and tighten evenly to remove flywheel.
- 3. On all other flywheels: Pry flywheel off of crankshaft.

NOTE: If flywheel to housing clearance will not allow use of a pry bar, install a punch through timing pin hole and tap on flywheel face to drive from crankshaft.

A—Guide Studs B—Jack Screw Holes



Remove Flywheel



Remove Flywheel

RG,15,DT7452 -19-27MAR00-1/1

Replace Flywheel Ring Gear



CAUTION: Oil fumes or oil can ignite above 193°C (380°F). Use a thermometer and do not exceed 182°C (360°F). Do not allow a flame or heating element to be in direct contact with the oil. Heat the oil in a well ventilated area. Plan a safe handling procedure to avoid burns.

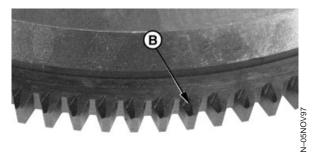
- 1. Place the flywheel on a solid flat surface.
- 2. Drive ring gear off with a brass drift (A) and hammer.

IMPORTANT: If flame heat is used, be sure gear is heated uniformly around circumference. DO NOT OVERHEAT. SEE CAUTION.

Overheating may also destroy original heat treatment of gear.

- 3. Heat new ring gear to 148°C (300°F) using either heated oil, oven heat, or flame heat.
- 4. Turn gear so side with chamfer (B) is toward engine with flywheel installed.
- 5. Install ring gear against shoulder of flywheel.





G7520 -

Flywheel Ring Gear Teeth

A—Brass Drift B—Chamfer

RG,15,DT7451 -19-14NOV97-1/1

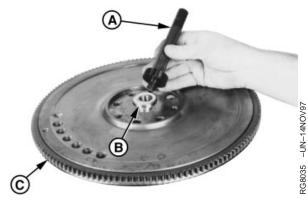
Replace Pilot Bearing in Flywheel—If Equipped

NOTE: Some engines are equipped with a pilot bearing (B) in flywheel (C). Flywheel must be removed from the engine to replace this bearing.

- With flywheel removed from engine, drive bearing out of flywheel using appropriate disks and driver (A) from D01045AA Bushing, Bearing and Seal Driver Set. Discard bearing.
- 2. Measure flywheel bore diameter. If bore is larger than specifications, replace flywheel.

| Specification | | | |
|--------------------------------|---------------------|--|--|
| Flywheel Pilot Bearing Bore | 34.978—35.004 mm | | |
| (Option Code 1508) ID | (1.3770—1.3781 in.) | | |
| Flywheel Pilot Bearing Bore | 44.978—45.004 mm | | |
| (Option Code 1502 and 1515) ID | (1.7708—1.7719 in.) | | |
| | | | |

3. Drive new pilot bearing into rear face of flywheel using appropriate disks and handle from same driver set, until bearing shoulder bottoms on flywheel face. Check bearing for smooth operation.



Flywheel Pilot Bearing

- A—Bushing Driver B—Pilot Bearing
- C—Flywheel

RG,15,DT7450 -19-15DEC99-1/1

Install Flywheel



CAUTION: Flywheel is heavy. Plan a proper handling procedure to avoid injuries.

IMPORTANT: Flywheel MUST BE clean and free of any oil, grease or debris.

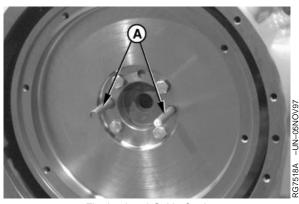
NOTE: Engines with flywheel option code 1557 have threaded studs (B) in flywheel. If studs were removed, apply LOCTITE® 271 Thread Lock and Sealer to threads and install studs into flywheel to end of threads.

1. Install two guide studs (A) in crankshaft cap screw threaded holes. Place flywheel on studs and slide into position against crankshaft.

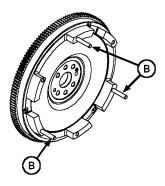
IMPORTANT: ALWAYS install new flywheel cap screws when flywheel has been removed.

 Apply LOCTITE® 242 Thread Lock and Sealer to cap screws and start cap screws in crankshaft. Do not tighten until guide studs are removed and all cap screws are started. Tighten cap screws to specifications.

Specification



Flywheel and Guide Studs



Flywheel (Option 1557)

A—Guide Studs B—Threaded Studs

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RG,15,DT7449 -19-16NOV99-1/1

RG10542 -UN-19NOV99

Crankshaft Rear Oil Seal and Wear Sleeve Handling Precautions

Use the following precautions for handling seal and wear sleeve assembly (A):

- Always install seal and wear sleeve assembly immediately after removal from plastic bag to avoid possible dirt contamination.
- No lubrication of any kind is to contact seal when installing. Use of a lubricant may result in premature seal failure.
- Install oil seal/wear sleeve assembly with the open side
 of seal and wear sleeve ID chamfer toward the engine.
 If seal is reversed, engine oil may be lost because
 grooves in oil seal lip would be incorrect with respect to
 direction of crankshaft rotation.



RG,15,DT7448 -19-14NOV97-1/1

Remove Crankshaft Rear Oil Seal and Wear Sleeve

The crankshaft rear oil seal (A) and wear sleeve (B) are fabricated as a non-separable part. To remove the oil seal/wear sleeve assembly, the two following procedures can be used depending on special tool availability.

A—Oil Seal B—Wear Sleeve



Crankshaft Rear Oil Seal and Wear Sleeve

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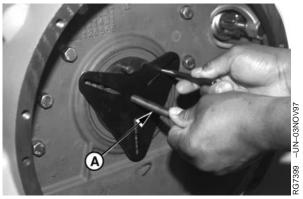
RG,15,DT7447 -19-14NOV97-1/9

02 040 19

Remove Oil Seal/Wear Sleeve Using JDG698A

- Adjust forcing screw (A) on JDG698A Seal and Wear Sleeve Remover and position screw so it centers tool on crankshaft flange.
- Using the slots in JDG698A Remover as a template, mark three locations on seal casing where screws should be installed for removal purposes. Remove tool from crankshaft flange.

A—Forcing Screw



Unitzed Crankshaft Rear Oil Seal/Wear Sleeve Puller

RG,15,DT7447 -19-14NOV97-2/9

IMPORTANT: Holes must be drilled at outer edge of seal case. Screws will pull seal against wear ring, thereby removing both pieces.

- 3. Drill a 3/16 in. hole through wear sleeve lip and seal casing at the three marked locations.
- 4. Position JDG698A Remover on end of crankshaft.



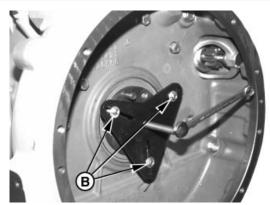
Setting Puller Removal Screws

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RG,15,DT7447 -19-14NOV97-3/9

- Install three 2-1/2 in. (approximate) sheet metal screws with washers (B) into slots of removal tool and thread screws into holes in seal casing. Evenly tighten screws until plate is flush with rear face of crankshaft.
- 6. Tighten forcing screw (plate should pull evenly against the three screws) until seal and wear sleeve assembly is removed from engine

B—Sheet Metal Screws



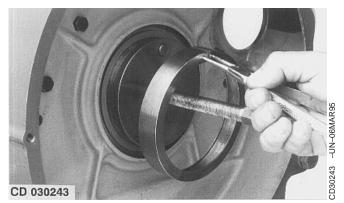
Puller in Position

RG7401 -UN-03NOV97

RG,15,DT7447 -19-14NOV97-4/9

Remove Oil Seal/Wear Sleeve Using JDG645E

 Place and center JDG645E Rear Crankshaft Oil Seal/Wear Sleeve Puller cap screws and driver plate assembly onto crankshaft rear face. Then, using snap ring pliers, set the thinner shoulder of ring tool between sleeve flange and seal case.



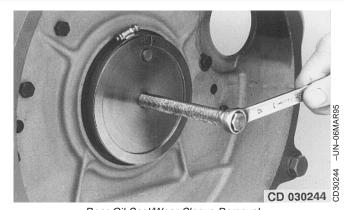
Rear Oil Seal/Wear Sleeve Removal

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RG,15,DT7447 -19-14NOV97-5/9

02 040 21

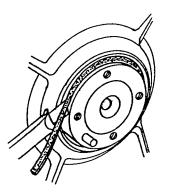
2. Secure the assembly with a clamp, then gradually tighten the screw until wear sleeve is extracted.



Rear Oil Seal/Wear Sleeve Removal

RG,15,DT7447 -19-14NOV97-6/9

3. Cut the rubber lip (now accessible) and remove it.



CD30396 -UN-10MAY95

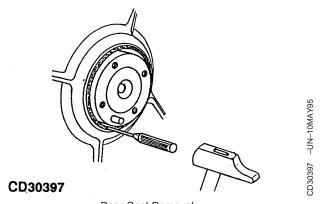
CD30396

Rear Oil Seal Removal

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RG,15,DT7447 -19-14NOV97-7/9

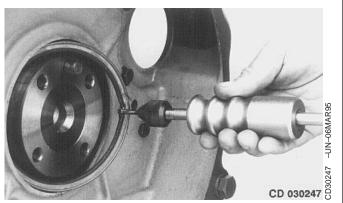
4. Using a punch and hammer, tap the seal case toward engine at any location until seal case pivots.



Rear Seal Removal

RG,15,DT7447 -19-14NOV97-8/9

5. Using JDG22 Seal Remover, extract seal case.



Rear Oil Seal/Wear Seal Removal

RG,15,DT7447 -19-14NOV97-9/9

02 040

Clean and Inspect Crankshaft Flange

- Clean OD of crankshaft flange and ID of flywheel housing with cleaning solvent, trichloroethylene, acetone, or any other suitable cleaner that will remove sealant.
- 2. Look for nicks or burrs on wear ring surface and bore in flywheel housing. If necessary, use polishing cloth to remove nicks or burrs.

Finish cleaning by wiping flange with a clean rag.



Clean Crankshaft Flange

DPSG,OUO1004,75 -19-23APR98-1/1

Install Crankshaft Rear Oil Seal and Wear Sleeve

IMPORTANT: No lubrication of any kind is to contact seal when installing. Use of a lubricant may result in premature seal failure. Install seal and wear sleeve assembly immediately after removal from plastic bag to avoid possible dirt contamination.

- Clean OD of crankshaft flange and ID of wear sleeve with trichloroethylene or equivalent just prior to application of sealant. Make sure that OD of crankshaft flange and ID of seal housing bore are free from nicks or burrs.
- 2. The oil seal/wear sleeve assembly can be installed using JT30040B or KCD10002A Installer Set.



Clean Crankshaft Flange

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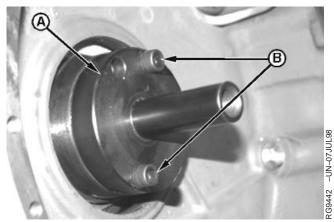
RG,15,DT7446 -19-14NOV97-1/4

Install Rear Oil Seal/Wear Sleeve Using JT30040B

- 1. Install JT30041A Pilot (A) from the JT30040B Seal and Wear Sleeve Installer Set on end of crankshaft using two socket-head cap screws. Tighten both cap screws until they touch base of pilot, then back them off approximately 1/2 turn.
- 2. Install JT30042 Driver over JT30041A Pilot until driver cross-plate bottoms on pilot. This will properly center pilot with crankshaft flange.

NOTE: It may be necessary to lift up on pilot to install driver to full depth over pilot and crankshaft flange.

3. Tighten two pilot socket head cap screws (B) securely. Remove driver from pilot.



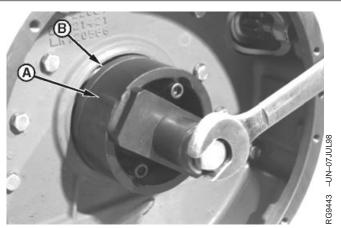
Rear Oil Seal/Sleeve Pilot Tool

A—Pilot **B—Cap Screws**

RG,15,DT7446 -19-14NOV97-2/4

IMPORTANT: Handle the rear oil seal and sleeve assembly carefully. If wear sleeve surface is scratched, gouged or any sealant (liquid) is present, order a new seal assembly.

- 4. Carefully start oil seal (B) and wear sleeve over pilot and crankshaft flange with open side of seal toward engine.
- 5. Attach JT30042 Driver (A) and thrust washer to the guide plate with cap screw. Tighten the cap screw until driver bottoms on pilot.
- 6. Remove seal driver and pilot plate. Check that seal and wear sleeve assembly is properly positioned on crankshaft flange and installed square in flywheel housing bore.



Rear Oil Seal/Sleeve Driver Tool

A—Driver B—Seal

RG9136 -UN-18MAY98

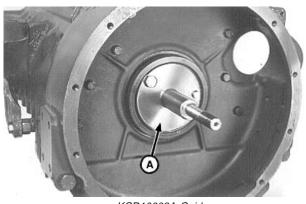
Install Rear Oil Seal/Wear Sleeve Using KCD10002A

1. Apply a light coating of LOCTITE® 680 (TY15969) completely around leading edge of crankshaft flange.

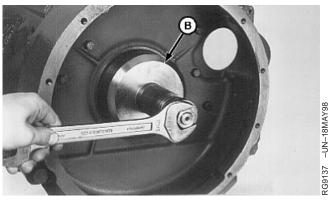
NOTE: Due to a diameter change of the crankshaft bore, it may be necessary to suppress the pilot pin from KCD10002. With this modification, KCD10002 becomes KCD10002A

- 2. Position guide (A) from KCD10002A Installer Set on crankshaft end with two cap screws finger tight.
- 3. Install new oil seal/wear sleeve assembly on guide with open side of seal toward engine. Center the guide and tighten cap screws.
- 4. Slide driver (B) onto guide (A) and gradually tighten hex nut until driver bottoms on guide.
- Remove seal driver and guide. Check that seal and wear sleeve assembly is properly positioned on crankshaft flange and installed square in flywheel housing bore.

A—Guide B—Driver



KCD10002A Guide



KCD10002A Driver

RG,15,DT7446 -19-14NOV97-4/4

CTM104 (19JUN00)

Remove Flywheel Housing

- Remove flywheel. (See REMOVE FLYWHEEL earlier in this group.)
- Remove starter if desired (see REMOVE AND INSTALL STARTER in Group 100). Starter and flywheel housing may be removed as an assembly.
- 3. Remove crankshaft rear oil seal as described earlier in this group.

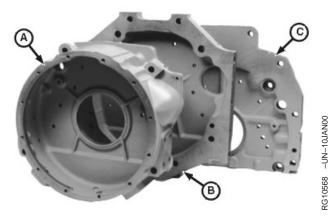


CAUTION: The flywheel housing is heavy. Plan a proper handling procedure to avoid injuries.

4. Remove flywheel housing-to-cylinder block cap screws and flywheel housing-to-oil pan cap screws. Remove flywheel housing from block.

NOTE: Illustration shows three different types of flywheel housings used:

- SAE 2, 3, and 4 housing (A).
- Standard flat housing (B).
- Special flat housing (C).



Flywheel Housings

- A-SAE 2, 3 and 4 Housing
- **B—Standard Flat Housing**
- C—Special Flat Housing

RG,15,DT7445 -19-23NOV99-1/1

Remove and Install Crankshaft Timing Wheel (Engines with VP44 Fuel Injection Pump)

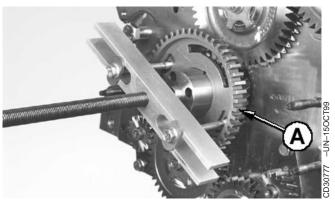
Remove Timing Wheel

- 1. Lock engine at No. 1 TDC.
- 2. Remove timing gear cover. (See REMOVE TIMING GEAR COVER in Group 050.)
- 3. Clean crankshaft nose.
- Remove timing wheel (A) using standard puller as shown.

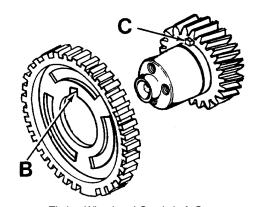
Install Timing Wheel

NOTE: Ensure that the word "FRONT" (stamped on the face of the timing wheel) is facing out from the engine.

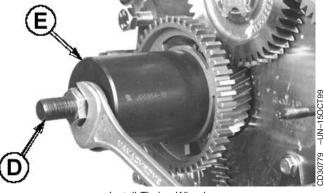
- 1. Slide timing wheel onto crankshaft nose with recess side toward timing gear cover. Be sure keyway (B) in timing wheel is properly aligned with Woodruff key (C).
- 2. Install JDG954A-2 Adapter (D) on nose of crankshaft. Tighten screws securely.
- 3. Install JDG954A-1 Installer (E) over adapter.
- 4. Tighten nut until timing wheel firmly seats against gear face.
- Remove adapter and installer and install timing gear cover. (See INSTALL TIMING GEAR COVER in Group 050.)



Remove Timing Wheel



Timing Wheel and Crankshaft Gear



Install Timing Wheel

- A—Timing Wheel
- **B**—Keyway
- C-Woodruff Key
- D-JDG954A-2 Adapter
- E-JDG954A-1 Installer

DPSG,OUO1004,1126 -19-26OCT99-1/1

Remove Crankshaft Main Bearings

- 1. Drain oil from engine crankcase and remove oil pan.
- 2. Remove timing gear cover. (See REMOVE TIMING GEAR COVER in Group 050.)
- 3. Remove cylinder block front plate. (See REMOVE CYLINDER BLOCK FRONT PLATE in Group 050.)
- 4. Remove flywheel housing. (See REMOVE FLYWHEEL HOUSING in this group.)
- 5. Remove connecting rods from crankshaft. (See REMOVE PISTONS AND CONNECTING RODS in Group 030.)

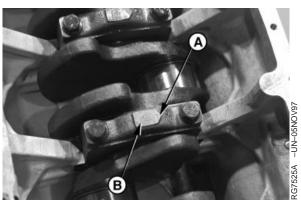
RG,15,DT7444 -19-14NOV97-1/3

IMPORTANT: Before removing main bearing caps, check for proper torque on all main bearings.

NOTE: When crankshaft is to be removed, leave front and rear main bearing caps installed until all connecting rod caps have been removed.

6. Check main bearing caps for arrows (A) cast in main bearing cap, and numbers (B) stamped on cap and oil pan rail. Arrow points toward camshaft side of engine.

If there are no numbers, stamp corresponding numbers on cap and oil pan rail to ensure correct placement of bearing caps during reassembly.



Crankshaft Main Bearing Caps

A—Cast Arrows B—Stamped Numbers

Continued on next page

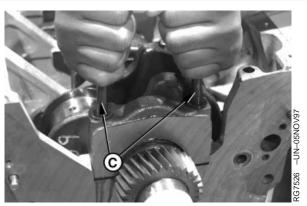
RG,15,DT7444 -19-14NOV97-2/3

02 040 29

Remove main bearing caps by extending cap screws
 (C) and forcing heads of screws together. Wiggle bearing cap back and forth while applying an upward force with cap screws until free from main bearing cap support.

IMPORTANT: Keep matched bearings with their respective main bearing cap for comparison with crankshaft journal (surface wear) from which removed.

8. Visually inspect condition of bearing inserts and crankshaft main journals as bearing caps are removed.



Crankshaft Main Bearing Cap Screws

C—Cap Screws

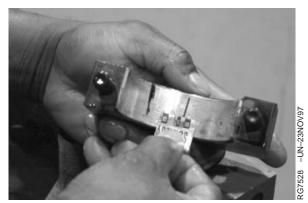
RG,15,DT7444 -19-14NOV97-3/3

Check Main Bearing Oil Clearance

NOTE: The use of PLASTIGAGE® will determine wear (crankshaft-to-bearing oil clearance) but will not determine condition of either bearing or journal surface.

- Place a strip of PLASTIGAGE® in the center of the main bearing cap (with insert) about three-fourths of the width of the bearing or on crankshaft journal to measure oil clearance.
- 2. Use clean (SAE30) oil on PLASTIGAGE® to prevent smearing.
- 3. Install cap and tighten cap screws to 135 N•m (100 lb-ft).
- 4. Remove cap and compare width of PLASTIGAGE® with scale provided on wrapper to determine clearance.

Specification



Using PLASTIGAGE

PLASTIGAGE is a registered trademark of the DANA Corp.

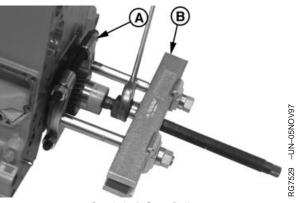
RG,15,DT7443 -19-14NOV97-1/1

Remove and Install Crankshaft Gear (Crankshaft Installed in Engine)

NOTE: Remove crankshaft gear for replacement only; it is not necessary to remove gear for crankshaft removal.

Remove Crankshaft Gear

- 1. Lock engine at No. 1 TDC compression.
- 2. Remove timing gear cover. (See REMOVE TIMING GEAR COVER in Group 050.)
- 3. Remove oil pump. (See REMOVE ENGINE OIL PUMP in Group 060.)
- 4. Remove upper idler gear and lower idler gear and shaft. (See REMOVE LOWER AND UPPER IDLER SHAFTS in Group 050.)
- 5. Remove front plate. (See REMOVE CYLINDER BLOCK FRONT PLATE in Group 050.)
- 6. Install No. 1123 (D01218AA) Pulling Attachment (A) or larger onto crankshaft gear.
- 7. Install D01200AA Push Puller (B). Remove crankshaft gear.



Crankshaft Gear Puller

A—Pulling Attachment B—Push Puller

Continued on next page

RG,15,DT7442 -19-14NOV97-1/2

-UN-05NOV97

-UN-05NOV97

Install Crankshaft Gear

IMPORTANT: If flame heat is used, be sure gear is

heated uniformly around circumference. DO NOT OVERHEAT. SEE CAUTION. Overheating may also destroy original

heat treatment of gear.



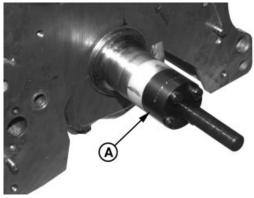
CAUTION: Oil fumes or oil can ignite above 193°C (380°F). Use a thermometer and do not exceed 182°C (360°F). Do not allow a heating element to be in direct contact with the oil. Heat the oil in a well-ventilated area. Plan a safe handling procedure to avoid burns.

- 1. Heat crankshaft gear to 148°C (300°F) using either heated oil or oven heat.
- 2. Install JDG954A-2 Adapter (A) on nose of crankshaft. Tighten cap screws securely.

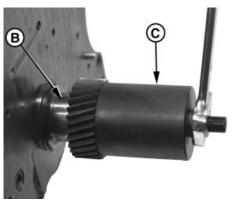
IMPORTANT: When installing gear, do not gouge or nick crankshaft flange or wear sleeve.

NOTE: Chamfered side of gear should be installed toward engine.

- 3. Place gear on crankshaft flange. Be sure Woodruff key (B) on crankshaft is properly aligned with keyway in gear
- 4. Install JDG954A-1 Installer (C) over adapter.
- 5. Tighten nut clockwise until gear firmly seats against crankshaft flange. Allow gear to cool before removing installer.
- 6. Refer to appropriate group to complete final assembly of parts removed to access crankshaft gear.



Crankshaft Gear Adapter Tool



Crankshaft Gear Woodruff Key/Installer Tool

A-JDG954A-2 Adapter B-Woodruff Key

C-JDG954A-1 Installer

RG,15,DT7442 -19-14NOV97-2/2

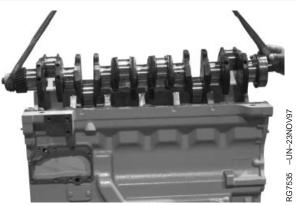
Remove Crankshaft

- Remove engine front plate. (See REMOVE CYLINDER BLOCK FRONT PLATE in Group 050.)
- 2. Remove flywheel housing and flywheel. (See REMOVE FLYWHEEL HOUSING earlier in this group.) (See REMOVE FLYWHEEL in this group.)
- 3. Remove main bearing caps and connecting rod caps, as described earlier in this group.



CAUTION: Crankshaft is very heavy. Plan a proper handling procedure to avoid injury.

- Attach a lifting sling to crankshaft. Using proper lifting equipment, carefully raise crankshaft out of cylinder block.
- 5. Clean crankshaft, especially oil passages, using solvent and compressed air.
- 6. Place crankshaft on clean V-blocks.
- If main bearing inserts are to be replaced, remove inserts from cylinder block. Otherwise, leave bearing inserts in block until assembled ID has been measured.



Remove Crankshaft from Cylinder Block

RG,15,DT7441 -19-14NOV97-1/1

RG7536B -UN-05NOV97

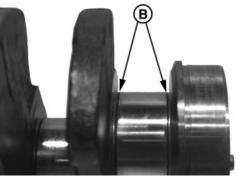
Inspect Crankshaft

NOTE: If vibration damper damage was discovered during teardown, it is recommended that the crankshaft be magna-fluxed. This will verify whether of not it has microscopic cracks or fissures. See INSPECT VIBRATION DAMPER earlier in this group.

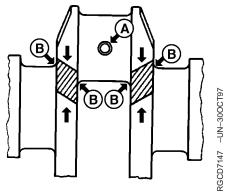
1. Thoroughly clean crankshaft. Clear restrictions from all oil passages.

IMPORTANT: Small cracks may not be visible to the eye. Use a method such as the Fluorescent Magnetic Particle Method. This method magnetizes the crank, employing magnetic particles which are fluorescent and glow under "black light". The crankshaft must be de-magnetized after inspection.

- Inspect crankshaft for signs of load stress, cracks, scoring, or journal scratches. Replace crankshaft if cracks are found.
- Check each journal for evidence of excessive overheating or discoloration. If either condition exists, replace crankshaft since heat treatment has probably been destroyed.
- 4. Inspect front crankshaft gear for cracks, chipped teeth, or excess wear. Replace gear as required.
- 5. Inspect the keyway for evidence of cracks or wear. Replace crankshaft as necessary.
- 6. Carefully inspect the rear hub of the crankshaft in the area of the wear sleeve contact surface for evidence of a rough or grooved condition. Any imperfections in this area will result in oil leakage. Slight ridges may be cleaned up with emery cloth or crocus cloth.
- Carefully check the crankshaft for cracks in the area of rod journal holes (A) and at journal fillets (B). Replace crankshaft if any cracks are found.



Crankshaft Main Bearing Journal Fillets



Crankshaft Rod Bearing Journal Holes/Fillets

A—Rod Journal Hole B—Journal Fillets

Measure Crankshaft Journals and Main Bearing ID

- With crankshaft removed from engine, assemble main bearing caps with bearing inserts. Be sure inserts are installed correctly.
- 2. Tighten main bearing cap screws to 135 N•m (100 lb-ft).
- 3. Measure and record main bearing assembled ID (A) at several points with an inside micrometer.
- Measure and record crankshaft main journal OD (B) and rod journal OD (C) at several points around each journal.
- NOTE: If an undersized crankshaft has been installed, measured dimensions will not meet specifications. However, bearing-to-journal oil clearance must be within specification. See CRANKSHAFT GRINDING GUIDELINES later in this group.
- Compare measurements with specifications given below.

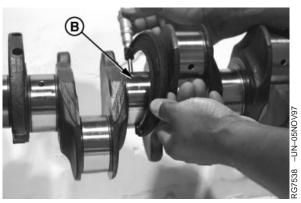
Specification

| Crankshaft Main Bearing ID |
|--|
| (3.1256—3.1273 in.) |
| Crankshaft Main Journal OD 79.324—79.350 mm |
| (3.1229—3.1240 in.) |
| Crankshaft Rod Journal OD |
| (3.0629—3.0640 in.) |
| Crankshaft Main 0.041—0.109 mm |
| Bearing-to-Journal Oil Clearance (0.0016—0.0043 in.) |
| Crankshaft Main or Rod Journal 0.010 mm (0.0004 in.) |
| Maximum Taper |
| Crankshaft Main or Rod Journal 0.005 mm (0.0002 in.) |
| Maximum Out-of-Round |

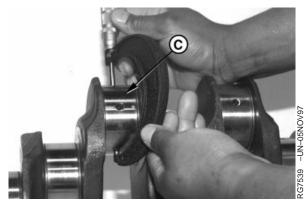
Replace or recondition crankshaft if it does not fall within above specifications.



Measuring Main Bearing Cap ID Assembly



Measuring Crankshaft Main Bearing Journal OD



Measuring Crankshaft Rod Bearing Journal OD

- A-Main Bearing ID
- **B**—Main Journal OD
- C—Rod Journal OD

RG,15,DT7439 -19-14NOV97-1/1

-UN-23NOV97

Measure Main Thrust Journal Width and Thrust Bearing Width

NOTE: If crankshaft has been previously reconditioned, thrust journal width may not be within above specifications. However, oil (side) clearance must be within specification.

1. Measure and record crankshaft main thrust journal width.

If crankshaft thrust journal width is not within specifications, install a new crankshaft.

2. Measure and record width of main thrust bearing. Oil (side) clearance between thrust bearing and thrust journal must be within specifications.

Specification

| Journal (New) Width (1.5335—1.53 | 865 in.) |
|----------------------------------|----------|
| Crankshaft Main Thrust Bearing | 87 mm |
| Overall Width (1.527—1.5 | 30 in.) |



Measuring Main Thrust Journal Width



Measuring Main Thrust Bearing Width



Assembled Main Thrust Bearing

RG,15,DT7438 -19-14NOV97-1/1

RG7542 -UN-23NOV97

Crankshaft Grinding Guidelines

IMPORTANT: Crankshaft grinding should be done ONLY by experienced personnel on equipment capable of maintaining crankshaft size and finish specifications. Undercut and rolled fillets (A) have taken the place of ground (tangential) fillets. DO NOT grind within this undercut area when undersize bearings are used.

Crankshafts have micro-finished journal surfaces.

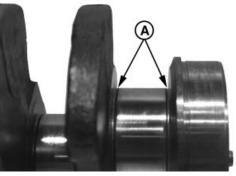
IMPORTANT: If undersize bearings are installed, recheck bearing-to-journal clearance. If oil clearance is not within specifications, premature wear of bearings and journals will result.

If the crankshaft is to be reground, use the following recommended guidelines:

- 1. Compare the crankshaft journal measurements taken during inspection and determine the size which the journals are to be reground.
- 2. Grind all main journals or all connecting rod journals to the same required size.

IMPORTANT: Care must be taken to avoid localized heating which often produces grinding cracks. Use coolant generously to cool the crankshaft while grinding. DO NOT crowd the grinding wheel into the work. Grind crankshaft with journals turning counterclockwise, as viewed from the front end of the crankshaft. Lap or polish journals in opposite direction of grinding.

- 3. Polish or lap the ground surfaces to the specified finish to prevent excessive wear of the journals.
- 4. Stone the edge of all oil holes in the journal surfaces smooth to provide a radius of approximately 1.50 mm (0.060 in.).



Crankshaft Main Bearing Journal Fillets



Assembled Main Thrust Bearing

A-Fillets

RG7542 -UN-23NOV97

RG7536A -UN-23NOV97

Continued on next page

Crankshaft, Main Bearings and Flywheel

- 5. When finished grinding, inspect the crankshaft by the fluorescent magnetic particle method, or other similar method to determine if cracks have originated due to the grinding operation.
- 6. De-magnetize the crankshaft after inspection.
- 7. Thoroughly clean the crankshaft and oil passages with solvent. Dry with compressed air.

040

RG,15,DT7437 -19-20DEC99-2/2

Crankshaft Grinding Specifications

| Bearing Size | Crankshaft Main Journal OD | Crankshaft Rod Journal OD |
|-------------------------------|----------------------------|---------------------------|
| Standard | 79.324—79.350 mm | 77.800—77.826 mm |
| | (3.1229—3.1240 in.) | (3.0629—3.0640 in.) |
| 0.25 mm (0.010 in.) Undersize | 79.074—79.100 mm | 77.550—77.576 mm |
| , | (3.1131—3.1141 in.) | (3.0531—3.0541 in.) |
| | | |

Main and Connecting Rod Journal Surface Finish (AA) Lap 0.20 um (8 AA) Thrust Surface Finish (AA) Lap 0.40 um (16 AA) Thrust Bearing Journal Width 38.952—39.028 mm (1.5335—1.5365 in.)

Direction of Crankshaft Rotation (viewed from flywheel end): Grinding Clockwise Counterclockwise Lapping Engine Stroke 127 mm (5.00 in.) Main Journal Maximum Runout (Concentricity) Relative to No. 1 and 0.05 mm (0.0019 in.) No.7 (6.8 L) or No. 1 and No. 5 (4.5 L) Journals

Main Journal Maximum Runout (Concentricity) Between Adjacent 0.025 mm (0.0009 in.)

Journals

RG,15,DT7435 -19-14NOV97-1/1

Measure Assembled ID of Main Bearing Caps

- 1. Remove bearing inserts from caps and cylinder block. Keep inserts in correct order if they are to be reused.
- Clean and inspect caps for damage. Small burrs or nicks on flat surfaces may be removed with a file. Use a medium-grit polishing cloth to dress curved bearing surfaces.
- 3. Install bearing caps (without bearings) in cylinder block. Tighten cap screws to 135 N•m (100 lb-ft).
- 4. Measure ID of bearing cap bores.

| Opecinication | | |
|---------------------------------|-----------------------|--|
| Crankshaft Main Bearing Bore | 84.455—84.481 mm | |
| (Without Bearings) ID | (3.3250-3.3260 in.) | |
| Crankshaft Main Bearing Bore | 337.896—337.972 mm | |
| Centerline-to-Top Deck Distance | (13.3029—13.3059 in.) | |
| | | |

Specification

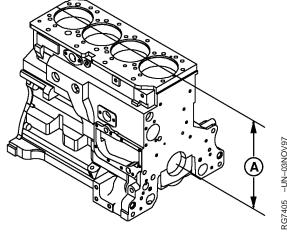
IMPORTANT: When cylinder block is line bored, dimension (A) from centerline of main bearing bore to cylinder block top deck will be changed. Piston may contact cylinder head if this dimension is less than specified above. Main bearing line boring should be done ONLY by experienced personnel on equipment capable of maintaining bore specifications.

 If bearing caps are damaged or bore is not within specification, install a new cap and line bore to specified size. (See MEASURE CRANKSHAFT JOURNALS AND MAIN BEARING ID, earlier in this group.)

NOTE: Replacement bearing caps are supplied with unfinished bearing bore.



Measuring Assembled Main Bearing Cap ID



Cylinder Block to Crankshaft Centerline

A-Top Deck-to-Centerline Bearing Bore

RG,15,DT7436 -19-14NOV97-1/1

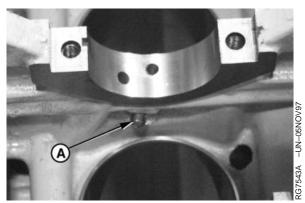
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Remove, Inspect, and Install Piston Cooling Orifices

IMPORTANT: A piston cooling orifice failure could cause damage to pistons, piston pins, rod pin bushings and liners. If a piston cooling orifice is left out, low or no oil pressure will result.

 Remove and clean each piston cooling orifice (A) to make sure it is not plugged or damaged. Replace if questionable.





Piston Cooling Orifice

RG,15,DT7434 -19-14NOV97-1/2

NOTE: If equipped with early design orifice (B), add a punch mark (C) to each orifice as shown. This is not necessary on later design orifice (D) because of its different shape. Adding a punch mark to orifice (B) will also prevent cooling jets from being mistakenly used on 300-Series Engines.

POWERTECH® Engines use a larger orifice diameter cooling jet for proper lubrication and cooling of piston skirts.

2. Install and tighten orifices.

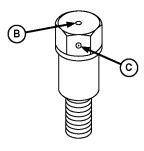
Specification

POWERTECH is a registered trademark of Deere & Company

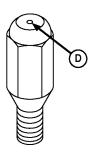
B—Early Design Orifice

C-Punch Mark

D-Later Design Orifice



Early Design Orifice



Later Design Orifice

RG,15,DT7434 -19-14NOV97-2/2

G9066 -UN-16MAR98

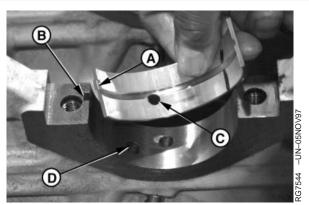
RG9065 -UN-16MAR98

02-040-39

Install Main and Thrust Bearing Inserts in Block

NOTE: Lower half of bearing insert with oil hole goes in block.

- Install main bearing inserts. Make sure that tang (A) in insert is engaged with slot (B) in the cylinder block and main bearing caps. Also make sure oil holes in insert (C) line up with oil passages in block (D).
 - A—Tang in Insert
 - B-Slot in Block
 - C-Oil Holes in Insert
 - D—Oil Passages in Block



Main and Thrust Bearing Insert

RG,15,DT7433 -19-14NOV97-1/3

NOTE: Only two-piece bearings (A) are provided for service.

During assembly, apply a liberal coating of clean engine oil to:

- All main bearing webs in block
- Both sides of main bearing inserts and thrust bearing inserts
- Entire OD of crankshaft main bearing journal

A-Two-Piece Bearing



Assembled Main Thrust Bearing

RG7542A -UN-05NOV97

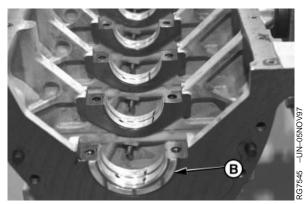
RG,15,DT7433 -19-14NOV97-2/3

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Crankshaft, Main Bearings and Flywheel

2. Install main thrust bearing (B) in thrust web of cylinder block.

B—Main Thrust Bearing



Main Thrust Bearing

RG,15,DT7433 -19-14NOV97-3/3

02 040 41

Install Crankshaft



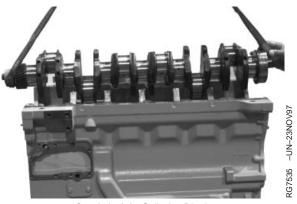
CAUTION: Crankshaft is heavy. Plan a proper lifting procedure to avoid injuries.

- 1. Carefully position crankshaft onto main bearing inserts using a hoist and lift sling.
- 2. Apply a liberal amount of clean oil to bearing insert.

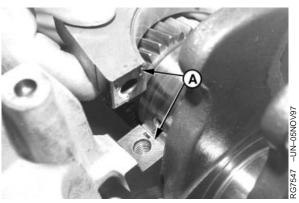
 Dip entire main bearing cap screws in clean engine oil and position them in main bearing caps.

IMPORTANT: Make sure main bearing caps are installed in locations from which they were removed. Numbers (B) stamped on the caps should match numbers stamped on pan rail of block. Arrow (C) on cap must point toward camshaft side of block.

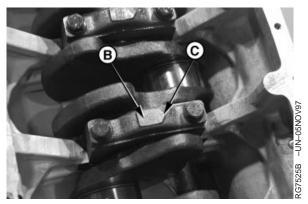
- Install main bearing caps so bearing tang (A) in cap and cylinder block are together on same side of cylinder block.
 - A—Bearing Tang
 - **B—Stamped Numbers**
 - C—Cast Arrow



Crankshaft in Cylinder Block



Main Bearing Insert Tangs



Bearing Cap Location and Direction Stamp

Continued on next page

RG,15,DT7432 -19-14NOV97-1/3

IMPORTANT: Do not use pneumatic wrench to install main bearing cap screws, as damage may occur to threads.

4. Tighten all main bearing cap screws to specifications except rear main (thrust) bearing cap screws. Tighten rear main (thrust) bearing cap screws fingertight.

Specification

IMPORTANT: DO NOT pry on thrust washer when forcing crankshaft back and forth to align thrust bearings.

- 5. Before tightening rear main (thrust) bearing cap screws, align upper and lower thrust bearings. Carefully force crankshaft and main thrust bearing cap to rear, using a prybar between crank throw and block web. Then, force crankshaft to front to line up thrust bearing surfaces.
- 6. Tighten rear main (thrust) bearing cap screws to specified torque.

Specification

7. Turn crankshaft by hand. If crankshaft does not turn easily, disassemble parts and determine the cause.



Main Bearing Cap Screws

Continued on next page

RG,15,DT7432 -19-14NOV97-2/3

IMPORTANT: Using pneumatic wrenches to install cap screws may cause damage to the threads. Never reuse connecting rod cap screws.

- Install connecting rod caps and bearings. Install new cap screws and tighten to specification. (See INSTALL PISTON AND CONNECTING ROD ASSEMBLY in Group 030.)
- 9. Check crankshaft for specified end play.

| Specification | | |
|---------------------|--------------------------------|--|
| Crankshaft End Play | 0.05—0.25 mm (0.002—0.010 in.) | |



Connecting Rod Bearing Cap Screws

RG,15,DT7432 -19-14NOV97-3/3

RG10544 -UN-03DEC99

Install Flywheel Housing

- Inspect and clean cylinder block and flywheel housing gasket surfaces using a brass scraper and/or steam cleaner. Remove any previously applied sealant.
- 2. Rinse well with plain water to remove all soap residue from gasket surfaces.

IMPORTANT: Surfaces to be bonded MUST BE free of oil, dirt, or cleaning agents.

3. Apply LOCTITE® 515 (TY6304) General Purpose Flexible Sealant in a continuous 2—4 mm bead to flywheel housing as shown.

NOTE: In lower figure for T06068TF151 engine, note that bead between No. 1 and No. 2 cap screw is centered on rib of housing and not centerline to cap screw holes.

 Locate bead in the center of mating surfaces as shown and completely encircle cap screws (except No. 3) and dowel holes.

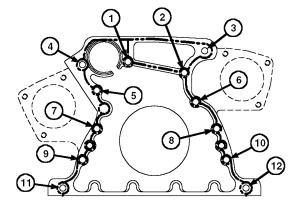
IMPORTANT: Tighten cap screws to specifications in sequence shown, within 10 minutes after parts are assembled.

5. Install flywheel housing on cylinder block and tighten cap screws to specifications.

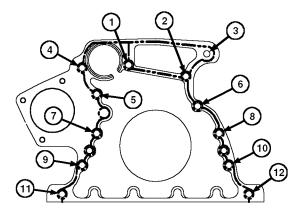
Specification

Check flywheel housing seal bore runout (concentricity). If runout exceeds specification, replace housing.

Specification



Flywheel Housing



Flywheel Housing (T06068TF151)

RG10545 -UN-03DEC99

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Continued on next page

Crankshaft, Main Bearings and Flywheel

7. Install crankshaft rear oil seal assembly. (See INSTALL CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE earlier in this group.)

8. If torque converter access hole plug was removed, apply LOCTITE® 277 to plug and install.

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RG,15,DT7431 -19-24NOV99-2/2

02 040 46

Complete Final Assembly

Use new gaskets and O-rings during final engine assembly. Clean all engine components as necessary prior to assembly.

- Install oil bypass valve assembly in front face of block. (See REMOVE, INSPECT AND INSTALL OIL BYPASS VALVE in Group 060)
- 2. Install front plate. (See INSTALL CYLINDER BLOCK FRONT PLATE in Group 050.)
- 3. Install balancer shafts (if equipped). (See INSTALL AND TIME BALANCER SHAFTS in Group 050.)
- 4. Install timing gear train and camshaft. (See INSTALL CAMSHAFT in Group 050.)
- 5. Install oil pump assembly. (See INSTALL ENGINE OIL PUMP in Group 060.)
- Install timing gear cover gasket and timing gear cover. (See INSTALL TIMING GEAR COVER in Group 050.)
- 7. Install oil pressure regulating valve assembly. (See REMOVE AND INSTALL OIL PRESSURE REGULATING VALVE AND SEAT in Group 060.)
- 8. Install front oil seal. (See REPLACE FRONT CRANKSHAFT OIL SEAL AND WEAR SLEEVE in this group.)
- 9. Install oil pan. (See INSTALL OIL PAN in Group 060.)

- Install crankshaft pulley, or vibration damper. (See INSTALL PULLEY OR VIBRATION DAMPER AND PULLEY in this group.)
- 11. Install push rods, and rocker arm assembly. (See INSTALL ROCKER ARM ASSEMBLY in Group 020.)
- 12. Install fuel supply pump. See Section 02, Group 090 of CTM207 (Mechanical Fuel Systems) or CTM170 (Electronic Fuel Systems).
- Install injection pump. See Section 02, Group 090 of CTM207 (Mechanical Fuel Systems) or CTM170 (Electronic Fuel Systems).
- 14. Install starter motor. (See REMOVE AND INSTALL STARTER in Group 100.)
- 15. Adjust valve clearance. (See CHECK AND ADJUST VALVE CLEARANCE in Group 020.)
- 16. Install and adjust poly-vee belts. (See Group 070.)
- 17. Fill engine with clean oil and proper coolant. (See Section 01, Group 002)
- 18. Perform engine break-in. (See PERFORM ENGINE BREAK-IN in Group 010.)

RG,15,DT7430 -19-14NOV97-1/1



Group 050 Camshaft, Balancer Shafts and Timing Gear Train

Measure Valve Lift

IMPORTANT: For a more accurate measurement, measure valve lift at 0.00 mm (0.00 in.) rocker arm-to-valve tip clearance.

NOTE: Measuring valve lift provides an indication of wear on camshaft lobes and camshaft followers or push rods.

- 1. Remove rocker arm cover.
- Using JDG820 or JDE83 Flywheel Turning Tool and JDE81-4 Timing Pin, lock No. 1 piston at TDC compression stroke.

See CHECK AND ADJUST VALVE CLEARANCE in Group 020 for engine valve locations.

- 3. Set rocker arm-to-valve tip clearance to 0.00 mm (0.00 in.) for:
 - No. 1 and 3 exhaust and No. 1 and 2 intake valves on 4-cylinder engines.
 - No. 1, 3, and 5 exhaust and No. 1, 2, and 4 intake valves on 6-cylinder engines.
- 4. Place dial indicator tip on top of valve rotator. Preload indicator tip and set dial at 0.0 mm (0.00 in.).
- 5. Remove timing pin from flywheel and manually rotate engine one full revolution (360°) in running direction.
- 6. Observe dial indicator reading as valve is moved to full open. Record maximum reading and compare with specifications given below.

Specification

| Intake Valves Valve Lift [at 0.00 | 11.77—12.21 mm |
|-----------------------------------|----------------------|
| mm (0.00 in.) Valve Clearance] | (0.463—0.481 in.) |
| Wear Limit | 11.34 mm (0.447 in.) |

Specification

| Exhaust Valves Valve Lift [at 0.00 | 11.51—11.94 mm |
|------------------------------------|----------------------|
| mm (0.00 in.) Valve Clearance] | (0.453-0.470 in.) |
| Wear Limit | 11.08 mm (0.436 in.) |



Measuring Valve Lift

02 050 1 7. If valve lift on all valves is within specifications, adjust valve lash to specified clearance. (See CHECK AND ADJUST VALVE CLEARANCE in Group 020.)

If valve lift on one or more valves is not within specification, remove and inspect entire valve train and camshaft.

- 8. Rotate engine one full revolution (360°). Lock engine
 - TDC No. 4 compression stroke for 4-cylinder
 - TDC No. 6 compression stroke for 6-cylinder engines.
- 9. Set rocker arm-to-valve tip clearance to 0.0 mm (0.00 in.) for:
 - No. 2 and 4 exhaust and No. 3 and 4 intake valves on 4-cylinder engines.
 - No. 2, 4, and 6 exhaust and No. 3, 5, and 6 intake valves on 6-cylinder engines.
- 10. Repeat steps 4—7.

RG,16,DT7507 -19-14NOV97-2/2

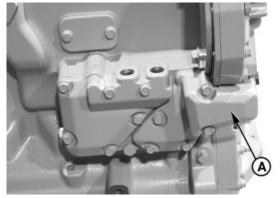
Remove Timing Gear Cover

NOTE: It is not necessary to remove water pump pulley, water pump, or belt tightener when removing timing gear cover.

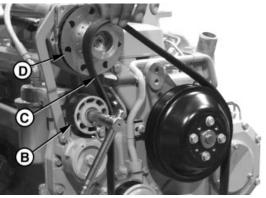
IMPORTANT: Air must be expelled from cooling system when system is refilled. Follow procedure given in your operator's manual.

Whenever the aluminum timing gear cover or water pump are replaced, the cooling system should be flushed and serviced. See FLUSH AND SERVICE COOLING SYSTEM in Section 01, Group 002. Ensure system, including radiator, is completely drained.

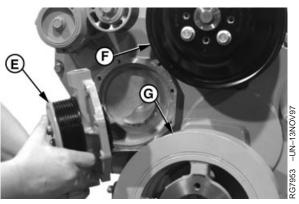
- 1. Drain oil from engine crankcase.
- 2. Remove fan.
- 3. Remove oil pan.
- 4. Remove oil cooler-to-water manifold elbow (A) at front plate.
- 5. Release fan belt tensioner (B) and remove fan belt (C).
- Remove alternator (D) and alternator mounting bracket. (See REMOVE AND INSTALL ALTERNATOR in Group 100.)
- 7. On non-auxiliary drive engines, remove tensioner bracket.
- 8. Remove water pump (E), if desired. (See REMOVE WATER PUMP in Group 070.)
- 9. Remove fan pulley (F).
- Remove crankshaft pulley or damper (G). (See REMOVE PULLEY OR VIBRATION DAMPER AND PULLEY in Group 040.)



Oil Cooler-to-Water Manifold Elbow



Fan Belt, Tensioner and Alternator



Water Pump, Fan and Crankshaft Pulley

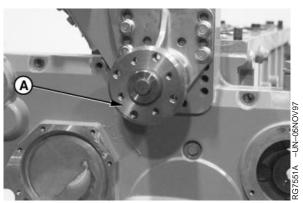
- A-Oil Cooler-to-Water Manifold Elbow
- B-Fan Belt Tensioner
- C—Fan Belt
- **D**—Alternator
- E-Water Pump
- F—Fan Pulley
- G—Crankshaft Pulley or Damper

Continued on next page

RG,16,DT7506 -19-08OCT99-1/4

11. Remove adjustable fan drive assembly (A). (See REMOVE AND INSPECT FAN DRIVE ASSEMBLY in Group 070.)

A-Adjustable Fan Drive



Adjustable Fan Drive Assembly

RG,16,DT7506 -19-08OCT99-2/4

- Unscrew oil pressure regulating valve plug. Remove spring and valve. (See REMOVE AND INSTALL OIL PRESSURE REGULATING VALVE AND SEAT in Group 060.)
- Remove auxiliary drive cover and gears, if equipped, as described later in this group. (See REMOVE AND INSTALL CAMSHAFT GEAR-DRIVEN AUXILIARY DRIVE later in this group.)
- 14. Remove wear sleeve. (See REPLACE FRONT CRANKSHAFT OIL SEAL AND WEAR SLEEVE in Group 040.)

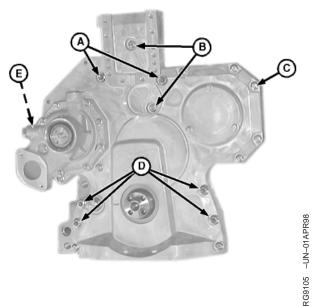


Oil Pressure Regulation Valve Plug



NOTE: Mark and identify location of timing gear cover hardware before removal to aid in reassembly.

- 15. On later engines¹, remove timing gear cover-to-cylinder block stud nuts and washers (A).
- 16. Remove timing gear cover-to-cylinder block stud nuts and washers (D).
- 17. Remove cap screws (B) and remove cap screw (E) on back of engine front plate.
- 18. Remove cap screws (C) bordering timing cover. Remove cover.
- 19. Remove oil seal from timing gear cover.
 - A-Stud Nuts and Washers
 - **B—Cap Screws**
 - C—Cap Screws
 - **D—Stud Nuts and Washers**
 - E—Cap Screw (Behind Engine Front Plate)



Timing Gear Cover

¹Serial Numbers: Dubuque-built engines (703905—), Saran-built engines (516218—), Torreon-built engines (001000—).

RG,16,DT7506 -19-08OCT99-4/4

Remove and Install Camshaft Bushing with Front Plate Installed

NOTE: A camshaft bushing is installed in front (No. 1) camshaft bore only. The front plate has a chamfered edge allowing camshaft bushing removal and installation with the front plate installed.

Remove Camshaft Bushing

- 1. Set engine at No. 1 "TDC" compression.
- 2. On turbocharged engines, disconnect the turbocharger oil inlet line. (See DISCONNECT TURBOCHARGER OIL INLET LINE in Group 010.)
- 3. Remove timing gear cover, as described earlier in this group. (See REMOVE TIMING GEAR COVER in this group.)
- 4. Remove rocker arm cover and rocker arm assembly. (See REMOVE CYLINDER HEAD in Group 020.)
- 5. Remove push rods and identify location for reinstallation.
- 6. On engines with rotary fuel injection pumps, remove fuel supply pump. See REMOVE FUEL SUPPLY PUMP in Section 02, Group 090 of CTM207 (Mechanical Fuel Systems) or CTM170 (Electronic Fuel Systems).

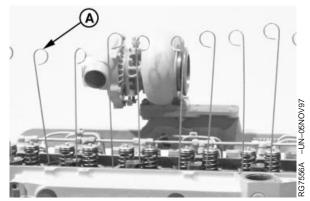
Continued on next page

RG,16,DT7505 -19-14NOV97-1/4

02 050 7

7. Revolve engine to an angle where camshaft followers fall away from camshaft or use D15001NU Magnetic Follower Holder Kit (A) to hold followers.

A-Magnetic Follower Holder Kit



Camshaft Follower Holder Kit

Continued on next page

RG,16,DT7505 -19-14NOV97-2/4

8. Remove camshaft. (See REMOVE CAMSHAFT later in this group.)

IMPORTANT: Engine MUST remain in a position where camshaft followers rest against cylinder head or are held in up position by magnetic holders so that followers do not fall into engine crankcase. If camshaft followers fall into crankcase, cylinder head removal will be required.

 Remove countersunk TORX® cap screw (A). Install JDG739-7 (M8 x 1.25) tapered bottom leg (B) from JDG739B Camshaft Bushing Service Kit into hole that has chamfered screw and star washer.

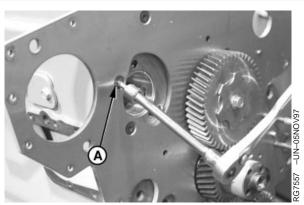
IMPORTANT: Block must be replaced if camshaft bore is damaged. Be careful when removing or installing bushing.

 Install JDG739-8 (M8 x 1.25) flat bottom legs and JDG739-3 Removing/Installing Plate (C) to cylinder block so plate is parallel with front plate and centered over camshaft bore. Tighten legs and hex nuts securely.

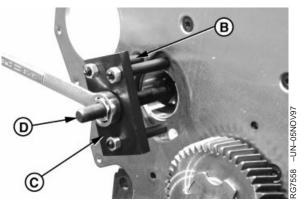
IMPORTANT: Cylinder block bore may be damaged if puller is not properly piloted in bushing.

Be sure puller is properly piloted before pulling bushing.

- 11. Insert JDG739-1 Bushing Remover into camshaft bore so puller pilots in bushing ID and JDG739-4 Bushing Installer Screw (D) extends through plate.
- 12. Install thrust washer and hex nut. Tighten hex nut until bushing is free of block bore. Remove puller and discard bushing.
- 13. Clean and inspect bore in cylinder block. If bore is damaged, replace cylinder block.



Front Plate on Cylinder Block



Camshaft Bushing Removal Tool

A-Cap Screw

B—JDG739-7 Tapered Bottom Leg (8 mm)

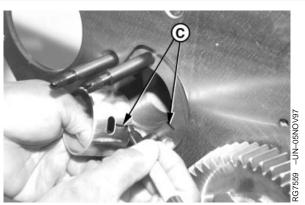
C-JDG739-3 Removing/Installing Plate

D—JDG739-4 Bushing Installer Screw

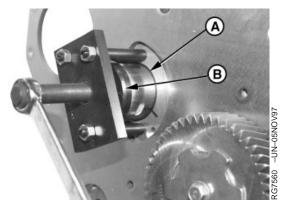
Install Camshaft Bushing

IMPORTANT: Bushings must be installed so oil supply hole in bushing aligns with oil drilling in block bore.

- 1. Mark orientation of oil supply hole (C) on front face of block and on bushing to help with bushing alignment during installation.
- Apply TY6333 High-Temperature Grease to ID and OD of new bushing (A), and to ID of bushing bore. Slide bushing onto JDG739-5B Bushing Installer (B) so notched end of bushing will be toward front end of engine when installed.
- Thread JDG739-4 Bushing Installer Screw into JDG739-3 Removing/Installing Plate. With bushing started, square in bore and oil hole aligned, tighten forcing screw until flange of bushing driver bottoms against face of block.
- Remove bushing tool from cylinder block and check oil supply hole for correct alignment. If holes are not aligned, remove and discard bushing. Install a new bushing.



Camshaft Bushing Oil Hole Alignment



Camshaft Bushing Installation Tool

A—Bushing

B-JDG739-5B Bushing Installer

C-Oil Supply Hole

RG,16,DT7505 -19-14NOV97-4/4

Remove and Install Camshaft Gear-Driven Auxiliary Drive

NOTE: Various auxiliary drive options are available; removal and installation of all options are similar. The auxiliary drive is integrated into the engine front timing gear cover.

- 1. Remove lube line.
- 2. Remove auxiliary drive gear cover (A).
- 3. Clean and inspect cover for cracks or damage.
- 4. Remove auxiliary drive assembly (B).

NOTE: Auxiliary drive assembly is repairable. Refer to CTM67, OEM Accessories, for additional service information.

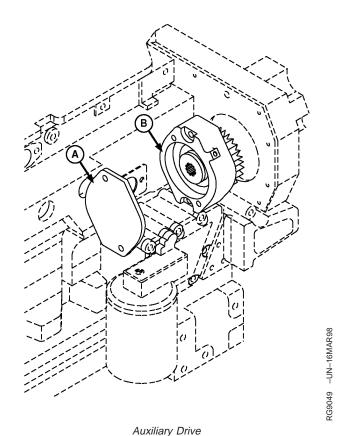
- 5. Inspect for cracked housing, worn or damaged bearings, damaged gear or spline.
- 6. Repair or replace auxiliary drive assembly as needed.
- 7. Install gasket on auxiliary drive assembly and position in the cylinder block plate. Install cap screws and tighten to specifications.

Specification

8. Install cover and tighten cap screws or nuts to specifications.

Specification

9. Install lube line.



A—Gear Cover

B—Auxiliary Drive Assembly

RG,16,DT7504 -19-14NOV97-1/1

Measure Camshaft End Play

Measure camshaft end play.

Specification

Camshaft End Play...... 0.08—0.23 mm (0.003—0.009 in.)

If end play is excessive, check thrust plate thickness with camshaft removed. (See MEASURE CAMSHAFT THRUST PLATE CLEARANCE AND THICKNESS, later in this group.)



Measuring Camshaft End Play

RG,16,DT7503 -19-14NOV97-1/1

Measure Balancer Shaft End Play (4-Cylinder Engines)

Measure balancer shaft end play.

Specification

Balancer Shaft End Play 0.05—0.26 mm (0.002—0.010 in.)

If balancer shaft end play exceeds specifications, check thrust plate thickness. (See INSPECT BALANCER SHAFT GEARS AND THRUST PLATES, later in this group.)



Measuring Balancer Shaft End Play-4-Cylinder

RG,16,DT7502 -19-14NOV97-1/1

Measure Idler Gear End Play

Check end play of upper and lower idler gears.

Specification

| opcomodiion | |
|---------------------------|--------------------|
| Upper Idler Gear End Play | . 0.070—0.170 mm |
| (| 0.0027—0.0066 in.) |
| Lower Idler Gear End Play | . 0.070—0.330 mm |
| (| 0.0027—0.0129 in.) |

If idler gear end play does not meet specifications, check idler gear, idler shaft, and thrust washer for wear. (See MEASURE IDLER GEAR BUSHING AND SHAFT later in this group.)



Measuring Idler Gear End Play

RG,16,DT7501 -19-14NOV97-1/1

Measure Timing Gear Backlash

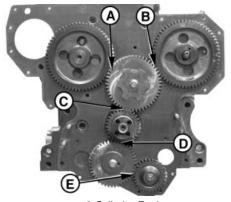
NOTE: All gears have helical cut teeth.

Measure timing gear backlash. Compare against the following specifications.

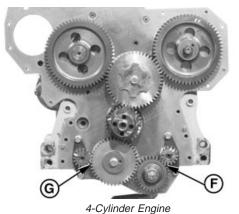
Timing Gear Backlash Specifications—Specification

| Camshaft-to-Upper Idler (A) | 0.08—0.75 mm |
|-----------------------------------|---------------------|
| Backlash | (0.0030—0.0291 in.) |
| Injection Pump-to-Upper Idler (B) | 0.08—0.75 mm |
| Backlash | (0.0030—0.0291 in.) |
| Upper Idler-to-Crankshaft (C) | 0.06—0.58 mm |
| Backlash | (0.0025—0.0226 in.) |
| Crankshaft-to-Lower Idler (D) | 0.07—0.60 mm |
| Backlash | (0.0026—0.0236 in.) |
| Oil Pump-to-Lower Idler (E) | 0.08—0.60 mm |
| Backlash | (0.0032—0.0235 in.) |
| Balancer Shaft-to-Oil Pump | 0.06—0.65 mm |
| | (0.0025—0.0254 in.) |
| Lower Idler-to-Balancer Shaft | 0.07—0.65 mm |
| (4-Cyl. Only) (G) Backlash | (0.0028—0.0253 in.) |
| Camshaft-to-Auxiliary Drive (Not | 0.05—0.68 mm |
| Shown) Backlash | (0.0021—0.0266 in.) |
| | |

- A—Camshaft Gear-to-Upper Idler Gear
- B—Injection Pump Gear-to-Upper Idler Gear
- C—Upper Idler Gear-to-Crankshaft Gear
- D—Crankshaft Gear-to-Lower Idler Gear
- E—Oil Pump Gear-to-Lower Idler Gear
- F—Balancer Shaft Gear-to-Oil Pump Gear
- G-Lower Idler Gear-to-Balancer Shaft Gear



6-Cylinder Engine



RG7703B -UN-07NOV97

RG7530 -UN-05NOV97

RG,16,DT7500 -19-10NOV99-1/1

Remove Camshaft

NOTE: It is not necessary to remove cylinder head from engine for camshaft removal. If push rods are bent or show excessive scuffing, it may be necessary to remove cylinder head for inspection of block, head and camshaft followers. (See REMOVE CYLINDER HEAD in Group 020.)

- 1. Drain engine oil and coolant, if not previously done.
- 2. Measure valve lift. (See MEASURE VALVE LIFT, earlier in this group).
- 3. Remove rocker arm assembly and push rods. (See REMOVE CYLINDER HEAD in Group 020.)
- 4. Remove timing gear cover. (See REMOVE TIMING GEAR COVER, earlier in this group.)

RG,16,DT7499 -19-14NOV97-1/5

 Remove cap screws (A) and camshaft activated fuel supply pump. See REMOVE FUEL SUPPLY PUMP in Section 02, Group 090 of CTM207 (Mechanical Fuel Systems) or CTM170 (Electronic Fuel Systems).

A—Cap Screws



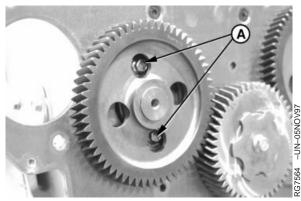
Fuel Supply Pump

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RG,16,DT7499 -19-14NOV97-2/5

Rotate engine gear train until cap screws (A) can be removed.

A—Cap Screws



Camshaft Gear

RG,16,DT7499 -19-14NOV97-3/5

IMPORTANT: Engine MUST remain in a position where camshaft followers rest against cylinder head or are held in up position with magnetic holders so that followers do not fall into engine crankcase. If camshaft followers fall into crankcase, cylinder head removal is required.

NOTE: D15001NU Magnetic Follower Holder Kit (C) may also be used to hold camshaft followers away from lobes.

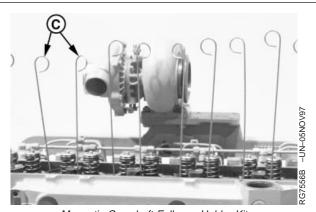
7. Revolve engine on repair stand to an angle where camshaft followers and fuel supply pump actuator pin (B) falls away from camshaft lobes.

IMPORTANT: DO NOT allow camshaft lobes to drag in bushing or honed bores.

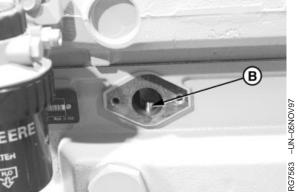
8. Carefully pull camshaft straight up, out of cylinder block.

NOTE: Rotate camshaft carefully to aid in removing.

- B—Pump Actuator Pin
- C-Magnetic Follower Holder Kit



Magnetic Camshaft Follower Holder Kit



Fuel Supply Pump Actuator Pin

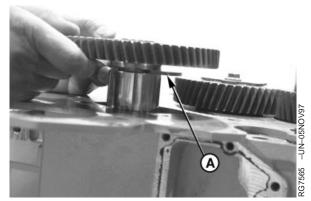
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RG,16,DT7499 -19-14NOV97-4/5

02 050 15

9. Remove thrust plate (A) from slot behind camshaft gear.

A-Thrust Plate



Camshaft and Thrust Plate

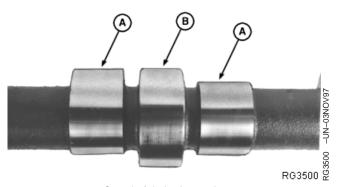
RG,16,DT7499 -19-14NOV97-5/5

Visually Inspect Camshaft

- 1. Clean camshaft in solvent. Dry with compressed air.
- 2. Inspect all camshaft lobes (A) and journals (B) for wear or damage. Replace camshaft as necessary.

IMPORTANT: New camshaft followers can be used with old camshaft. DO NOT reuse old camshaft followers with a new camshaft.

NOTE: Very light score marks are acceptable if valve lift is within specification. If pitting or galling exists, replace camshaft. (See MEASURE VALVE LIFT earlier in this group.)



Camshaft Lobe Inspection

A—Lobes B—Journal

RG,16,DT7498 -19-14NOV97-1/1

Measure Camshaft Thrust Plate Clearance and Thickness

Clean camshaft thrust plate and check clearance using a feeler gauge. Replace parts as necessary.

Specification

Camshaft Thrust Plate Clearance 0.08—0.23 mm (0.003—0.009 in.)

NOTE: Thrust plate clearance determines camshaft end play.

Check thrust plate thickness.

Specification

Camshaft Thrust Plate Thickness 3.96—4.01 mm (0.156—0.158 in.)



Measuring Camshaft Thrust Plate

RG,16,DT7514 -19-15NOV97-1/1

Inspect and Measure Camshaft Bushing ID and Journal OD

All engine camshafts have a (replaceable) bushing installed in No. 1 (front) camshaft bore.

- Measure camshaft journals. If a camshaft journal is damaged or does not meet specification, install a new camshaft.
- Measure camshaft bushing ID and remaining bores in cylinder block. If camshaft bore is damaged or is not within specification, have a qualified machine shop install new bushings.

If No. 1 camshaft bushing ID does not meet specifications, replace camshaft bushing. (See REMOVE AND INSTALL CAMSHAFT BUSHING earlier in this group.)



| Camsnatt Journal OD | 55.872—55.898 mm |
|----------------------------------|---------------------|
| | (2.1997—2.2007 in.) |
| Camshaft Bore, Front No. 1 in | 59.961—59.987 mm |
| Block (Without Bushing) ID | (2.3607—2.3617 in.) |
| Camshaft Bore, Front No. 1 in | 55.961—55.987 mm |
| Block (With Bushing) ID | (2.2031—2.2042 in.) |
| Camshaft Bore, All Except No. 1 | 55.986—56.012 mm |
| ID | (2.2042—2.2052 in.) |
| Camshaft Journal-to-Bushing, No | 0.063—0.115 mm |
| 1 Bore (With Bushing) Oil | (0.0025—0.0045 in.) |
| Clearance | |
| Camshaft Journal-to-Bushing, All | 0.088—0.140 mm |
| Except No. 1 Bore Oil Clearance | (0.0035—0.0055 in.) |
| | |



Measuring Camshaft Journal OD

RG,16,DT7497 -19-14NOV97-1/1

Measure Camshaft Lobe Height

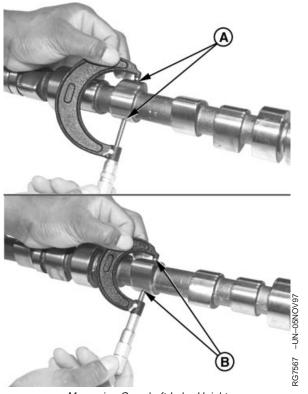
 Measure each camshaft lobe at highest point (A) and at narrowest point (B). The difference between these dimensions is camshaft lobe height. If height is not within specification on any lobe, install a new camshaft.

Specification

2. Measure fuel supply pump camshaft lobe diameter. If diameter is not within specification or lobe surface is grooved, install a new camshaft.

Specification

> A—High Point B—Narrow Point



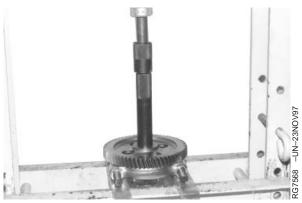
Measuring Camshaft Lobe Height

RG,16,DT7496 -19-14NOV97-1/1

Remove and Install Camshaft Gear

IMPORTANT: Camshaft must be replaced if dropped or damaged. Do not allow camshaft to strike floor when removing gear.

- 1. Press camshaft out of gear.
- 2. Clean camshaft and gears in solvent. Dry with compressed air.
- 3. Inspect camshaft journals for nicks and scratches. Replace camshaft if damage is found.

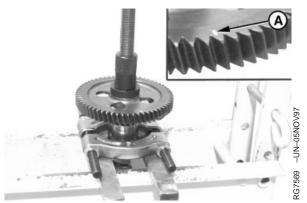


Remove Camshaft Gear from Camshaft

Continued on next page

RG,16,DT7495 -19-14NOV97-1/2

- 4. Support camshaft under first bearing journal in a hydraulic press.
- 5. Heat gear to 66—93°C (140—160°F) before pressing onto shaft to prevent metal transfer.
- 6. Apply LOCTITE® 680 (TY15969) Maximum Strength Retaining Compound to camshaft nose.
- 7. Install Woodruff key in camshaft nose.
- 8. Install gear with timing mark (A) away from camshaft (towards front timing gear cover). Press gear onto camshaft with a tubular driver until gear bottoms against camshaft shoulder.



Camshaft Gear to Camshaft Alignment

A—Timing mark

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RG,16,DT7495 -19-14NOV97-2/2

Inspect Camshaft Followers

NOTE: Cylinder head must be removed before camshaft followers can be removed from engine. (See REMOVE CYLINDER HEAD in Group 020.)

- 1. Inspect followers for uneven wear or damage. Also inspect corresponding camshaft lobe for wear or damage. Replace as necessary.
- 2. Measure follower OD and follower bore ID in cylinder block.

| _ | | | | |
|----|-------|----|------|--|
| Sn | acifi | CO | hion | |

| Specification | |
|---------------------------------------|----------------------|
| Camshaft Follower OD | 31.61—31.64 mm |
| | (1.245—1.246 in.) |
| Camshaft Follower Bore in Block | 31.70-31.75 mm |
| ID | (1.248—1.250 in.) |
| Camshaft Follower-to-Bore 0.06—0.13 m | nm (0.002-0.005 in.) |
| Clearance | |

Replace camshaft followers that are not within specification.

CTM104 (19JUN00)

Replace cylinder block if any one camshaft follower bore is not within specification.



Camshaft Follower

RG6324 -UN-23NOV97

RG,16,DT7494 -19-14NOV97-1/1

Inspect, Measure, and Install Fuel Supply Pump Push Rod

- 1. Remove and clean push rod (A). Label end(s) for reassembly in same orientation.
- 2. Measure push rod OD (B). If OD is less than specifications listed, install a new push rod.

| pecification |
|--------------|
| |

- 3. Check crown on push rod ends. If flat or concave, replace push rod and check camshaft lobe for wear. (See VISUALLY INSPECT CAMSHAFT in this group.)
- 4. Measure push rod bore ID (C) in block.

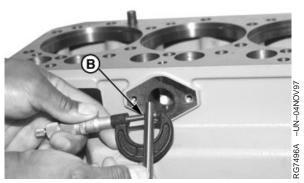
Specification

Repair or replace block as necessary.

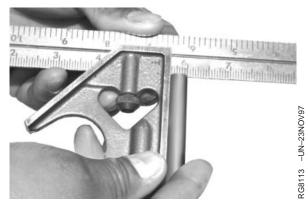
- 5. Lubricate push rod with clean engine oil and install in bore with same end orientation as removed.
 - A-Push Rod
 - B-Push Rod OD
 - C-Push Rod Bore ID



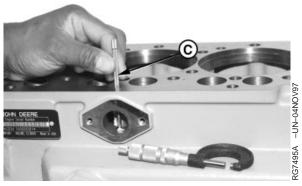
Fuel Supply Pump Push Rod



Push Rod OD Wear



Push Rod End Crown Wear



Push Rod Bore in Block Wear

Remove Balancer Shafts—If Equipped (4-Cylinder Engines)

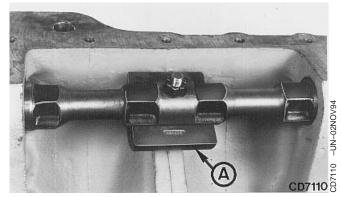
NOTE: Balancer shafts may be equipped with fixed weights, or removable weights attached with one or two cap screws.

- 1. Remove lower idler gear and oil pump gear (shown removed).
- 2. On later engines with removable weights¹, weights (A) must be removed before removing balancer shaft.
- 3. Remove cap screws from balancer shaft thrust plate as shown.

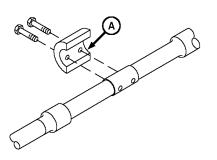
¹Serial Numbers: Dubuque-built engines (700877—), Saran-built

engines (500212---), Torreon-built engines (001000---).

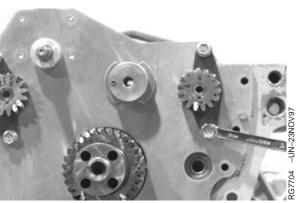
A-Weights



Balancer Shaft Weight (Single Cap Screw Mounted)



Balancer Shaft Weight (Dual Cap Screw Mounted)



Thrust Plate Cap Screw

Continued on next page

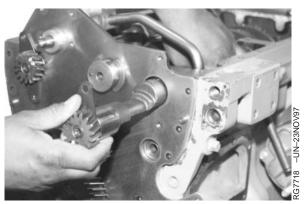
RG,16,DT7491 -19-15DEC99-1/2

RG10364 -UN-30SEP99

IMPORTANT: Identify left and right balancer shafts for correct assembly. Permanently mark a letter "R" or letter "L" on the rear of the shaft for identification. Interchanging shaft locations could cause premature wear of shafts and bushings.

NOTE: When removing balancer shafts, use care that neither shaft journals nor bushings are damaged in cylinder block.

4. Remove balancer shafts.



Balancer Shaft (S.N. — 700876 Shown)

RG,16,DT7491 -19-15DEC99-2/2

Inspect and Measure Balancer Shaft Bushings and Journals

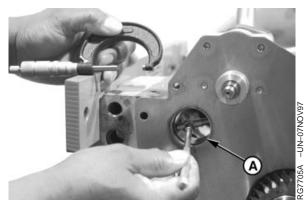
- 1. Inspect, measure and record bushing ID (A) at all locations.
- 2. Measure balancer shaft journal OD (B). Difference between journal OD and bushing ID is oil clearance.

If oil clearance is not within specification, install new bushings and, if necessary, new balancer shaft.

| S | pecification |
|---|--------------|
|---|--------------|

| Balancer Shaft Bushing (New) ID | 40.177—40.237 mm |
|----------------------------------|---------------------|
| | (1.5818—1.5841 in.) |
| Balancer Shaft Journal OD | 40.135—40.161 mm |
| | (1.5801—1.5811 in.) |
| Balancer Shaft | 0.016—0.102 mm |
| Journal-to-Bushing Oil Clearance | (0.0006—0.0040 in.) |
| Cylinder Block Bore for Balancer | 43.262—43.288 mm |
| Shaft Bushing ID | (1.7032—1.7042 in.) |
| | |

A—Bushing ID B-Journal OD



Measuring Balancer Shaft Bushing ID



Measuring Balance Shaft Journal OD

RG,16,DT7490 -19-14NOV97-1/1

Remove and Install Balancer Shaft Bushings (4-Cylinder Engines)

IMPORTANT: Cylinder block front plate must be removed in order to replace balancer shaft bushings.

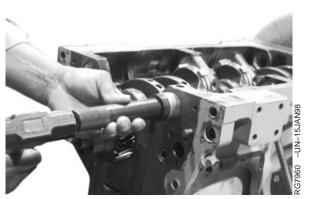
- 1. Remove all fuel lines from injection or rotary pump.
- 2. Remove front plate. See REMOVE CYLINDER BLOCK FRONT PLATE, later in this group.
- Remove bushings from block with JD249 (JD-249)
 Balancer Shaft Bushing Driver and JDG963 Adapter.
 To remove the rear (third) bushing, the flywheel housing must be removed.

IMPORTANT: Make sure oil holes in bushing and block are aligned for proper bushing and journal lubrication.

- 4. Lubricate bushings with clean engine oil and install in block with same tools used during removal.
- 5. Insert balancer shaft to check for bushing-to-shaft clearance. If shaft can be rotated by hand with a slight-to-moderate drag, adequate bushing-to-balancer shaft clearance exists. It is not necessary to hone bushings to obtain specified oil clearance. Excessive clearance can result in shaft seizure.



Removing Bushing



Installing Bushing

RG,16,DT7489 -19-23MAY00-1/1

050

Inspect Balancer Shaft Gears and Thrust Plates

1. Inspect for broken, cracked or excessively worn gears.

NOTE: Gear removal is required for thrust plate removal.

2. Inspect thrust plate (A) for scoring or excessive wear.

Specification

Balancer Shaft Thrust Plate 2.97—3.02 mm (0.117—0.119 in.) (New) Thickness

RG7708 -UN-07NOV97



Balancer Shaft Thrust Plate

A—Thrust Plate

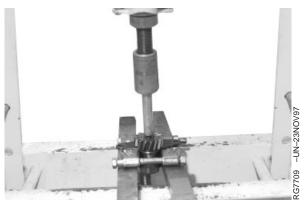
RG,16,DT7488 -19-14NOV97-1/1

Remove and Install Balancer Shaft Gears

IMPORTANT: DO NOT intermix gears and shafts. Shafts are finish lapped in different locations; therefore, balancer shafts MUST BE installed in the location from which removed. Reversing shaft locations could result in excessive bushing and shaft wear. If in doubt about proper shaft locations, replace the balancer shaft and bushings.

NOTE: Balancer shaft kits provided for service are delivered without gear.

- 1. Support back side of gear in a press and push on balancer shaft to remove gear.
- 2. Inspect Woodruff key or spring pin (later engines), gear, and thrust plate for cracks and wear. Replace if necessary.



Remove Balancer Shaft Gear from Shaft

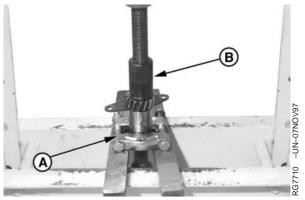
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RG,16,DT7487 -19-14NOV97-1/2

02 050 25

- 3. Position balancer shaft in JD247 (JD-247) Balancer Shaft Holding Tool or bearing pulling attachment (A).
- 4. Install thrust plate.
- 5. Use Woodruff key or spring pin (later engines) to index gear on balancer shaft. Be sure timing mark is on front face of gear.
- 6. Press gear onto shaft with a tube-type driver (B) until gear is flush with shaft.

Specification



Balancer Shaft Gear to Shaft

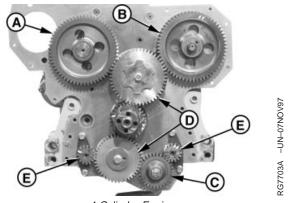
A—Bearing Pulling Attachment B—Tube-Type Driver

RG,16,DT7487 -19-14NOV97-2/2

Remove Cylinder Block Front Plate

Before the front plate can be removed, the following components must first be removed:

- Timing gear cover. (See REMOVE TIMING GEAR COVER in this group.)
- Camshaft and gear (A). (See REMOVE CAMSHAFT in this group.)
- Injection pump drive gear (B) and injection pump. See Section 02, Group 090 of CTM207 (Mechanical Fuel Systems) or CTM170 (Electronic Fuel Systems).
- Oil pump drive gear (C) and oil pump. (See REMOVE ENGINE OIL PUMP in Group 060.)
- Idler gears (D)
- Balancer shafts (E)¹ (See REMOVE BALANCER SHAFTS in this group.)



4-Cylinder Engine

- A—Camshaft and Gear
- **B**—Injection Pump Drive Gear
- C-Oil Pump Drive Gear
- D—Idler Gears (Upper and Lower)
- E—Balancer Shafts¹

¹ 4-cylinder engine only

Continued on next page

RG,16,DT7486 -19-10NOV99-1/4

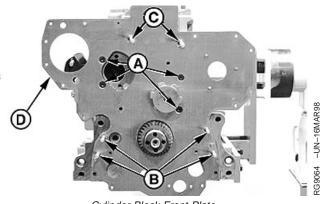
1. Remove four countersunk, TORX® screws (A) from gear and oil pump using T-40 TORX® adapter.

NOTE: On earlier engines¹, there are two countersunk TORX[®] screws used in place of threaded studs (C).

- 2. Remove six threaded studs (B) and (C) using E-8 TORX® Socket.
- 3. Remove front plate (D).

TORX is a registered trademark of Camcar/Textron

¹ Serial Numbers: Dubuque-built engines (—703904), Saran-built engines (—516217), Torreon-built engines (does not apply).



Cylinder Block Front Plate

- A-Screws
- **B—Threaded Studs**
- C—Threaded Studs
- **D**—Front Plate

RG,16,DT7486 -19-10NOV99-2/4

4. Remove oil bypass valve and spring.



Oil Bypass Valve and Spring

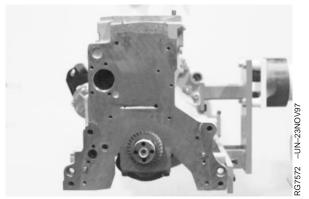
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RG,16,DT7486 -19-10NOV99-3/4

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IMPORTANT: All surfaces must be free of oil and dirt.

5. Thoroughly clean front face of cylinder block.



Front Face of Cylinder Block

RG,16,DT7486 -19-10NOV99-4/4

Measure Idler Gear Bushing and Shaft

 Measure idler gear bushing ID and shaft OD to determine oil clearance. If oil clearance exceeds specification, replace worn parts.

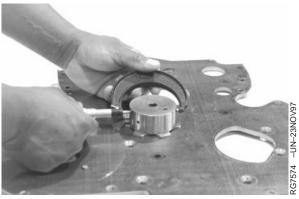
Specification

| 11 | |
|---------------------------------------|---------------------|
| , | (2.7481—2.7493 in.) |
| Upper Idler Gear Bushing (22 mm | |
| Wide Gear) ID | (1.751-1.753 in.) |
| Lower Idler Gear Bushing ID | 44.489—44.539 mm |
| | (1.7515—1.7535 in.) |
| Upper Idler Gear Shaft (30 mm | 69.757—69.777 mm |
| Wide Gear) OD | (2.7463—2.7471 in.) |
| Upper Idler Gear Shaft (22 mm | 44.43—44.46 mm |
| Wide Gear) OD | (1.749-1.750 in.) |
| Lower Idler Gear Shaft OD | 44.437—44.463 mm |
| | (1.7495—1.7505 in.) |
| Upper Idler Gear | 0.075—0.125 mm |
| Bushing-to-Shaft Oil Clearance | (0.0030—0.0049 in.) |
| Lower Idler Gear | 0.026—0.102 mm |
| | (0.0010—0.0040 in.) |
| Upper Idler Gear End Play | 0.070—0.170 mm |
| | (0.0027—0.0066 in.) |
| Lower Idler Gear End Play | 0.070—0.330 mm |
| · · · · · · · · · · · · · · · · · · · | (0.0027—0.0129 in.) |

- 2. If idler gear end play, measured earlier in this group, was out of specification, remove idler shaft and thrust washer from front plate. (See REMOVE LOWER AND UPPER IDLER SHAFTS, later in this group.)
- 3. Check thrust washer for wear.
- 4. Measure idler gear hub width and shaft width. Replace worn parts that are out of specification.



Measuring Idler Gear Bushing ID



Measuring Idler Shaft Journal ID

RG,16,DT7484 -19-08NOV99-1/1

RG7573 -UN-23NOV97

Remove Idler Gear Bushings

NOTE: Bushing for "wide" 30 mm (1.18 in.) upper idler gear is not replaceable. If bushing is worn, replace gear assembly.

- For "narrow" 22 mm (0.87 in.) upper idler gear bushing, press worn bushing out of gear using 27527 Disc Driver from D01045AA Master Driver Set and JDG537 (OTC815) Handle.
- For lower idler gear bushing, press worn bushing out of gear using discs from D01045AA Master Driver Set and JGD537 (OTC815) Handle.



22 mm (0.87 in.) Upper Idler Gear



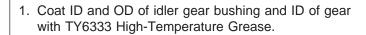
Lower Idler Gear

RG,16,DT7483 -19-14NOV97-1/1

Install Idler Gear Bushings

NOTE: Bushing for "wide" 30 mm (1.18 in.) upper idler gear is not replaceable. If bushing is worn, replace gear assembly.

IMPORTANT: Bushing failure will result if upper and lower bushings are interchanged. Lower idler gear bushings are splash lubricated and have a spiral oil groove; upper idler gear bushings are pressure lubricated and DO NOT have oil grooves.



- 2. Install bushing into upper "narrow" 22 mm (0.087 in.) idler gear using JD252 (JD-252) Driver¹ and JDG537 (OTC815) Handle.
- 3. Install bushing into lower idler gear using discs and driver from D01045AA Master Driver Set.



Upper Idler Gear



Lower Idler Gear

¹ Discs from D01045AA Master Driver Set can be used if JD252 (JD-252) Driver is not available.

DPSG,OUO1004,43 -19-10APR98-1/1

Remove Lower and Upper Idler Shafts

- 1. Remove lower idler shaft and thrust washer by driving or pressing on shaft from block side of front plate.
- 2. Remove upper idler shaft and thrust washer by driving or pressing on shaft from block side of front plate.



Upper Idler Shaft



Lower Idler Shaft

RG,16,DT7482 -19-14NOV97-1/1

Clean and Inspect Front Plate

IMPORTANT: All surfaces must be free of oil and dirt.

- 1. Clean front plate with hot soapy water.
- 2. Rinse well with plain water to remove all soap residue from gasket surface.
- 3. Inspect front plate for damage.

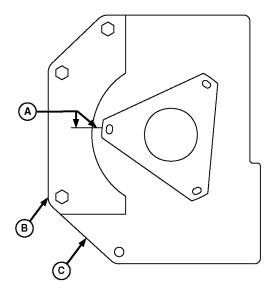
RG,16,DT7481 -19-14NOV97-1/1

02 050 31

Transfer Fuel Injection Pump Timing Mark onto Replacement Front Plate

IMPORTANT: Replacement front plates do not have an injection pump timing mark. It is extremely important that the timing mark be accurately transferred from original front plate to the replacement plate in the exact location for correct injection pump timing.

- 1. Position DFRG5 Aluminum Template (B) onto original front plate (C) as shown. (See Section 05, Group 190, Dealer Fabricated Tools, for manufacturing detail.) Install and tighten three 3/8-16 cap screws securely.
- 2. Transfer injection pump timing mark (A) from previous front plate onto template using a fine tip marker and straightedge. Remove template from front plate being replaced.
- 3. Attach template (with timing mark) to new replacement front plate and tighten cap screws securely.
- 4. Transfer timing mark from the template to the new front plate using a scribe. Scribe deep enough so mark becomes a permanent reference.
- 5. Remove template from front plate and install front plate. (See INSTALL CYLINDER BLOCK FRONT PLATE later in this group).



Front Plate Timing Mark

- A—Timing Mark
- **B**—Aluminum Template
- C-Front Plate

RG,16,DT7480 -19-14NOV97-1/1

RG9057 -UN-16MAR98

Install spring pins in lower (A) and upper (B) idler gear shafts. This locks thrust washer to shaft to allow 4.32 mm (0.170 in.) projection (C) above front face of each shaft. The pins on idler shafts extend through both rear and front thrust washers.

Specification

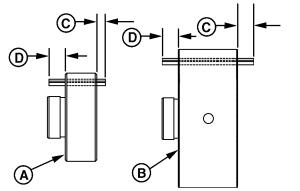
Lower and Upper Idler Shaft.................................. 2.79—4.83 mm (0.11—0.19 in.) Spring Pin (D) Protrusion

A-Lower Idler Gear Shaft

B—Upper Idler Gear Shaft

C-4.32 mm (0.170 in.) Projection

D-2.79-4.83 mm (0.11-0.19 in.) Protrusion



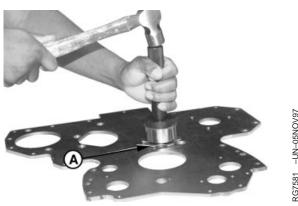
Idler Shaft Spring Pins

RG,16,DT7479 -19-14NOV97-1/1

Install Upper Idler Shaft in Front Plate

IMPORTANT: Oil holes in idler shaft must be properly indexed to provide adequate lubrication to the idler gear bushing. Install shaft so the oil hole is pointing toward top of engine ±15°. Install thrust washer (A) with "X" mark facing away from gear (toward front plate).

- 1. Install rear thrust washer (A) and upper idler shaft into front plate. Spring pin (if equipped) must extend through hole in thrust washer and front plate.
- 2. Drive or press shaft into front plate until thrust washer is fully seated.



Upper Idler Shaft in Front Plate

A—Thrust Washer

RG,16,DT7478 -19-14NOV97-1/1

02 050

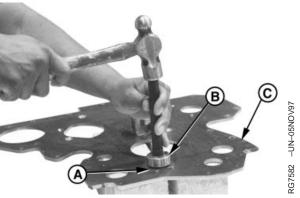
RG9135 -UN-18MAY98

Install Lower Idler Shaft in Front Plate

NOTE: Spring pin (B) is only used on later engines.

IMPORTANT: Install thrust washer (A) with "X" mark facing away from gear (toward plate).

- 1. Install thrust washer (A) and lower idler shaft with spring pin (B). Spring pin must extend through hole in thrust washer and front plate.
- 2. Drive shaft into front plate (C) until thrust washer is fully seated.



Lower Idler Shaft in Front Plate

- A-Thrust Washer
- **B—Spring Pin**
- C-Front Plate

RG,16,DT7477 -19-14NOV97-1/1

Install Cylinder Block Front Plate

- 1. Install oil bypass valve and spring into block.
- 2. If not previously done, use a brass scraper and remove any previously applied sealant.

IMPORTANT: Be sure cylinder block and front plate surfaces are free of oil, dirt, previously applied sealant, and cleaning agents.

Wash gasket surfaces with a steam cleaner using hot soapy water. Rinse well with plain water to remove all soap residue from gasket surface.



Oil Bypass Valve and Spring

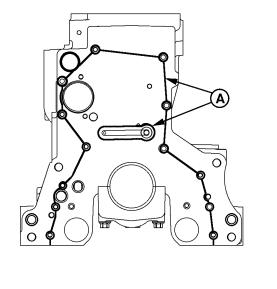
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RG,16,DT7476 -19-14NOV97-1/3

02 050 35

- 4. Apply LOCTITE® 515 Flexible Form-In-Place Gasket (TY6304) in a continuous 1.5—2.0 mm (0.06—0.08 in.) bead (A) to cylinder block.
- 5. Locate bead in the center of the mating surfaces and completely encircle cap screw and dowel holes.

A-Flexible Gasket Pattern



Flexible Gasket Application Pattern

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RG,16,DT7476 -19-14NOV97-2/3

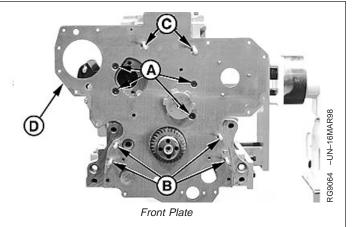
6. Install front plate (D).

IMPORTANT: Tighten screws to specified torque using a cross pattern, within 10 minutes after parts are assembled.

NOTE: On earlier engines¹, there are two countersunk TORX[®] screws in place of threaded studs (C).

Specification

| Front Plate Countersunk TORX® | 25 N•m (18 lb-ft |
|--------------------------------|------------------|
| Screws (A) Torque | |
| Front Plate Threaded Studs (B) | 35 Nem (26 lb-ft |
| and (C) Torque | |



A—Countersunk TORX® Screws

B—Threaded Studs

C—Threaded Studs

D—Front Plate

TORX is a registered trademark of Camcar/Textron

¹ Serial Numbers: Dubuque-built engines (—703904), Saran-built engines (—516217), Torreon-built engines (does not apply).

RG,16,DT7476 -19-14NOV97-3/3

Install and Time Balancer Shafts (4-Cylinder **Engines**)

1. Using JDG820 or JDE83 Flywheel Turning Tool and JDE81-4 Timing Pin, lock No. 1 piston at TDC compression stroke.



Engine Rotation Tool and Timing Pin in Place

-UN-23NOV97

RG,16,DT7475 -19-14NOV97-1/7

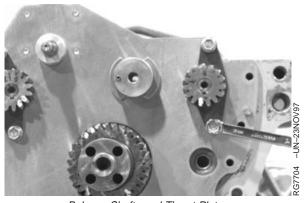
2. Lubricate balancer shaft bushings and journals with clean engine oil.

IMPORTANT: Balancer shafts MUST BE installed in the location from which removed. Reversing shaft locations could result in excessive bushing and shaft wear. If in doubt about proper shaft locations, replace the balancer shaft and bushings.

3. Install balancer shafts and thrust plates. Tighten thrust plate cap screws to specifications.

Specification

Screws Torque



Balance Shafts and Thrust Plates

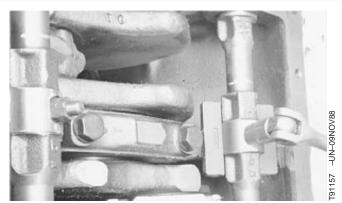
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RG,16,DT7475 -19-14NOV97-2/7

4. Later engines¹ have balancer shafts with removable weights. Install weights to balancer shafts using new cap screws and nuts. Tighten to specifications.

Specification

| Balancer Shaft Removable | 58 Nem (43 lb-ft) |
|----------------------------|-------------------|
| Weights (One-Bolt Weights) | |
| Torque | |
| Balancer Shaft Removable | 40 N•m (30 lb-ft) |
| Weights (Two-Bolt Weights) | |
| Torque | |
| | |



Balancer Shaft Removable Weights

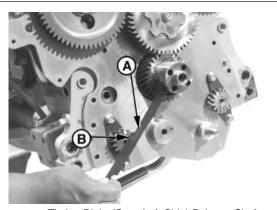
¹Serial Numbers: Dubuque-built engines (700877—), Saran-built engines (500212—), Torreon-built engines (001000—).

RG,16,DT7475 -19-14NOV97-3/7

RG7712 -UN-07NOV97

- Turn right (camshaft side) balancer shaft so timing mark on gear is aligned with JD254A (JD-254A) Timing Tool (A). Timing mark on balancer shaft gear must point to centerline of crankshaft when correctly timed.
- NOTE: Keyway (B) in balancer shaft gear will be at 12 o'clock position, when engine is locked at No. 1 TDC compression.
- Apply TY6333 High-Temperature Grease to idler gear bushing ID and shaft OD. Install lower idler gear without turning balancer shaft.

A—Timing Tool B—Keyway



Timing Right (Camshaft Side) Balance Shaft

Continued on next page

RG,16,DT7475 -19-14NOV97-4/7

NOTE: Install thrust washer with "X" mark facing away from gear.

- 7. Install thrust washer over lower idler gear (C) and shaft.
- Lubricate and install cap screw through idler shaft into threaded leg of oil pump housing and finger tighten only.

C-Lower Idler Gear



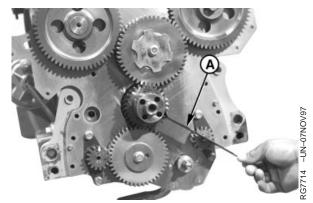
Lower Idler Gear and Thrust Washer

RG7713 -UN-07NOV97

RG,16,DT7475 -19-14NOV97-5/7

- 9. Turn left (injection pump side) balancer shaft so timing mark on gear is aligned with JD254A (JD-254A) Timing Tool (A).
- 10. Install oil pump gear. Finger tighten gear retaining nut.
- 11. Recheck gear timing for both balancer shafts

A—Timing Tool



Timing Left (Engine Pump Side) Balancer Shaft

Continued on next page

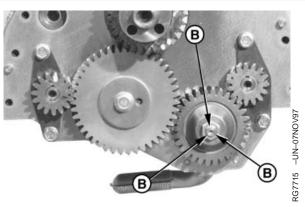
RG,16,DT7475 -19-14NOV97-6/7

 Tighten oil pump drive gear retaining nut to specifications. Stake nut to shaft in three places (B). (See INSTALL ENGINE OIL PUMP in Group 060 for oil pump installation.)

Specification

13. Tighten lubricated lower idler gear cap screws to specifications.

Specification



Early Model Shown

B—Stake Points

RG,16,DT7475 -19-14NOV97-7/7

Install Camshaft

 Using JDG820 or JDE83 Flywheel Turning Tool and JDE81-4 Timing Pin, lock No. 1 piston at TDC compression stroke.

NOTE: Injection pumps must be properly installed and timed during camshaft installation.

For Stanadyne and Lucas rotary pumps, see appropriate pump installation procedure in Section 02, Group 090 of CTM207 (Mechanical Fuel Systems).

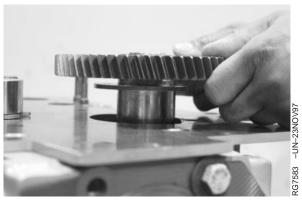
For static lock-pin timing of Bosch VP44 pumps, see BOSCH VP44 ROTARY INJECTION PUMP TIMING in Section 02, Group 90 of CTM170 (Electronic Fuel Systems). Then, see INSTALL BOSCH VP44 FUEL INJECTION PUMP in Section 02, Group 090 of CTM170 (Electronic Fuel Systems).

For static lock-pin timing of Denso and Motorpal pumps, see DENSO AND MOTORPAL IN-LINE INJECTION PUMP TIMING in Section 02, Group 090 of CTM207 (Mechanical Fuel Systems). Then, see the appropriate pump installation procedure in Section 02, Group 090 of CTM207 (Mechanical Fuel Systems).

- 2. Install fuel injection pump and drive gear. See appropriate reference as identified in NOTE above.
- 3. Lubricate camshaft bearing journals, lobes, and followers with TY6333 High-Temperature Grease.

IMPORTANT: DO NOT allow camshaft lobes to drag on camshaft bore or bushing surfaces while installing camshaft. Bearing surfaces may become scratched or scored. Rotate camshaft during installation to avoid obstruction in any

4. Install camshaft and thrust plate in cylinder block. Be careful not to damage bushing ID.



Camshaft and Thrust Plate in Cylinder Block

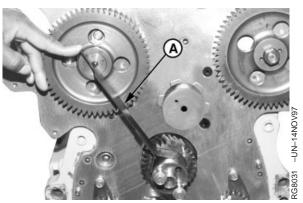
Specification

02 050 41

RG,16,DT7474 -19-30NOV99-2/6

 With JD254A (JD-254A) Timing Tool resting on nose of crankshaft and center of camshaft (as shown), turn camshaft until timing mark (A) on camshaft gear aligns with timing tool.

A—Timing Mark



Setting Camshaft Timing

Continued on next page

RG,16,DT7474 -19-30NOV99-3/6

NOTE: Denso, Motorpal and Bosch VP44 injection pumps are static lock-pin timed during installation. The following step applies to Stanadyne and Lucas Pumps only.

IMPORTANT: Use the timing mark corresponding to the number of cylinders the engine has that is being timed.

7. On Stanadyne and Lucas rotary pumps: Check injection pump gear timing with JD254A (JD-254A) Timing Tool resting on nose of crankshaft and center of injection pump shaft. Timing mark (B) on injection pump drive gear, as described in table below, must align with timing tool (as shown).

INJECTION PUMP GEAR TIMING MARKS

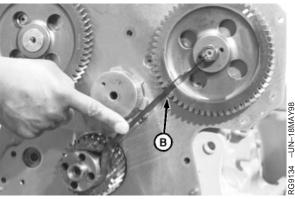
| Injection Pump Model | Timing Mark |
|--------------------------------------|-------------|
| Lucas and Stanadyne 4-Cyl. Engine | 4 |
| Stanadyne 6-Cyl. Engine | S6 |
| Lucas 6-Cyl. Engine | L6 |
| Lucas (1st Production 1170 Combines) | L6 |
| Lucas (Early 1170 Combines) | 6C |
| Lucas (Late 1170 Combines) | 6Z |

IMPORTANT: To ensure proper lubrication of new upper idler gear bushing and camshaft bushing, install new upper idler gear with the reference number facing away from engine.

 Lubricate upper idler gear bushing ID and shaft OD with TY6333 High-Temperature Grease. Using JDG791A Idler Gear Installer Pilot,¹ install idler gear without turning camshaft gear or injection pump gear.

NOTE: Install thrust washer with "X" mark facing away from gear.

 Lubricate upper idler gear cap screw threads with oil. Install upper idler gear thrust washer and cap screw. Tighten cap screw to specifications.



Setting Injection Pump Timing

B—Timing Mark

¹JDG791A needs to be modified to allow space for the spring pin in idler shaft.

Continued on next page

RG,16,DT7474 -19-30NOV99-4/6

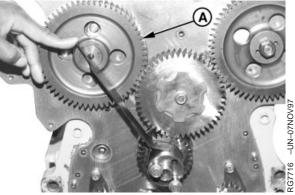
Specification

RG,16,DT7474 -19-30NOV99-5/6

02 050 43

10. Recheck camshaft gear (A) and injection pump drive gear timing to make sure they are correct.

A—Camshaft Gear



Rechecking Camshaft Timing

RG,16,DT7474 -19-30NOV99-6/6

Clean and Inspect Timing Gear Cover

- 1. Drive crankshaft front oil seal out of cover.
- Remove material and sealant from cylinder block and timing gear cover gasket surfaces. If necessary, remove oil filler neck and gasket and injection pump drive gear nut cover plate and gasket.



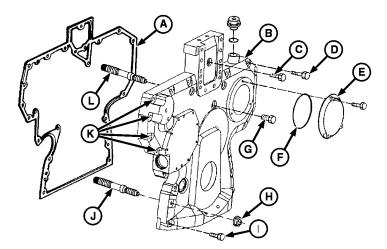
CAUTION: Do not spin bearings when drying with compressed air.

3. If engine is equipped with the auxiliary drive, remove auxiliary drive as described earlier in this group.

- If engine is equipped with electronic tachometer (magnetic pick-up) sensor, remove sensor and O-ring. (See REMOVE AND INSTALL MAGNETIC PICK-UP SENSOR, as described in this group.)
- 5. Clean timing gear cover in solvent. Dry with compressed air.
- 6. Inspect cover for cracks or damage. Make sure seal bore is clean and free of nicks.

RG,16,DT7472 -19-14NOV97-1/1

Install Timing Gear Cover



Timing Gear Cover

A-Gasket

B—Timing Gear Cover

C—Cap Screw M8 x 35 mm (1 Used)

D-Cap Screw M8 x 40 mm (10 Used W/Aux Drive) (6 Used W/O Aux Drive)

PLATE, earlier in this group.

Tighten screws to specifications.

E—Injection Pump Drive Gear **Cover Plate**

F-O-Ring

G—Cap Screw (2 Used W/Aux Drive) (1 Used W/O Aux Drive)

H—Flange Nut M10 (4 Used)

I—Cap Screw M8 x 55 (2 Used)

J-Stud (4 Used)

K—Stud Locations (OEM applications only. See note below.)

L-Stud (2 Used)1

1. Make sure gasket surfaces on cover and front plate Thread Lock and Sealer to studs. Install studs are clean. See CLEAN AND INSPECT FRONT in front plate and wait two hours before installing timing gear cover. Studs must not protrude from front plate.

- 3. Install timing gear cover (B) on engine.
- 4. Apply LOCTITE® 592 (TY9375) Pipe Sealant to cap screw (G) and torque timing cover cap screws and nuts to specifications.

Specification

LOCTITE® 242 (T43512) Thread Lock and Sealer to

2. Install injection pump drive gear cover plate (E) using a new O-ring (F), if necessary. Apply

cap screws on rotary injection pump covers.

Injection Pump Drive Gear 6 Nem (4.5 lb-ft) (54 lb-in.) Cover Torque

NOTE: On some OEM engine applications, cap screws in location (K) are replaced by studs with nuts to prevent interference with auxiliary driven hydraulic pump. Apply LOCTITE® 271

Specification

Plate and Cylinder Block Cap Screws and Nuts Torque Torque

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¹ Serial Numbers: Dubuque-built engines (703905—), Saran-built engines (516218—), Torreon-built engines (001000—).

Continued on next page

RG,16,DT7471 -19-15NOV99-1/5

 Install oil pressure regulating valve assembly. (See REMOVE AND INSTALL OIL PRESSURE REGULATING VALVE AND SEAT in Group 060.)

RG,16,DT7471 -19-15NOV99-2/5

02 050 45

- 6. Install adjustable fan drive and fan pulley (B). (See INSTALL FAN DRIVE ASSEMBLY in Group 070.)
- 7. Install water pump, if removed. (See INSTALL WATER PUMP in Group 070.)

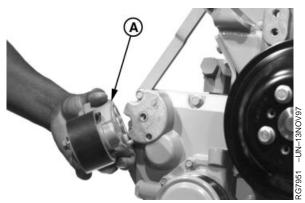
B—Fan Pulley



RG,16,DT7471 -19-15NOV99-3/5

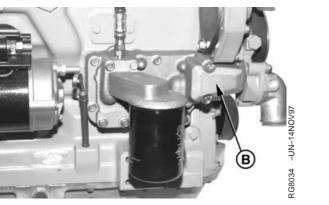
8. Install belt tensioner (A), if removed. (See REMOVE AND INSTALL AUTOMATIC (SPRING) BELT TENSIONER in Group 070.)

A-Belt Tensioner



RG,16,DT7471 -19-15NOV99-4/5

- 9. Install oil cooler-to-water manifold elbow (B) at front plate. (See Group 060.)
- 10. Install oil pan. (See INSTALL OIL PAN in Group 060.)
 - B-Oil Cooler-to-Water Manifold Elbow



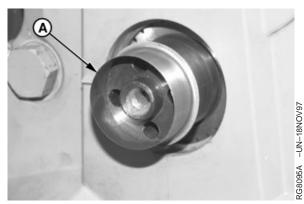
RG,16,DT7471 -19-15NOV99-5/5

Install Crankshaft Front Wear Sleeve and Oil Seal

NOTE: Some engines manufactured in 1999—2000 are not equipped with front wear sleeves; however, sleeve is recommended for service whenever front oil seal is replaced.

Install Front Crankshaft Wear Sleeve

- 1. Coat ID of new wear sleeve with LOCTITE® 680 (TY15969) Maximum Strength Retaining Compound.
- 2. Install wear sleeve (A) on nose of crankshaft with lip of sleeve toward crankshaft.



Crankshaft Wear Sleeve

A-Crankshaft Wear Sleeve

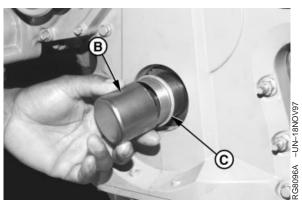
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RG,16,DT7470 -19-16JUN00-1/3

NOTE: Flange on wear sleeve should be seated against crankshaft drive gear when properly installed.

On some engines, the gear shaft key may protrude off the crankshaft gear. In this case, place an appropriate spacer inside the installation tool (B).

- Position installation tool (B), provided in front wear sleeve kit, over wear sleeve. Install wear sleeve using a dead blow hammer until tool bottoms on nose of crankshaft.
- 4. Clean any sealant from OD of crankshaft flange (C) and wear sleeve.
 - B—Wear Sleeve Installation Tool C—Crankshaft Flange



Crankshaft Wear Sleeve Installation Tool



Install Front Crankshaft Oil Seal

IMPORTANT: To assure proper sealing, the OD of the crankshaft and wear sleeve MUST BE cleaned with Brake Kleen, Ignition Cleaner, or equivalent, and dried prior to installing seal (C).

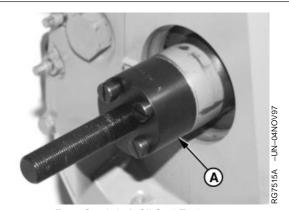
- 1. Inspect and clean seal bore in timing gear cover. Check for nicks or burrs. Use a medium-grit emery cloth to smooth rough areas.
- 2. Slide JDG954A-2 Adapter (A) on nose of crankshaft and tighten cap screws.

IMPORTANT: DO NOT allow oil to contact coating on OD of seal.

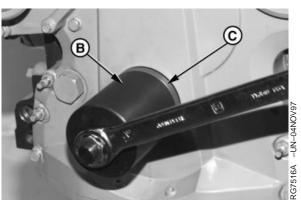
- 3. Apply a light coating of clean engine oil to lips of seal and position seal on crankshaft flange. (The spring-loaded side of seal goes into timing gear cover first.)
- 4. Place JDG954A-1 Installer (B) over adapter. Tighten screw until driver bottoms on flange of timing gear cover.
- 5. Install belt pulley or vibration damper. (See INSTALL PULLEY OR VIBRATION DAMPER AND PULLEY in Group 040.)

A-JDG954A-2 Adapter B—JDG954A-1 Installer C—Oil Seal

CTM104 (19JUN00)



Front Crankshaft Oil Seal Tool



Front Crankshaft Oil Seal Tool



Front Crankshaft Oil Seal

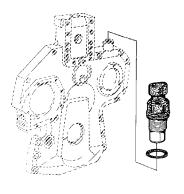
RG,16,DT7470 -19-16JUN00-3/3

Remove and Install Magnetic Pick-Up Sensor

- 1. Disconnect wiring connector and remove magnetic pick-up. Discard O-ring.
- 2. Replace magnetic pickup as required.
- 3. Install magnetic pick-up with a new O-ring and tighten to specifications.

Specification

4. Install electrical connector.

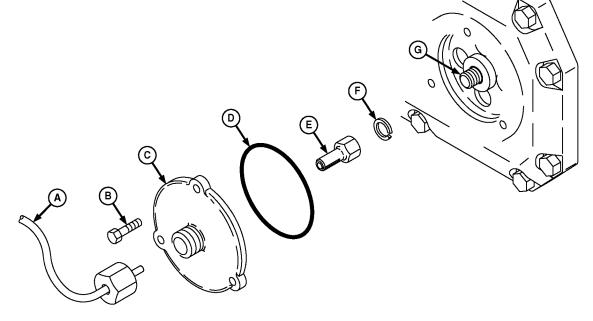


Magnetic Pick-Up

DPSG,OUO1004,1179 -19-29NOV99-1/1

RG10551 -UN-02DEC99

Replace Mechanical Tachometer Adapter



Mechanical Tachometer

A—Tachometer Cable C—Cover B—Cap Screws D—O-Ring

- Disconnect cable (A) and remove cover (C) and O-ring (D).
- 2. Remove adapter (E) and lock washer from end of injection pump shaft (G). Be careful not to let adapter or washer fall inside timing cover.
- 3. Replace parts as required.
- 4. Install adapter (E) and lock washer on injection pump shaft. Tighten adapter to specifications.

Specification

E—Adapter G—Injection Pump Shaft F—Lock Washer

5. Install new O-ring and cover. Tighten cap screws (B) to specifications.

Specification

Mechanical Tachometer Cover...... 6 N•m (4.5 lb-ft) (54 lb-in.) Plate Torque

DPSG,OUO1004,42 -19-09APR98-1/1

Complete Final Assembly

- Install fuel supply pump. See Section 02, Group 090 of CTM207 (Mechanical Fuel Systems) or CTM170 (Electronic Fuel Systems).
- 2. Remove camshaft follower holding tools (if used for camshaft removal).
- 3. Install push rods and rocker arm assembly. (See INSTALL ROCKER ARM ASSEMBLY in Group 020.)
- Adjust valve clearance. (See CHECK AND ADJUST VALVE CLEARANCE in Group 020.) Install rocker arm cover and sealing ring. (See INSTALL ROCKER ARM COVER in Group 020.)

- 5. Install fan. (See INSPECT AND INSTALL FAN ASSEMBLY in Group 070.)
- Install alternator. (See REMOVE AND INSTALL ALTERNATOR in Group 100.)
- Fill engine crankcase with clean oil having correct viscosity and grade specifications. (See Section 01, Group 002.)
- 8. Perform engine break-in. (See PERFORM ENGINE BREAK-IN in Group 010.)

RG,16,DT7469 -19-14NOV97-1/1

General Lubrication System Information

The oil filter can be located on right side of the engine or remotely located on left side.

Dipsticks and oil fill locations can be located on either side of the engine. The oil fill can also be located on the rocker arm cover.

The pressure regulating valve and the bypass valve are located in the front face of the block. Two regulating valve springs are available: one for 4-cylinder engines and one for 6-cylinder engines.

Oil coolers are full-flow, plate-type coolers. They may be equipped with 3, 5, 7, or 9 plates.

One oil pump is available and is used on both 4- and 6-cylinder engines.

NOTE: For lubrication system diagnostics, see DIAGNOSING LUBRICATION SYSTEM MALFUNCTIONS in Section 04, Group 150.

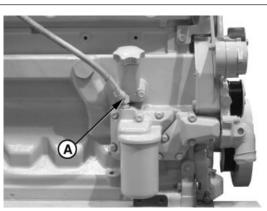
RG,20,DT7533 -19-08DEC99-1/1

Remove, Inspect, and Install Oil Filter Base

Several oil filter locations are available. Two versions are being shown in this procedure.

- 1. Disconnect turbocharger oil inlet line (A) from oil filter header.
- 2. On left hand and remote mount filters, disconnect oil inlet and outlet lines.

A-Turbocharger Oil Inlet Line

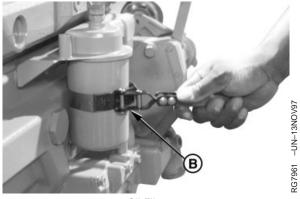


Turbocharger Oil Inlet Line

Continued on next page RG,20,DT7532 -19-24SEP99-1/4

02 060 1 3. Remove oil filter (B) using a suitable filter wrench.

B-Oil Filter



Oil Filter

Continued on next page

RG,20,DT7532 -19-24SEP99-2/4

RG10373 -UN-040CT99

- 5. Remove oil tube adapter (B) and remove tubes (D), if equipped.
- 6. Clean all gasket material from mating surfaces. Inspect all parts and replace if needed.
- 7. Install new gasket and O-rings (if required) and install oil filter header/rear adapter (A) or remote filter header to bracket. Tighten cap screws to specifications.

| ١ |
|---|
| |

| Oil Filter Header Cap Screws | 35 Nem (26 lb-ft) |
|----------------------------------|-------------------|
| (High, Front and Rear Mounted) | |
| Torque | |
| Oil Filter Header-to-Bracket Cap | 73 Nem (54 lb-ft) |
| Screws (Left Hand and Remote | |
| Mounted) Torque | |

NOTE: On early engines, O-rings for tubes (D) are installed in grooves of adapter (B). Later engines are equipped with beaded tubes which retain the O-rings.

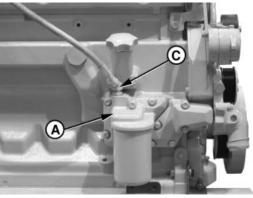
8. Using a new gasket and O-rings, install adapter (B) and tubes (D) on high, front and rear mount assemblies. Apply LOCTITE® 242 Thread Lock and Sealer to short cap screw (E) for open hole in oil cooler. Tighten all cap screws to specifications.

Specification

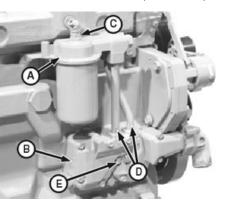
- 9. Connect turbocharger oil inlet line (C) and tighten to specifications.

Specification

- On left hand and remote mount filters, connect oil inlet and outlet lines. Tighten line end nuts to specifications.



Filter Header (Front Mount)



Filter Adapters (High Mount)

- A-Oil Filter Header/Rear Adapter
- B-Oil Tube Adapter/Oil Cooler Cover
- C—Turbocharger Oil Inlet Line
- **D**—Tubes
- E-Cap Screw

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Continued on next page

RG,20,DT7532 -19-24SEP99-3/4

Lubrication System

Specification

Torque

IMPORTANT: Ensure oil inlet and outlet lines are properly clamped and protected to prevent excessive motion or abrasion.

11. Spread a layer of clean engine oil on new filter packing. Install filter and tighten until packing contacts filter base. Tighten an additional 1/2—3/4 turn after packing contacts base. DO NOT overtighten oil filter.

RG,20,DT7532 -19-24SEP99-4/4

060

02 060

-UN-040CT99

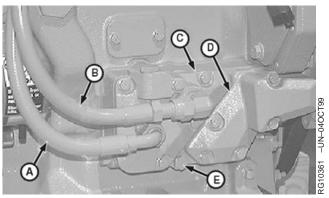
RG10362

RG10363 -UN-040CT99

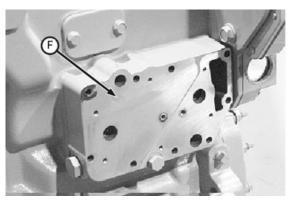
Remove, Inspect, and Install Oil Cooler

Remove Oil Cooler Assembly

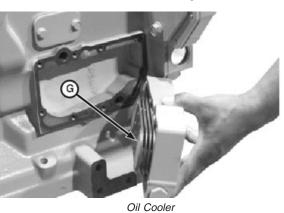
- 1. Remove oil cooler drain plug (E) and drain coolant.
- On high mount, rear and front mount oil filters, remove oil filter header with tubes and adapter/cooler cover, if equipped. See REMOVE, INSPECT, AND INSTALL OIL FILTER BASE, earlier in this group.
- 3. On left hand or remote oil filters, disconnect oil lines (A) and (B) and remove cooler cover (C).
- 4. Remove elbow adapter (D).
- 5. Remove housing (F).
- 6. Remove oil cooler (G).
 - A—To Oil Filter Inlet (Dirty Oil)
 - B-From Oil Filter Outlet (Clean Oil)
 - C—Cover
 - D-Adapter
 - E-Oil Drain Plug
 - F-Oil Cooler Housing
 - G-Oil Cooler



Oil Cooler Assembly (Remote Filter Application Shown)



Oil Cooler Housing



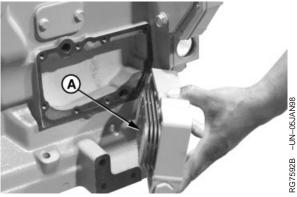
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RG,20,DT7531 -19-24SEP99-1/6

Inspect Oil Cooler Assembly

- Inspect oil cooler (A) (shown installed in housing) for physical damage, plugging, or leakage which may allow mixing of oil and coolant.
- 2. Back flush oil cooler to clean all debris from core.
- 3. Pressure test oil cooler in liquid and compressed air if mixing of oil and coolant is suspected.

Oil cooler should show no leakage when 140—170 kPa (1.4—1.7 bar) (20—25 psi) air pressure is applied for a minimum of 30 seconds.



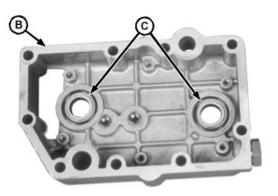
Oil Cooler

A-Oil Cooler

RG,20,DT7531 -19-24SEP99-2/6

RG9085 -UN-16MAR98

- 4. Inspect oil cooler housing (B).
- NOTE: Service oil cooler housings have a 3.5 mm (0.138 in.) O-ring groove width. Older housings had a 4.5 mm (0.177 in.) groove width. Check O-ring grooves for latest width specification and replace if necessary.
- Remove O-rings (C) and inspect surface finish of O-ring grooves. If there are ridges discernible with a fingernail, replace oil cooler housing. Additionally, if there is porosity in grooves larger than 0.5 mm (0.20 in.), replace housing.
- 6. Replace parts as needed. DO NOT attempt to repair oil cooler.



Oil Cooler Housing

B—Oil Cooler Housing C—O-Rings

Continued on next page

RG,20,DT7531 -19-24SEP99-3/6

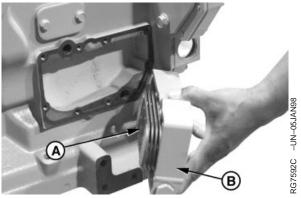
02 060 7

Install Oil Cooler Assembly

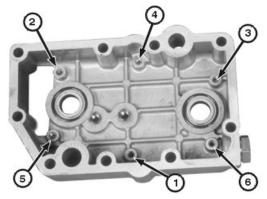
- 1. Lubricate new O-rings with clean engine oil.
- 2. Install oil cooler (A) in oil cooler housing (B).
- Apply LOCTITE® 242 Thread Lock and Sealer to six Allen head cap screws and install oil cooler in housing. Tighten all cap screws by hand, then tighten to the following specifications in sequence shown.

Specification

> A—Oil Cooler B—Oil Cooler Housing



Oil Cooler and Housing



Oil Cooler Torque Sequence

RG,20,DT7531 -19-24SEP99-4/6

-UN-120CT99

RG10377

-UN-040CT99

RG10372

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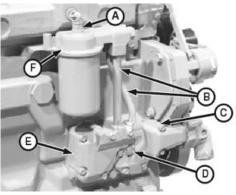
4. On high mount, rear and front mount applications:
Use new gaskets and install oil cooler assembly. Be
sure gasket is properly aligned with cap screw holes.

Install parts (A, B, E and F). (See REMOVE, INSPECT AND INSTALL OIL FILTER BASE earlier in this group.)

5. Apply LOCTITE® 242 Thread Lock and Sealer to cap screw (D) for open hole in oil cooler and install elbow adapter (C). Tighten cap screws to specifications.

Specification

- A-Turbocharger Oil Inlet Line
- **B**—Tubes
- C-Elbow Adapter
- D—Cap Screw
- E-Oil Tube Adapter/Oil Cooler Cover
- F-Oil Filter Header/Rear Adapter



Oil Cooler Installation

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Continued on next page

RG,20,DT7531 -19-24SEP99-5/6

6. **On left hand or remote filter applications:** Use new gaskets and install oil cooler assembly. Be sure gasket is properly aligned with cap screw holes.

Apply LOCTITE® 242 Thread Lock and Sealer to cap screws (E) for open holes in oil cooler. Install cover (C) and adapter (D) and tighten all cap screws to specifications.

| s | | | | | |
|---|--|--|--|--|--|
| | | | | | |
| | | | | | |

| Oil Cooler Cover Cap Screws | 35 N•m (26 lb-ft) |
|------------------------------|-------------------|
| (Remote Filter Applications) | |
| Torque | |
| Oil Cooler Elbow Adapter Cap | 35 Nem (26 lb-ft) |
| Screws Torque | |

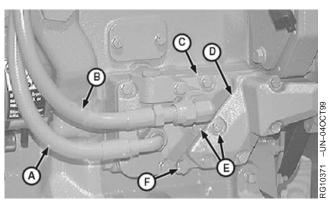
7. Connect lines (A) and (B) and tighten to specifications.

| Speci | fication |
|-------|----------|
|-------|----------|

8. Install oil cooler drain plug and tighten to specifications.

Specification

Oil Cooler Drain Plug Torque...... 5 Nem (60 lb-in.)



Oil Cooler

- A-Oil Line
- **B**—Oil Line
- C—Cooler Cover
- D—Elbow Adapter E—Cap Screws
- F—Drain Plug

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RG,20,DT7531 -19-24SEP99-6/6

02 060

Remove, Inspect, and Install Oil Bypass Valve

- Remove timing gear cover and front plate. (See REMOVE TIMING GEAR COVER in Group 050.) (See REMOVE CYLINDER BLOCK FRONT PLATE in Group 050.)
- 2. Remove oil bypass valve and spring.
- 3. Inspect valve and spring for damage. Replace parts if necessary.
- Check bypass valve spring free length and compression strength using D01168AA Spring Compression Tester. Replace parts if not within specification.



| Oil Bypass Valve Springs Free | 51 | mm (| 2.00 in | .) |
|---------------------------------|-------|-------|----------|----|
| Length | | | | |
| Spring Load at 29 mm (1.14 in.) | 7.8 N | 1 (20 | lb-force | (ڊ |
| Compressed Length | | | | |

- 5. Install oil bypass valve and spring in cylinder block.
- Install front plate and timing gear cover. (See INSTALL TIMING GEAR COVER in Group 050.) (See INSTALL CYLINDER BLOCK FRONT PLATE in Group 050.)

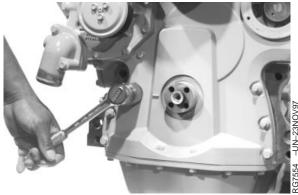


Oil Bypass Valve and Spring

RG,20,DT7530 -19-17NOV97-1/1

Remove and Install Oil Pressure Regulating Valve and Seat

1. Remove oil pressure regulating valve plug from timing gear cover.



Oil Pressure Regulating Valve Plug

Continued on next page

RG,20,DT7529 -19-10NOV99-1/5

- 2. Remove oil pressure regulating valve and spring.
- 3. Check valve cone for excessive wear and damaged sealing face.
- 4. Check oil pressure regulating spring free length and compression strength using D01168AA Spring Compression Tester. Replace parts if not within specification.

Oil Pressure Regulating Valve Spring Specifications— Specification

Saran Engines Listed Below)

Spring Free Length

4-Cylinder Engines (Except for 40.5—49.4 N (9.1—11.1 lb-force)

Saran Engines Listed Below)

Spring Load at 42.5 mm

(1.68 in.)

CD4045HF157/158,

CD4045TF157/158 and

CD4045TF257/258 Spring Free

Length

CD4045HF157/158,

CD4045TF157/158 and

CD4045TF257/258 Spring Load

at 42.5 mm

(1.68 in.)

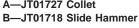


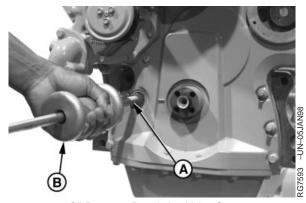
Oil Pressure Regulating Valve

RG,20,DT7529 -19-10NOV99-2/5

5. Pull valve seat out of cylinder block with JT01727 Collet (A) and JT01718 Slide Hammer (B) from D01061AA Blind-Hole Puller Set, or equivalent.

A—JT01727 Collet





Oil Pressure Regulating Valve Seat

Continued on next page

RG,20,DT7529 -19-10NOV99-3/5

02 060 11

IMPORTANT: DO NOT drive against raised inner rim of valve seat so that valve seat bore is not damaged.

 Drive valve seat into cylinder block with JD248A (JD-248A) Oil Pressure Relief Valve Bushing Driver and JDG536 (OTC813) Handle until the seat bottoms in bore.



Oil Pressure Regulating Valve Seat

RG,20,DT7529 -19-10NOV99-4/5

7. Install valve, spring, washer, and plug in timing gear cover. Tighten plug to specification.

Specification



Oil Pressure Regulating Valve in Timing Gear Cover

RG,20,DT7529 -19-10NOV99-5/5

Lubrication System

Remove and Install Oil Fill Tube

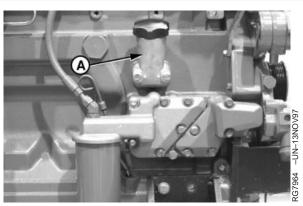
1. Remove oil fill tube (A).

060

12

- 2. Inspect and replace tube as needed.
- 3. Using a new gasket, install oil fill tube.
- 4. Apply LOCTITE® 242 Thread Lock and Sealer to threads of cap screws.
- 5. Tighten cap screws to specifications.

Specification



Oil Fill Tube

A-Oil Fill Tube

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RG,20,DT7528 -19-17NOV97-1/1

CTM104 (19JUN00)

02 060 13

Remove and Install Dipstick Tube with Oil Pan Installed

Remove Dipstick Tube

IMPORTANT: Orientation of dipstick tube in engine varies by application. Make index marks on tube and block to ensure correct orientation when reinstalling tube.

NOTE: Saran (CD) engines for the 6000-TEN series tractors use either a 71 mm or a 67.5 mm cylinder block machining height (C) for the oil dipstick tube location. Service tubes and dipsticks are as follows: R136162 Tube and AT21535 Dipstick for 71 mm configuration (Engine S.N. —550948CD), or R501178 Tube and RE502740 Dipstick for 67.5 mm configuration (Engine S.N. 550949CD—). Additionally, there may be some later engines still using the 71 mm configuration dipstick tube with a spacer to compensate for the 67.5 mm block machining. For service, these should be replaced with the 67.5 mm configuration tube and dipstick.

- 1. Remove dipstick (A).
- 2. Using JT01724 (5/16 in.) Collet, JT01720 Actuator Pin, and 1156 Slide Hammer, remove dipstick tube (B) from block.

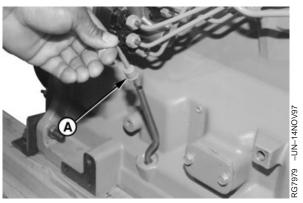
Install Dipstick Tube

1. Coat end of new dipstick tube with LOCTITE® 271 Thread Lock and Sealer.

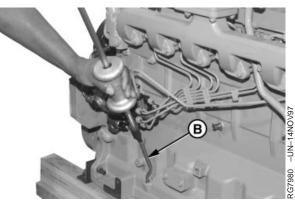
NOTE: 6010—6910 Tractors use a straight dipstick tube.

2. Orient right-hand dipstick tube with first bend directed toward rear of engine and centerline plane of first bend angled 20 degrees toward the crankshaft centerline.

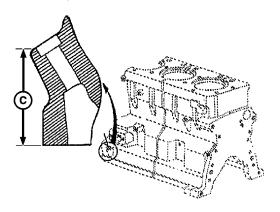
Orient left-hand dipstick tube with first bend directed toward rear of engine and centerline plane of first bend parallel with the crankshaft centerline.



Dipstick and Dipstick Tube



Dipstick Tube Removal Tool



- A—Dipstick
- B—Dipstick Tube
- C—Block Machining Height

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Continued on next page

RG.20.DT7527 -19-10NOV99-1/2

3G10564 -UN-21DEC99

NOTE: JDG965 Dipstick Driver cannot be used for straight dipstick tube used on 6010—6910 Tractors. Use Engine Oil Dipstick Tube Driver (dealer fabricated tool) on these tractors. Refer to Section 05, Group 190, Dealer Fabricated Tools.

- 3. Using JDG965 Dipstick Driver (C), install dipstick tube until shoulder bottoms.
- 4. Install dipstick.

C—Dipstick Driver



Dipstick Tube Installation Tool

RG,20,DT7527 -19-10NOV99-2/2

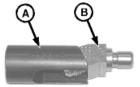
Remove and Install Dipstick Tube with Fitting

- 1. Unscrew dipstick tube from fitting and remove.
- 2. Remove fitting from block.
- 3. Coat smooth end of dipstick fitting with LOCTITE® 271 Thread Lock and Sealer.
- 4. Position fitting (B) in JDG1146 Dipstick Fitting Installer (A) as shown.

Orient fitting with threaded end pointing out and straight up from block.

Drive fitting flush with block.

5. Install dipstick tube on fitting.



Left-Hand Dipstick Tube Fitting

A—JDG1146 Dipstick Fitting Installer Tool B—Dipstick Fitting (Angled Design)

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DPSG,OUO1004,80 -19-24APR98-1/1

RG9115 -UN-02APR98

060 15

Remove, Inspect and Install Oil Pump **Pick-Up Tube Assembly**

A loose or damaged suction tube or O-ring can cause a temporary loss of prime for the engine oil pump at start-up. There will be low or no oil pressure at starting, followed by normal engine oil pressure.

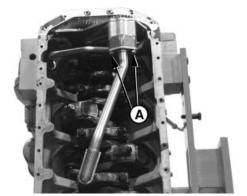
NOTE: If the pick-up tube is to be inspected only and not removed, verify mounting cap screw torque to ensure proper seating and seal.

- 1. Remove oil pan.
- 2. Loosen cap screws (A) and remove oil pump pick-up tube assembly.
- 3. Inspect pick-up tube for cracks, restrictions or damage. Replace if necessary.
- 4. Install assembly with new O-ring and tighten cap screws to specifications.

Specification

Screws Torque

5. Reinstall oil pan. (See INSTALL OIL PAN, as described later in this group.)



Oil Pump Pick-Up Tube Assembly

A-Cap Screws

RG,20,DT7526 -19-17NOV97-1/1

Engine Oil Pump Assembly

A-Outlet Tube

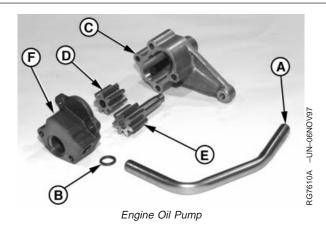
B-O-Ring

C—Pump Housing

D-Idler Gear

E-Drive Gear

F—Cover

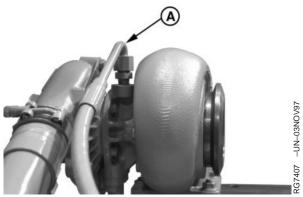


RG,20,DT7525 -19-17NOV97-1/1

Remove Engine Oil Pump

- 1. Drain oil and disconnect turbocharger oil inlet line (A) at the turbocharger.
- 2. Remove oil pan.
- 3. Remove gasket from oil pan and oil pan rail.

A-Oil Inlet Line



Turbocharger Oil Inlet Line

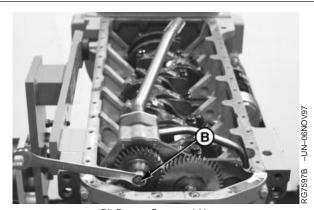
RG,20,DT7524 -19-17NOV97-1/3

- 4. On 4-cylinder engines with balancer shafts, lock crankshaft at TDC using JDG820 or JDE83 Flywheel Turning Tool and JDE81-4 Timing Pin. Then lock the balancer shaft (injection pump side) using a lock-grip pliers so that balancer shaft cannot turn while oil pump gear is being removed.
- IMPORTANT: When removing nut and gear from tapered oil pump drive shaft, take care not to damage fine threads on end of shaft.
- 5. Remove nut (B) and pull gear from tapered oil pump drive shaft.

To remove oil pump gear, loosen nut several turns and apply force between the front plate and gear on two sides of gear with pry bars.

If above method does not work, loosen oil pump housing cap screws and strike the nut on end of shaft with a small **lead** hammer while applying force to gear until gear is free of tapered shaft.

 Remove oil pump pick-up tube. (See REMOVE, INSPECT AND INSTALL OIL PUMP PICK-UP TUBE ASSEMBLY earlier in this group.)



Oil Pump, Gear and Nut

B—Gear Retaining Nut

Continued on next page

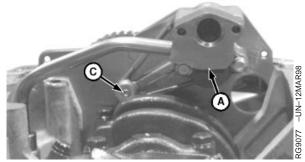
RG,20,DT7524 -19-17NOV97-2/3

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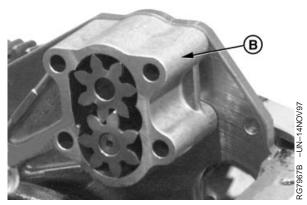
7. Remove upper two cap screws and remove cover (A).

NOTE: The lower idler gear cap screw (C) has to be removed to remove the oil pump housing.

- 8. Loosen idler cap screw (C).
- 9. Remove lower oil pump housing cap screws and turn idler cap screw (C) out while removing oil pump housing assembly (B).
 - A-Cover
 - **B**—Oil Pump Housing
 - C-Idler Cap Screw



Oil Pump Cover



Oil Pump Housing Assembly

RG,20,DT7524 -19-17NOV97-3/3

Inspect and Measure Clearances

Inspect oil pump components for excessive wear. Replace parts or oil pump assembly, as necessary.

1. Check gear-to-pump cover axial clearance.

Specification

| Oil Pump Gears Thickness | 35.975—36.025 mm |
|--------------------------------|-----------------------|
| | (1.4163—1.4183 in.) |
| Oil Pump Gears Axial Clearance | 0.045—0.165 mm |
| | (0.0018 - 0.0065 in.) |



Checking Gear-to-Pump Cover Axial Clearance



Checking Gear Thickness

Continued on next page

02-060-17

RG,20,DT7523 -19-17NOV97-1/4

2. Check gear-to-pump housing radial clearance.

Specification

Oil Pump Gears Radial Clearance...... 0.131—0.211 mm (0.005—0.008 in.)



Checking Gear-to-Pump Housing Radial Clearance

RG,20,DT7523 -19-17NOV97-2/4

RG7603 -UN-23NOV97

- 3. Check housing and cover bore ID and shaft OD. Inspect cover and housing for evidence of gear rub. Light contact is acceptable.
- 4. Measure bushing ID in housing and bore in cover.

| Oil Pump Drive Shaft OD | 16.017—16.037 mm |
|--------------------------------|---------------------|
| | (0.6306—0.6314 in.) |
| Oil Pump Bushing in Housing ID | 16.052—16.102 mm |
| | (12.316—12.332 in.) |



Measuring Drive Shaft OD for Wear



Measuring Bushing ID in Housing for Wear Continued on next page

RG7606 -UN-23NOV97

02-060-18

5. Measure idler shaft OD and idler gear ID

Specification

| Oil Pump Idler Shaft OD | 12.316—12.332 mm |
|-------------------------|---------------------|
| | (0.4849-0.4855 in.) |
| Oil Pump Idler Gear ID | 12.355—12.363 mm |
| | (0.4864—0.4867 in.) |



Measure Idler Shaft OD for Wear



Measure Idler Gear ID for Wear

RG,20,DT7523 -19-17NOV97-4/4

Complete Oil Pump Disassembly

- 1. Remove O-ring from pump housing and cylinder block (for outlet tube).
- 2. Remove O-ring from oil pick-up tube.
- 3. Clean oil pump parts in solvent. Dry with compressed air.
- 4. Inspect pick-up tube. Check flange-to-pick-up tube weld for cracks. If cracks or other defects are found, replace pick-up tube. (See REMOVE, INSPECT AND INSTALL OIL PUMP PICK-UP TUBE ASSEMBLY, earlier in this group.)

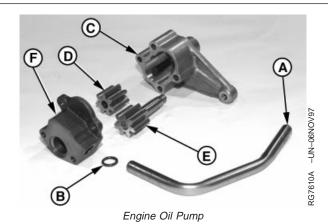


RG,20,DT7522 -19-17NOV97-1/1

Assemble Engine Oil Pump

IMPORTANT: Lubricate gears and shaft with clean engine oil before assembling.

- 1. Install new O-ring (B) in pump cover (F).
- 2. Put idler gear (D) and drive gear (E) in pump housing (C).
 - A—Outlet Tube
 - B—O-Ring
 - C—Pump Housing
 - D-Idler Gear
 - E—Drive Gear
 - F—Cover



RG,20,DT7521 -19-17NOV97-1/1

Install Engine Oil Pump

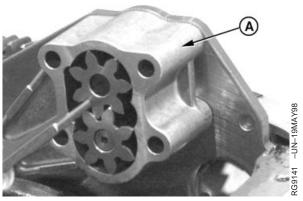
NOTE: This procedure is for installing the oil pump with timing gear cover installed. If timing gear cover is removed from engine, refer to INSTALL AND TIME BALANCER SHAFTS in Group 050 (for 4-cylinder engines only).

- 1. On 4-cylinder engines with balancer shafts, lock No. 1 piston at TDC compression stroke.
- 2. Install new O-rings in cylinder block and oil pump cover (for outlet tube). Install tube into cover and block.
- 3. Lubricate lower idler gear cap screw threads (C) and draw into leg of housing finger tight while installing oil pump housing (A) with gears onto front plate.
- 4. Wedge a hardened round punch between the drive gear and idler gear.
- 5. Install oil pump drive gear (D) so that it meshes with lower idler gear (E) and balancer shaft gear (4045 engines only) without altering gear train timing.
- 6. Install new retaining nut and tighten to specifications.

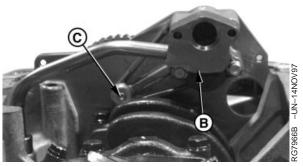
Specification

Oil Pump Drive Gear "Staked" 50 N•m (37 lb-ft) Nut Torque

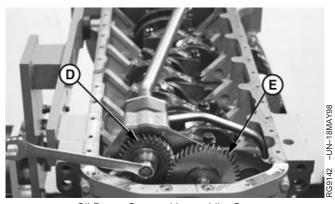
- 7. Stake oil pump drive gear nut by applying three center punch marks near ID of shaft.
- 8. Swing (position) oil pump cover (B) onto pump housing and install two lower cap screws finger tight.



Oil Pump Housing Assembly



Oil Pump Cover and Lower Idler Gear Cap Screw



Oil Pump, Gear and Lower Idler Gear

A—Oil Pump Housing

B—Oil Pump Cover

C—Idler Gear Cap Screw D—Oil Pump Drive Gear

E—Lower Idler Gear

Continued on next page

RG,20,DT7520 -19-17NOV97-1/3

 Install new O-ring (A) on neck of pick-up tube. Install pick-up tube. (See REMOVE, INSPECT AND INSTALL OIL PUMP PICK-UP TUBE ASSEMBLY, earlier in this group.)

A-O-Ring



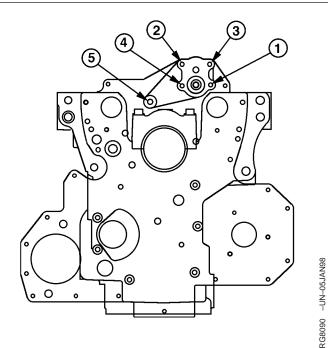
O-Ring on Pick-Up Tube Neck

RG,20,DT7520 -19-17NOV97-2/3

NOTE: Idler gear cap screw threads (5) must be lubricated.

10. Tighten four cap screws and lower idler gear cap screw to specified torque according to sequence shown.

Specification



Viewed from Rear of Engine

RG,20,DT7520 -19-17NOV97-3/3

02 060 23

Install Oil Pan

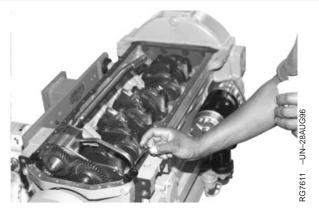
- 1. Apply LOCTITE® 515 Flexible Form-In-Place Gasket on oil pan rail, as shown, where flywheel housing, front plate, and timing gear cover attach to cylinder block.
- 2. Install oil pan gasket.
- 3. Install oil pan and tighten cap screws to specifications.

| Specification | | |
|------------------------------|-------------------|--|
| Oil Pan M8 Cap Screws Torque | 35 N•m (26 lb-ft) | |
| Oil Pan M10 Cap Screws up to | 70 N•m (52 lb-ft) | |
| 110 mm Torque | | |
| Oil Pan M10 Cap Screws 110 | 60 N•m (44 lb-ft) | |
| mm and Above Torque | | |
| Oil Pan M10 Cap Screws on | 44 N•m (33 lb-ft) | |
| PE4045DLV50 and | | |
| PE4045TLV50 Engines Only | | |
| Torque | | |
| Oil Pan RE70330 Cap Screws | 20 N•m (15 lb-ft) | |
| (Option Code 1924) Torque | | |
| | | |

 Install O-ring or copper washer on drain plug. If copper washer is used, install with raised center against plug. Install plug in oil pan. Tighten drain plug to specifications.

| Specification | | |
|------------------------------|-------------------|--|
| Oil Pan Drain Plug Plug with | 70 N•m (52 lb-ft) | |
| Copper Washer Torque | | |
| Oil Pan Drain Plug Plug with | 50 Nem (37 lb-ft) | |
| O-Ring Torque | | |

- 5. If equipped with elbow drain fittings, the threads and sealing surfaces must be free of oil film to ensure an effective seal. Apply LOCTITE® 592 Pipe Sealant with TEFLON® to fitting except for the leading one to three threads. Install and tighten fitting.
- Fill engine crankcase with correct grade and viscosity engine oil. (See DIESEL ENGINE OIL in Section 01, Group 002.)



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Remove Water Manifold/Thermostat Cover and Thermostat



CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns. Do not drain coolant until coolant temperature is below operating temperature. Always loosen cooling system filler cap, radiator cap, or drain valve slowly to relieve pressure.

NOTE: On some engines, the water manifold/thermostat housing is an integral part of the cylinder head.

1. Partially drain coolant from system.



Cooling System Safety

TS281 -UN-23AUG88

RG,25,JW7561 -19-18NOV99-1/3

- 2. Remove thermostat cover-to water pump tube (A) and seal.
- 3. Visually inspect area around water manifold/thermostat cover for leaks.

A—Tube



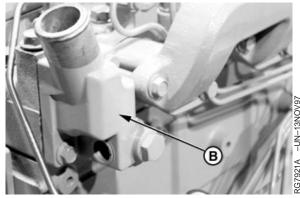
Thermostat Cover-to-Water Pump Tube

Continued on next page

RG,25,JW7561 -19-18NOV99-2/3

- 4. Remove water manifold/thermostat cover (B) with gasket.
- 5. Remove thermostat.
- 6. Remove and discard all gasket material. Clean gasket surfaces.
- 7. Clean and inspect cover for cracks or damage.

B—Cover



Water Manifold/Thermostat Cover

RG,25,JW7561 -19-18NOV99-3/3

Install Water Manifold/Thermostat Cover and Thermostat

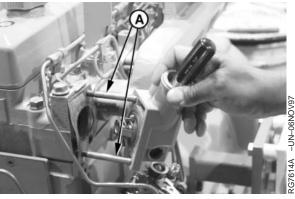
IMPORTANT: Install manifold gasket so that smaller (round) holes are at lower left and upper right corners of manifold (matching studs A).

1. Using guide studs (A) to keep gasket in place, install a new gasket on cylinder head.

NOTE: Thermostat must be installed with jiggle pin facing up in the 12 o'clock position.

2. Using a screwdriver to hold thermostat in place, install thermostat and water manifold/thermostat cover. Tighten cover cap screws to specifications.

Specification



Water Manifold/Thermostat Cover

A—Guide Studs

Continued on next page

RG,25,JW7559 -19-18NOV99-1/3

3. Lubricate new O-ring with PT507 Multi-Purpose Grease. Install seal (B) in thermostat cover.

B—Seal



Thermostat Cover Seal

RG,25,JW7559 -19-18NOV99-2/3

- 4. Install water manifold/thermostat cover-to-water pump tube (C). Tighten clamps.
- 5. Fill cooling system and check for leaks.

IMPORTANT: Air must be expelled from cooling system when filling. Loosen temperature sending unit fitting at rear of cylinder head or plug in thermostat housing to allow air to escape when filling system. Tighten fitting or plug when all air has been expelled.

C—Tube



Thermostat Cover-to-Water Pump Tube

RG,25,JW7559 -19-18NOV99-3/3

Remove and Install Water **Manifold/Thermostat Cover and Thermostat** (6010 Series Tractors with Single Thermostat)



CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns. Do not drain coolant until coolant temperature is below operating temperature. Always loosen cooling system filler cap, radiator cap, or drain valve slowly to relieve pressure.

1. Partially drain coolant from system.



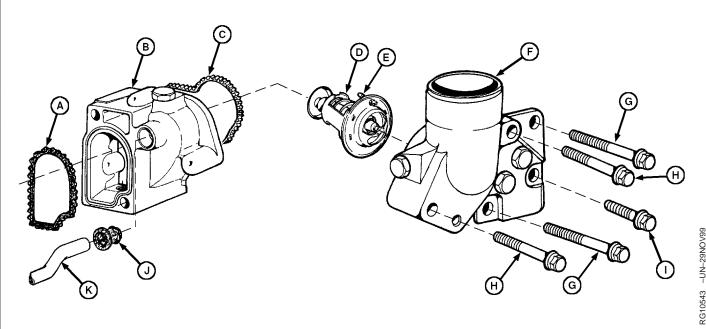
Cooling System Safety

Continued on next page

DPSG,OUO1004,1135 -19-18NOV99-1/3

-UN-23AUG88

CTM104 (19JUN00)



Water Manifold and Thermostat (6010 Series Tractors)

A-Seal

B—Water Manifold

C—Seal

D—Thermostat

E-Jiggle Pin

F—Thermostat Cover

G—Cap Screw (M10 x 90) Thermostat Cover-to-Water Manifold-to-Cylinder Head

H—Cap Screw (M10 x 70) Thermostat Cover-to-Water Manifold

I—Cap Screw (M10 x 25) Thermostat Cover-to-Water Manifold

J-Seal

K-Water Manifold-to-Water **Pump Tube**

- 2. Remove water manifold-to-water pump tube (K) and seal (J).
- 3. Visually inspect area around water manifold/thermostat cover for leaks.
- 4. Remove cap screws (G) and remove water manifold/thermostat cover assembly with gasket.
- 5. Remove thermostat cover (F) and thermostat (D).
- 6. Remove and discard all gasket material. Clean gasket surfaces.
- 7. Clean and inspect cover for cracks or damage.

NOTE: Thermostat must be installed with jiggle pin (E) facing up in the 12 o'clock position.

8. Install thermostat (D), cover (F) and seal (C) on water manifold. Hand tighten cover cap screws (H) and (I).

9. Install water manifold/thermostat cover assembly on engine using cap screws (G). Tighten all cap screws to specifications.

Specification

Manifold Cap Screws (H and I) (6010 Series Tractors with Single Thermostat) Torque Head Cap Screws (G) (6010 Series Tractors with Single Thermostat) Torque

- 10. Install new seal (J) and tube (K). Tighten tube clamps securely.
- 11. Fill cooling system and check for leaks.

Continued on next page

DPSG,OUO1004,1135 -19-18NOV99-2/3

Cooling System

IMPORTANT: Air must be expelled from cooling system when filling. Loosen temperature sending unit fitting at rear of cylinder head or plug in

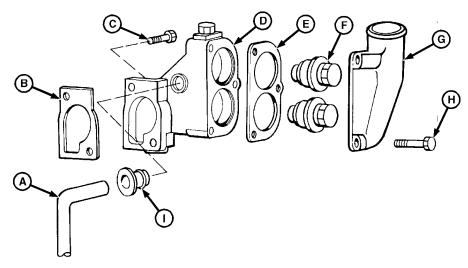
thermostat housing to allow air to escape when filling system. Tighten fitting or plug when all air has been expelled.

DPSG,OUO1004,1135 -19-18NOV99-3/3

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070

Remove and Install Water Manifold and Thermostats (Dual Thermostats)



Water Manifold and Dual Thermostats

G-Cover

A—Tube B-Gasket C-Cap Screw (2 used) D-Water Manifold

E-Gasket

F—Thermostat (2 used) H—Cap Screw (3 used)

I—Seal

CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns. Do not drain coolant until the coolant temperature is below operating temperature. Always loosen cooling system filler cap, radiator cap, or drain valve slowly to relieve pressure.

NOTE: Configuration of water manifold/dual thermostat assembly varies by engine application.

- 1. Partially drain coolant from system.
- 2. Remove water manifold-to-water pump tube (A) and seal (I).
- 3. Remove parts (E—H).
- 4. Remove water manifold (D) and gasket (B).
- 5. Discard all gasket material and clean mating surfaces.

6. Clean and inspect manifold and cover for cracks and damage.

NOTE: On vertical mounted manifolds (shown above), thermostats must be installed with jiggle pin facing up in the 12 o'clock position.

- 7. Install parts (B—H).
- 8. Lubricate O-ring with PT507 Multi-Purpose Grease and install seal (I) and tube (A).

IMPORTANT: Air must be expelled from cooling system when filling. Loosen temperature sending unit fitting at rear of cylinder head or plug in thermostat housing to allow air to escape when filling system. Tighten fitting or plug when all air has been expelled.

DPSG,OUO1004,18 -19-02APR98-1/1

Test Thermostat(s)

Inspect thermostat(s) for debris or damage, and test each thermostat using an approved testing procedure. (See INSPECT THERMOSTAT AND TEST OPENING TEMPERATURE in Section 04, Group 150 for testing procedure and specifications.)

NOTE: Deaeration is accomplished by a jiggle pin or groove in thermostat flange area (positioned at top).

RG,25,JW7560 -19-20NOV97-1/1

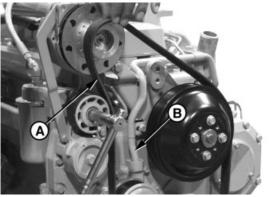
Remove Water Pump



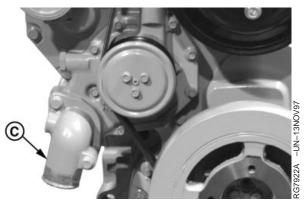
CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns. Do not drain coolant until the coolant temperature is below operating temperature. Always loosen cooling system filler cap, radiator cap, or drain valve slowly to relieve pressure.

IMPORTANT: Whenever the aluminum timing gear cover or water pump are replaced, the cooling system should be flushed and serviced. See FLUSH AND SERVICE COOLING SYSTEM in Section 01, Group 002. Ensure system, including radiator, is completely drained.

- 1. Drain coolant.
- 2. Remove fan (shown removed).
- 3. Release tension on belt (A) using a breaker bar and socket.
- 4. Remove poly-vee belt from pulleys.
- 5. Remove thermostat housing-to-water pump tube (B).
- Remove water pump inlet elbow (C) and O-ring, if desired.
- 7. Remove water pump (D).
- 8. Remove pulley from water pump.
 - A—Belt
 - **B—Thermostat Housing-to-Water Pump Tube**
 - C-Inlet Elbow
 - D-Water Pump



Belt and Housing-to-Water Pump Tube



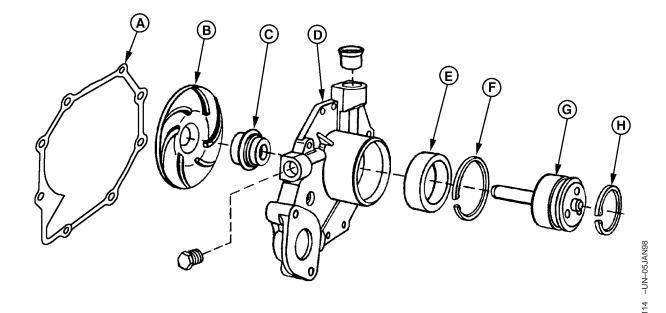
Water Pump Inlet Elbow



Water Pump

RG,25,JW7558 -19-20NOV97-1/1

Water Pump Assembly



Water Pump Assembly

A—Gasket B—Impeller

C—Seal D—Housing E—Bearing F—Internal Snap Ring

G—Shaft H—External Snap Ring

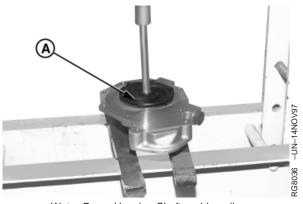
RG,25,JW7557 -19-20NOV97-1/1

Disassemble Water Pump

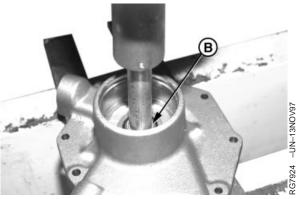
1. Using appropriate external snap ring pliers, remove internal snap ring from front bore of pump housing.

IMPORTANT: If plastic impeller breaks while pressing shaft through impeller, remove brass bushing from shaft before pressing shaft through rest of housing. Use a knife-edge puller to remove bushing.

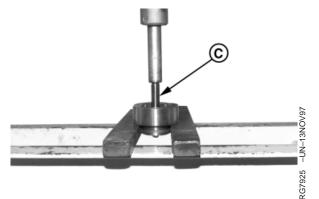
- Support nose of water pump housing and press shaft through impeller (A) until impeller is free from shaft and bearing/shaft assembly is removed from housing. Discard impeller.
- 3. Using the appropriate driver from D01045AA Bushing, Bearing and Seal Driver Set, drive or press seal (B) from pump housing.
- 4. Support inner bearing race and press shaft (C) out of bearing. Discard bearing.
 - A—Impeller
 - B—Seal
 - C—Shaft



Water Pump Housing Shaft and Impeller



Water Pump Housing Seal



Inner Shaft and Bearing

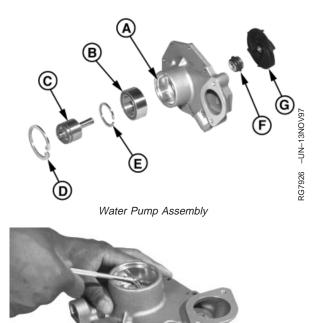
RG,25,JW7556 -19-20NOV97-1/1

Inspect, Clean, and Measure Water Pump Parts

- 1. Inspect water pump housing (A) for cracks or damage.
- 2. Remove gasket material from housing and clean with solvent. Dry with compressed air.
- 3. Inspect parts for wear or damage.

| Specification | | |
|-----------------------------|---------------------|--|
| Water Pump Impeller Bore ID | 11.973—11.999 mm | |
| | (0.4714—0.4724 in.) | |
| Water Pump Bearing Shaft | 12.025—12.038 mm | |
| (Impeller End) OD | (0.4734—0.4739 in.) | |
| Water Pump Bearing Shaft | 39.997—40.013 mm | |
| (Pulley End) OD | (1.5747—1.5753 in.) | |
| Water Pump Housing Bearing | 61.961—61.987 mm | |
| Bore ID | (2.4394—2.4404 in.) | |

- 4. Remove foam filters and clean out weep holes in housing. Inspect weep holes for oil or coolant leakage.
 - Oil leakage indicates a damaged sealed bearing (B).
 - Coolant leakage indicates a damaged housing seal (F).
 - A—Housing
 - B—Bearing
 - C—Shaft
 - D-Internal Snap Ring
 - E-External Snap Ring
 - F—Seal
 - G-Impeller



Water Pump Housing Weep Hole

RG,25,JW7555 -19-20NOV97-1/1

Assemble Water Pump

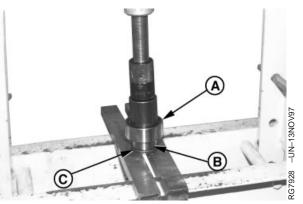
- Thoroughly clean and inspect water pump mounting surface in timing gear cover before installing water pump assembly.
- 2. Using appropriate snap ring pliers, install external snap ring (C) into groove in shaft (B).
- 3. Using appropriate driver which bears on inner bearing race, install bearing (A) onto shaft against snap ring.

IMPORTANT: Do not push against end of bearing shaft. Push against outer race only, when installing bearing and shaft assembly into housing.

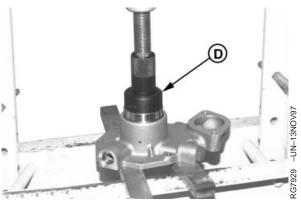
- 4. Using JDG956 Water Pump Bearing Installer (D), install bearing and shaft assembly into housing until it bottoms in housing bore.
- 5. Install large internal snap ring into groove in front bore of pump housing.

NOTE: Water pumps have a unitized (one-piece) water seal.

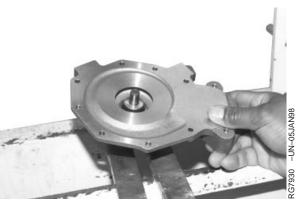
- Using installation tool provided in seal kit, install seal (dry) onto water pump shaft and into housing until it is firmly seated.
 - A—Bearing
 - B—Shaft
 - C—Snap Ring
 - D—JDG956 Water Pump Bearing Installer



Shaft, Bearing and Snap Ring Assembly



Shaft Assembly in Housing



Shaft Seal in Housing

Continued on next page

RG,25,JW7554 -19-20NOV97-1/2

NOTE: Water pumps are available with two different types of impellers to ensure adequate coolant flow for a given engine application. Standard flow pumps have fins on both sides of impeller (A). High flow pumps have fins on one side of impeller (B). Be sure to replace impeller with the same type of impeller to ensure proper engine cooling.

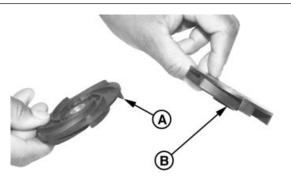
7. Support front nose of water pump shaft.

IMPORTANT: When installing impeller, press only on brass bushing (C), as impeller could crack

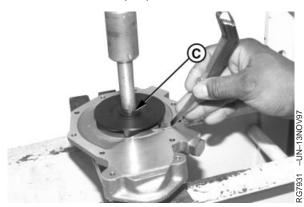
8. Using an appropriate driver, install impeller onto shaft to the specified dimension below.

Specification

- Rotate impeller a complete revolution by hand and check with feeler gauge for impeller-to-housing clearance.
- 10. Install new foam filters in weep holes.



Water Pump Impeller Differences



Install Impeller

- A—Standard Flow Impeller
- B—High Flow Impeller
- C—Bushing

RG,25,JW7554 -19-20NOV97-2/2

-UN-13NOV97

Install Water Pump

1. Install pulley (A) onto water pump (B). Tighten cap screws to specifications.

Specification

2. Clean gasket surfaces. Using a new gasket, install water pump onto timing gear cover. Tighten cap screws to specifications.

Specification



Water Pump with Pulley on Timing Gear Cover

A—Pulley

B-Water Pump

Continued on next page

RG,25,JW7553 -19-20NOV97-1/2

3. Using a new O-ring, install water pump inlet elbow (C), if removed. Tighten cap screws to specifications.

Specification

- 4. Install poly-vee belt. Be sure that belt is correctly seated in all pulley grooves.
- 5. Install fan and tighten cap screws with lock washers to the following specification:

| Specification | on |
|---------------|----|
|---------------|----|

| Fan-to-Pulley Hub M8 Cap | 35 Nem (26 lb-ft) |
|---------------------------|-------------------|
| Screws Torque | |
| Fan-to-Pulley Hub M10 Cap | 70 Nem (52 lb-ft) |
| Screws Torque | |

6. Fill cooling system with proper coolant. (See Section 01, Group 002.)

IMPORTANT: Air must be expelled from cooling system when refilled. Loosen temperature sending unit fitting at rear of cylinder head or plug in thermostat housing to allow air to escape when filling system. Tighten fitting or plug when all the air has been expelled.



Water Pump Inlet Elbow

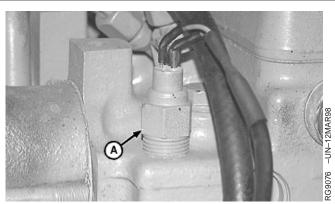
C-Inlet Elbow

RG,25,JW7553 -19-20NOV97-2/2

Cooling System Deaeration

Deaeration is normally accomplished by the jiggle pin in the thermostat flange. However, a pocket of air can stay on the top rear of the engine. When refilling the cooling system, loosen the coolant temperature sensor (A) or plug at the rear of the cylinder head to allow air to escape.

A—Coolant Temperature Sensor



Cooling System Deaeration

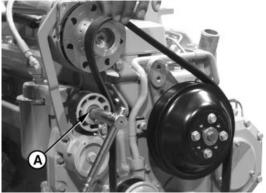
DPSG,OUO1004,19 -19-03APR98-1/1

Remove and Install Automatic (Spring) Belt **Tensioner**

NOTE: Belt tensioner cap screw (A) is left-hand threaded.

- 1. Release tension on belts using a breaker bar and socket.
- 2. Remove poly-vee belts from pulleys.
- 3. Remove belt tensioner.

A-Belt Tensioner Cap Screw



Automatic Belt Tensioner and Belt

RG,25,JW7552 -19-20NOV97-1/2

4. Inspect sheave (B).

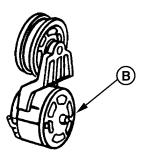
NOTE: If belt tensioner mounting plate was removed, tighten cap screws to timing gear cover first and then tighten cap screws to engine.

5. Install belt tensioner and tighten cap screws to specifications.

Specification

Belt Tensioner-to-Timing Cover 50 Nem (37 lb-ft) and Engine Cap Screws Torque Torque

6. Install poly-vee belts. Be sure that belt is correctly seated in all pulley grooves.



RG7972 -UN-14NOV97

Tensioner Sheave Inspection

B—Sheave

RG,25,JW7552 -19-20NOV97-2/2

Checking Belt Tensioner Spring Tension and Belt Wear

Belt drive systems equipped with automatic (spring) belt tensioners cannot be adjusted or repaired. The automatic belt tensioner is designed to maintain proper belt tension over the life of the belt. If tensioner spring tension is not within specification, replace tensioner.

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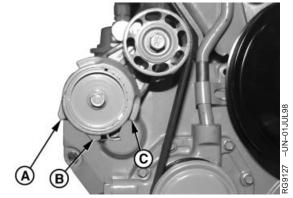
RG,25,JW7551 -19-20NOV97-1/3

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Checking Belt Wear

The belt tensioner is designed to operate within the limit of arm movement provided by the cast stops (A and B) when correct belt length and geometry are used.

- 1. Visually inspect cast stops (A and B) on belt tensioner assembly.
- If the tensioner stop on swing arm (C) is hitting the fixed stop (B), check mounting brackets (alternator, belt tensioner, etc.) and the belt length. Replace belt as needed.



Check Belt Wear

- A—Cast Stop
- **B**—Cast Stop
- C-Swing Arm

RG,25,JW7551 -19-20NOV97-2/3

RG7977 -UN-14NOV97

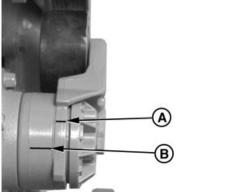
-UN-14NOV97

Checking Tensioner Spring Tension

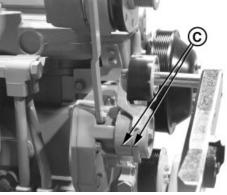
A belt tension gauge will not give an accurate measure of the belt tension when automatic spring tensioner is used. Measure tensioner spring tension using a torque wrench and procedure outlined below:

- 1. Release tension on belt using a breaker bar and socket on tension arm. Remove belt from pulleys.
- 2. Release tension on tension arm and remove breaker bar.
- 3. Put a mark (A) on swing arm of tensioner as shown.
- 4. Measure 21 mm (0.83 in.) from (A) and put a mark (B) on tensioner mounting base.
- 5. Rotate the swing arm using a torque wrench until marks (A and B) are aligned (C).
- Record torque wrench measurement and compare with specification below. Replace tensioner assembly as required.





Tensioner Spring Tension Check Marks



Tensioner Spring Tension Check

- A—Reference Mark
- **B**—Reference Mark
- C—Alignment

RG,25,JW7551 -19-20NOV97-3/3

Manual Belt Tensioner Adjustment

NOTE: Two types of manual tensioners shown.

Inspect belts for cracks, fraying, or stretched-out areas. Replace if necessary.

As a reference check, twist belt in the middle of a 10—12 inch span with two fingers. A properly tensioned belt will turn 75—85 degrees. If belt turns more, it needs to be tightened. If belt turns less, it needs to be loosened.

NOTE: If timing gear cover or alternator bracket interfere with installation/centering of belt tension gauge (A), install gauge with face toward engine.

- 1. Install JDG1341 Belt Tension Gauge (A) on belt, halfway between pulleys as shown.
- 2. Loosen cap screws (B) and (C).
- 3. Slide alternator or tensioner bracket (D) in slot by hand to remove all excess slack in belt.

IMPORTANT: Do not pry against alternator rear frame.

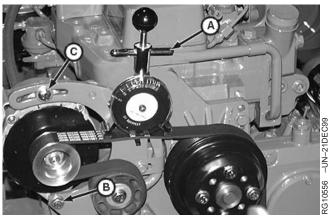
4. Stretch belt by prying outward on alternator front frame or tensioner bracket. Observing tension gauge, stretch the belt until specified tension is achieved.

Specification

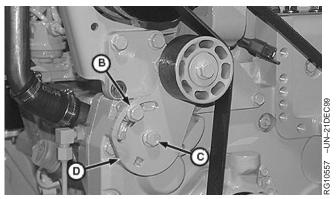
5. Tighten cap screws (B) and (C).

NOTE: After ten minutes run-in, new belts are considered used. Belt tension must then be rechecked per used belt specifications.

- 6. Run engine for ten minutes and immediately re-check belt tension per used belt specification above.
- 7. Reset belt tension as necessary.



Adjust Belt Tension



Adjust Belt Tension

- A-Belt Tension Gauge
- B—Cap Screw
- C—Cap Screw
- D—Tensioner Bracket

Inspect and Install Fan Assembly

Several fan drive ratios are available, allowing a closer matching of fan speed to application.

 Inspect fan blades for bent or damaged condition. Bent blades reduce cooling system efficiency and throw the fan out of balance. Replace fan if blades are bent or damaged.

NOTE: Engines may be equipped with either suction-type fan or a blower-type fan, depending on application. Take care not to install fan incorrectly. Refer to illustrations to identify fan type and corresponding installation.

2. Install fan on pulley or pulley hub.

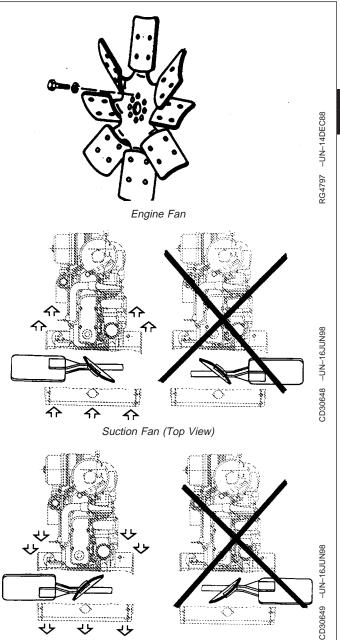
Install blower type fan with concave side of blade toward radiator.

Install suction type fan with concave side of blade toward engine.

Tighten cap screws (with lock washers) to specifications.

Specification

| Fan-to-Pulley Hub M8 Cap | 35 N•m (26 lb-ft) |
|---------------------------|-------------------|
| Screws Torque | |
| Fan-to-Pulley Hub M10 Cap | 70 Nem (52 lb-ft) |
| Screws Torque | |



Blower Fan (Top View)

RG,25,JW7550 -19-11NOV99-1/1

Remove and Inspect Fan Drive Assembly

Fan assemblies can be mounted in several positions to accommodate different application and engine cooling requirements.

- 1. Remove fan.
- 2. Release tension on belt and remove poly-vee belt from pulleys.
- 3. Remove fan pulley (A).
- 4. Inspect pulley and grooves

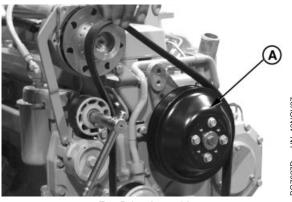
NOTE: Cap screw position (B) is used as an example only. Position of fan drive varies by application.

- Mark cap screw positions (B) on timing gear cover before removal to ensure that fan pulley is installed in same position as removed. This will ensure proper belt tension is achieved.
- 6. Remove hub (C) and fan drive.

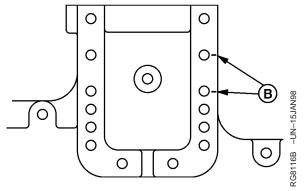
A—Fan Pulley

B—Fan Drive Cap Screw Position

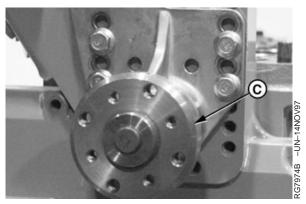
C—Hub



Fan Drive Assembly



Cap Screw Marking for Installation



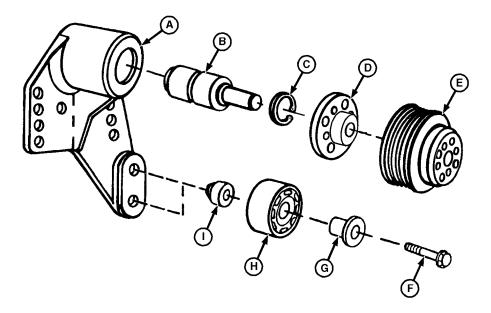
Hub and Fan Drive

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Replace Bearings in Adjustable Fan Drive Assembly



Adjustable Fan Drive Assembly

A—Bearing Housing B—Bearing/Shaft C—Snap Ring D—Hub E—Pulley F—Cap Screw G—Sleeve H—Idler Pulley I—Spacer

Disassemble Fan Drive Assembly

NOTE: Some parts in illustration above may not be available separately for service. See parts catalog for service parts/assemblies.

- 1. Support back side of fan hub (D) and press nose of bearing/shaft (B) out of hub.
- 2. Remove snap ring (C) from front bore of bearing housing (A).
- 3. Support front nose of bearing housing and press bearing/shaft out of housing. Discard bearing.
- 4. Remove parts (F-I) if required.
- Thoroughly clean and inspect fan hub, bearing housing and idler pulley for cracks or any other damage.
- 6. Measure parts and compare with specifications given. Replace parts not within specifications.

Fan Drive (Option Codes 2301 and 2302)—Specification

| Bearing Housing ID | 38.018—38.038 mm |
|--------------------|---------------------|
| | (1.4968—1.4976 in.) |
| Bearing OD | 38.087—38.100 mm |
| | (1.4995—1.5000 in.) |
| Shaft OD | 18.948—18.961 mm |
| | (0.7460—0.7465 in.) |
| Hub ID | 18.910—18.936 mm |
| | (0.7445—0.7455 in.) |

Fan Drive (Option Codes 2303, 2304, 2312, 2313, and 2314)—Specification

| Bearing Housing ID | 47.573—47.599 mm |
|--------------------|---|
| | (1.8730—1.8740 in.) |
| Bearing OD | 47.612—47.625 mm |
| | (1.8745—1.8750 in.) |
| Shaft OD | 25.387—25.400 mm |
| | (0.9995—1.0000 in.) |
| Hub ID | 25.337—25.353 mm |
| | (0.9975—0.9985 in.) |
| | 25.387—25.400 mm (0.9995—1.0000 in.) 25.337—25.353 mm |

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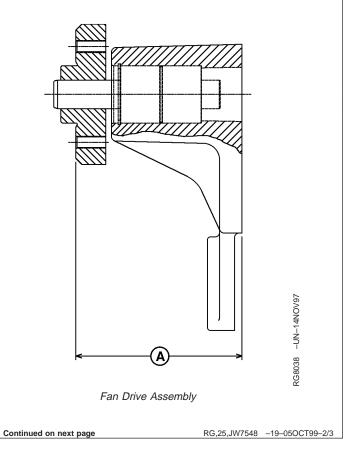
RG,25,JW7548 -19-05OCT99-1/3

Assemble Fan Drive Assembly

- 1. Support rear face of bearing housing and drive bearing into housing by pressing on outer bearing shell until bearing bottoms in housing bore.
- 2. Install internal snap ring into front groove of housing bore.
- 3. Support shaft through rear housing bore and press fan hub onto shaft to dimension (A).

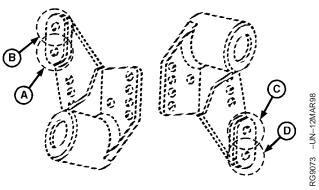
| 110.85—110.87 mm |
|-------------------|
| (4.364—4.365 in.) |
| |
| 106.65—106.67 mm |
| (4.199—4.200 in.) |
| |
| |

A—Dimension



4. If idler pulley was removed, reinstall according to following table:

| Fan Pulley | Fan Height | Idler Position |
|--------------------|--------------------|----------------|
| 168 mm (6.61 in.) | 210 mm (8.27 in.) | В |
| 140 mm (5.51 in.) | 210 mm (8.27 in.) | A |
| 203.2 mm (8.0 in.) | 226 mm (8.9 in.) | В |
| 168 mm (6.61 in.) | 226 mm (8.9 in.) | В |
| 140 mm (5.51 in.) | 226 mm (8.9 in.) | A |
| 203.2 mm (8.0 in.) | 258 mm (10.16 in) | В |
| 168 mm (6.61 in.) | 258 mm (10.16 in) | В |
| 140 mm (5.51 in.) | 258 mm (10.16 in) | A |
| 203.2 mm (8.0 in.) | 290 mm (11.42 in.) | В |
| 168 mm (6.61 in.) | 290 mm (11.42 in.) | В |
| 140 mm (5.51 in.) | 290 mm (11.42 in.) | A |
| 203.2 mm (8.0 in.) | 402 mm (15.83 in.) | D |
| 168 mm (6.61 in.) | 402 mm (15.83 in.) | С |
| 140 mm (5.51 in.) | 402 mm (15.83 in.) | С |



Fan Drive Idler Position

- A-Idler Position A
- B—Idler Position B
- C-Idler Position C
- D-Idler Position D

5. Torque idler retaining cap screw to specifications.

CTM104 (19JUN00)

Specification

Fan Drive Idler Cap Screw..... 50 Nem (37 lb-ft) Torque

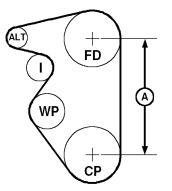
RG,25,JW7548 -19-05OCT99-3/3

Install Fan Drive Assembly

IMPORTANT: Be sure adjustable fan drive assembly is installed in correct position as removed to ensure proper belt tension.

 For engines using poly-vee belts: If reference marks were not made on timing gear cover during removal of fan drive assembly, use the following table to determine proper fan height.

| POLY-VEE BELT (MANUAL TENSIONER) | | | |
|---------------------------------------|------------|--------------------------|--|
| 4.5 L Fan Belt Option | Fan Height | 6.8 L Fan Belt Option | |
| 290 mm (11.42 in.) W/Idler Pulley (A) | | | |
| 240A, 240B, 240C, 240D | | | |
| 338 mm (13.31 in.) (A) | | | |
| 240E | | 240F | |
| 402 mm (15.83 in.) (A) | | | |
| 240G, 240H, 240J | | 240K | |



Fan Height (Poly-Vee Belt)

A—Fan Height Distance ALT—Alternator CP—Crank Pulley FD—Fan Drive I—Idler WP—Water Pump

Continued on next page

RG,25,JW7547 -19-09DEC99-1/4

RG10375 -UN-130CT99

For engines using poly-rib-belts: If reference marks were not made on timing gear cover during removal of fan drive assembly, use figure to the right and following table to determine proper fan height.

| POLY-RIB BELT | | | |
|---|----------------------------|---|--|
| 4.5 L Fan Belt Option | Fan Height | 6.8 L Fan Belt Option | |
| 210 m | nm (8.27 in.) W/Idler Pull | ey (A) | |
| 24AG, 24AH, 24AJ, 24AK, 24AL, 24AM | | 24AJ, 24AN | |
| 226 r | nm (8.9 in.) W/Idler Pulle | ey (A) | |
| 2406, 2408, 2415, 2435, 2436, 2461, 240P, 240Q | | 2401, 2402, 2403, 2405, 2407, 2412, 2471, 2472, 2473, 2474, 240T, 240W | |
| 258 m | m (10.16 in.) W/Idler Pul | ley (A) | |
| 24AR, 24AT | | | |
| 290 m | m (11.42 in.) W/Idler Pul | ley (A) | |
| 2404, 2407, 2409, 2410, 2411, 2412, 2437, 2439, 2440, 2460, 2462, 240U | | 2409, 2411, 2413, 2414, 2415, 2435, 2438, 2475, 2476, 240R, 240S, 240V | |
| | 338 mm (13.31 in.) (B) | | |
| 2416, 2417, 2419, 2420, 2421, 2423, 2424, 2442, 2443, 2463, 2466, 2468 | | 2416, 2418, 2420, 2421, 2422, 2423, 2424, 2441, 2477, 2478, 2479, 2482 | |
| | 402 mm (15.83 in.) (B) | | |
| 2426, 2428, 2430, 2431, 2432, 2444, 2445, 2464, 2465, 2469, 2470 | | 2417, 2419, 2425, 2427, 2429, 2480 | |
| 402 m | m (15.83 in.) W/Idler Pul | ley (C) | |
| 2434, 2446 | | 2433 | |

A—Fan Height Distance

B—Fan Height Distance

C—Fan Height Distance

ALT—Alternator

CP—Crank Pulley

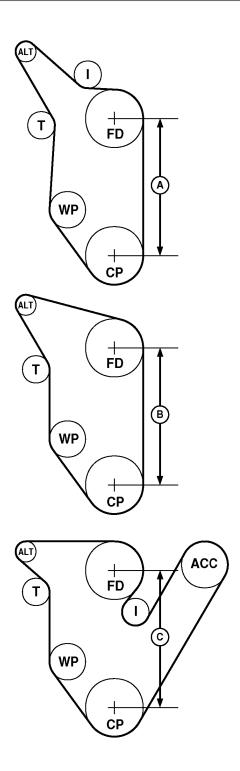
ACC—Air Conditioning Compressor

FD-Fan Drive

I—Idler

T—Tensioner

WP-Water Pump



Fan Height (Poly-Rib Belt)

RG9128 -UN-01JUL98

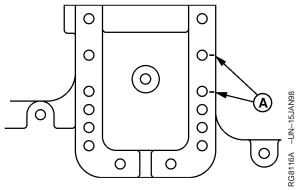
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NOTE: Cap screw position (A) is used as an example only. Position of fan drive varies by application.

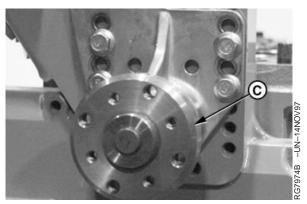
3. Install hub (C) with fan drive assembly, in positions (A) marked during disassembly, and tighten cap screws to specifications.

Specification

A—Cap Screw Position C—Fan Drive Hub



Fan Drive Mounting



Fan Drive Hub

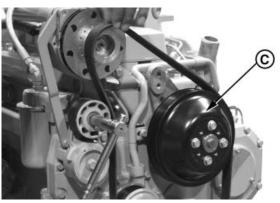
RG,25,JW7547 -19-09DEC99-3/4

4. Install fan pulley (C) and tighten cap screws to specifications.

Specification

5. Install poly-vee belt. Be sure belt is correctly seated in all pulley grooves.

C—Fan Pulley



Fan Pulley

RG,25,JW7547 -19-09DEC99-4/4

Remove and Install Fan Drive Assembly (2254 Combine)

- 1. Remove parts (A—E) and (H—N) as required.
- 2. Inspect and replace parts as necessary.
- 3. Press bearing shaft (A) into fan bracket (B) until bearing face is flush with bracket end face.
- Place fan bracket under a press so that the thrust, when pressing on pulley, is received only by the bearing shaft end (F). Press pulley until distance (G) is obtained.

| _ | | | |
|-----|-------|-------|----|
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5. Install fan bracket on engine and tighten hardware to specifications.

Fan Drive Assembly (2254 Combine)—Specification

| Fan Idler Axle Shaft-to-Block (D) | 340 N•m (251 lb-ft) |) |
|-----------------------------------|---------------------|---|
| Torque | | |
| Fan Idler-to-Shaft Retaining Nut | 225 Nem (166 lb-ft) |) |
| (J) Torque | | |
| Fan Drive Bracket-to-Block Cap | 340 N•m (251 lb-ft) |) |
| Screw (K) Torque | | |
| Fan Drive Bracket-to-Cylinder | 140 N•m (103 lb-ft) |) |
| Head Cap Screws (M) Torque | | |
| Upper Fan Drive | 140 N•m (103 lb-ft) |) |
| Bracket-to-Lower Bracket Cap | | |

A—Bearing Shaft

B-Fan Bracket

C—Pulley

Screws/Nuts (L) Torque

D—Idler Axle Shaft

E—Idler

F—Bearing Shaft End

G—Distance for Pulley Installation

H—Spacer

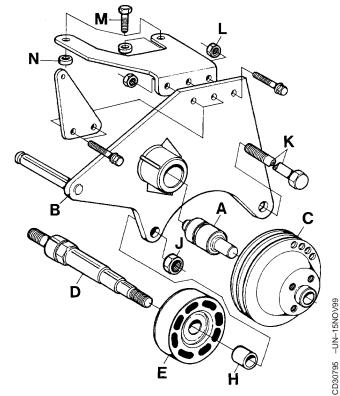
J—Nut

K-Screw

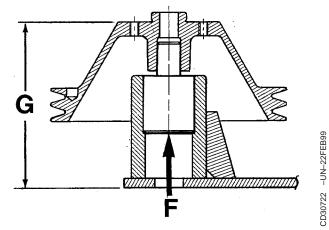
L-Nut

M—Cap Screw

N—Spacer



Fan Drive Assembly



Pulley-to-Bracket Distance

DPSG,OUO1004,2508 -19-05JAN00-1/1

Remove and Install Coolant Heater—If Equipped



CAUTION: To avoid shock or hazardous operation, always use a three-wire heavy-duty electrical cord equipped with three-wire connectors. If a two-to-three contact adapter is used at the wall receptacle, always connect green wire to a good ground. Keep electrical connectors clean to prevent arcing. Only plug coolant heater into electrical power if heating element is immersed in coolant. Sheath could burst and result in personal injury.

- 1. Unplug heater from electrical power source.
- 2. Drain cooling system.
- 3. Disconnect cord (A) from heater assembly.
- 4. Loosen retaining nut (C) and remove adapter (D) and heater element from block.
- 5. Inspect and replace parts as necessary.

NOTE: The heater element (G) cannot be repaired. Replace if defective.

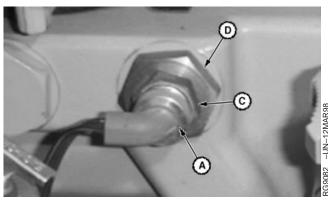
- 6. Install a new gasket (E). Apply JDT308 Soap Lubricant to new O-ring (F) and install.
- 7. Install heater element through adapter (D) and install nut (C) loosely.
- 8. Install heater into cylinder block with element pointing to the rear.
- 9. Tighten adapter (D).
- 10. Turn element clockwise and then counterclockwise until element contacts casting. Move element midway between contact points.
- 11. Hold element with a wrench and tighten retaining nut (C) to specifications.

Specification

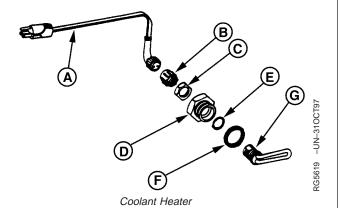


-UN-23AUG88

Electrical Shock Safety



Coolant Heater



- A—Cord
- **B**—Dust Cover
- C-Retaining Nut
- D—Adapter
- E—Gasket
- F-O-Ring
- **G**—Heater Element

Continued on next page

RG,25,JW7546 -19-20NOV97-1/2

Cooling System

NOTE: If heater has been ordered as an attachment only, it will include a dust cover (B). The cover is used to protect the electrical connectors when cord assembly (A) has been removed.

12. Install cord.

13. Service engine with coolant.

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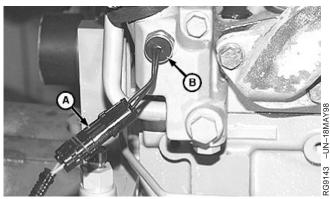
RG,25,JW7546 -19-20NOV97-2/2

Remove and Install Cold Start Advance Switch (If Equipped)

- 1. Drain coolant from thermostat housing.
- 2. Disconnect connector (A) and remove switch (B).
- 3. Install switch with new O-ring in thermostat housing and tighten to specifications.

Specification

4. Connect harness connector.



Cold Start Switch

A—Connector B—Switch

DPSG,OUO1004,1062 -19-29SEP99-1/1



02 080 1

Extending Turbocharger Life

Turbochargers are designed to last the life of the engine, but because they operate at such high speeds (100,000 rpm or more), a moment's carelessness can cause them to fail in seconds.

The major causes of turbocharger failures are attributed to:

- Lack of lube oil (quick starts and hot shutdowns)
- Oil contamination
- · Ingestion of foreign objects
- Restricted oil drainage
- Low oil level
- Operation on excessive side slopes
- Abnormally high exhaust temperatures

Lack of Lube Oil

Oil not only lubricates the turbocharger's spinning shaft and bearings, it also carries away heat. When oil flow stops or is reduced, heat is immediately transferred from the hot turbine wheel to the bearings, which are also heating up because of the increased friction due to the lack of oil. This combination causes the turbocharger shaft temperature to increase rapidly.

If oil flow does not increase and the process continues, bearings will fail. Once the bearings fail (which can happen in just seconds), seals, shaft, turbine and compressor wheels can also be damaged.

The principal causes of turbocharger bearing lubrication problems are low oil pressure, a bent, plugged or undersized oil lube supply line, plugged or restricted oil galleries in the turbocharger, or improper machine start-up and shutdown procedures.

Oil levels and pressure should always be closely monitored and all worn hoses and lines should be replaced. The turbocharger oil supply line should be checked frequently to make sure it is not kinked or bent, and it should always be replaced with a line of equal size, length and strength.

The easiest way to damage a turbocharger is through improper start-up and shutdown procedures. Always idle the engine for at least 30 seconds (no load) after start-up and before shutdown. Warming the engine up before applying a load allows oil pressure to build up and lines to fill with oil.

Idling the engine before shutdown allows the engine and turbocharger to cool. "Hot" shutdowns can cause the turbocharger to fail because, after high-speed operation, the turbocharger will continue to rotate long after the engine has been shut off and oil pressure has dropped to zero. This will cause heat to build up and possible bearing damage. It can also cause carbon and varnish deposits to form.

Oil Contamination

A second cause of turbocharger failures is contaminated oil. It can be caused by a worn or damaged oil filter or not changing the lube oil at recommended intervals. Expecting the oil filter to remove dirt, sand, metal chips, etc., from the oil before they reach the engine or turbocharger can be a costly mistake because contaminated oil may completely bypass the engine oil filter if the oil filter or oil cooler is clogged, if the filter element is improperly installed, or if the oil is thick during cold weather.

Four good ways of avoiding oil contamination are:

- Always inspect the engine thoroughly during major overhaul. Look especially for any sludge or debris left in lube oil galleries.
- Change lube oil at recommended intervals. Analysis of oil samples at filter change periods can help identify potentially harmful contaminants in the oil.
- Clean the area around the oil fill cap before adding oil.
- Use a clean container when adding oil.

Continued on next page

RG,30,JW7583 -19-20NOV97-1/2

Ingestion of Foreign Objects

A third cause of turbocharger damage is the ingestion of foreign objects. Foreign objects or particles can be ingested and cause damage to the turbocharger on both compressor and turbine sides. This is easy to avoid.

On the compressor side, foreign objects usually take the form of dust, sand, or shreds of air cleaner element that enter through improperly installed air cleaner elements. Leaky air inlet piping (loose clamps or torn rubber joints) or torn pleats in dry-type air cleaner elements also create problems.

The result is erosion of compressor blades that can cause the delicately balanced wheel to wobble.

IMPORTANT: Whenever an internal engine failure (valve, valve seat, piston) occurs, a thorough inspection of the turbocharger MUST BE performed before returning engine to service.

Restricted Oil Drainage

A fourth cause of turbocharger damage is restricted lube oil drainage. The lubricating oil carries away heat generated by friction of the bearings and from the hot exhaust gases. If drainage back to the sump is impeded, the bearings will overheat with damage that will ultimately lead to failure.

There are two primary reasons for restricted drainage. A blocked drain tube, due to either damage or a

buildup of sludged oil, or high crankcase pressure, which can be due to restricted crankcase breather or excessive engine blow-by.

Periodically check both the turbocharger oil drain tube and engine breather tube for damage or restriction. Correction of these conditions leads to longer turbocharger life.

Abnormally High Exhaust Temperatures

A fifth cause of turbocharger damage is abnormally high exhaust temperatures. Elevated exhaust temperatures cause coking of oil which can lead to bearing failure. Extreme over-temperature operation can case wheel burst.

There are two basic causes of over-temperature. The first is restricted air flow and the second is overpowering the engine. In either case the engine has more fuel than available air for proper combustion; this overfueled condition leads to elevated exhaust temperatures.

Causes of restricted air flow can include damaged inlet piping, clogged air filters, excessive exhaust restriction, or operation at extreme altitudes. Overpowering generally is due to improper fuel delivery or injection timing. If overtemperature operation has been identified, an inspection of the air inlet and exhaust systems should be performed. Also, check the fuel delivery and timing.

RG,30,JW7583 -19-20NOV97-2/2

Remove Turbocharger

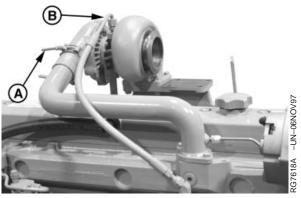


CAUTION: After operating engine, allow exhaust system to cool before removing turbocharger.

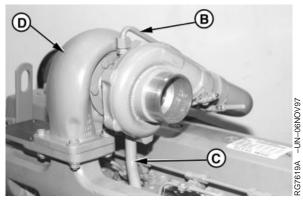
Thoroughly clean exterior of turbocharger and surrounding area to prevent entry of dirt into the air intake system during removal.

IMPORTANT: When cleaning turbocharger, do not spray directly into compressor cover or turbine housing. If turbocharger inspection is required, do not clean exterior prior to removal. Doing so may wash away evidence of a potential failure mode. See TURBOCHARGER SEVEN-STEP INSPECTION later in this group.)

- 1. Remove air intake hose and exhaust elbow (shown removed). Loosen hose clamp (A).
- 2. Disconnect oil inlet line (B) and oil return pipe (C) from turbocharger (D).
- 3. Remove mounting cap screws and nuts and lift turbocharger from exhaust manifold. Remove stainless steel gasket.
- 4. Place turbocharger on a clean flat surface. Cap or plug all air intake and exhaust openings.
- Perform turbocharger seven-step inspection as described later, if failure mode has not yet been determined. (See TURBOCHARGER SEVEN-STEP INSPECTION in this group.)



Remove Turbocharger



Disconnect Turbocharger Lines

- A-Hose Clamp
- B-Oil Inlet Line
- C-Oil Return Pipe
- D-Turbocharger

RG,30,JW7582 -19-27SEP99-1/1

Turbocharger Failure Analysis

The following is a guide for diagnosing the cause of turbocharger failures after removal from the engine.

| Problem | Possible Cause | Suggested Remedy | | |
|-----------------------------------|---|--|--|--|
| COMPRESSOR HOUSING INLET DEFECTS | | | | |
| Foreign Object Damage | Objects left in intake system. | Disassemble and inspect intake system for foreign objects (this group). Inspect engine for internal damage. | | |
| | Leaking and/or defective intake system. | Inspect air intake system connections including air filter; repair as required (this group). Inspect air intake related engine components. | | |
| Compressor Wheel Rub | Bearing failure. | Determine if engine and/or operator contributed to lack of lubrication, contaminated lubrication, excessive temperature, or debris generating engine failure in progress. Correct as required. | | |
| | Manufacturing defects. | Correct as required. | | |
| COMPRESSOR HOUSING OUTLET DEFECTS | | | | |
| Oil and/or Dirt in Housing | Restricted air intake system. Prolonged periods of low rpm engine idling. | Inspect and clean air cleaner. Check with operator to confirm conditions. (See Operator's Manual.) | | |
| | Defective oil seal ring. Restricted oil drain line. | Repair as required (this group). Inspect and clear oil drain line as required. | | |
| TURBINE HOUSING INLET DEFECTS | | | | |
| Oil in Housing | Internal engine failure. Oil leaking from compressor housing seal. | Inspect and repair engine as required. Verify that oil is in compressor housing and refer to "Compressor Housing Outlet Defects" as listed earlier in this chart. | | |
| Center Wall Deteriorated | Excessive operating temperature. | Check for restricted air intake. Check engine for overfueling. Check injection pump timing. | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

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RG,RG34710,1258 -19-23OCT97-1/2

Air Intake and Exhaust System

TURBINE HOUSING OUTLET DEFECTS

Turbine Wheel Rub Bearing failure. Determine if engine and/or operator contributed to lack

of lubrication, contaminated lubrication, excessive temperature, or debris generating engine failure in

progress. Correct as required.

Manufacturing defect. Correct as required (this group).

Foreign Object Damage Internal engine failure. Inspect and repair engine as required.

Objects left in intake system. Disassemble and inspect air intake system (this

group).

Leaking air intake system. Correct as required (this group).

Oil and/or Excessive Carbon Internal engine failure. Verified by oil in turbine housing. Correct as required.

Turbine seal failure. Inspect for excessive heat from overfueling and/or

restricted air intake.

Prolonged periods of low rpm engine Ask operator to run engine under load or at a higher idling. Ask operator's Manual).

idling. rpm (see Operator's Manual).

Restricted oil drain line. Inspect and clear oil drain line as required.

EXTERNAL CENTER HOUSING AND JOINT DEFECTS

Leaks from Casting Defective casting. Replace turbocharger (this group).

Defective gasket. Verify if leaks are occurring at gasket joints.

Leaks from Joints Loose attaching screws. Tighten to specifications in CTM (this group).

Defective gasket. Inspect and repair as required.

INTERNAL CENTER HOUSING DEFECTS

Excessive Carbon Build-Up in Housing

or on Shaft

Hot engine shutdown.

Excessive operating temperature.

Restricted oil drain line.

Operating engine at high speeds and loads immediately after start-up.

Review proper operation with operator as shown in

operator's manual.

Restricted air intake; overfueling or mistimed engine.

Inspect and clean oil drain lines as required. Idle engine for a few minutes to allow oil to reach

bearings before applying heavy loads.

RG,RG34710,1258 -19-23OCT97-2/2

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Turbocharger Seven-Step Inspection

The following inspection procedure is recommended for systematic failure analysis of a suspected failed turbocharger. This procedure will help to identify when a turbocharger has failed, and why it has failed, so the primary cause of the failure can be corrected.

Proper diagnosis of a non-failed turbocharger is important for two reasons. First, identification of a non-failed turbocharger will lead to further investigation and repair of the cause of a performance complaint.

Second, proper diagnosis eliminates the unnecessary expense incurred when a non-failed turbocharger is replaced.

The seven recommended inspection steps, which are explained in detail on following pages, are:

- Compressor Housing Inlet and Compressor Wheel.
- Compressor Housing Outlet.
- Turbine Housing Inlet.
- Turbine Housing Outlet and Turbine Wheel.
- External Center Housing and Joints.
- Internal Center Housing.
- Turbocharger Bench Test.

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RG,30,JW7574 -19-20NOV97-1/13

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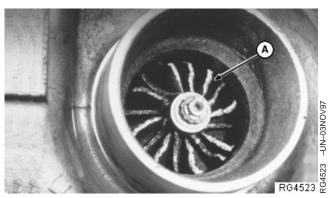
NOTE: To enhance the turbocharger inspection, an inspection sheet (Form No. DF-2280 available from Distribution Service Center—English only) can be used that lists the inspection steps in the proper order and shows potential failure modes for each step. Check off each step as you complete the inspection and record any details or problems obtained during inspection. Retain this with the work order for future reference.

Compressor Housing Inlet and Compressor Wheel

1. Check compressor inlet and compressor wheel (A) for foreign object damage.

NOTE: Foreign object damage may be extensive or minor. In either case, the source of the foreign object must be found and corrected to eliminate further damages.

2. Mark findings on your checklist and continue the inspection.



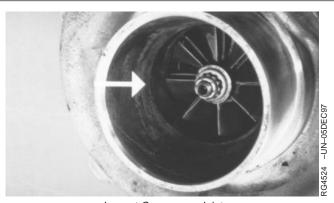
Inspect Compressor Wheel Blades

A—Compressor Wheel

RG,30,JW7574 -19-20NOV97-2/13

NOTE: You will need a good light source for this check.

Check compressor inlet for wheel rub on the housing (arrow). Look very closely for any score marks on the housing itself and check the tips of the compressor wheel blades for damage.



Inspect Compressor Inlet

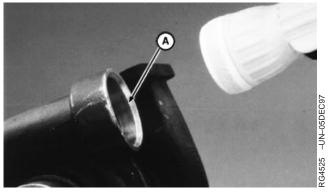
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RG,30,JW7574 -19-20NOV97-3/13

Compressor Housing Outlet

- 1. Check compressor housing outlet (A). The outlet should be clean and free of dirt or oil.
- 2. Mark it on your checklist if dirt or oil is found and continue the inspection.

A—Compressor Outlet



Inspect Compressor Outlet

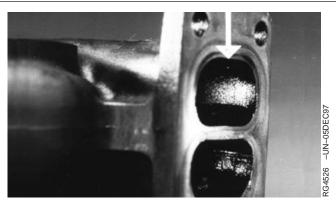
RG,30,JW7574 -19-20NOV97-4/13

Turbine Housing Inlet

CTM104 (19JUN00)

Check the turbine housing inlet ports (arrow) for oil in housing, excessive carbon deposit or erosion of center walls.

NOTE: If the inlet is wet with oil, or has excessive carbon deposits, an engine problem is likely. Center wall erosion (cracking or missing pieces), indicates excessive exhaust temperature.



Inspect Turbine Housing Inlet Ports

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RG,30,JW7574 -19-20NOV97-5/13

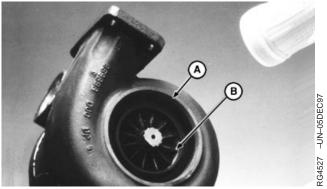


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Turbine Housing Outlet and Turbine Wheel

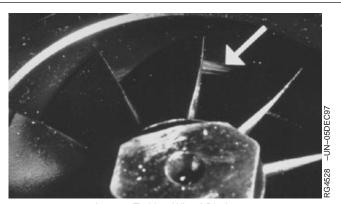
- 1. Use a flashlight to look up inside the turbine housing outlet (A) and check blades (B) for foreign object damage.
 - A—Turbine Outlet
 - **B—Turbine Blades**



Inspect Turbine Housing Outlet and Wheel

RG,30,JW7574 -19-20NOV97-6/13

2. Inspect the wheel blades and housing for evidence of wheel rub (arrow). Wheel rub can bend the tips of the blades with the housing showing wear or damage.



Inspect Turbine Wheel Blades

Continued on next page

RG,30,JW7574 -19-20NOV97-7/13

External Center Housing and Joints

Visually check the outside of the center housing, all connections to the compressor, and turbine housing for oil.

NOTE: If oil is present, make sure it is not coming from a leak at the oil supply or return line.



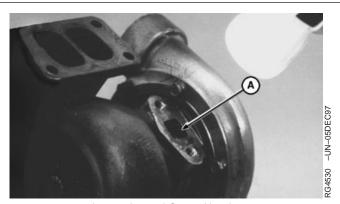
Inspect Housing for Oil

RG,30,JW7574 -19-20NOV97-8/13

Internal Center Housing

 Using a flashlight, look through the oil return hole (A), to check the condition of the shaft and/or bearings. There should not be excess carbon deposits on the shaft or in the housing.

A-Oil Return

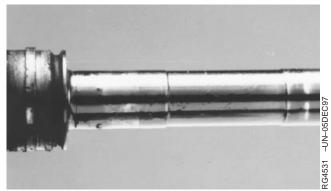


Inspect Internal Center Housing

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RG,30,JW7574 -19-20NOV97-9/13

Excessive "blueing" or "coking" of oil along the complete length of the shaft indicates a possible lack of lubrication caused by an engine failure, or improper operation, such as hot shutdowns.



Inspect Turbine Shaft for Blueing

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RG,30,JW7574 -19-20NOV97-10/13

Turbocharger Bench Test

- 1. Mount the turbocharger in a vise.
- 2. Rotate the shaft, using both hands, to check rotation and clearance. The shaft should turn freely; however, there may be a slight amount of drag.



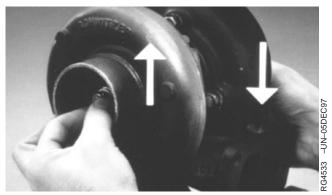
Shaft Rotation and Clearance Check

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RG,30,JW7574 -19-20NOV97-11/13

Next, pull up on the compressor end of the shaft and press down on the turbine end while rotating shaft. Neither the compressor wheel nor the turbine wheel should contact the housing at any point.

NOTE: There will be some "play" because the bearings inside the center housing are free floating.



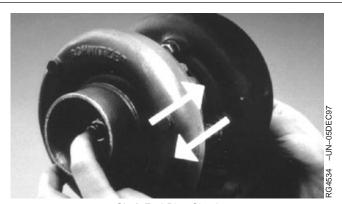
Compressor and Turbine Wheel Check

RG,30,JW7574 -19-20NOV97-12/13

4. Next, check shaft end play by moving the shaft back and forth while rotating. There will be some end play but not to the extent that the wheels contact the housings.

IMPORTANT: Before you finalize your conclusion that the turbocharger has not failed, it is strongly recommended that the following procedures of checking radial bearing clearance and axial bearing end play with a dial indicator be performed. These procedures are not required if a failure mode has already been identified.

NOTE: These diagnostic procedures will allow you to determine the condition of the turbocharger. If the turbocharger has failed, analysis of your inspection notes should direct you to the specific areas of the engine to correct the problems causing the turbocharger failure. (See TURBOCHARGER FAILURE ANALYSIS, outlined earlier in this group.) It is not unusual to find that a turbocharger has not failed. If your turbocharger passes all the inspections, the problem lies somewhere else.



Shaft End Play Check

Perform Radial Bearing Clearance Test

This test will give an indication of the condition of the radial bearings within the center housing and rotating assembly.

NOTE: Prelube center housing bearings prior to performing radial clearance test. (See PRELUBE TURBOCHARGER, later in this group.)

AiResearch/Garret Turbocharger)

1. Position dial indicator with extension adapter onto center housing so that tip rests on shaft extending through oil return cavity.

IMPORTANT: Use only moderate force (3—4 lb.) on each end of the shaft when checking clearance.

- 2. Grasp rotating shaft at both ends and move the shaft toward the indicator then away from the indicator (arrows) by applying moderate force of 3—4 lb.
- 3. Observe and record total indicator movement.

Specification

Turbocharger (AiResearch/Garret)...... 0.08—0.18 mm (0.003—0.007 in.) Radial Bearing Clearance maximum

4. If total indicator reading is not within specification, replace turbocharger.



Radial Bearing Clearance Test

Continued on next page

RG,30,JW7573 -19-15DEC99-1/2

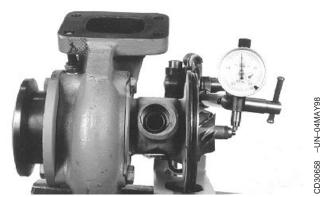
CZ Turbocharger

- 1. Remove compressor cover.
- 2. Install a dial indicator against end of shaft as shown.
- 3. Move shaft alternately toward and away from indicator and record total travel. Compare reading with the following specification.

Specification

Turbocharger (CZ) Radial Bearing...... 0.37—0.46 mm (0.015—0.018 in.) Clearance

- 4. If total indicator reading is not within specification, replace turbocharger.
- 5. Install compressor cover.



Radial Bearing Clearance Test

RG,30,JW7573 -19-15DEC99-2/2

Perform Axial Bearing End Play Test

This test will give an indication of the condition of the axial bearing within the center housing and rotating assembly.

- 1. Mount magnetic base dial indicator so that indicator tip rests on end of shaft. Preload indicator tip and zero dial on indicator.
- 2. Move shaft axially back and forth by hand.
- 3. Observe and record total dial indicator movement.

Specification

| Turbocharger (AiResearch/Garret) | 0.025—0.102 mm |
|----------------------------------|-------------------|
| Axial Bearing End Play | (0.001—0.004 in.) |
| Turbocharger (CZ) Axial Bearing | 0.11—0.16 mm |
| End Play | (0.004—0.006 in.) |

If bearing end play is not within specification, replace turbocharger.



Axial Bearing and End Play Test

RG,30,JW7572 -19-20NOV97-1/1

CTM104 (19JUN00)

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Adjust Turbocharger Wastegate Actuator (If Equipped)

- 1. Loosen jam nut (A).
- 2. Disconnect hose and pressurize actuator to 12 psi and hold at this calibration pressure.
- Push bypass lever (D) as far as possible toward the actuator and apply pressure to keep lever in that position.

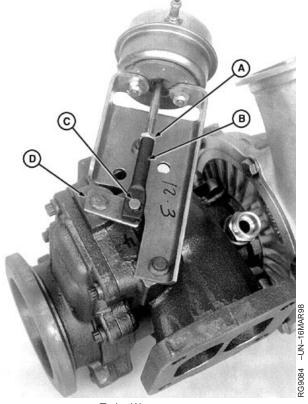
IMPORTANT: Twisting or forcing the entire rod in or out will change the calibration, causing damage to engine from overboost.

- 4. Turn rod end (B) in either direction until rod eye can just be slipped over bypass lever pin. Loosen rod end an additional half turn, install onto pin and secure with retainer clip (C). Release pressure on actuator.
- Pressurize the actuator to 12 psi. Measure the end play with a dial indicator, moving the bypass assembly back and forth in a direction perpendicular to the actuator rod. End play should be within specifications listed. If necessary to adjust, set end play at 0.38 mm (0.015 in.)

Specification

Turbocharger Actuator End Play.............. 0.05—0.056 mm (0.002—0.022 in)

- 6. Vary the pressure from 9—12 psi a few times to verify smooth and free operation of the bypass assembly.
- 7. Attach hose to actuator and secure with hose clamp.



Turbo Wastegate

- A-Jam Nut
- B—Rod End
- C—Retainer Clip
- D-Bypass Lever

DPSG,OUO1004,4 -19-31MAR98-1/1

Repair Turbocharger

Turbochargers used on the engines covered in this manual are available through service parts as a complete remanufactured assembly only. Individual components for repair are not available.

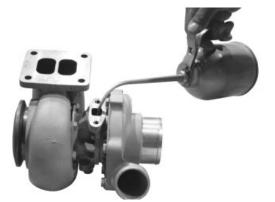
RG,30,JW7571 -19-20NOV97-1/1

Prelube Turbocharger

IMPORTANT: DO NOT spin the rotor assembly with compressed air. Damage to bearings can occur when using compressed air.

Fill oil inlet or drain port with clean engine oil and spin rotating assembly (by hand) to properly lubricate bearings.

If turbocharger is to be stored for an extended period of time, lubricate internally and install protective covers on all openings.



Turbocharger Pre-Use Lubrication

RG,30,JW7570 -19-20NOV97-1/1

RG7624 -UN-23NOV97

Install Turbocharger

IMPORTANT: If turbocharger failed because of foreign material entering the air intake system, be sure to examine the system and clean as required to prevent a repeat failure.

If not done previously, prime (prelube) the turbocharger rotating assembly prior to mounting turbocharger on engine. Prelube center housing with clean engine oil through the oil drain hole. Turn rotating assembly by hand to lubricate bearings.

 Position turbocharger (D) and new stainless steel gasket onto exhaust manifold. Tighten stud nuts to specifications.



2. Install oil return pipe (C) to turbocharger. Tighten oil return pipe cap screws to specifications.

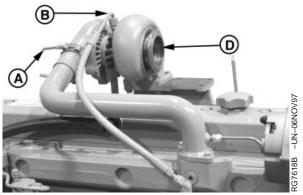
Specification

3. Connect turbocharger oil inlet line (B) and tighten to specifications.

Specification

4. Connect air inlet hose-to-turbocharger compressor housing. Tighten hose clamp (A) on air inlet line to specifications.

Specification



Install Turbocharger



Connect Turbocharger Lines

- A-Hose Clamp
- B—Oil Inlet Line
- C-Oil Return Pipe
- D—Turbocharger

080 18 IMPORTANT: Since the greatest suction force occurs between air cleaner and turbocharger, ensure that hose connections are tight to prevent entry of dirt into system.

5. Install exhaust adapter and exhaust elbow. Tighten cap screws and clamp to specifications.

Specification

Exhaust Adapter-to-Turbocharger...... 7.5 Nem (5.5 lb-ft) (66 lb-in.) Clamp Torque Torque

RG,30,JW7569 -19-27SEP99-2/2

Turbocharger Break-In

IMPORTANT: A new or repaired turbocharger DOES NOT have an adequate oil supply for immediate start-up of engine. Perform the steps below to prevent damage to turbocharger bearings.

1. Either push the throttle lever to the "STOP" position, hold the engine shut-off knob out, or disconnect electrical wire from injection pump.

IMPORTANT: DO NOT crank engine longer than 30 seconds at a time to avoid damage to starter motor.

- 2. Crank engine over with starter motor until oil pressure gauge needle registers within the "GREEN" zone of pressure gauge.
- 3. Start and run engine at low idle while checking oil inlet and air piping connections for leaks.

RG,30,JW7568 -19-20NOV97-1/1

Recommendations for Turbocharger Use

IMPORTANT: Should the engine stall when operating under load, IMMEDIATELY restart the engine to prevent overheating of turbocharger parts.

02 080 19

In most cases, turbocharger damage is caused by improper start-up and shutdown procedures. Always idle the engine for at least 30 seconds (no load) after start-up and before shutdown.

DPSG,OUO1004,5 -19-31MAR98-1/1

Remove, Inspect, and Install Exhaust Manifold

- 1. Remove turbocharger (if equipped), exhaust elbow, or exhaust pipe if desired. Turbocharger can be removed with exhaust manifold (A). (See REMOVE TURBOCHARGER, earlier in this group.)
- 2. Remove exhaust manifold using guide studs (C).

NOTE: Some exhaust manifolds are equipped with a one-piece gasket.

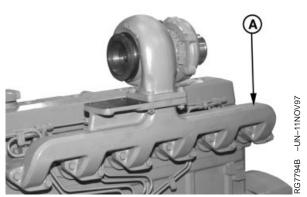
- 3. Inspect exhaust manifold and gasket(s) (B).
- 4. Thoroughly clean passages in exhaust manifold.
- 5. Inspect each exhaust manifold for cracks or damage. Inspect machined mounting surfaces for burrs or other defects which might prevent gasket(s) from sealing properly. Replace parts as needed.
- 6. Install gasket(s) on exhaust manifold.

NOTE: Stainless steel gaskets can be reused if not damaged. Graphite gaskets must be replaced.

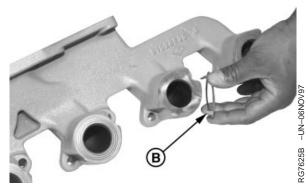
- 7. Using guide studs (C), install exhaust manifold.
- 8. Apply PT569 NEVER-SEEZ® Compound to cap screws.
- 9. Tighten exhaust manifold-to-cylinder head cap screws to specifications. On 6-cylinder engines F250, tighten cap screws on No. 3 and No. 4 cylinders first. On all other engines, tighten No. 2 and No. 3 cylinders first.

Specification

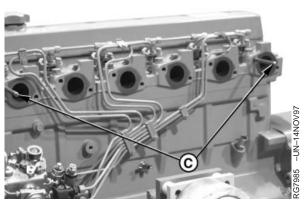
Exhaust Manifold-to-Cylinder 70 Nem (52 lb-ft) Head Cap Screws Torque



Exhaust Manifold w/Turbocharger Installed



Exhaust Manifold Gaskets



Exhaust Manifold Guide Studs

- A-Exhaust Manifold
- B-Gasket
- C-Guide Studs

NEVER-SEEZ is a registered trademark of Emhart Chemical Group

RG,30,JW7567 -19-20NOV97-1/1

Remove and Install Air-to-Air Aftercooler

Refer to machine technical manual for removal, inspection, and installation procedures.

CTM104 (19JUN00)

RG,30,JW7566 -19-20NOV97-1/1

Remove and Install Air Intake Pipe

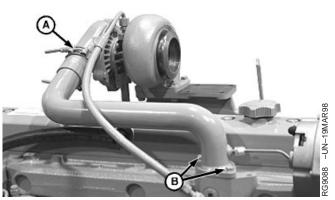
NOTE: Configuration of air intake pipe varies by application. Engines may also be equipped with an air heater or spacer between intake tube and manifold. (See REMOVE AND INSTALL AIR HEATER next in this group.)

- 1. Remove cap screws (B).
- 2. Loosen hose clamp (A) and remove air intake pipe.
- 3. Inspect and repair as required.
- 4. Install new gasket and air intake pipe. Tighten cap screws to specifications.



5. Tighten hose clamp (A) to specifications.

Specification



Air Intake Pipe

A—Hose Clamp B—Cap Screws

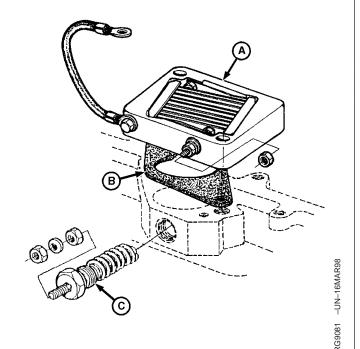
DPSG,OUO1004,6 -19-10NOV99-1/1

Remove and Install Air Heater

NOTE: Figure shows two types of air heaters. One or the other is used per application.

On later model grid-type air heaters, gasket (B) is replaced by an O-ring, eliminating the need for ground wire shown.

- 1. Disconnect wiring.
- 2. If machine is equipped with grid-type air heater (A), remove air intake pipe. (See REMOVE AND INSTALL AIR INTAKE PIPE in this group.)
- 3. Remove air heater (A) or (C).
- 4. Replace parts as required.
- 5. Install air heater (A) with new gasket (B). Coat threads of air heater (C) with LOCTITE® 592 Pipe Sealant with TEFLON® and install.
- 6. Install air intake pipe if required.
 - A—Grid-Type Air Heater
 - B-Gasket
 - C-Glow Plug Air Heater



Air Heater (Two Versions Shown)

LOCTITE is a registered trademark of Loctite Corp. TEFLON is a registered trademark of Du Pont Co.

DPSG,OUO1004,7 -19-10NOV99-1/1

Remove and Install Starting Aid—If Equipped

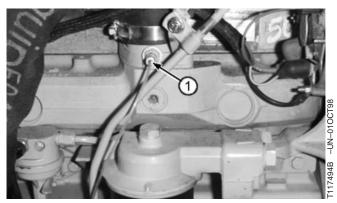
1. Disconnect starting aid tube (1).

NOTE: When removing nozzle, note the location of red dot when removing.

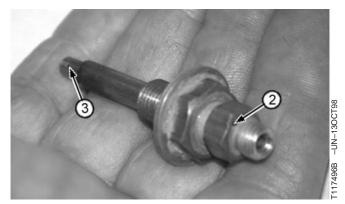
- 2. Remove nozzle holder from air inlet.
- 3. Clean or replace nozzle holder as required.

NOTE: Red dot (2) on nozzle holder must be installed at the 12 o'clock position, facing the incoming air flow. Nozzle orifice (3) needs to be in the path of the air flow to disperse fluid for quick start of engine.

- 4. Install nozzle and connect starting aid tube.
 - 1—Starting Aid Tube
 - 2-Red Dot for Nozzle Installation
 - 3-Orifice



Starting Aid Tube



Nozzle Holder

DPSG,OUO1004,995 -19-12AUG99-1/1



Group 090 Fuel System

Fuel System

NOTE: Repair, operation, diagnostics and testing of fuel systems has been moved to two other technical manuals: CTM207—Mechanical Fuel Systems and CTM170—Electronic Fuel Systems.



DPSG,OUO1004,2652 -19-17APR00-1/1

Remove and Install Starter

NOTE: Refer to CTM77 for repair and testing of starter motor.

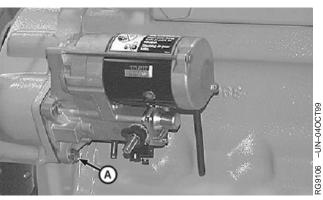


CAUTION: Disconnect battery ground strap or serious injury could result if tools ground electrical system.

- 1. Disconnect ground strap from battery.
- 2. Disconnect wiring to starter motor.
- 3. If equipped with RH dipstick tube, remove tube.

NOTE: On Models 6010—6910 and 7210—7610
Tractors, use KJD10213 Starter Motor Removal
Tool as necessary to remove cap screws.

- 4. Remove three mounting cap screws and/or nuts (A).
- 5. Remove starter motor.
- 6. Install starter motor and tighten cap screws and/or nuts.
- 7. Connect starter wiring and ground strap.
- 8. Install dipstick tube if removed.



Starter Motor

A—Cap Screw

DPSG,OUO1004,37 -19-08APR98-1/1

Remove and Install Alternator

NOTE: Refer to CTM77 for repair and testing of alternator.

IMPORTANT: Always disconnect battery negative (—) cables before removing alternator or a short circuit could result.

- 1. Disconnect battery ground (—) cable.
- 2. Disconnect positive (+) red wire and regulator connector.
- 3. Remove belt guard.
- 4. Remove alternator belt using 1/2 in. drive ratchet on belt tensioner.
- 5. Remove alternator.

NOTE: If mounting plate for alternator and tensioner was removed, install all hardware and tighten cap screws finger tight. Torque plate-to-timing gear cover hardware first, then plate-to-engine hardware.

6. Install alternator. Tighten all mounting hardware to specifications.

Strap Support-to-Alternator Bracket Torque

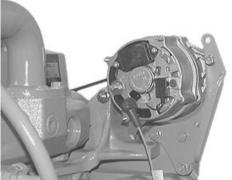
Specification

Torque

NOTE: If engine is equipped with a manual belt tensioner, See MANUAL BELT TENSIONER ADJUSTMENT in Group 070 for installing belt and adjusting tension during alternator installation.

7. If removed, install alternator pulley and tighten pulley nut to specifications.

Specification



Alternator

RG9107 -UN-040CT99

Starting and Charging Systems

- 8. Install alternator belt using 1/2 in. drive ratchet on automatic belt tensioner.
- 9. Install belt guard.
- 10. Connect positive (+) red wire and regulator connector.
- 11. Connect battery ground (—) cable.

02 100 3

DPSG,OUO1004,39 -19-24NOV99-2/2



03

Section 03 **Theory of Operation**

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Base Engine Operation

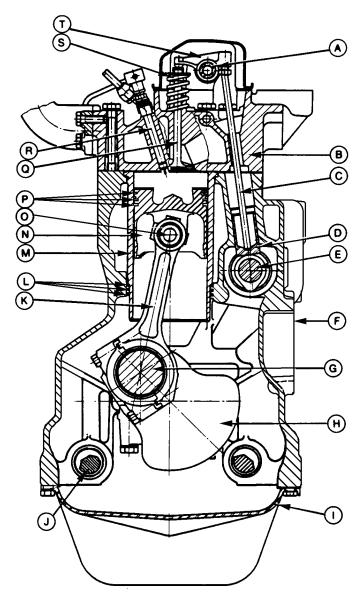
Base Engine Theory of Operation

NOTE: This group covers theory of operation on the base engine only. For theory of operation on mechanical fuel systems, see CTM207, Section 03, Group 130. For theory of operation on Level 4 electronic fuel systems with Bosch VP44 pump, see CTM170, Section 03, Groups 130 and 140.

03 120 1

DPSG,OUO1004,2745 -19-27APR00-1/1

General Engine Operation



As Viewed from Flywheel End

A—Rocker Arm Shaft

B—Cylinder Head

C—Push Rod

D—Camshaft Follower

E—Camshaft

F—Cylinder Block

G—Crankshaft

H—Crankshaft Counterweight

I—Oil Pan

J—Balancer Shafts¹

K—Connecting Rod

L—Liner Packing Rings

M—Cylinder Liner

N—Piston

O—Piston Pin

P—Piston Rings

Q-Valve

R—Fuel Injection Nozzle

S—Valve Spring

T—Rocker Arm

¹ 4-Cylinder Engines Only

General Engine Operation—Continued

Engines are vertical, in-line, valve-in-head, 4-cycle (stroke) diesel engines.

Direct fuel injection is provided by a rotary-type injection pump or an in-line injection pump and 9.5 mm injection nozzles mounted in cylinder head. The camshaft and injection pump are timed to the crankshaft by the timing gear train.

Some engines are equipped with a turbocharger. The turbocharger uses energy from exhaust gases to compress intake air and force it into the combustion chamber.

The cylinder block (F) is a one-piece casting. The block is available in structural and non-structural configurations.

The camshaft (E) is timed to the crankshaft (G) through the timing gear train. The camshaft rotates in honed bores in the cylinder block. All engines use a bushing in No. 1 camshaft bore. The camshaft lobes determine the duration and lift of each valve, and operate the fuel supply pump on rotary-type injection pumps.

Intake and exhaust valves (Q) are operated by camshaft followers (D), push rods (C) and rocker arm assembly (T). Valve seat inserts in cylinder head are used for intake and exhaust valves.

The crankshaft (G) is a one-piece, heat-treated, nodular-iron or steel forging which operates in replaceable two-piece main bearings. Crankshafts are dynamically balanced and are machined with undercut and rolled fillets. Two-piece main thrust bearing inserts are used to control crankshaft end play.

Cylinder liners (M) are "wet" sleeve type and are individually replaceable. Liner packing rings (L) are used at the lower connection between cylinder block and liners.

Pistons (N) are made of high-grade cast aluminum alloy with internal ribbing. The skirt is cam ground to allow for expansion during operation. The piston crown has a cut-out combustion bowl with a truncated cone center. All piston rings (P) are located above the piston pin. Two compression rings and one oil control ring are used. The top compression ring is a keystone-shaped ring, located close to the top of the piston for improved engine performance.

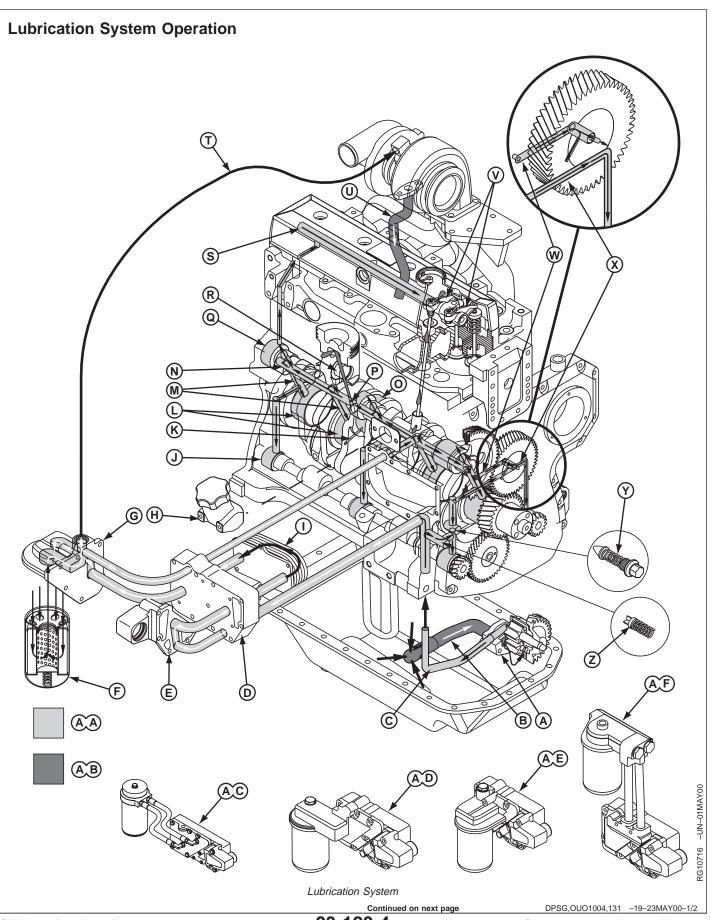
The hardened, fully-floating piston pins (O) are held in place by snap rings. Spray jets (piston cooling orifices) in cylinder block spray pressurized oil on the underside of the piston to lubricate piston pins and cool pistons.

The forged steel connecting rods (K) have replaceable pin bushing and bearing inserts. Some connecting rods have a tapered pin-end while others have a straight pin-end. Rods and caps have a tongue-and-groove on earlier engines and a PRECISION JOINT™ on later engines.

The engine is equipped with a gear-driven oil pump and full-flow oil filter. The oil filter has an internal bypass valve which opens if the filter element becomes restricted. Engines are equipped with an oil cooler mounted on the right side of the cylinder block. The engine is equipped with a pressure regulator valve to relieve excessive pressure build-up in the main oil gallery, and a bypass valve to prevent oil starvation if the oil cooler and filter become plugged.

Balancer shafts (J) are used on four-cylinder engines to reduce vibration. The two shafts rotate on bushings in cylinder block and are counter-rotating at twice engine speed.

The engine has a pressurized cooling system, consisting of radiator, water pump, multi-blade fan, and one or two thermostats.



- A-Oil Pump
- **B**—Oil Suction Line
- C—Oil Outlet Tube
- D-Oil Cooler Housing
- E-Coolant Passage Adapter
- G-Oil Filter Header/Adapter
- H—Oil Fill Tube
- I-Oil Cooler
- J—Balancer Shaft Bushings

an oil bypass valve (Z).

main oil gallery (N).

(J).

- K—Crankshaft Drilled Cross-Passages
- L-Main Bearing Bushings
- M—Oil Passages
- N-Main Oil Gallery
- O-Connecting Rod Bearings
- P—Piston Cooling Orifice
- Q—Camshaft Bushings R-Piston Pin and Bushing
- S-Rocker Arm Shaft

The engine lubrication system consists of a positive

displacement gear-driven oil pump (A), full-flow oil filter

(F), oil cooler (I), oil pressure regulating valve (Y), and

The oil pump pulls oil from the oil pan sump through a strainer and a suction line (B). The pump forces oil

through the outlet tube (C) into a vertical drilling in the

cylinder block, and up to the oil cooler and filter. After

flowing through the cooler and filter, oil flows into the

The main oil gallery runs the length of the cylinder

The cross-drillings (X) intersect with those same oil

passages and feed oil to the balancer shaft bushings

From the main bearings, oil flows to the connecting rod bearings (O) through drilled cross-passages (K) in the

crankshaft between the main journals and connecting

rod journals. Oil from the main bearing also supplies

oil to the piston cooling orifices (P).

block and delivers oil to oil passages (M) that feed the camshaft bushings (Q) and main bearing bushings (L).

- T—Turbocharger Oil Supply
- **U—Turbocharger Drain Line**
- V-Rocker Arms
- W-Machined Groove
- X—Cross-Drillings
- Y—Oil Pressure Regulating Valve
- Z-Oil Bypass Valve
- AA-Pressurized Oil
- AB—Pressure-Free Oil AC—Remote Mount Filter
- Assembly AD—Low-Mount Rear Vertical
- Oil Filter Assembly AE—Low-Mount Front Vertical
- Oil Filter Assembly AF—High-Mount Vertical Oil Filter Assembly

Oil from the piston cooling orifices sprays on the underside of the piston to keep the piston crown cool. The oil spray also provides splash lubrication for the piston pin and bushing (R) by splashing oil into a hole drilled in the top end of the connecting rod.

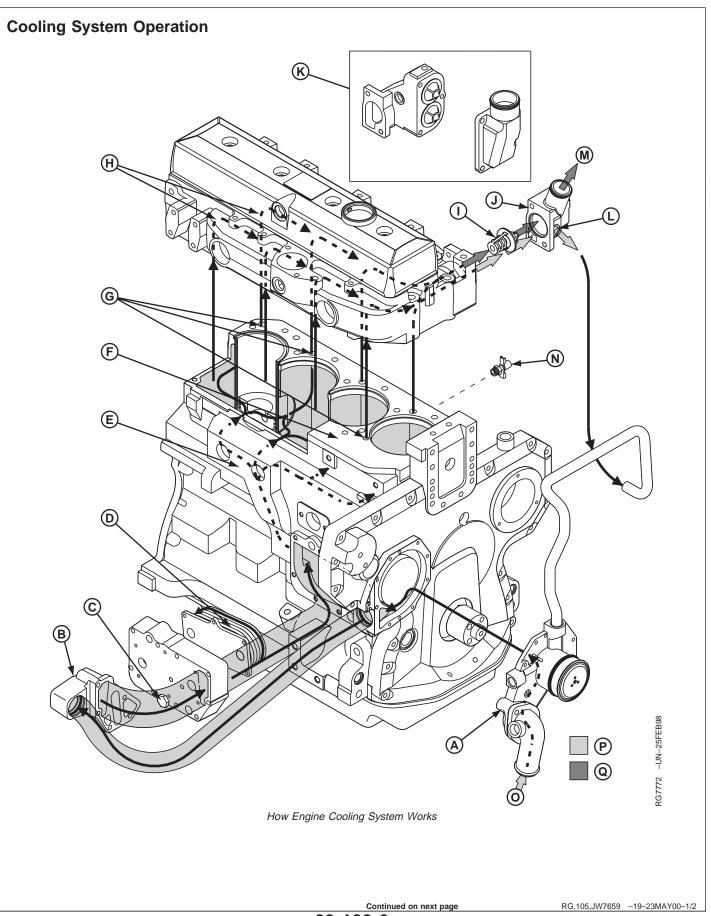
At the rear of the cylinder block, oil flows from the rear camshaft bore (Q), up through the cylinder head, and into the rocker arm shaft (S). Oil flows through the rocker arm shaft and lubricates each of the rocker arms (V). Oil drips from the rocker arms to lubricate the adjusting screws, push rods, and camshaft followers.

At the front of the cylinder block, oil flows from the oil passage into a machined groove (W) in the front face of the block. This groove connects with the upper idler gear shaft to provide oil to the idler gear bushing. The lower idler gear bushing is splash lubricated.

The turbocharger oil supply line (T) supplies oil to the turbocharger from filtered side of oil filter adapter. Oil returns from the turbocharger through the drain line

(U).

DPSG,OUO1004,131 -19-23MAY00-2/2



A-Water Pump

B—Coolant Passage Adapter C—Oil Cooler Drain Plug D-Oil Cooler Plates

E—Main Coolant Gallery

F—Coolant Jacket

G—Block Deck Passages H-Passages

I—Thermostat(s) J-Water Manifold/Thermostat Housing

K—Dual Thermostat Assembly

L—Bypass Circuit

M—To Radiator Top Tank N-Drain Valve

O-Suction Side of Water

P—High Temperature Coolant **Q**—Low Temperature Coolant

The cooling system includes the radiator, water pump (A), and thermostat(s) (I).

Coolant is circulated from the water pump into the coolant passage adapter (B) and circulates around the oil cooler plates (D). From the oil cooler, coolant flows into the main coolant gallery (E). From the gallery coolant flows into the coolant jacket (F), around the cylinder liners, up through the block deck passages (G), and into the cylinder head. In the cylinder head, the coolant flows through passages (H) around the intake and exhaust ports, valve seats, and injection nozzles. Coolant flows toward the front end of the cylinder head and exits through the water manifold/thermostat housing (J). Engines may be equipped with a dual thermostat assembly (K).

During the warm-up period, thermostat(s) (I) are closed and coolant is directed through a bypass circuit (L) into suction side of water pump. The coolant continues circulating through the cylinder block, cylinder head, and water pump to provide a uniform and fast warm-up period.

Once the engine has reached operating temperature, the thermostat(s) open and allow coolant to flow through the upper radiator hose to the radiator top tank (M). Coolant circulates through the radiator, dissipates heat, and then flows out of the radiator through the lower hose and into the suction side (O) of the water pump. Coolant continues flowing through the engine and radiator circuit until the coolant temperature drops below the thermostat opening temperature.

RG,105,JW7659 -19-23MAY00-2/2

Head Gasket Joint Construction and Operation

The head gasket joint consists of the following components:

- Cylinder head gasket
- Cylinder head (A)
- Cylinder block (E)
- Cylinder liners (C)
- Cylinder head cap screws (B)

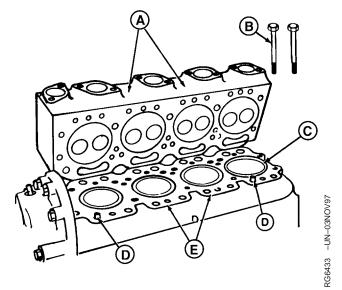
The head gasket must form an air-tight seal between cylinder liners and cylinder head that can withstand the temperatures and pressures of the combustion process. The gasket must also form a liquid-tight seal between the cylinder head and cylinder block to retain coolant and oil in their respective passages. The gasket (F) is constructed of thin, formed sheets of steel-inserted, non-asbestos material. The surface of gasket is treated to improve liquid sealing and anti-stick characteristics. A fire ring combustion seal (G) is located at each cylinder bore and is held in place by a U-shaped stainless steel flange (H).

The cylinder head and block must be flat to provide an even clamping pressure over the entire surface of gasket, and must have the proper surface finish to keep gasket material from moving in the joint. Dowel pins (D) are used to properly locate head gasket on block.

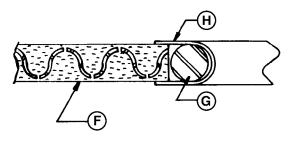
The cylinder liners must protrude evenly from top of cylinder block the specified amount to provide adequate clamping force on fire ring of each cylinder.

The cap screws must be proper length, made of proper material, and be tightened to proper torque in order to provide an adequate clamp load between other joint components.

Each of the above components contributes to the integrity of the head gasket joint. If any of these components do not conform to specifications, gasket joint may fail, resulting in combustion leaks, coolant leaks, or oil leaks.



Head Gasket Joint Construction and Operation



Head Gasket Joint Construction and Operation

- A—Cylinder Head
- **B—Cylinder Head Cap Screws**
- C—Cylinder Liners
- D—Dowel Pins
- E—Cylinder Block
- F—Gasket Body
- G—Fire Ring Combustion Seal
- H-Stainless Steel Flange

Continued on next page

RG,105,JW7658 -19-21NOV97-1/2

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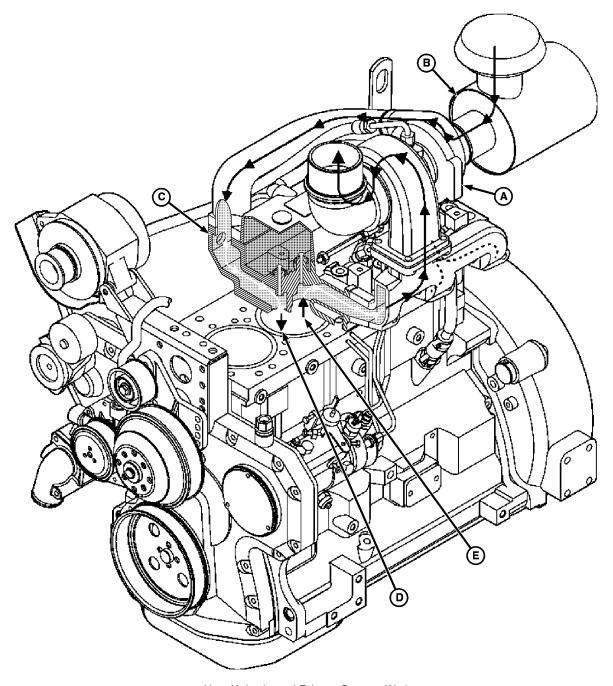
Base Engine Operation

Operating conditions such as coolant, oil, and combustion temperatures, and combustion pressures can reduce the ability of the head gasket joint to function properly. Failure of head gasket and mating parts may occur when coolant and oil temperatures become excessive, or when abnormally high combustion temperatures and pressures persist.

03 120

RG,105,JW7658 -19-21NOV97-2/2

Air Intake and Exhaust System Operation



How Air Intake and Exhaust Systems Work

A—Turbocharger B—Air Cleaner

C—Intake Side of Cylinder Head D—Outside Intake Air

E-Exhaust Air

Engine suction draws dust-laden outside air (D) through an air inlet stack into the air cleaner (B). Air is filtered through dry type primary and secondary (safety) filter elements in the air cleaner canister.

Clean air travels through the air intake hose to the turbocharger (A) and into the intake side of the cylinder head (C).

Continued on next page

RG,110,JW7673 -19-24NOV97-1/2

Exhaust (E), drives the turbocharger to deliver a larger quantity of air to meet the engine requirements than what could be delivered under naturally aspirated (non-turbocharged) conditions.

On some engines, an air-to-air aftercooler cools the turbocharger compressor discharge air by routing it

through a heat exchanger before it enters the engine. The heat exchanger uses no liquid coolant but relies on air flow to cool the charge air.

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RG,110,JW7673 -19-24NOV97-2/2

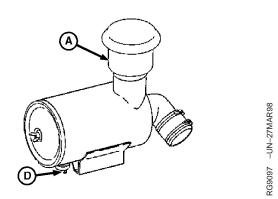
Air Cleaner Operation

Under suction generated by the engine, unfiltered air flows through air inlet tube (A) and is forced into a high-speed centrifugal motion by tilted fins in the element. By this circulating action most of the dust and dirt particles are separated from the air and collected in the dust unloading valve (D).

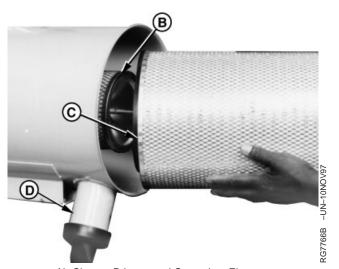
The remaining dirt is removed as the air flows through the primary element (C) and the secondary (safety) filter (B) before being drawn into the engine.

The secondary (safety) filter ensures that, should primary element fail, no unfiltered air is drawn into the engine.

- A-Air Inlet Tube
- B—Secondary (Safety) Filter
- C—Primary Element
- **D**—Dust Unloading Valve



Air Cleaner Assembly



Air Cleaner Primary and Secondary Elements

RG,110,JW7672 -19-24NOV97-1/1

Turbocharger Operation

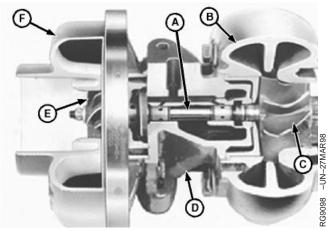
The turbocharger, which is basically an air pump that is driven by exhaust gases, allows the engine to produce added power without increasing displacement.

Turbochargers are specially matched for the power ratio requirements of each specific application.

The turbine wheel (C) is driven by the hot engine exhaust gases. These gases flowing through the turbine housing (B) act on the turbine wheel causing shaft (A) to turn.

Compressor wheel (E) brings in filtered air and discharges the compressed air into the intake manifold where it is then delivered to engine cylinders.

Engine oil under pressure from the engine lubrication system is forced through passages in center housing (D) to bearings.



Turbocharger Components

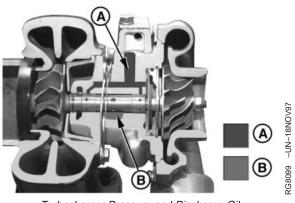
- A-Shaft
- **B—Turbine Housing**
- C—Turbine Wheel
- **D—Center Housing**
- E—Compressor Wheel F—Compressor Housing

RG,110,JW7669 -19-24NOV97-1/1

How the Turbocharger Is Lubricated

Engine oil under pressure from the engine lubrication system is pumped through a passage in the bearing housing and directed to the bearings, thrust plate, and thrust sleeve. Oil is sealed from the compressor and turbine by a piston ring at both ends of the bearing housing.

The turbocharger contains two floating bearings. These bearings have clearance between the bearing OD and the housing bore as well as clearance between the bearing ID and the shaft OD. These clearances are lubricated by the oil supply pressure oil (A) and the bearings are protected by a cushion of oil. Discharge oil (B) drains by gravity from the bearing housing to the engine crankcase.



Turbocharger Pressure and Discharge Oil

- A—Pressure Oil
- B—Discharge Oil

RG,110,JW7668 -19-23MAY00-1/1

Section 04 **Diagnostics**

Contents

Page **Group 150—Observable Diagnostics and Tests** Diagnosing Lubrication System Check for Excessive Crankcase Pressure (Blow-By)......04-150-2 Pistons, Rings, Cylinder Liners Check. 04-150-3 L2 - Engine Oil Pressure Low04-150-4 L3 - Engine Oil Pressure High04-150-6 Diagnosing Cooling System Malfunctions 04-150-7 C1 - Engine Coolant Temperature Above C2 - Engine Coolant Temperature Below C3 - Coolant in Oil or Oil in Coolant 04-150-8 Test Engine Compression Pressure 04-150-9 Check Engine Oil Pressure04-150-15 Check for Excessive Engine Crankcase Check for Turbocharger Oil Seal Leak 04-150-18 Inspect Thermostat and Test Opening Pressure Test Cooling System and Check for Head Gasket Failures04-150-22 Check and Service Cooling System04-150-25 Check Air Intake System......04-150-27 Measure Intake Manifold Pressure Check for Intake and Exhaust Restrictions Check for Exhaust Air Leaks (Turbocharged

Test Air Filter Restriction Indicator Switch04-150-33

Group 150 Observable Diagnostics and Tests

About This Section of the Manual

This section of the manual contains necessary information to diagnose some base engine, all lubrication system and all cooling system problems. This section is divided into two areas: diagnosing malfunctions and testing procedures. The diagnosing malfunction areas are further divided into the following headings, containing the following symptoms:

- (L) Diagnosing Lubrication System Malfunctions:
 - L1 Excessive Oil Consumption
 - L2 Engine Oil Pressure Low
 - L3 Engine Oil Pressure High
- (C) Diagnosing Cooling System Malfunctions:
 - C1 Coolant Temperature Above Normal
 - C2 Coolant Temperature Below Normal
 - C3 Coolant in Oil or Oil in Coolant

Procedures for diagnosing some of the above symptoms are formatted such that a test or repair is recommended, then, based on the results, another test or repair is recommended. Other symptoms are formatted in a symptom - problem - solution format. In these symptoms, the problems are arranged in the most likely or easiest to check first. Symptoms arranged in both formats refer to testing procedures in the second part of this section. The second part of this section contains the following testing procedures:

- Base Engine Testing Procedures:
 - Test Engine Compression Pressure
 - Test Engine Cranking Speed
 - Dynamometer Test
- Lubrications System Testing Procedures:
 - Engine Oil Consumption
 - Check Engine Oil Pressure
 - Check for Excessive Crankcase Pressure (Blow-By)
 - Check for Turbocharger Oil Seal Leak
- Cooling System Testing Procedures:
 - Inspect Thermostat and Test Opening Temperature
 - Pressure Test Cooling System and Radiator Cap
 - Check for Head Gasket Failures
 - Check and Service Cooling System
- Air Supply and Exhaust Systems Testing Procedures:
 - Check Air Intake System
 - Measure Intake Manifold Pressure (Turbo Boost)
 - Check for Intake and Exhaust Restrictions
 - Test for Intake Air Leaks
 - Check for Exhaust Leaks (Turbocharger Engines)
 - Test Turbocharger Wastegate
 - Test Air Filter Restriction Indicator Switch

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Diagnosing Lubrication System Malfunctions

DPSG,RG40854,519 -19-06MAR00-1/1

L1 - Excessive Oil Consumption

Before using this diagnostic procedure:

Check for too low or too high engine oil level.

Check for too low viscosity, or coolant- or fuel-diluted engine oil.

Check for excessive external oil leaks.

- - -1/1

Check Oil in Coolant

Check the coolant for signs of oil.

No oil found in coolant:
Go to 2.

Oil found in coolant:
See COOLANT IN OIL
OR OIL IN COOLANT
later in this group.

Check for Excessive Crankcase Pressure (Blow-By) Check for excessive crankcase pressure. See CHECK FOR EXCESSIVE ENGINE CRANKCASE PRESSURE (BLOW-BY) later in this group.

No fumes and no dripping oil observed: Go to 3.

Excessive fumes or dripping oil observed; appears to be caused by boost pressure (if equipped with turbocharger):
Check the turbocharger, repair/replace as needed.
See TURBOCHARGER FAILURE ANALYSIS in Group 080 in Section 2 of this manual.

Excessive fumes or dripping oil observed; does not appear to be caused by boost pressure (if equipped with turbocharger): Excessive blow-by, not caused by boost pressure is most likely caused by faulty piston rings/cylinder liners not providing an adequate combustion seal. Perform a compression test to verify this is the case. See TEST ENGINE COMPRESSION PRESSURE later in this group.

---1/1

3 Turbocharger Oil Seal Leak Check

NOTE: This check is not needed for non-turbocharged ("D" engines). For these engines Go to 4.

Check for turbocharger oil seal leaks. See TURBOCHARGER OIL SEAL LEAK TEST later in this group.

NO signs of oil leakages: Go to 4.

Signs of oil leakages present:

Investigate problems associated with oil leakage as outlined in the test procedure, perform necessary repairs, and retest.

- - -1/1

Pistons, Rings, Cylinder Liners Check

At this point, the most likely cause of excessive oil consumption is one of the following failures in the pistons, rings, and/or cylinder liners or in the valve guides. Check the most likely items as needed.

- Oil control rings worn or broken
- · Scored cylinder liners or pistons
- Piston ring grooves excessively worn
- Insufficient piston ring tension
- Piston ring gaps not staggered
- Cylinder liners glazed (insufficient load during engine break-in)
- Worn valve guides or stems

Problem found with pistons, rings, and/or liners or valve guides. Repair problem as necessary.

- - -1/1

L2 - Engine Oil Pressure Low

| L2 - Engine Oil Pressure Low | | | |
|------------------------------|---------------------------------------|---|--|
| Symptom | Problem | Solution | |
| Engine Oil Pressure Low | Low crankcase oil level | Fill crankcase to proper oil level. | |
| | Clogged oil cooler or filter | Remove and inspect oil cooler. See REMOVE, INSPECT, AND INSTALL OIL COOLER in Group 060 in Section 2 of this manual. Replace oil filter. | |
| | Excessive oil temperature | Remove and inspect oil cooler. See REMOVE, INSPECT, AND INSTALL OIL COOLER in Group 060 in Section 2 of this manual. | |
| | Defective oil pump | Remove and inspect oil pump. See REMOVE ENGINE OIL PUMP in Group 060 in Section 2 of this manual. | |
| | Incorrect oil | Drain crankcase and refill with correct oil. | |
| | Oil pressure regulating valve failure | Remove and inspect oil pressure regulating valve. See REMOVE AND INSTALL OIL PRESSURE REGULATING VALVE AND SEAT in Group 060 in Section 2 of this manual. | |
| | Broken piston spray jet | Replace piston spray jet. See REMOVE, INSPECT, AND INSTALL PISTON COOLING ORIFICES in Group 030 in Section 2 of this manual. | |
| | | | |

Continued on next page

DPSG,RG41221,28 -19-18MAY00-1/2

| Symptom | Problem | Solution |
|---------|--|---|
| | Clogged oil pump screen or cracked pick-up tube | Remove oil pan and clean screen. Replace pick-up tube. See REMOVE, INSPECT, AND INSTALL OIL PICKUP TUBE ASSEMBLY in Group 060 in Section 2 of this manual. |
| | Excessive main or connecting rod bearing clearance | Determine bearing clearance. See CYLINDER BLOCK, LINERS, PISTONS, AND RODS SPECIFICATIONS in Group 200 in Section 6 or CRANKSHAFT, MAIN BEARINGS, AND FLYWHEEL SPECIFICATIONS in Group 200 in Section 6 of this manual. |
| | | DPSG,RG41221,28 -19-18MAY00-2/2 |

L3 - Engine Oil Pressure High

| L3 - Liigille Oil i lessule liigil | | | |
|------------------------------------|---|---|--|
| Symptom | Problem | Solution | |
| Engine Oil Pressure High | Improper oil classification | Drain crankcase and refill with correct oil. | |
| | Oil pressure regulating valve bushing loose (wanders) | Remove and inspect oil pressure regulating valve. See REMOVE AND INSTALL OIL PRESSURE REGULATING VALVE AND SEAT in Group 060 of this manual. | |
| | Improperly operating regulating valve | Remove and inspect oil pressure regulating valve. See REMOVE AND INSTALL OIL PRESSURE REGULATING VALVE AND SEAT in Group 060 in Section 2 of this manual. | |
| | Plugged piston spray jet | Replace piston spray jet. See REMOVE, INSPECT, AND INSTALL PISTON COOLING ORIFICES in Group 030 in section 2 of this manual. | |
| | Stuck or damaged filter bypass valve | Remove and inspect filter bypass valve. See REMOVE, INSPECT, AND INSTALL OIL BYPASS VALVE in Group 060 in Section 2 of this manual. | |
| | | | |

DPSG,RG41221,39 -19-19MAY00-1/1

Diagnosing Cooling System Malfunctions

RG,RG34710,1543 -19-30SEP97-1/1

C1 - Engine Coolant Temperature Above Normal

| Symptom | Problem | Solution | |
|--|---|--|--|
| Engine Coolant Temperature Above Normal | Lack of coolant in cooling system | Fill cooling system to proper level. | |
| | Radiator core and/or side screens dirty | Clean radiator as required. | |
| | Engine overloaded | Reduce engine load. | |
| | Too low crankcase oil level | Fill crankcase to proper oil level. | |
| | Loose or defective fan belt | Replace/tighten fan belt as required. | |
| | Defective thermostat(s) | Test thermostat opening temperature; replace thermostats as required. See INSPECT THERMOSTAT AND TEST OPENING TEMPERATURE later in this group. | |
| | Damaged cylinder head gasket | Replace cylinder head gasket. See CHECK FOR HEAD GASKET FAILURES later in this group. | |
| | Defective water pump | Replace water pump. See REMOVE WATER PUMP in Group 070 in Section 2 of this manual. | |
| | Defective radiator cap | Replace radiator cap as required. See PRESSURE TEST COOLING SYSTEM AND RADIATOR CAP later in this group. | |

C2 - Engine Coolant Temperature Below Normal

Symptom Problem Solution

Engine Coolant Temperature

Below Normal

Defective thermostat(s)

Test thermostats; replace thermostats as required. See INSPECT THERMOSTAT AND TEST OPENING TEMPERATURE

later in this group.

DPSG,RG41221,41 -19-19MAY00-1/1

C3 - Coolant in Oil or Oil in Coolant

| Symptom | Problem | Solution | |
|----------------------------------|--------------------------------|---|--|
| Coolant in Oil or Oil in Coolant | Faulty cylinder head gasket | Look for signs of head gasket failure. See CHECK FOR HEAD GASKET FAILURES later in this group. | |
| | Faulty oil cooler | Remove and inspect engine oil cooler. See REMOVE, INSPECT, AND INSTALL OIL COOLER in Group 060 in Section 2 of this manual. | |
| | Leaking cylinder liner seals | Remove and inspect cylinder liners. See VISUALLY INSPECT CYLINDER LINERS in Group 030 in Section 2 of this manual. | |
| | Cracked cylinder head or block | Locate crack; repair/replace components as required. | |
| | | | |
| | | DPSG,RG41221,42 -19-19MAY00-1/1 | |

04

Test Engine Compression Pressure

IMPORTANT: Compression pressures are affected by the cranking speed of the engine.

Before beginning test, ensure that batteries are fully charged and injection nozzle area is thoroughly cleaned.

1. Start engine and run at rated speed until it warms up to normal operating temperature. (From a cold start, operate engine 10—15 minutes at slow idle.)

Shut off fuel supply and remove fuel injection nozzles. See CTM207 (Mechanical Fuel Systems) or CTM170 (Electronic Fuel Systems).

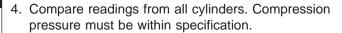
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RG,105,JW7652 -19-21NOV97-1/3

Install JT01679¹ Adapter with O-ring (or D14550BA²
Adapter) in injection nozzle bore. Use JT02017 Holding
Clamp¹ to hold JT01679 Adapter in position. Install
hold-down screw in clamp and tighten screw to 37 N•m
(27 lb-ft). Attach JT01682¹ Test Gauge (or D14547BA²)
to adapter.

NOTE: If using FKM10021 Compression Test Set, install 19.58—90.578 Adapter (A) in injection nozzle bore with R73788 Nozzle Spacer (B) and two R92352 Nozzle Seals (C). Use holding plate (D) to secure. Then attach FKM10022 Test Gauge (E) to adapter.





| Specification | |
|-----------------------------|----------------------------|
| Engine Compression Pressure | 2400 kPa (24 bar) |
| Test Engine Compression | (350 psi) |
| Pressure: Minimum | |
| Maximum Difference between | 350 kPa (3.5 bar) (50 psi) |
| Cylinders | |

C---!!--!

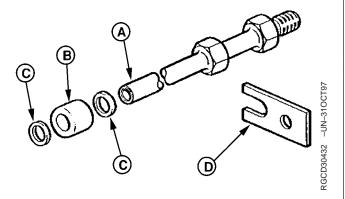
NOTE: Pressure given was taken at 183 m (600 ft) above sea level. A 3.6 percent reduction in gauge pressure will result for each additional 300 m (1000 ft) rise in altitude.

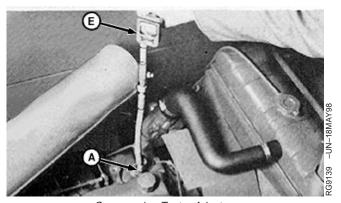
All cylinders within an engine should have approximately the same pressure. There should be less than 340 kPa (3.4 bar) (50 psi) difference between cylinders.

 If pressure is much lower than shown, remove gauge and apply oil to ring area of piston through injection nozzle bore. Do not use too much oil. Do not get oil on the valves.



Compression Tester in Nozzle Bore





Compression Tester Adapters

A-19.58-90.578 Adapter

B—R73788 Nozzle Spacer C—R92352 Nozzle Seal

D—Holding Plate

E—FKM10022 Test Gauge

¹ Part of JT01674 Compression Test Set

²Part of D14546BA Compression Test Set

If pressure is high, worn, or stuck rings are indicated, replace piston rings or install new piston and liner set as needed. (See Section 02, Group 030.)

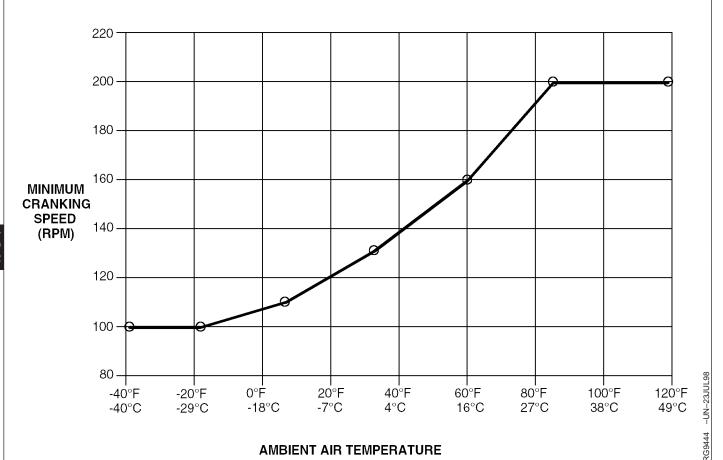
If pressure is low, valves could be worn or sticking. Recondition cylinder head as required. (See Section 02, Group 020.)

 Measure compression pressure in all remaining cylinders and compare readings. Recondition cylinders and valves as required.

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RG,105,JW7652 -19-21NOV97-3/3

Test Engine Cranking Speed



AMBIENT AIR TEMPERATURE

Engine Cranking Speed Test

IMPORTANT: Cranking speed specifications above are for OEM engines only. See Machine Technical Manual for other applications.

> Make sure that batteries are fully charged before performing this test.

- 1. Disable the fuel supply system at the injection pump so fuel delivery is in the OFF position.
- 2. If not using the machine tachometer, install a photo tach or TIME TRAC®.
- 3. Crank the engine for 15 seconds and record engine speed.

4. Compare recorded engine speed to chart above.

Cranking speed should meet or exceed specified engine rpm for a given ambient air temperature. For example, at 29°C (85°F) ambient air temperature, cranking speed should be at least 200 rpm.

If cranking speed is below specifications, check the following:

- Starting system problems (low battery, loose or defective wiring, defective starter, etc.).
- Excessive engine loads (hydraulic pumps/thick oil, thick engine oil, etc.).

TIME TRAC is a registered trademark of Stanadyne Automotive

DPSG,OUO1004,164 -19-26APR00-1/1

04 150 13

Dynamometer Test

IMPORTANT: Dynamometers should be periodically checked for accuracy and calibrated as necessary.

NOTE: High elevations may affect engine performance. (See EFFECTS OF ALTITUDE AND TEMPERATURE ON ENGINE PERFORMANCE, in Section 06, Group 210.)

- Connect engine to dynamometer using manufacturer's instructions.
- Operate engine at one-half load until coolant and crankcase oil temperatures are up to normal operating range.
- 3. Run engine at fast idle.

4. Gradually increase load on engine until speed is reduced to rated speed rpm.

NOTE: Refer to appropriate machine technical manual for average power ratings of specific applications. Allow ±5% for minimum and maximum power.

- Read horsepower on dynamometer and record reading over a period of several minutes after engine stabilizes.
- Compare readings taken with power rating level for your engine application, as listed in Section 06, Group 210.

RG,100,JW7644 -19-12NOV99-1/1

Engine Oil Consumption

All engines consume some oil. The consumption rate depends on loading, design of key parts and engine condition. Since fuel consumption is an indicator of operating power levels, fuel used versus oil consumed is a critical factor in analyzing oil consumption. Oil consumption should be measured over a 100-hour period.

Long-term oil consumption (three oil drain intervals after the engine is broken in) with consumption rates poorer than 400:1 (100 gallons of fuel and 1 quart of oil) indicates a need to monitor/investigate. Suggested steps would be:

- Check for signs of ingested dust or perform an OILSCAN® test to check for silicon.
- Check for proper crankcase oil fill level.
- Perform compression test to find low compression cylinders.
- Remove head and inspect for glazed or worn liners.
- Inspect pistons for carbon deposits in the ring land
- Measure valve stem OD and valve guide ID to determine clearance.

NOTE: Ring gap alignment does not identify the leak source.

Intake valves do not have valve stem seals, and some oil deposits on the valve stem tulip are normal.

When changing to a premium oil such as TORQ-GARD SUPREME® PLUS-50®, little oil consumption change is expected, although a small percentage of engines may experience a noticeable change in consumption rates. This may be due to the following:

- The previous oil may have left deposits on internal components. Use of PLUS-50® oil will cause different chemical reactions in those deposits. The time required for the engine to regain the previous oil consumption rate will vary from one to three normal drain intervals.
- TORQ-GARD SUPREME® PLUS-50® contains a high-performance anti-oxidant along with other additives resulting in the oil remaining in the specified viscosity grade throughout the recommended drain interval. API oil grades CD, CE, and CF-4 universal engine oils do not provide this oxidation resistance which results in more rapid thickening. Increased oil viscosity can reduce oil consumption.

OILSCAN is a trademark of Deere & Company TORQ-GARD SUPREME is a registered trademark of Deere & Company

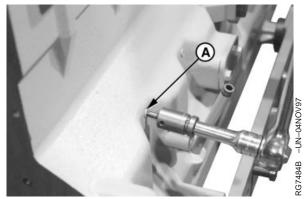
PLUS-50 is a registered trademark of Deere & Company

DPSG,OUO1004,114 -19-23MAY00-1/1

Check Engine Oil Pressure

1. Remove main oil gallery plug (A) using JDG782 Oil Gallery Plug Tool.

A-Oil Gallery Plug



Main Oil Gallery Plug Removal Tool

04 150 15

Continued on next page

RG,105,JW7651 -19-21NOV97-1/2

2. Attach pressure gauge (B) from JT05470 Universal Pressure Test Kit to oil gallery.

IMPORTANT: To achieve an accurate oil pressure reading, warm up engine crankcase oil to 105°C (220°F) or high oil pressure readings will occur.

- 3. Start engine and run at speeds given below.
- 4. Measure oil pressure and compare readings.

| Specification | |
|-----------------------------------|-----------------------------|
| Minimum Oil Pressure—No Load | 100 kPa (1.0 bar) (14 psi) |
| at Slow Idle and 93°C (200°F) Oil | |
| Temperature Minimum Pressure | |
| Minimum Oil Pressure—Full Load | 275 kPa (2.75 bar) (40 psi) |

at Rated Speed and 105°C (220°F) Oil Temperature

Minimum Pressure

NOTE: Tolerance extremes and gauge fluctuations can result in the gauge reading up to 586 kPa (5.86 bar) 85 psi. This is not detrimental to the engine.

The oil pressure regulating valve is designed so that adjustment of oil pressure should not be required.

5. Replace oil pressure regulating valve if oil pressure is not within specified range.



Pressure Gauge to Oil Gallery Port

B—Pressure Gauge

RG,105,JW7651 -19-21NOV97-2/2

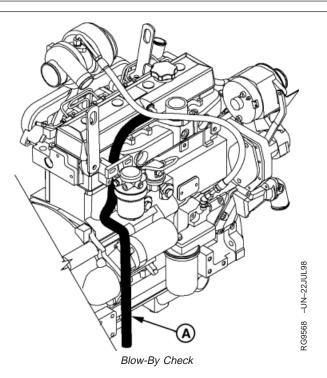
Check for Excessive Engine Crankcase Pressure (Blow-By)

Excessive blow-by coming out of the crankcase breather tube (A) indicates that either the turbocharger (if equipped) seals are faulty or the piston rings and cylinder liners are not adequately sealing off the combustion chamber. This is a comparative check that requires some experience to determine when blow-by is excessive.

Run engine at high idle and check crankcase breather tube. Look for significant fumes and/or dripping oil coming out of the breather tube at fast idle, with no load.

If excessive blow-by is observed, perform the following to determine if the turbocharger (if equipped) is causing the blow-by:

- 1. Remove the turbocharger oil drain line where it connects to the engine block and run line into a bucket.
- 2. Run engine at high idle, slightly loaded, and determine if boost pressure is forcing oil through the drain line. Check crankcase breather tube to determine if blow-by has decreased.
- 3. If it appears that boost pressure is forcing oil through the drain line, and/or blow-by decreases with the drain line disconnected from block, replace the turbocharger, and retest.



A—Breather Tube

RG,105,JW7650 -19-21NOV97-1/1

Check for Turbocharger Oil Seal Leak

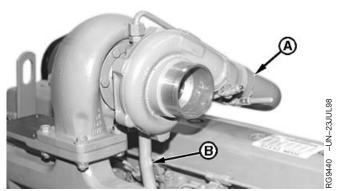
Seals are used on both sides of the turbocharger rotor assembly. The seals are used to prevent exhaust gasses and air from entering the turbocharger housing. Oil leakage past the seals is uncommon but can occur.

A restricted or damaged turbocharger oil return line can cause the housing to pressurize, causing oil to leak by the seals. Additionally, intake or exhaust restrictions can cause a vacuum between the compressor and turbocharger housing, causing oil to leak by the seals.

- 1. Remove exhaust pipe (shown removed) and crossover tube (A).
- 2. Inspect the turbine casing and crossover tube for evidence of oil leakage.

If oil leakage is present, perform the following:

- Inspect turbocharger oil return line (B) for kinks or damage. Replace if necessary.
- Check the air intake filter, hoses, and crossover tube for restrictions.
- Check the exhaust system for restrictions to include position of exhaust outlet.
- 3. Perform necessary repairs and repeat test.



Turbocharger Oil Seal Leak Test

A—Crossover Tube B—Oil Return Line

DPSG,OUO1004,225 -19-10JUL98-1/1

Inspect Thermostat and Test Opening Temperature

Visually inspect thermostat for corrosion or damage. Replace as necessary.

Test thermostat as follows:



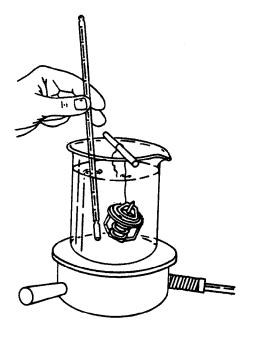
CAUTION: DO NOT allow thermostat or thermometer to rest against the side or bottom of container when heating water. Either may rupture if overheated.

- 1. Remove thermostats. (See procedure in Section 02, Group 070.)
- 2. Suspend thermostat and a thermometer in a container of water.
- 3. Stir the water as it heats. Observe opening action of thermometer and compare temperatures with specification given in chart below.

NOTE: Due to varying tolerances of different suppliers, initial opening and full open temperatures may vary slightly from specified temperatures.

| THERMOSTAT TEST SPECIFICATIONS | | |
|--------------------------------|-------------------------|---------------|
| Rating | Initial Opening (Range) | Full Open |
| | | (Nominal) |
| 71°C (160°F) | 69—72°C (156—162°F) | 84°C (182°F) |
| 77°C (170°F) | 74—78°C (166—172°F) | 89°C (192°F) |
| 82°C (180°F) | 80—84°C (175—182°F) | 94°C (202°F) |
| 89°C (192°F) | 86—90°C (187—194°F) | 101°C (214°F) |
| 90°C (195°F) | 89—93°C (192—199°F) | 103°C (218°F) |
| 92°C (197°F) | 89—93°C (193—200°F) | 105°C (221°F) |
| 96°C (205°F) | 94—97°C (201—207°F) | 100°C (213°F) |
| 99°C (210°F) | 96—100°C (205—212°F) | 111°C (232°F) |

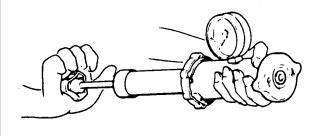
- Remove thermostat and observe its closing action as it cools. In ambient air the thermostat should close completely. Closing action should be smooth and slow.
- 5. If any thermostat is defective on a multiple thermostat engine, replace all thermostats.



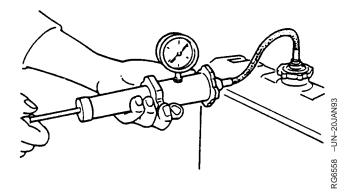
Test Thermostat Opening Temperature

-UN-20JAN93

Pressure Test Cooling System and Radiator Cap



Pressure Testing Radiator Cap



Pressure Testing Radiator

A

CAUTION: Explosive released 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.

Test Radiator Cap:

- 1. Remove radiator cap and attach to D05104ST Pressure Pump as shown.
- 2. Pressurize cap to the following specification¹.

Specification

Cooling System Test Pressure...... 70 kPa (0.7 bar) (10 psi)

Gauge should hold pressure for 10 seconds within the normal range if cap is acceptable.

If gauge does not hold pressure, replace radiator cap.

3. Remove the cap from gauge, turn it 180°, and retest cap. This will verify that the first measurement was accurate.

Test Cooling System:

NOTE: Engine should be warmed up to test overall cooling system.

- 1. Allow engine to cool, then carefully remove radiator cap.
- Fill radiator with coolant to the normal operating level.

IMPORTANT: DO NOT apply excessive pressure to cooling system. Doing so may damage radiator and hoses.

- Connect gauge and adapter to radiator filler neck. Pressurize cooling system to 70 kPa (0.7 bar) (10 psi)¹, using D05104ST Pressure Pump.
- 4. With pressure applied, check all cooling system hose connections, radiator, and overall engine for leaks.

If leakage is detected, correct as necessary and pressure test system again.

¹Test pressures recommended are for all Deere OEM cooling systems. On specific vehicle applications, test cooling system and pressure cap according to the recommended pressure for that vehicle.

Continued on next page

RG,105,JW7649 -19-21NOV97-1/2

Observable Diagnostics and Tests

If no leakage is detected, but the gauge indicated a drop in pressure, coolant may be leaking internally within the system or at the block-to-head gasket.

RG,105,JW7649 -19-21NOV97-2/2

150 21

Check for Head Gasket Failures

NOTE: Booklet DB1119—CYLINDER HEAD GASKET FAILURES for 6466 and 6076 Engines can be used as a guide for diagnosing head gasket failures on PowerTech® 4.5 L and 6.8 L Engines. However, use specifications provided in this manual (CTM104).

Head gasket failures generally fall into three categories:

- Combustion seal failures.
- · Coolant seal failures.
- Oil seal failures.

Combustion seal failures occur when combustion gases escape between cylinder head and head gasket combustion flange, or between combustion flange and cylinder liner. Leaking combustion gases may vent to an adjacent cylinder, to a coolant or oil passage, or externally.

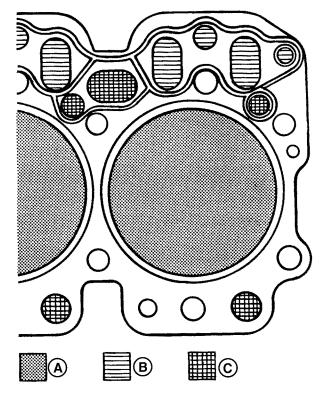
Coolant or oil seal failures occur when oil or coolant escapes between cylinder head and gasket body, or between cylinder block and gasket body. The oil or coolant may leak to an adjacent coolant or oil passage, or externally. Since oil and coolant passages are primarily on right-hand (camshaft) side of engine, fluid leaks are most likely to occur in that area.

Follow these diagnostic procedures when a head gasket joint failure occurs or is suspected.

- 1. Before starting or disassembling engine, conduct a visual inspection of machine and note any of the following:
 - Oil or coolant in head gasket seam, or on adjacent surfaces. Especially right rear corner of gasket joint.
 - Displacement of gasket from normal position.
 - Discoloration or soot from combustion gas leakage.
 - Leaking radiator, overflow tank, or hoses.
 - · Leaking coolant from water pump weep hole.
 - Damaged or incorrect radiator, fan, or shroud.
 - Obstructed air flow or coolant flow.
 - Worn or slipping belts.

CTM104 (19JUN00)

• Damaged or incorrect pressure cap.



Diagnosing Head Gasket Joint Failures

A—Combustion Sealing Area

B—Oil Sealing Areas

C-Coolant Sealing Areas

Continued on next page

RG,105,JW7657 -19-23MAY00-1/4

RG6432 -UN-03NOV97

- · Presence of oil in coolant.
- Low coolant levels or Improper coolant.
- · Unusually high or low oil levels.
- Oil degradation, dilution, or contamination.
- Incorrectly specified injection pump.
- Indications of fuel or timing adjustments.
- Unburned fuel or coolant in exhaust system.
- 2. Obtain coolant and oil samples for further analysis.
- Start and warm up engine if it can be safely operated. Examine all potential leakage areas again as outlined previously. Using appropriate test and measurement equipment, check for the following:
 - White smoke, excessive raw fuel, or moisture in exhaust system.
 - Rough, irregular exhaust sound, or misfiring.
 - Air bubbles, gas trapped in radiator/overflow tank.
 - · Loss of coolant from overflow.
 - · Excessive cooling system pressure.
 - Coolant overheating.
 - · Low coolant flow.
 - · Loss of cab heating (air lock).
- 4. Shut engine down. Recheck crankcase, radiator, and overflow tank for any significant differences in fluid levels, viscosity, or appearance.
- 5. Compare your observations from above steps with the diagnostic charts earlier in this group. If diagnostic evaluations provide conclusive evidence of combustion gas, coolant, or oil leakage from head gasket joint, the cylinder head must be removed for inspection and repair of gasket joint components.

COMBUSTION SEAL LEAKAGE

Symptoms:

- · Exhaust from head gasket crevice
- Air bubbles in radiator/overflow tank
- Coolant discharge from overflow tube
- Engine overheating
- Power loss
- Engine runs rough
- · White exhaust smoke

Continued on next page

RG,105,JW7657 -19-23MAY00-2/4

PN=393

CTM104 (19JUN00)

- · Loss of cab heat
- Gasket section dislodged, missing (blown)
- Coolant in cylinder
- · Coolant in crankcase oil
- Low coolant level

Possible Causes:

- Insufficient liner standout
- Excessive liner standout differential between cylinders
- · Low head bolt clamping loads
- Rough/damaged liner flange surface
- Cracked/deformed gasket combustion flange
- Out-of-flat/damaged/rough cylinder head surface
- · Missing/mislocated gasket fire ring
- Block cracked in liner support area
- · Excessive fuel delivery
- · Advanced injection pump timing
- Hydraulic or mechanical disturbance of combustion seal

NOTE: Cracked cylinder head or liners may also allow combustion gas leakage into coolant.

COOLANT SEAL LEAKAGE

Symptoms:

- · Coolant discharge from head gasket crevice
- Coolant in crankcase oil
- Low coolant level
- · High oil level
- Coolant discharge from crankcase vent

Possible Causes:

- Excessive liner standout
- Excessive liner standout differential between cylinders
- · Low head bolt clamping loads
- Out-of-flat/damaged/rough block surface
- Out-of-flat/damaged/rough cylinder head surface
- · Oil or coolant overheating
- Cracks/creases in gasket body surfaces
- Damage/voids in elastomer beading

OIL SEAL LEAKAGE

Symptoms:

- Oil discharge from head gasket crevice
- · Oil in coolant
- Low crankcase oil level
- Reduced oil to rocker arms (noisy)

Possible Causes:

- · Excessive liner standout
- Excessive liner standout differential between cylinders
- Low head bolt clamping loads
- Out-of-flat/damaged/rough block surface
- Out-of-flat/damaged/rough cylinder head surface
- · Oil or coolant overheating
- Cracks/creases in gasket body surfaces
- Damage/voids in elastomer beading
- Damaged/missing O-ring seal at oil port to rocker arms

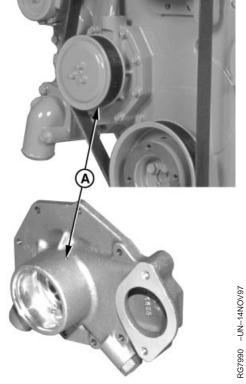
NOTE: Defective oil cooler may also allow oil leakage into coolant.

RG,105,JW7657 -19-23MAY00-4/4

Check and Service Cooling System

- 1. Remove trash that has accumulated on or near radiator.
- Visually inspect entire cooling system and all components for leaks or damage. Repair or replace as necessary.
- 3. Inspect radiator hoses for signs of leakage or rot. Replace hoses as necessary.
- 4. Inspect the water pump weep hole (A) for any restrictions.
- 5. Insert a heavy gauge wire deep into weep hole to make sure hole is open.

A-Weep Holes



Inspect Water Pump Weep Hole

Continued on next page

RG,100,JW7635 -19-15DEC99-1/2



CAUTION: Do not drain coolant until it has cooled below operating temperature. Always loosen block drain valve slowly to relieve any excess pressure.

6. Remove and check thermostat(s) (B). (See TEST THERMOSTATS in Section 02, Group 070.)

IMPORTANT: Whenever the aluminum timing gear cover or water pump are replaced, the radiator should be completely drained by opening the radiator petcock and removing the lower radiator hose.

 Drain coolant at drain valve (C) and flush cooling system. (See FLUSH AND SERVICE COOLING SYSTEM in Section 01, Group 002.)

IMPORTANT: Air must be expelled from cooling system when system is refilled. Loosen temperature sending unit fitting at rear of cylinder head or plug in thermostat housing (A) to allow air to escape when filling system. Retighten fitting or plug when all the air has been expelled.

- Fill cooling system with recommended concentration of coolant, clean soft water, and inhibitors. (See DIESEL ENGINE COOLANT RECOMMENDATIONS in Section 01, Group 002.)
- 9. Run engine until it reaches operating temperature. Check entire cooling system for leaks.
- 10. After engine cools, check coolant level.

NOTE: Coolant level should be even with bottom of radiator filler neck.

- Check system for holding pressure. (See PRESSURE TEST COOLING SYSTEM AND RADIATOR CAP in this group.)
 - A—Thermostat Housing
 - B—Thermostat
 - C—Drain Valve

CTM104 (19JUN00)



Cooling System Safety

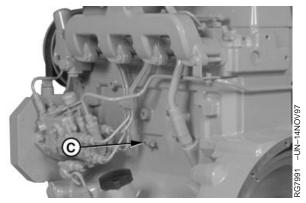
-UN-23AUG88



Check Thermostat Housing



Check Thermostat

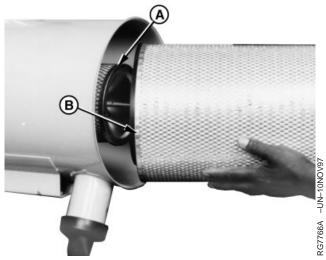


Engine Block Coolant Drain Valve

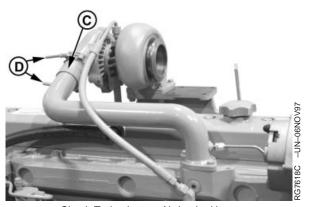
RG,100,JW7635 -19-15DEC99-2/2

Check Air Intake System

- Replace air cleaner primary filter element (B). Replace secondary element (A) if primary element has holes in it.
- 2. Check condition of air intake hose(s) (C). Replace hoses that are cracked, split, or otherwise in poor condition.
- 3. Check hose clamps (D) for tightness. Replace clamps that cannot be properly tightened. This will help prevent dust from entering the air intake system which could cause serious engine damage.
 - A—Secondary Filter Element
 - **B**—Primary Filter Element
 - C—Air Intake Hose(s)
 - **D—Hose Clamps**



Check Air Cleaner Elements



Check Turbocharger Air Intake Hoses

RG,100,JW7637 -19-21NOV97-1/1

Measure Intake Manifold Pressure (Turbocharger Boost)

IMPORTANT: If testing the engine with the air filter system removed, install JDG576
Turbocharger Shield to inlet of turbocharger.

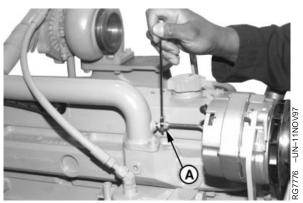
NOTE: On "H" engines, pressure reading should be taken at intake manifold after the aftercooler.

 Disconnect line (A) from intake manifold and install the appropriate fitting from JDE147 Manifold Pressure Test Kit or FKM10002 Universal Pressure Test Kit. Connect gauge (B) and hose assembly to fitting. Be sure all connections are tight.

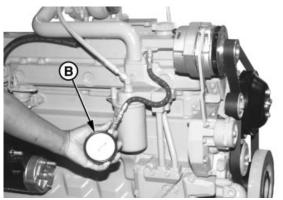
IMPORTANT: Engine speed and load should be stabilized before taking a gauge reading. Be sure that gauge works properly and familiarize yourself with the use of the gauge.

Turbo-boost pressure checks are only a guide to determine if there is an engine problem (valve leakage, faulty nozzles, etc.). Low pressure readings are not a conclusive reason for increasing injection pump fuel delivery. Pump adjustment should be within specifications as established by an authorized diesel repair station.

2. Before checking boost pressure, warm up engine to allow the lubricating oil to reach operating temperature.



Check Turbocharger Boost Pressure



Check Turbocharger Boost Pressure

A—Intake Manifold Line B—Pressure Gauge

Continued on next page

DPSG,OUO1004,134 -19-26APR00-1/2

IMPORTANT: On some vehicles, it may not be possible to meet the turbo boost pressure due to inability to get full load rated speed. In these cases, see **Machine Operation and Test Manual for** the appropriate test method and pressure.

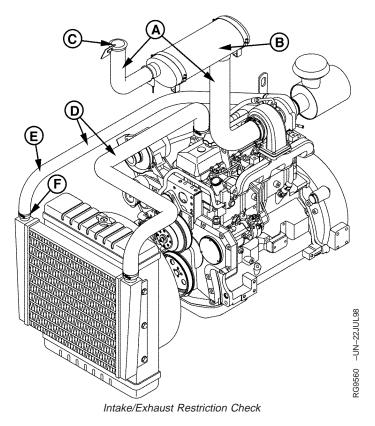
- 3. Observe pressure reading on gauge. Compare readings with charts in Section 06, Group 210. Boost pressure should be within ranges shown in charts when engine is developing rated power at full load rated speed.
- 4. If boost pressure is too high, remove fuel injection pump and have it checked for high fuel delivery by an authorized diesel repair station.

If boost pressure is too low, check the following:

- · Restricted air filter elements.
- Restricted fuel filter elements.
- Incorrect fast idle adjustment.
- Incorrect injection pump timing.
- · Exhaust manifold leaks.
- · Intake manifold leaks.
- Faulty fuel transfer pump.
- Low compression pressure.
- Faulty fuel injection nozzles.
- Carbon build-up in turbocharger.
- Turbocharger compressor or turbine wheel rubbing housing.
- Low fuel injection pump fuel delivery.
- Restricted exhaust.
- 5. After completing test, remove test equipment and reinstall nozzle adapter and plug. Tighten securely.

DPSG,OUO1004,134 -19-26APR00-2/2

Check for Intake and Exhaust Restrictions



A—Exhaust Piping B—Muffler

C—Rain Cap D—Intake Piping E-Elbows

F—Connections

Low power, low boost pressure, and excessive black exhaust smoke can be caused by an intake air or exhaust restriction.

- 1. Inspect the exhaust piping (A), the muffler (B), and the rain cap (C) for damage or any possible restrictions.
- Inspect the intake piping (D), any elbows (E), and any connections (F). Look for collapsed pipes, dented pipes and loose connections. Replace components as needed.

DPSG,OUO1004,222 -19-10JUL98-1/1

Test for Intake Air Leaks

Loose connections or cracks in the suction side of the air intake pipe can allow debris to be ingested into the engine causing rapid wear in the cylinders. Additionally, on turbocharged engines, compressor damage may occur and cause an imbalance resulting in bearing failure.

Air leaking from loose connections or cracks on the pressure side of the turbocharger can cause excessive smoke and low power.

NOTE: The following test procedure requires that the air intake be sealed off to pressurize the system.

Using a plastic bag to seal the air intake filter is used as an example.

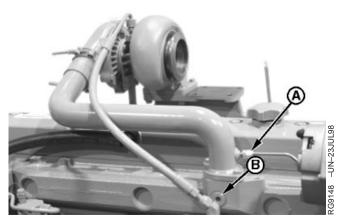


CAUTION: Do not start engine during this test procedure. Plastic bag (or whatever material/object used to seal intake) can be sucked into the engine.

- 1. Remove air cleaner cover and main filter element.
- 2. Put a plastic bag over secondary filter element and install main element and cover.
- 3. Remove plug (B) from manifold or disconnect start aid line (A) from crossover tube if (equipped) and using suitable adapter, connect a regulated air source.
- 4. Pressurize air intake system to 13.8—20.7 kPa (0.13-0.21 bar) (2—3 psi).
- 5. Spray soap and water solution over all connections from the air cleaner to the turbocharger or air inlet to check for leaks. Repair all leaks.
- 6. Remove plastic bag from filter element and reinstall element and cover.



Air Intake Leak Test



Air Intake Leak Test

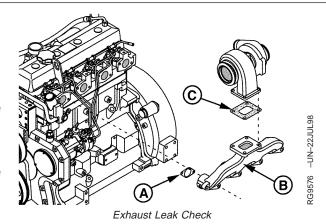
A—Start Aid Line B—Plug

DPSG,OUO1004,220 -19-26APR00-1/1

Check for Exhaust Air Leaks (Turbocharged Engines)

Exhaust leaks, upstream of the turbocharger, will cause the turbocharger turbine to rotate at a reduced speed resulting in low boost pressure, low power, and excessive black smoke.

Inspect the exhaust manifold gasket (A), the exhaust manifold (B), and the turbocharger gasket (C) for damage and any signs of leakage. Replace components as needed.



- A—Exhaust Manifold Gasket
- **B**—Exhaust Manifold
- C—Turbocharger Gasket

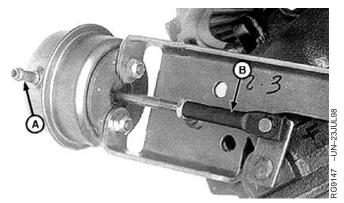
DPSG,OUO1004,288 -19-23JUL98-1/1

Test Turbocharger Wastegate

- 1. Check hose to wastegate actuator for kinks or cracks. Replace if damaged.
- 2. Disconnect hose from wastegate actuator.
- 3. Connect a regulated air source to actuator fitting (A).
- 4. Vary pressure to wastegate actuator from 9—12 psi.

Actuator rod (B) should move in and out freely as pressure is varied.

If rod does not move freely, check wastegate adjustment. (See ADJUST TURBOCHARGER WASTEGATE ACTUATOR in Section 02, Group 080.)



Wastegate Check

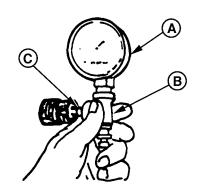
A—Actuator Fitting B—Actuator Rod

DPSG,OUO1004,224 -19-10JUL98-1/1

Test Air Filter Restriction Indicator Switch

- 1. Remove air filter restriction indicator switch from air intake piping.
- 2. Install pipe nipple (C), tee fitting (B), and gauge (A) from D05022ST Water Vacuum Gauge Kit into air filter restriction indicator hole. Install air filter restriction indicator into tee fitting.
- 3. Start engine and slowly cover the air cleaner inlet with a piece of paper or cardboard.
- 4. Air restriction indicator must show red at 5.6—6.8 kPa (56—68 bar) (22.7—27.3 in. water) (1.6—2.0 in. hg) vacuum.

If air restriction indicator shows red at any other value than listed above, install a new indicator.



Test Air Filter Restriction Indicator

A—Gauge

B—Tee Fitting

C—Pipe Nipple

RG,110,JW7671 -19-24NOV97-1/1

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Section 05 **Tools and Other Materials**

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| Page | Page |
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| Group 170—Repair Tools and Other Materials Cylinder Head and Valves Essential Tools05-170-1 Cylinder Head and Valves Service Equipment and Tools | Engine Oil Dipstick Tube Driver (6010—6910 Series Tractor Engines) |
| Group 180—Diagnostic Service Tools Diagnostic Essential Tools | |
| Group 190—Dealer Fabricated Service Tools How to Make Tools | |

Group 170 Repair Tools and Other Materials

Cylinder Head and Valves Essential Tools

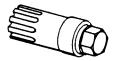
NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC).

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DPSG,OUO1004,2707 -19-26APR00-1/15

Flywheel Turning Tool JDE83

Used to rotate flywheel on engines with 142-tooth flywheel ring gear and a 26.5 mm (1.04 in.) ID flywheel housing guide bore diameter.



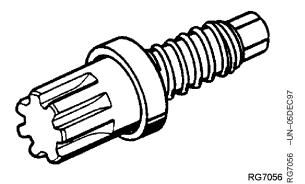
JDE83

05 170

DPSG,OUO1004,2707 -19-26APR00-2/15

Flywheel Turning Tool JDG820

Used to rotate flywheel on engines with 129-tooth flywheel ring gear and a 29.9 mm (1.18 in.) ID flywheel housing guide bore diameter.



JDG820

Continued on next page

DPSG,OUO1004,2707 -19-26APR00-3/15

RG5068 -UN-05DEC97

RG6246 -UN-05DEC97

RG5070 -UN-23AUG88

RG5061 -UN-05DEC97

| Γiming Pin . | | | | | | | | | | | | .IDF81-4 |
|---------------|--|------|--|--|--|--|--|--|--|--|--|-----------|
| HIIIIII FIII. | | | | | | | | | | | | . JDE01-4 |

Lock engine at TDC.



RG5068

JDE81-4

DPSG,OUO1004,2707 -19-26APR00-4/15

Dial Indicator D17526CI (English, in.) or D17527CI (Metric, mm)

Use with JDG451 Height Gauge or magnetic base to measure valve recess in cylinder head.



RG6246

D17526CI/D17527CI

DPSG,OUO1004,2707 -19-26APR00-5/15

Valve Spring Compressor JDE138

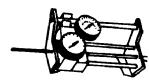
Used to compress valve springs when removing and installing valves.



DPSG,OUO1004,2707 -19-26APR00-6/15

Spring Compression Tester..... D01168AA

Test valve spring compression.



RG5061

D01168AA

DPSG,OUO1004,2707 -19-26APR00-7/15 Continued on next page

05-170-2

RG5084 -UN-23AUG88

RG5064 -UN-05DEC97

Nozzle Bore Cleaning Tool JDE39

Clean injection nozzle bores in cylinder head.



JDE39

DPSG,OUO1004,2707 -19-26APR00-8/15

Valve Guide Knurler Kit JT05949

Knurl valve guides.



RG5064

JT05949

05 170 ว

DPSG,OUO1004,2707 -19-26APR00-9/15

Valve Seat Driver JDG676

Use with JDG675 Adapter to install intake and exhaust valve seat inserts in cylinder head.



RG5065

JDG676

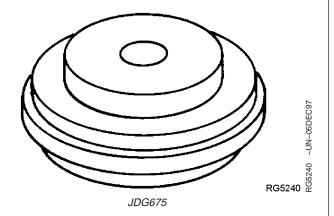
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RG5065 -UN-05DEC97

DPSG,OUO1004,2707 -19-26APR00-10/15

Valve Seat Insert Installing Adapter. JDG675

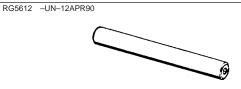
Use with JDG676 Valve Seat Driver to install intake and exhaust valve seat inserts.



DPSG,OUO1004,2707 -19-26APR00-11/15

Valve Stem Seal Installer JDG678

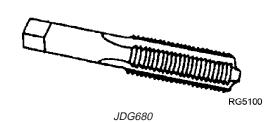
Use to install valve stem seals.



JDG678

DPSG,OUO1004,2707 -19-26APR00-12/15

Used to restore threaded holes in cylinder block for cylinder head cap screws.



RG5100 -UN-05DEC97

Continued on next page DPSG,OUO1004,2707 -19-26APR00-13/15

RG7029 -UN-05DEC97

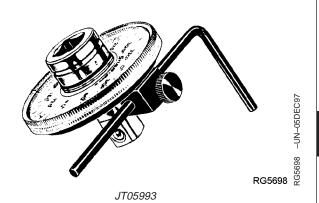
Height Gauge......JDG451 or KJD10123

Used with a dial indicator to measure valve recess in cylinder head. Also used to measure piston and liner height.



DPSG,OUO1004,2707 -19-26APR00-14/15

Used to torque-turn flanged-head cylinder head and connecting rod cap screws.



DPSG,OUO1004,2707 -19-26APR00-15/15

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Cylinder Head and Valves Service Equipment and Tools

NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC). Some tools may be available from a local supplier.

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DPSG,OUO1004,2708 -19-26APR00-1/8

Crankshaft Front/Rear Rotation Adapter. JDG966

Rotate crankshaft from front and rear with flywheel removed.

DPSG,OUO1004,2708 -19-26APR00-2/8

Valve Inspection Center

Check valves for out-of-round.

DPSG,OUO1004,2708 -19-26APR00-3/8

Precision "Bevelled Edge" Straightedge D05012ST

Check cylinder head flatness.

DPSG,OUO1004,2708 -19-26APR00-4/8

Plastic Brush

Clean valve guides.

DPSG,OUO1004,2708 -19-26APR00-5/8

End Brush D17024BR

Remove carbon on valve seats.

DPSG,OUO1004,2708 -19-26APR00-6/8

Heavy-Duty Seat Grinder JT05893

Grind valve seats.

Continued on next page

DPSG,OUO1004,2708 -19-26APR00-7/8

Eccentrimeter

Measure valve seat runout.

DPSG,OUO1004,2708 -19-26APR00-8/8

05 170 7

Cylinder Head and Valves Other Materials Number Name Use AR44402 (U.S.) Valve Stem Lubricant Lubricate valve stems.

DPSG,OUO1004,2709 -19-26APR00-1/1

Cylinder Block, Liners, Pistons and Rods **Essential Tools**

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

SERVICEGARD is a trademark of Deere & Company

DPSG,OUO1004,2711 -19-26APR00-1/15

Dial Indicator D17526CI (English, in.) or D17527CI (Metric, mm)

Use with JDG451, KJD10123 or magnetic base to measure valve recess in cylinder head and piston and liner height.



RG6246 -UN-05DEC97

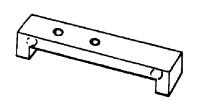
RG6246

D17526CI or D17527CI

DPSG,OUO1004,2711 -19-26APR00-2/15 RG7029 -UN-05DEC97

Height Gauge......JDG451 or KJD10123

Used with a dial indicator to measure valve recess in cylinder head. Also used to measure piston and liner height.



JDG451 or KJD10123

RG7029

DPSG,OUO1004,2711 -19-26APR00-3/15

Cylinder Liner Puller D01062AA, D01073AA or KCD10001

Used to remove and install cylinder liners.



RG5019

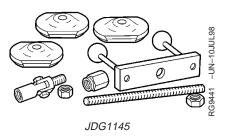
D01062AA/D01073AA/KCD10001

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DPSG,OUO1004,2711 -19-26APR00-4/15

Cylinder Liner Puller JDG1145

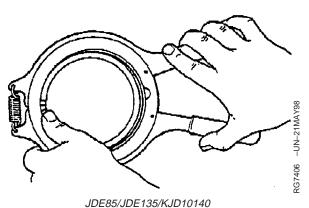
Used to remove and install cylinder liners.



DPSG,OUO1004,2711 -19-26APR00-5/15

Piston Ring Expander JDE85, JDE135, KJD10140

Remove and install piston rings.



DPSG,OUO1004,2711 -19-26APR00-6/15

RG5076 -UN-23AUG88 Piston Ring Groove Wear Gauge JDE62

Check wear of keystone ring groove on pistons with tapered rods.

Piston Ring Groove Wear Gauge JDG957

Check wear of keystone ring groove on pistons with straight rods.



JDE62/JDG957

Continued on next page

DPSG,OUO1004,2711 -19-26APR00-7/15

CTM104 (19JUN00)

RG5074 -UN-07NOV97

RG5107 -UN-23AUG88

Flexible Cylinder Hone D17004BR

Hone cylinder liners.



RG5074

D17004BR

DPSG,OUO1004,2711 -19-26APR00-8/15

Piston Pin Bushing Remover and Installer JD286 (JD-286)

Remove and install large 41 mm (1.6 in.) piston pin bushings.

Piston Pin Bushing Remover and Installer JDE88

Remove and install small 35 mm (1.3 in.) piston pin bushings.

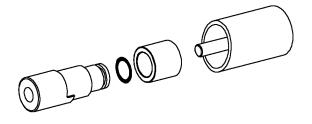


JD286 (JD-286)

DPSG,OUO1004,2711 -19-26APR00-9/15

Connecting Rod Bushing Service Set JDG953

Replace pin bushing in connecting rods with tapered pin-end.

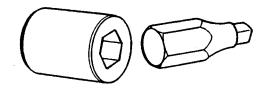


JDG953

DPSG,OUO1004,2711 -19-26APR00-10/15

Oil Gallery Plug Tool JDG782

Used to remove and install oil gallery plug.



JDG782

RG6612 - JIN-29.IAN

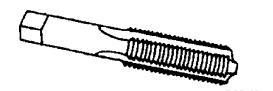
RG9126 -UN-22APR98

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DPSG,OUO1004,2711 -19-26APR00-11/15

RG5100 -UN-05DEC97

Used to restore threaded holes in cylinder block for cylinder head cap screws.

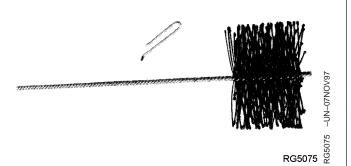


JDG680

DPSG,OUO1004,2711 -19-26APR00-12/15

O-Ring Groove Cleaning Brush D17015BR

Clean cylinder liner O-ring groove in block.



D17015BR

DPSG,OUO1004,2711 -19-26APR00-13/15

Piston Ring Compressor......JDE84

Compress rings while installing pistons.



RG5031 -UN-05DEC97

Continued on next page

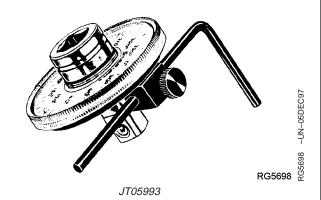
RG5031

JDE84

DPSG,OUO1004,2711 -19-26APR00-14/15

Torque Angle Gauge JT05993

Used to torque-turn flanged-head cylinder head and connecting rod cap screws.



DPSG,OUO1004,2711 -19-26APR00-15/15

05 170 13

Cylinder Block, Liners, Pistons and Rods Service Equipment and Tools

NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC). Some tools may be available from a local supplier.

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DPSG,OUO1004,2713 -19-26APR00-1/3

Piston Ring Groove Cleaning Tool N/A

Clean piston ring grooves.

DPSG,OUO1004,2713 -19-26APR00-2/3

Check cylinder head flatness.

DPSG,OUO1004,2713 -19-26APR00-3/3

Cylinder Block, Liners, Pistons and Rods Other Materials

| Number | Name | Use |
|--|--|--|
| N/A (U.S.) | PLASTIGAGE® | Determine connecting rod bearing-to-journal oil clearance. |
| T43512 (U.S.) TY9473 (Canadian) 242 (LOCTITE®) | Thread Lock and Sealer (Medium Strength) | Apply to cylinder block oil gallery plugs. |
| TY9375 (U.S.) TY9480 (Canadian) 592 (LOCTITE®) | Pipe Sealant | Apply to cylinder block coolant gallery plugs. |
| T43514 (U.S.) TY9475 (Canadian) 277 (LOCTITE®) | Plastic Gasket | Apply to steel caps/soft plugs in cylinder block. |
| AR54749 (U.S.) | Soap Lubricant | Apply to cylinder liner O-rings and packing. |

PLASTIGAGE is a registered trademark of DANA Corp. LOCTITE is a registered trademark of Loctite Corp.

DPSG,OUO1004,2712 -19-26APR00-1/1

Crankshaft, Main Bearings and Flywheel Essential Tools

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

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DPSG,OUO1004,2715 -19-26APR00-1/13

Dial Indicator D17526CI (English, in.) or D17527CI (Metric, mm)

Used with magnetic base to measure radial runout (concentricity) and wobble on vibration damper.



RG6246 -UN-05DEC97

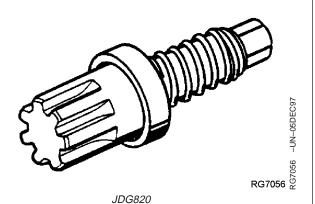
RG6246

D17526CI or D17527CI

DPSG,OUO1004,2715 -19-26APR00-2/13

Flywheel Turning Tool JDG820

Used to rotate flywheel on engines with 129-tooth flywheel ring gear and a 29.9 mm (1.18 in.) flywheel housing guide bore diameter. JDE81-1 may be used if JDG820 is not available.



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DPSG,OUO1004,2715 -19-26APR00-3/13

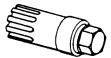
RG5109 -UN-23AUG88

RG6214 -UN-05DEC97

RG5068 -UN-05DEC97

Flywheel Turning Tool JDE83

Used to rotate flywheel on engines with 142-tooth flywheel ring gear and a 26.5 mm (1.04 in.) flywheel housing guide bore diameter.



-UN-22JUL92

JDE83

DPSG,OUO1004,2715 -19-26APR00-4/13

Remove crankshaft front oil seal with timing gear cover installed. Also used to remove crankshaft rear oil seal without removing flywheel housing.



JDG22

DPSG,OUO1004,2715 -19-26APR00-5/13

Seal Puller Adapter JDG719

Used with standard metal screw, JDE38-2 shank, and JDE38-3 Slide Handle to remove front crankshaft oil seal with timing gear cover installed. Also used to remove rear crankshaft oil seal with seal housing installed.



JDG719

RG6214

DPSG,OUO1004,2715 -19-26APR00-6/13

Used to lock engine/flywheel.



RG5068

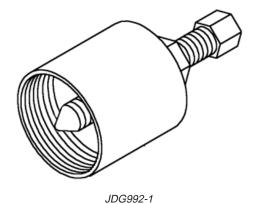
Timing Pin

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DPSG,OUO1004,2715 -19-26APR00-7/13

05-170-17

Used with JDG992-2 Front Wear Sleeve Puller to remove front wear sleeve with timing gear cover installed.



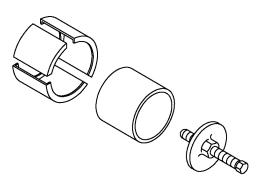
RG9124 -UN-22APR98

DPSG,OUO1004,2715 -19-26APR00-8/13

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Front Wear Sleeve Puller JDG992-2

Used with JDG992-1 to remove front wear sleeve with timing gear cover installed.



RG9125 -UN-19MAY98

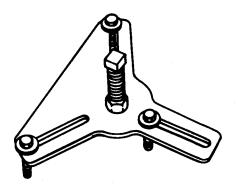
JDG992-2

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DPSG,OUO1004,2715 -19-26APR00-9/13

Seal and Wear Sleeve Remover. JDG698A

Remove unitized crankshaft rear oil seal and wear sleeve.

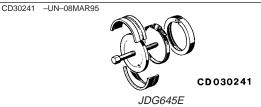


JDG698A

DPSG,OUO1004,2715 -19-26APR00-10/13

Rear Crankshaft Oil Seal/Wear Sleeve Puller . . JDG645E

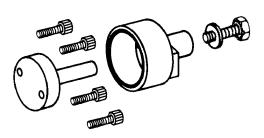
Remove rear oil seal/wear sleeve from crankshaft flange.



DPSG,OUO1004,2715 -19-26APR00-11/13

Rear Oil Seal/Wear Sleeve Installer Set. . . . JT30040B or KCD10002A

Install crankshaft rear oil seal/wear sleeve assembly.



JT30040B or KCD10002A

RG9122 -UN-22APR98

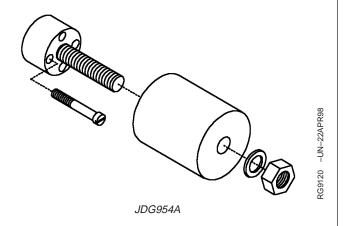
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DPSG,OUO1004,2715 -19-26APR00-12/13

Used to install the crankshaft gear either prior to, or after installing crankshaft into engine. Also used to install front oil seal with timing gear cover installed on engine.

JDG954A-1 Installer may be used to install the crankshaft gear when the crankshaft is REMOVED from the engine. Also used to install timing wheel on crankshaft on engines with VP44 injection pumps.



DPSG,OUO1004,2715 -19-26APR00-13/13

Crankshaft, Main Bearings and Flywheel Service Equipment and Tools

NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC). Some tools may be available from a local supplier.

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DPSG,OUO1004,2716 -19-26APR00-1/4

Bushing, Bearing and Seal Driver Set D01045AA

Install pilot bearing in flywheel.

DPSG,OUO1004,2716 -19-26APR00-2/4

Pulling Attachment. D01218AA

Use with D01200AA Push Puller to remove crankshaft gear from crankshaft.

DPSG,OUO1004,2716 -19-26APR00-3/4

Use with D01218AA to remove crankshaft gear from crankshaft.

DPSG,OUO1004,2716 -19-26APR00-4/4

05 170

Crankshaft, Main Bearings and Flywheel **Other Materials**

| Number | Name | Use | | | | | | |
|---|--|--|--|--|--|--|--|--|
| | Brake Kleen or Ignition Cleaner | Remove sealant from crankshaft flange. | | | | | | |
| TY15969 (U.S.) TY9479 (Canadian) 680 (LOCTITE®) | Retaining Compound (Maximum Strength) | Apply to crankshaft front wear sleeve, camshaft nose and rear crankshaft flange. | | | | | | |
| T43513 (U.S.) TY9474 (Canadian) 271 (LOCTITE®) | Thread Lock and Sealer (High Strength) | Apply to threaded studs of flywheel (option code 1557). | | | | | | |
| T43512 (U.S.) TY9473 (Canadian) 242 (LOCTITE®) | Thread Lock and Sealer (Medium Strength) | Apply to flywheel mounting cap screws. | | | | | | |
| | PLASTIGAGE® | Check main bearing-to-crankshaft journal oil clearance. | | | | | | |
| TY6304 (U.S.) TY9484 (Canadian) LOCTITE® 515 (LOCTITE®) | Flexible Sealant | Apply to rear face of cylinder block prior to installing flywheel housing. | | | | | | |
| T43514 (U.S.) TY9475 (Canadian) 277 (LOCTITE®) | Plastic Gasket | Apply to torque converter access hole plug. | | | | | | |
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LOCTITE is a registered trademark of Loctite Corp. PLASTIGAGE is a registered trademark of DANA Corp.

DPSG,OUO1004,2717 -19-26APR00-1/1

Camshaft, Balancer Shafts and Timing Gear **Train Essential Tools**

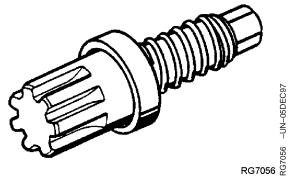
NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC).

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DPSG,OUO1004,2723 -19-26APR00-1/12

Flywheel Turning Tool JDG820

Used to rotate flywheel on engines with 129-tooth flywheel ring gears and a 29.9 mm (1.18 in.) ID flywheel housing guide bore diameter. JDE81-1 may be used also if JDG820 is not available.

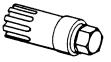


JDG820

DPSG,OUO1004,2723 -19-26APR00-2/12

Flywheel Turning Tool JDE83

Used to rotate flywheel on engines with 142-tooth flywheel ring gears and a 26.5 mm (1.04 in.) ID flywheel housing quide bore diameter.



JDE83

Continued on next page

DPSG,OUO1004,2723 -19-26APR00-3/12

-UN-22JUL92

RG5068 -UN-05DEC97

Lock engine at TDC when installing injection pump or timing valve train. Use with JDG820, JDE81-1 or JDE83 Flywheel Turning Tool.



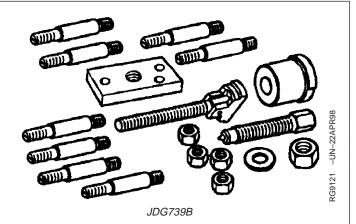
RG5068

JDE81-4

DPSG,OUO1004,2723 -19-26APR00-4/12

Camshaft Bushing Service Set. JDG739B

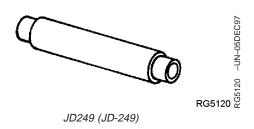
Used to remove and install front camshaft bushing.



DPSG,OUO1004,2723 -19-26APR00-5/12

Balancer Shaft Bushing Driver JD249 (JD-249)

Use with JDG963 Balancer Shaft Bushing Adapter to replace balancer shaft bushings.



Continued on next page

DPSG,OUO1004,2723 -19-26APR00-6/12

05 170 24

RG7940 -UN-15JAN98

Balancer Shaft Bushing Adapter. JDG963

Use with JD249 (JD-249) Balancer Shaft Bushing Driver to remove and install balancer shaft bushings.



JDG963

DPSG,OUO1004,2723 -19-26APR00-7/12

Idler Gear Bushing Driver JD252 (JD-252)

Use with JDG537 Handle to remove and install idler gear bushings.



RG10566

JD252 (JD-252)

DPSG,OUO1004,2723 -19-26APR00-8/12

Use with JD252 (JD-252) Idler Gear Bushing Driver to remove and install idler gear bushings.



RG10567

JDG537

0567 -UN-28JAN00

RG10566 -UN-28JAN00

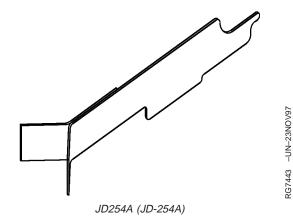
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DPSG,OUO1004,2723 -19-26APR00-9/12

Gear Timing Tool JD254A (JD-254A)

Time camshaft gear, injection pump gear and balancer shafts.



DPSG,OUO1004,2723 -19-26APR00-10/12

Idler Gear Installer Pilot JDG791A

Guide upper idler gear onto idler shaft.

05 170

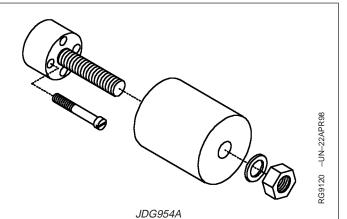


RG7939 -UN-05JAN98

DPSG,OUO1004,2723 -19-26APR00-11/12

Crankshaft Gear and Front Oil Seal Installer. . . JDG954A

Used to install crankshaft front oil seal.



DPSG,OUO1004,2723 -19-26APR00-12/12

Camshaft, Balancer Shafts and Timing Gear Train Service Equipment and Tools

NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC). Some tools may be available from a local supplier.

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DPSG,OUO1004,2724 -19-26APR00-1/5

Magnetic Follower Holder Kit D15001NU

Hold camshaft followers when removing and installing camshaft.

DPSG,OUO1004,2724 -19-26APR00-2/5

Balancer Shaft Holding Tool JD247 (JD-247)

Hold balancer shaft while pressing gear on shaft.

DPSG,OUO1004,2724 -19-26APR00-3/5

TORX® Driver Set

Remove and install engine front plate mounting hardware.

TORX is a registered trademark of Camcar/Textron

DPSG,OUO1004,2724 -19-26APR00-4/5

Master Driver Set D01045AA

Use discs with JDG537 Handle to remove and install idler gear bushings. Install pilot bearing in flywheel.

DPSG,OUO1004,2724 -19-26APR00-5/5

Camshaft, Balancer Shafts and Timing Gear Train Other Materials

| Number | Name | Use |
|---|--|--|
| TY6333 (U.S.) | High-Temperature Grease | Coat camshaft followers, camshaft lobes, journals and bushings during installation. Coat idler gear, bushing, and shaft during installation. |
| TY6304 (U.S.) TY9484 (Canadian) 515 (LOCTITE®) | Flexible Sealant | Apply to cylinder block front plate. |
| T43512 (U.S.) TY9473 (Canadian) 242 (LOCTITE®) | Thread Lock and Sealer (Medium Strength) | Apply to injection pump cover cap screws. |
| T43513 (U.S.) TY9474 (Canadian) 271 (LOCTITE®) | Thread Lock and Sealer (High Strength) | Apply to four timing gear cover studs used on OEM engine applications with auxiliary driven hydraulic pump. |
| TY9375 (U.S.) TY9480 (Canadian) 592 (LOCTITE®) | Pipe Sealant | Apply to one timing gear cover cap screw. |
| TY15969 (U.S.) TY9479 (Canadian) 680 (LOCTITE®) | Retaining Compound (Maximum Strength) | Front crankshaft wear sleeve and camshaft nose. |
| | | |
| | | |

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DPSG,OUO1004,2725 -19-26APR00-1/1

Lubrication System Essential Tools

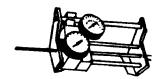
NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC).

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DPSG,OUO1004,2727 -19-26APR00-1/9

Spring Compression Tester..... D01168AA

Test oil bypass valve and oil pressure regulating valve spring compression.



RG5061

D01168AA

28

DPSG,OUO1004,2727 -19-26APR00-2/9

Oil Pressure Relief Valve Bushing Driver JD248A (JD-248A)

0

RG9118 -UN-17APR98

RG5061 -UN-05DEC97

Use with JDG536 Handle to install oil pressure relief valve bushing.

JD248A (JD-248A)

DPSG,OUO1004,2727 -19-26APR00-3/9

Use with JD248A (JD-248A) to install oil pressure relief valve bushing.



RG9117 -UN-17APR98

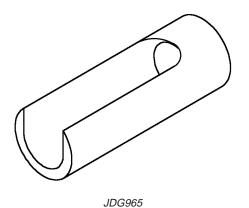
JDG536

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DPSG,OUO1004,2727 -19-26APR00-4/9

Dipstick Driver JDG965

Install dipstick tube in block.



RG7982 -UN-15JAN98

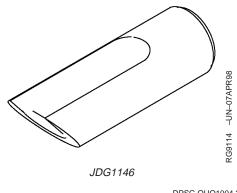
DPSG,OUO1004,2727 -19-26APR00-5/9

Dipstick Fitting Installer. JDG1146

Install dipstick tube fitting in block.

CTM104 (19JUN00)

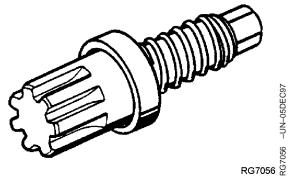
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DPSG,OUO1004,2727 -19-26APR00-6/9

Flywheel Turning Tool JDG820

Used to rotate flywheel on engines with 129-tooth flywheel ring gear and a 29.9 mm (1.18 in.) flywheel housing guide bore diameter. JDE81-1 may be used if JDG820 is not available.



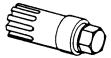
JDG820

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DPSG,OUO1004,2727 -19-26APR00-7/9

Flywheel Turning Tool JDE83

Used to rotate flywheel on engines with 142-tooth flywheel ring gear and a 26.5 mm (1.04 in.) flywheel housing guide bore diameter.



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RG6251 -UN-22JUL92

JDE83

DPSG,OUO1004,2727 -19-26APR00-8/9

Used to lock engine/flywheel.



RG5068

JDE81-4

05 170 31

DPSG,OUO1004,2727 -19-26APR00-9/9

Lubrication System Service Equipment and Tools

NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC). Some tools may be available from a local supplier.

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DPSG,OUO1004,2728 -19-26APR00-1/5

Blind-Hole Puller Set D01061AA

Remove oil pressure regulating valve seat and dipstick tube from block.

DPSG,OUO1004,2728 -19-26APR00-2/5

Used with JT01720 Actuator Pin and 1156 Slide Hammer to remove dipstick tube from cylinder block.

DPSG,OUO1004,2728 -19-26APR00-3/5

Actuator Pin JT01720 (28250)

Used with JT01724 Collet and 1156 Slide Hammer to remove dipstick tube from cylinder block.

DPSG,OUO1004,2728 -19-26APR00-4/5

Slide Hammer 1156 (Formerly D01299AA)

Used with JT01724 Collet and JT01720 Actuator Pin to remove dipstick tube from cylinder block.

CTM104 (19JUN00)

DPSG,OUO1004,2728 -19-26APR00-5/5

Lubrication System Other Materials

| Number | Name | Use |
|--|--|--|
| T43512 (U.S.) TY9473 (Canadian) 242 (LOCTITE®) | Thread Lock and Sealer (Medium Strength) | Apply to oil cooler-to-housing cap screws, oil fill tube cap screws, and end of dipstick tube. |
| T43513 (U.S.) TY9474 (Canadian) 271 (LOCTITE®) | Thread Lock and Sealer (High Strength) | Apply to dipstick tube with fitting. |
| TY6304 (U.S.) TY9484 (Canadian) 515 (LOCTITE®) | Flexible Form-in-Place Gasket | Apply to oil pan rail. |
| TY9375 (U.S.) TY9480 (Canadian) 592 (LOCTITE®) | Pipe Sealant | Apply to oil pan elbow drain fitting. |

LOCTITE is a registered trademark of Loctite Corp.

DPSG,OUO1004,2729 -19-26APR00-1/1

Cooling System Essential Tools

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

SERVICEGARD is a trademark of Deere & Company

DPSG,OUO1004,2731 -19-26APR00-1/3

Water Pump Bearing Installer JDG956

Install water pump bearing.



RG7950 -UN-05JAN98

JDG956

DPSG,OUO1004,2731 -19-26APR00-2/3

Belt Tension Gauge.................JDG529 -UN-10MAY95

Used to check belt tension on 8-rib poly-vee belt.



DPSG,OUO1004,2731 -19-26APR00-3/3

Cooling System Service Equipment and Tools

NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC). Some tools may be available from a local supplier.

SERVICEGARD is a trademark of Deere & Company

DPSG,OUO1004,2732 -19-26APR00-1/2

Bushing, Bearing and Seal Driver Set D01045AA

Remove inner seal in water pump housing.

DPSG,OUO1004,2732 -19-26APR00-2/2



Cooling System Other Materials

Number Name Use

PT507 (U.S.) Multi-Purpose Grease Thermostat housing O-rings.

JDT308 (U.S.) Soap Lubricant Apply to coolant heater O-ring.

DPSG,OUO1004,2733 -19-26APR00-1/1



Air Intake and Exhaust System Other Materials

592 (LOCTITE®)

Number Name Use

PT569 (U.S.) NEVER-SEEZ® Exhaust manifold-to-cylinder head

cap screws.

TY9375 (U.S.) Pipe Sealant Air heater threads. TY9480 (Canadian)

NEVER-SEEZ is a registered trademark of Emhart Chemical Group LOCTITE is a registered trademark of Loctite Corp.

DPSG,OUO1004,2735 -19-26APR00-1/1



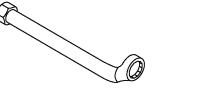
Starting and Charging System Essential Tools

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

SERVICEGARD is a trademark of Deere & Company

DPSG,OUO1004,1141 -19-18NOV99-1/2

Remove starter motor on 6010—6910 and 7210—7610 Tractors.



KJD10213

RG9116 -UN-19MAY98

DPSG,OUO1004,1141 -19-18NOV99-2/2

Group 180 Diagnostic Service Tools

Diagnostic Essential Tools

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

SERVICEGARD is a trademark of Deere & Company

DPSG,OUO1004,2738 -19-26APR00-1/6

Compression Test Set . . JT01674 (formerly D14546BA or FKM10021)

Used to check cylinder compression pressure. Use adapter and gauge/hose assembly from set.



RG5161 -UN-23AUG88

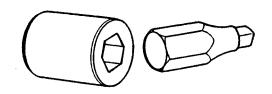
JT01674

05 180 1

DPSG,OUO1004,2738 -19-26APR00-2/6

Oil Gallery Plug Tool JDG782

Used to remove and install oil gallery plug.

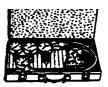


JDG782

DPSG,OUO1004,2738 -19-26APR00-3/6

Universal Pressure Test Kit.....JT05470 (D15027NU or FKM10002)

Used to check engine oil pressure.



JT05470

Continued on next page

RG5162 -UN-23AUG88

DPSG,OUO1004,2738 -19-26APR00-4/6

Cooling System Pressure Pump..... D05104ST

Used to pressure test radiator cap and cooling system.



D05104ST

DPSG,OUO1004,2738 -19-26APR00-5/6

Manifold Pressure Tester JDE147 or FKM10002

Used to test intake manifold pressure on turbocharged engines.

RG5163 -UN-23AUG88





DPSG,OUO1004,2738 -19-26APR00-6/6

Diagnostic Service Tools

Diagnostic Service Equipment and Tools

NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC). Some tools may be available from a local supplier.

SERVICEGARD is a trademark of Deere & Company

DPSG,OUO1004,2739 -19-26APR00-1/4

Water Vacuum Gauge Kit D05022ST

Used to test air filter restriction indicator switch.

DPSG,OUO1004,2739 -19-26APR00-2/4

Turbocharger Shield JDG576

Cover turbocharger inlet when testing engine with air filter system removed.

DPSG,OUO1004,2739 -19-26APR00-3/4

Air Regulator with Gauge

Pressurize wastegate actuator to test operation of wastegate.

DPSG,OUO1004,2739 -19-26APR00-4/4

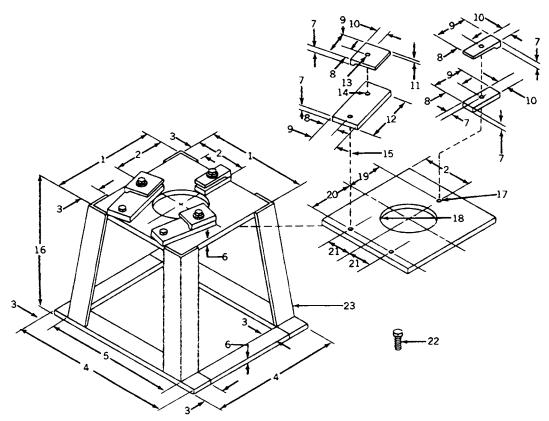
Group 190 **Dealer Fabricated Service Tools**

How to Make Tools

These tools can be made in a service shop using common shop tools and locally obtained materials.

RG,199,JW7719 -19-25NOV97-1/1

DFRG3—Cylinder Liner Holding Fixture



Cylinder Liner Holding Fixture

1-254.0 mm (10 in.) 7—12.7 mm (0.5 in.) 13—0.328 in. Drill Through 2—127.0 mm (5 in.) 8-31.8 mm (1.25 in.) 14—5/16 in. —18 Tap 3-38.1 mm (1.5 in.) 15-2 (assemblies above) used 21-60.45 mm (2.38 in.) 9—63.5 mm (2.5 in.) 4-405.4 mm (16 in.) 10-25.4 mm (1 in.) 16—304.8 mm (12 in.) 5-330.2 mm (13 in.) 11—6.35 mm (0.25 in.) 17—5/16 in. —18 Tap 6-9.52 mm (0.38 in.) 12—152.4 mm (6 in.) 18-69.85 mm (2.75 in.) Radius

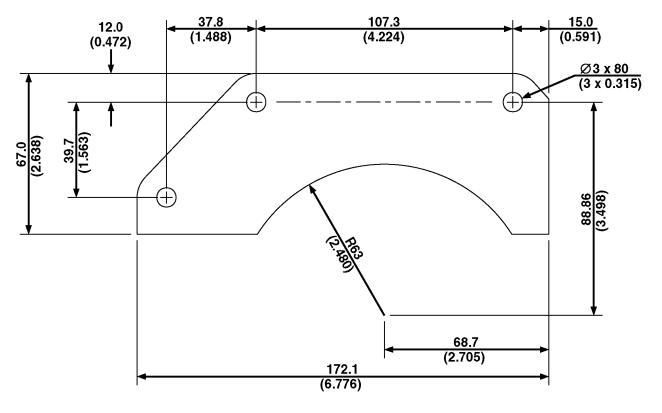
19-101.6 mm (4 in.) 20-111.25 mm (4.38 in.) 22-5/16 in. x 1 in. Cap Screw 23-38.1 mm (1.5 in.) Angle Iron

RG,199,JW7720 -19-23MAY00-1/1

PN=449

CTM104 (19JUN00)

DFRG5—Injection Pump Front Plate Timing Mark Transfer Tool



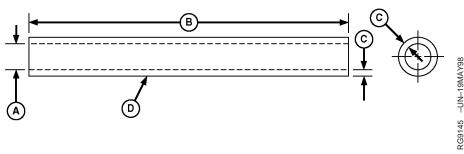
DFRG-5

Material—Aluminum

This template is used to transfer the injection pump timing mark from the engine's original front plate to the replacement front plate (which does not have the mark). Refer to Section 02, Group 050 for procedure to use this tool.

RG,199,JW7720 -19-25NOV97-1/1

Engine Oil Dipstick Tube Driver (6010—6910 Series Tractor Engines)



6010 Series Tractor Oil Dipstick Driver

A—Inside Diameter 9.75—10 mm (0.38—0.39 in.)

B—Length of Tubing 146 mm (5.75 in.)

C—Tubing Wall Thickness 3 mm (0.12 in.)

D—Steel Tubing 12.5 mm (0.50 in)

This tool is required to install the straight engine oil dipstick tube in engine block on 6010—6910 Tractors.

For service procedure to use this tool, refer to Section 02, Group 060.

05 190 3

DPSG,OUO1004,132 -19-23MAY00-1/1



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Section 06 **Specifications**

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Contents

Group 200 Repair and General OEM Specifications

Unified Inch Bolt and Cap Screw Torque Values

| SAE Grade and Head Markings | NO MARK | 1 or 2 ^b | 5 5.1 5.2 | 8 8.2 |
|---|---------|---------------------|-----------|-------|
| SAE Grade and Nut Markings | NO MARK | 2 | | |

| | | Gra | ide 1 | | Grade 2 ^b | | | Grade 5, 5.1, or 5.2 | | | Grade 8 or 8.2 | | | | | |
|-------|--------|--------|-------|-------|----------------------|--------|------|----------------------|-------|--------|----------------|-------|-------|--------|------|--------------|
| Size | Lubri | cateda | Di | 'ya | Lubri | cateda | Di | 'y ^a | Lubri | cateda | Di | 'ya | Lubri | cateda | Di | rya |
| | N⋅m | lb-ft | N⋅m | lb-ft | N·m | lb-ft | N·m | lb-ft | N⋅m | lb-ft | N⋅m | lb-ft | N∙m | lb-ft | N⋅m | lb-ft |
| 1/4 | 3.7 | 2.8 | 4.7 | 3.5 | 6 | 4.5 | 7.5 | 5.5 | 9.5 | 7 | 12 | 9 | 13.5 | 10 | 17 | 12.5 |
| 5/16 | 7.7 | 5.5 | 10 | 7 | 12 | 9 | 15 | 11 | 20 | 15 | 25 | 18 | 28 | 21 | 35 | 26 |
| 3/8 | 14 | 10 | 17 | 13 | 22 | 16 | 27 | 20 | 35 | 26 | 44 | 33 | 50 | 36 | 63 | 46 |
| 7/16 | 22 | 16 | 28 | 20 | 35 | 26 | 44 | 32 | 55 | 41 | 70 | 52 | 80 | 58 | 100 | 75 |
| 1/2 | 33 | 25 | 42 | 31 | 53 | 39 | 67 | 50 | 85 | 63 | 110 | 80 | 120 | 90 | 150 | 115 |
| 9/16 | 48 | 36 | 60 | 45 | 75 | 56 | 95 | 70 | 125 | 90 | 155 | 115 | 175 | 130 | 225 | 160 |
| 5/8 | 67 | 50 | 85 | 62 | 105 | 78 | 135 | 100 | 170 | 125 | 215 | 160 | 240 | 175 | 300 | 225 |
| 3/4 | 120 | 87 | 150 | 110 | 190 | 140 | 240 | 175 | 300 | 225 | 375 | 280 | 425 | 310 | 550 | 400 |
| 7/8 | 190 | 140 | 240 | 175 | 190 | 140 | 240 | 175 | 490 | 360 | 625 | 450 | 700 | 500 | 875 | 650 |
| 1 | 290 | 210 | 360 | 270 | 290 | 210 | 360 | 270 | 725 | 540 | 925 | 675 | 1050 | 750 . | 1300 | 975 |
| 1-1/8 | 400 | 300 | 510 | 375 | 400 | 300 | 510 | 375 | 900 | 675 | 1150 | 850 | 1450 | 1075 | 1850 | 1350 |
| 1-1/4 | 570 | 425 | 725 | 530 | 570 | 425 | 725 | 530 | 1300 | 950 | 1650 | 1200 | 2050 | 1500 | 2600 | 1950 |
| 1-3/8 | 750 | 550 | 950 | 700 | 750 | 550 | 950 | 700 | 1700 | 1250 | 2150 | 1550 | 2700 | 2000 | 3400 | 2550 |
| 1-1/2 | 1000 | 725 | 1250 | 925 | 990 | 725 | 1250 | 930 | 2250 | 1650 | 2850 | 2100 | 3600 | 2650 | 4550 | 2550 3350 |
| 1 1/2 | , 1000 | 120 | 1200 | 323 | . 550 | 123 | 1200 | 300 | 2450 | 1000 | 2000 | 2100 | 3000 | 2000 | 4000 | 3330 |

DO NOT use these values if a different torque value or tightening procedure is given for a specific application. Torque values listed are for general use only. Check tightness of fasteners periodically.

Shear bolts are designed to fail under predetermined loads. Always replace shear bolts with identical grade.

Fasteners should be replaced with the same or

higher grade. If higher grade fasteners are used,

Make sure fasteners threads are clean and that you properly start thread engagement. This will prevent them from failing when tightening.

Tighten plastic insert or crimped steel-type lock nuts to approximately 50 percent of the dry torque shown in the chart, applied to the nut, not to the bolt head. Tighten toothed or serrated-type lock nuts to the full torque value.

DX,TORQ1 –19–20JUL94–1/1

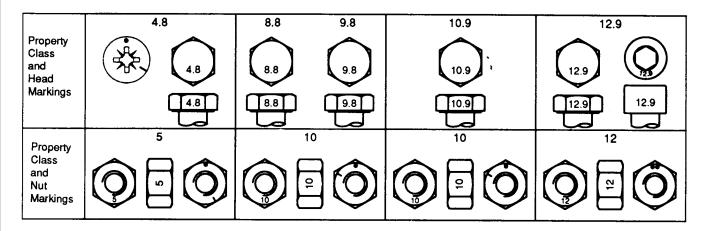
these should only be tightened to the strength of the original.

Make sure fasteners threads are clean and that you

^a "Lubricated" means coated with a lubricant such as engine oil, or fasteners with phosphate and oil coatings. "Dry" means plain or zinc plated without any lubrication.

^b Grade 2 applies for hex cap screws (not hex bolts) up to 152 mm (6-in.) long. Grade 1 applies for hex cap screws over 152 mm (6-in.) long, and for all other types of bolts and screws of any length.

Metric Bolt and Cap Screw Torque Values



| | Class 4.8 | | | | Class 8.8 or 9.8 | | | Class 10.9 | | | | Class 12.9 | | | | |
|------|-------------|-------|------|-------|------------------|-------------|------|------------|------|-------------|------|------------|-------------------------|-------|------|-------|
| Size | Lubricateda | | Drya | | Lubri | Lubricateda | | Drya | | Lubricateda | | rya | Lubricated ^a | | Drya | |
| | N⋅m | lb-ft | N⋅m | lb-ft | N⋅m | lb-ft | N⋅m | lb-ft | N⋅m | lb-ft | N⋅m | lb-ft | N⋅m | lb-ft | N⋅m | lb-ft |
| M6 | 4.8 | 3.5 | 6 | 4.5 | 9 | 6.5 | 11 | 8.5 | 13 | 9.5 | 17 | 12 | 15 | 11.5 | 19 | 14.5 |
| M8 | 12 | 8.5 | 15 | 11 | 22 | 16 | 28 | 20 | 32 | 24 | 40 | 30 | 37 | 28 | 47 | 35 |
| M10 | 23 | 17 | 29 | 21 | 43 | 32 | 55 | 40 | 63 | 47 | 80 | 60 | 75 | 55 | 95 | 70 |
| M12 | 40 | 29 | 50 | 37 | 75 | 55 | 95 | 70 | 110 | 80 | 140 | 105 | 130 | 95 | 165 | 120 |
| M14 | 63 | 47 | 80 | 60 | 120 | 88 | 150 | 110 | 175 | 130 | 225 | 165 | 205 | 150 | 260 | 190 |
| M16 | 100 | 73 | 125 | 92 | 190 | 140 | 240 | 175 | 275 | 200 | 350 | 255 | 320 | 240 | 400 | 300 |
| M18 | 135 | 100 | 175 | 125 | 260 | 195 | 330 | 250 | 375 | 275 | 475 | 350 | 440 | 325 | 560 | 410 |
| M20 | 190 | 140 | 240 | 180 | 375 | 275 | 475 | 350 | 530 | 400 | 675 | 500 | 625 | 460 | 800 | 580 |
| M22 | 260 | 190 | 330 | 250 | 510 | 375 | 650 | 475 | 725 | 540 | 925 | 675 | 850 | 625 | 1075 | 800 |
| M24 | 330 | 250 | 425 | 310 | 650 | 475 | 825 | 600 | 925 | 675 | 1150 | 850 | 1075 | 800 . | 1350 | 1000 |
| M27 | 490 | 360 | 625 | 450 | 950 | 700 | 1200 | 875 | 1350 | 1000 | 1700 | 1250 | 1600 | 1150 | 2000 | 1500 |
| M30 | 675 | 490 | 850 | 625 | 1300 | 950 | 1650 | 1200 | 1850 | 1350 | 2300 | 1700 | 2150 | 1600 | 2700 | 2000 |
| 1400 | 000 | | 4450 | 050 | | | | | | | | | | | | |
| M33 | 900 | 675 | 1150 | 850 | 1750 | 1300 | 2200 | 1650 | 2500 | 1850 | 3150 | 2350 | 2900 | 2150 | 3700 | 2750 |
| M36 | 1150 | 850 | 1450 | 1075 | 2250 | 1650 | 2850 | 2100 | 3200 | 2350 | 4050 | 3000 | 3750 | 2750 | 4750 | 3500 |

DO NOT use these values if a different torque value or tightening procedure is given for a specific application. Torque values listed are for general use only. Check tightness of fasteners periodically.

Shear bolts are designed to fail under predetermined loads. Always replace shear bolts with identical property class.

Fasteners should be replaced with the same or higher property class. If higher property class fasteners are used, these should only be tightened to the strength of the original.

Make sure fasteners threads are clean and that you properly start thread engagement. This will prevent them from failing when tightening.

Tighten plastic insert or crimped steel-type lock nuts to approximately 50 percent of the dry torque shown in the chart, applied to the nut, not to the bolt head. Tighten toothed or serrated-type lock nuts to the full torque value.

³ "Lubricated" means coated with a lubricant such as engine oil, or fasteners with phosphate and oil coatings. "Dry" means plain or zinc plated without any lubrication.

General OEM Engine Specifications

| ITEM | | | | | ENGINE | | | | | | |
|----------------------------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|--|--|
| | 4045DF150 | 4045TF150 | 4045TF250 | 4045HF150 | 6068DF150 | 6068TF150 | 6068TF250 | 6068HF150 | 6068HF250 | | |
| Number of Cylinders | 4 | 4 | 4 | 4 | 6 | 6 | 6 | 6 | 6 | | |
| Bore | 106 mm | | |
| | (4.19 in.) | | |
| Stroke | 127 mm | | |
| | (5.0 in.) | | |
| Displacement | 4.5 L | 4.5 L | 4.5 L | 4.5 L | 6.8 L | | |
| | (276 cu | (276 cu | (276 cu | (276 cu | (414 cu | | |
| | in.) | | |
| Compression | 17.6:1 | 17.0:1 | 17.0:1 | 17.0:1 | 17.6:1 | 17.0:1 | 17.0:1 | 17.0:1 | 17.0:1 | | |
| Max. Crank Pressure | 0.5 kPa | | |
| | (2 H₂O) | 2 H₂O) | (2 H₂O) | (2 H₂O) | | |
| Governor Regulation (Industrial) | 7—10 % | 7—10 % | 7—10 % | 7—10 % | 7—10 % | 7—10 % | 7—10 % | 7—10 % | 7—10 % | | |
| Governor Regulation (Generator) | 5 % | 5 % | 5 % | 5 % | 5 % | 5 % | 5 % | 5 % | 5 % | | |
| Oil Pressure Rated | 345 kPa | | |
| Speed | (50 psi) | | |
| Oil Pressure Low Idle | 105 kPa | | |
| | (15 psi) | | |
| Length | 861.0 mm | 861.0 mm | 861.0 mm | 861.0 mm | 1117 mm | 1117 mm | 1117 mm | 1116 mm | 1141 mm | | |
| | (33.9 in.) | (33.9 in.) | (33.9 in.) | (33.9 in.) | (44.0 in.) | (44.0 in.) | (44.0 in.) | (43.9 in.) | (44.9 in.) | | |
| Width | 598 mm | 623 mm | 623 mm | | |
| | (23.5 in.) | (24.5 in.) | (24.5 in.) | | |
| Height | 854 mm | 980 mm | 980 mm | 980 mm | 956 mm | 984 mm | 984 mm | 1009 mm | 1009 mm | | |
| | (33.6 in.) | (38.6 in.) | (38.6 in.) | (38.6 in.) | (37.6 in.) | (38.7 in.) | (38.7 in.) | (39.7 in.) | (39.7 in.) | | |
| Weight | 387 kg | 396 kg | 396 kg | 396 kg | 522 kg | 533 kg | 533 kg | 550 kg | 568 kg | | |
| | (851 lb) | (872 lb) | (872 lb) | (872 lb) | (1149 lb) | (1172 lb) | (1172 lb) | (1210 lb) | (1250 lb) | | |

DPSG,OUO1004,102 -19-28APR98-1/1

Engine Rebuild Specifications

| Item | Measurement | Specification |
|---------------------------------------|-------------|-----------------------------------|
| Engine Lift Strap Cap Screws | Torque | 170 N•m (125 lb-ft) |
| Engine Repair Stand M12 Cap Screws | Torque | 140 N•m (105 lb-ft) |
| Engine Repair Stand M14 Cap Screws | Torque | 225 N•m (165 lb-ft) |
| | | DPSG.OUO1004.2706 -19-26APR00-1/1 |

Cylinder Head and Valves Specifications

| | Item | Measurement | Specification |
|--------|--|----------------|--|
| | Intake Valve Clearance Checking (Rocker Arm-to-Valve Tip) (Engine Cold) | Clearance | 0.31—0.38 mm (0.012—0.015 in.) |
| | Exhaust Valve Clearance Checking (Rocker Arm-to-Valve Tip) (Engine Cold) | Clearance | 0.41—0.48 mm (0.016—0.019 in.) |
| | Intake Valve Clearance Adjustment (Rocker Arm-to-Valve Tip) (Engine Cold) | Clearance | 0.36 mm (0.014 in.) |
| | Exhaust Valve Clearance Adjustment (Rocker Arm-to-Valve Tip) (Engine Cold) | Clearance | 0.46 mm (0.018 in.) |
| | Rocker Arm Adjusting Screw Jam Nut | Torque | 27 N•m (20 lb-ft) |
| | Intake Valves | Lift | 11.77—12.21 mm (0.463—0.481 in.) |
| | | Wear Limit | 11.34 mm (0.447 in.) |
|)) | Exhaust Valves | Lift | 11.51—11.94 mm (0.453—0.470 in.) |
| t | | Wear Limit | 11.08 mm (0.436 in.) |
| | Rocker Arm Assembly | | |
| | Spring Tension at 46 mm (1.81 in.) Compressed Height | Spring Tension | 18—27 N (4—6 lb-force) |
| | Spring Compressed Height | Height | 46 mm @ 18—27 N (1.81 in. @ 4—6 lb-force) |
| | Shaft | OD | 19.99—20.02 mm (0.787—0.788 in.) |
| | | Wear Limit | 19.94 mm (0.785 in.) |
| | Shaft Support ID | Maximum ID | 20.17 mm (0.794 in.) |
| | Bore | ID | 20.07—20.12 mm (0.790—0.792 in.) |
| | | Wear Limit | 20.17 mm (0.794 in.) |
| | | | |

| - 1 | | | |
|-----|--|--|---------------------------------------|
| | Item | Measurement | Specification |
| | Fuel Supply Pump Push Rod | OD | 9.891—9.917 mm (0.3894—0.3904 in.) |
| | Fuel Supply Pump Push Rod Bore in Block | ID | 10.00—10.05 mm (0.3937—0.3957 in.) |
| | Camshaft Follower | OD | 31.61—31.64 mm (1.245—1.246 in.) |
| | Intake Valves | Recess in Cylinder Head | 0.61—1.11 mm (0.024—0.044 in.) |
| | | Wear Limit | 1.63 mm (0.064 in.) |
| | Exhaust Valve | Recess in Cylinder Head | 1.22—1.72 mm (0.048—0.068 in.) |
| | | Wear Limit | 2.26 mm (0.089 in.) |
| | Valve Springs | | |
| | Spring Free Length 0 N (0 lb-force) ¹ | Height | 54.0 mm (2.125 in.) |
| | Spring Compressed 240—280 N (54—62 lb-force) | Height | 46.0 mm (1.81 in.) |
| | Spring Compressed 590—680 N (133—153 lb-force) | Height | 34.5 mm (1.36 in.) |
| | Intake Valve Head | OD | 46.47—46.73 mm (1.830—1.840 in.) |
| | Exhaust Valve Head | OD | 42.37—42.63 mm (1.668—1.678 in.) |
| | Intake Valve Stem | OD | 7.864—7.884 mm (0.3096—0.3104 in.) |
| | Exhaust Valve Stem | OD | 7.848—7.874 mm (0.3090—0.3100 in.) |
| | Valve Face | Maximum Runout (Intake and Exhaust) | 0.038 mm (0.0015 in.) |

Repair and General OEM Specifications

Continued on next page

DPSG,OUO1004,2710 -19-26APR00-2/4

¹ Free length may vary slightly between valve springs.

| Item | Measurement | Specification |
|------------------------------------|---|--|
| Valves | Face Angle | 29.25° ± 0.25° |
| Cylinder Head Flatness | Maximum Acceptable Out-of-Flat for Entire Length or Width | 0.08 mm (0.003 in.) |
| | Maximum Acceptable Out-of-Flat for Every 150 mm [5.90 in.] | 0.03 mm (0.001 in.) |
| Cylinder Head Thickness and Finish | New Cylinder Head Thickness | 104.87—105.13 mm (4.129—4.139 in.) |
| | Minimum Acceptable Thickness Combustion Face Surface Finish (Surface Grind Only) (AA) Maximum Wave Depth Maximum Material Removal for Resurfacing | 104.24 mm (4.104 in.) 0.7—3.2 micrometers (31—125 micro-in.) 0.012 mm (0.0005 in.) 0.76 mm (0.030 in.) |
| Valve Guide Bore (New) | ID | 7.912—7.938 mm (0.312—0.313 in.) |
| Valve Guide-to-Valve Stem (New) | Clearance | 0.05—0.10 mm (0.002—0.004 in.) |
| | Wear Limit | 0.15 mm (0.006 in.) |
| Valve Seat Grinding | Valve Seat Angle Valve Seat Width Maximum Valve Seat Runout | 30° 1.50—2.00 mm (0.059—0.079 in.) 0.08 mm (0.003 in.) |
| Cylinder Liner | Height above Block | 0.030—0.100 mm (0.001—0.004 in.) |
| | Maximum Permissible Height Difference at Nearest Point of Two Adjacent Liners, or Within a Single Liner | 0.05 mm (0.002 in.) |
| Cylinder Head Cap Screws | | |
| Step 1—Initial | Torque | 100 N•m (75 lb-ft) |
| Step 2—Second | Torque | 150 N•m (110 lb-ft) |
| Step 3—Verify (After 5 Minutes) | Torque | 150 N•m (110 lb-ft) |
| Step 4—Final | Torque-Turn | Tighten each screw an additional 60° $\pm~10^{\circ}$ |

Repair and General OEM Specifications

| Item | Measurement | Specification |
|--------------------------|-------------|-----------------------------------|
| Rocker Arm Support Studs | Torque | 60 N•m (44 lb-ft) |
| Rocker Arm Cover Nuts | Torque | 35 N•m (26 lb-ft) |
| | | |
| | | |
| | | |
| | | DPSG,OUO1004,2710 -19-26APR00-4/4 |

Cylinder Block, Liners, Pistons and Rods Specifications

| Item | Measurement | Specification | |
|---|--|--|--|
| Piston Rings—4045DF, TF150 and 6068DF, TF150 Engines | End Gap (No. 1 Compression) End Gap (No. 2 Compression) End Gap (No. 3 Oil Control) | 0.33—0.58 mm (0.013—0.023 in.) 1.24—1.49 mm (0.049—0.059 in.) 0.30—0.56 mm (0.011—0.022 in.) | |
| Piston Rings—4045TF250 and 6068TF250 Engines | End Gap (No. 1 Compression) End Gap (No. 2 Compression) End Gap (No. 3 Oil Control) | 0.33—0.64 mm (0.013—0.025 in.) 0.75—1.00 mm (0.030—0.039 in.) 0.33—0.64 mm (0.013—0.025 in.) | |
| Cylinder Liner | Height above Block | 0.030—0.100 mm (0.001—0.004 in.) | |
| | Maximum Permissible Difference between Readings within One Cylinder or between Adjacent Cylinders | 0.05 mm (0.002 in.) | |
| Cylinder Liner | Thickness | 5.875—6.375 mm (0.2313—0.2510 in.) | |
| Cylinder Liner Packing Step | Dimension | 2.0185—2.2865 mm (0.07947—0.09002 in.) | |
| Piston Ring-to-Groove Clearance— New Piston Ring (Second and Third Ring Grooves) | Maximum Clearance | 0.20 mm (0.008 in.) | |
| Piston Pin Bore (Small Pin) | ID | 34.935—34.945 mm (1.3754—1.3758 in.) | |
| Piston Pin Bore (Large Pin) | ID | 41.285—41.295 mm (1.6254—1.6258 in.) | |
| Piston Skirt (Measurement Taken at Bottom of Skirt 28 mm [1.1 in.] from Bottom of Piston) | Diameter | 106.38—106.40 mm (4.188—4.189 in.) | |
| Piston | Height (Measured from Center of Pin Bore to Top of Piston) | 71.64—71.70 mm (2.820—2.823 in.) | |
| Piston Skirt | OD 28 mm (1.1 in.) from Bottom of Piston | 106.38—106.40 mm (4.188—4.189 in.) | |
| Cylinder Liner | ID | 106.48—106.52 mm (4.192—4.194 in.) | |

| Item | Measurement | Specification |
|--|----------------------|---|
| Cylinder Liner Out-of-Round (Top or Bottom) | Maximum Out-of-Round | 0.05 mm (0.002 in.) |
| Cylinder Liner Taper | Maximum Taper | 0.05 mm (0.002 in.) |
| Piston-to-Liner Clearance (Measured at Bottom of Piston Skirt) (Naturally Aspirated Engines) | Clearance | 0.08—0.14 mm (0.003—0.005 in.) |
| Piston-to-Liner Clearance (Measured at Bottom of Piston Skirt) (Turbocharged Engines) | Clearance | 0.08—0.15 mm (0.003—0.006 in.) |
| Crankshaft Journal | OD | 77.800—77.826 mm (3.0629—3.0640 in.) |
| Assembled Rod Bearing | ID | 77.876—77.927 mm (3.0659—3.0679 in.) |
| Connecting Rod Bearing-to-Journal (New Parts) | Oil Clearance | 0.050—0.127 mm (0.0020—0.0050 in.) |
| (New Faits) | Wear Limit | 0.152 mm (0.0600 in.) |
| Connecting Rod Bore (Without Bearing Inserts) | ID | 82.677—82.703 mm (3.2550—3.2560 in.) |
| Connecting Rod Bore Maximum Permissible Out-of-Round | Out-of-Round | 0.038 mm (0.0015 in.) |
| Piston Pin (Small) | OD | 34.920—34.930 mm (1.3748—1.3752 in.) |
| | Wear Limit | 34.907 mm (1.3743 in.) |
| Piston Pin (Large) | OD | 41.270—41.280 mm (1.6248—1.6252 in.) |
| | Wear Limit | 41.257 mm (1.6243 in.) |
| Piston Pin | Length | 71.51—72.11 mm (2.815—2.839 in.) |
| Piston Pin Bushing Installed (Small Pin) | ID | 34.950—34.976 mm (1.3760—1.3770 in.) |
| , | Wear Limit | 35.026 mm (1.3790 in.) |

| | Item | Measurement | Specification |
|---------------|---|---------------|---|
| | Piston Pin Bushing Installed (Large Pin) | ID | 41.300—41.326 mm (1.6260—1.6270 in.) |
| | FIII) | Wear Limit | 41.376 mm (1.6290 in.) |
| | Piston Pin-to-Bushing | Oil Clearance | 0.020—0.056 mm (0.0008—0.0022 in.) |
| | | Wear Limit | 0.102 mm (0.0040 in.) |
| | Connecting Rod Small Pin Bore (Bushing Removed) | ID | 38.087—38.113 mm (1.4995—1.5005 in.) |
| | Connecting Rod Large Pin Bore (Bushing Removed) | ID | 46.025—46.051 mm (1.8120—1.8130 in.) |
| | Connecting Rod Pin-to-Bushing (Tapered Pin-End) | Oil Clearance | 0.020—0.056 mm (0.0008—0.0022 in.) |
| | Connecting Rod Pin-to-Bushing (Straight Pin-End) | Oil Clearance | 0.020—0.056 mm (0.0008—0.0022 in.) |
| | (Chargin i iii <u>Lina</u>) | Wear Limit | 0.102 mm (0.0040 in.) |
| | Rod Bearing Bore-to-Piston Pin Bushing Bore (Center-to-Center) | Measurement | 202.95—203.05 mm (7.990—7.994 in.) |
| 16 10 0 | Cylinder Block Oil and Coolant Gallery Plugs | | |
| U | 1/2 in. Plug (W/O Turbocharger, Return Port) | Torque | 45 N•m (33 lb-ft) |
| | 1/4 in. Plug (Coolant Gallery) | Torque | 17 N•m (13 lb-ft) |
| | 1/8 in. Plug (Oil Gallery) | Torque | 17 N•m (13 lb-ft) |
| | 3/8 in. Plug (Oil Gallery) | Torque | 45 N•m (33 lb-ft) |
| | 1-5/8 in. Steel Plug (Coolant Gallery) ¹ | Torque | 60 N•M (44 lb-ft) |
| | 1-5/8 in. Composite Plug (Coolant Gallery) ² | Torque | 30 N•m (22 lb-ft) |
| | | | |

¹ (Saran "CD" engines —540458)

² (Saran "CD" engines 540459—)

| Item | Measurement | Specification |
|---|---------------|---|
| Cylinder Block Main Bearing Bore | ID | 84.455—84.481 mm (3.3250—3.3260 in.) |
| Camshaft Follower Bore in Block | ID | 31.70—31.75 mm (1.248—1.250 in.) |
| Camshaft Follower (New) | OD | 31.61—31.64 mm (1.245—1.246 in.) |
| Camshaft Follower-to-Bore | Clearance | 0.06—0.13 mm (0.002—0.005 in.) |
| Camshaft Bore in Block, Front No. 1 (Without Bushing) | ID | 59.961—59.987 mm (2.3607—2.3617 in.) |
| Camshaft Bore in Block, Front No. 1 (With Bushing) | ID | 55.961—55.987 mm (2.2031—2.2042 in.) |
| Camshaft Bore in Block (All Except No. 1) | ID | 55.986—56.012 mm (2.2042—2.2052 in.) |
| Camshaft Journal-to-Bushing (No. 1 Bore With Bushing) | Oil Clearance | 0.063—0.115 mm (0.0025—0.0045 in.) |
| Camshaft Journal-to-Bushing (All Except No. 1) | Oil Clearance | 0.088—0.140 mm (0.0035—0.0055 in.) |
| Balancer Shaft Bore in Block (Bushing Removed) | ID | 43.262—43.288 mm (1.7032—1.7042 in.) |
| Balancer Shaft Bushing | ID | 40.177—40.237 mm (1.5818—1.5841 in.) |
| Balancer Shaft Journal-to-Bushing | Clearance | 0.016—0.102 mm (0.0006—0.0040 in.) |
| Lower Block Bore for Seating Liner | ID | 115.75—115.80 mm (4.557—4.559 in.) |
| Upper Block Bore for Seating Liner | ID | 120.70—120.75 mm (4.752—4.754 in.) |
| Liner Flange ID in Block | ID | 126.33—126.35 mm (4.973—4.974 in.) |
| | | |

| Item | Measurement | Specification |
|---|----------------------|---|
| OD of Liner at Upper Bore | OD | 120.61—120.69 mm (4.7484—4.7516 in.) |
| Liner-to-Cylinder Block Clearance at Lower Bore | Clearance | 0.035—0.100 mm (0.001—0.004 in.) |
| Liner-to-Cylinder Block Clearance at Upper Bore | Clearance | 0.10—0.14 mm (0.004—0.005 in.) |
| Cylinder Liner | ID | 106.48—106.52 mm (4.192—4.194 in.) |
| Cylinder Wear | Maximum Wear | 0.10 mm (0.004 in.) |
| Cylinder Taper | Maximum Taper | 0.05 mm (0.002 in.) |
| Cylinder Out-of-Round | Maximum Out-of-Round | 0.05 mm (0.002 in.) |
| Cylinder Liner Flange Counterbore Depth in Block | Depth | 5.952—5.988 mm (0.2343—0.2357 in.) |
| Cylinder Liner Flange | Thickness | 6.022—6.058 mm (0.2371—0.2385 in.) |
| Cylinder Block Top Deck | | |
| Maximum Acceptable Out-of-Flat, Entire Length or Width (Used) | Measurement | 0.08 mm (0.003 in.) |
| Maximum Acceptable Out-of-Flat (Any 150 mm [5.90 in.] Length) | Measurement | 0.025 mm (0.001 in.) |
| Top Deck Surface Finish (Surface Grind Only) (AA) | Surface Finish | 0.8—3.2 micrometers (32—125 micro-in.) |
| Top Deck Surface Finish Wave Depth | Maximum Depth | 0.012 mm (0.0005 in.) |
| Main Bearing Bore Centerline-to-Cylinder Block Top Deck | Distance | 337.896—337.972 mm (13.3029—13.3059 in.) |
| Piston Cooling Orifice | Diameter | 1.4 mm (0.055 in.) |
| Piston Cooling Orifice | Torque | 11 N•m (8 lb-ft) (96 lb-in.) |

Repair and General OEM Specifications

| Item | Measurement | Specification |
|--|-------------------|--|
| Push Rod | OD | 9.891—9.917 mm (0.3894—0.3904 in.) |
| Push Rod Bore in Block | ID | 10.00—10.05 mm (0.3937—0.3957 in.) |
| Connecting Rod Cap Screws | Initial Torque | 58 N•m (43 lb-ft) |
| Connecting Rod Cap Screws | Torque-Turn | 1/4 Turn (90—100°) After Initial Torque |
| Piston Protrusion (Using JDG451 or KJD10123 Gauge) | | |
| 4-Cyl. Standard Duty Codes 4801, 4803, 4809. 6-Cyl. Standard Duty Codes 4805, 4807. | Piston Protrusion | 0.08—0.31 mm (0.003—0.012 in.) |
| 4-Cyl. Heavy Duty Code 4804. 6-Cyl. Heavy Duty Codes 4808, 4810. | Piston Protrusion | 0.08—0.25 mm (0.003—0.010 in.) |
| Piston Protrusion (Using Magnetic Base Dial Indicator) | | |
| 4-Cyl. Standard Duty Codes 4801, 4803, 4809. 6-Cyl. Standard Duty Codes 4805, 4807. | Piston Protrusion | 0.15—0.38 mm (0.006—0.015 in.) |
| 4-Cyl. Heavy Duty Code 4804. 6-Cyl. Heavy Duty Codes 4808, 4810. | Piston Protrusion | 0.15—0.33 mm (0.006—0.013 in.) |

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Crankshaft, Main Bearings and Flywheel Specifications

| Item | Measurement | Specification |
|--|---|--|
| Damper | Maximum Radial Runout (Concentricity) | 1.50 mm (0.060 in.) |
| Damper Pulley Outer Ring | Wobble (Maximum) | 1.50 mm (0.060 in.) |
| Damper Pulley Inner Ring | Wobble (Maximum) | 0.5 mm (0.020 in.) |
| Crankshaft Damper Pulley Cap Screws | | |
| Five Cap Screw Mounted Damper (4 Outer Cap Screws) | Torque | 95 N•m (70 lb-ft) |
| Five Cap Screw Mounted Damper (Center Cap Screw) | Torque | 150 N•m (111 lb-ft) |
| Four Cap Screw Mounted Damper | Torque | 80 N•m (60 lb-ft) |
| Crankshaft | End Play | 0.05—0.25 mm (0.002—0.010 in.) |
| Flywheel Face Flatness | Maximum Variation Maximum Variation per 25 mm (1.0 in.) of Travel | 0.23 mm (0.009 in.) 0.013 mm (0.0005 in.) |
| Flywheel Bearing Bore Concentricity | Maximum Variation | 0.127 mm (0.005 in.) |
| Flywheel Pilot Bearing Bore (Option Code 1508) | ID | 34.978—35.004 mm (1.3770—1.3781 in.) |
| Flywheel Pilot Bearing Bore (Option Code 1502 and 1515) | ID | 44.978—45.004 mm (1.7708—1.7719 in.) |
| Flywheel Mounting Cap Screws | Torque | 138 N•m (102 lb-ft) |
| Crankshaft Main Bearing-to-Journal | Oil Clearance | 0.041—0.109 mm (0.0016—0.0043 in.) |
| Crankshaft Main Bearing | ID | 79.391—79.433 mm (3.1256—3.1273 in.) |
| Crankshaft Main Journal | OD | 79.324—79.350 mm (3.1229—3.1240 in.) |

Repair and General OEM Specifications

| Item | Measurement | Specification |
|--|--|---|
| Crankshaft Rod Journal | OD | 77.800—77.826 mm (3.0629—3.0640 in.) |
| Crankshaft Main or Rod Journal | Maximum Taper | 0.010 mm (0.0004 in.) |
| Crankshaft Main or Rod Journal | Maximum Out-of-Round | 0.005 mm (0.0002 in.) |
| Crankshaft Main Thrust Bearing Journal (New) | Width | 38.952—39.028 mm (1.5335—1.5365 in.) |
| Crankshaft Main Thrust Bearing | Overall Width | 38.79—38.87 mm (1.527—1.530 in.) |
| Crankshaft Main Bearing Bore (Without Bearings) | ID | 84.455—84.481 mm (3.3250—3.3260 in.) |
| Crankshaft Main Bearing Bore Centerline-to-Top Deck | Distance | 337.896—337.972 mm (13.3029—13.3059 in.) |
| Piston Cooling Orifice | Diameter | 1.4 mm (0.055 in.) |
| Piston Cooling Orifice | Torque | 11 N•m (8 lb-ft) (96 lb-in.) |
| Crankshaft Main Bearing Cap Screws | Torque | 135 N•m (100 lb-ft) |
| Crankshaft Rear Main (Thrust) Bearing Cap Screws | Torque | 135 N•m (100 lb-ft) |
| Flywheel Housing Cap Screws | Torque | 125 N•m (92 lb-ft) |
| Flywheel Housing Seal Bore | Maximum Permissible Runout (Concentricity) | 0.152 mm (0.006 in.) |
| | | |

DPSG,OUO1004,2718 -19-26APR00-2/2

Camshaft, Balancer Shafts and Timing Gear Train Specifications

| Item | Measurement | Specification |
|---|---|---|
| Intake Valves | Valve Lift [at 0.00 mm (0.00 in.) Valve Clearance] Wear Limit | 11.77—12.21 mm (0.463—0.481 in.) 11.34 mm (0.447 in.) |
| Exhaust Valves | Valve Lift [at 0.00 mm (0.00 in.) Valve Clearance] Wear Limit | 11.51—11.94 mm (0.453—0.470 in.) 11.08 mm (0.436 in.) |
| Auxiliary Drive-to-Cylinder Block Plate | Torque | 95 N•m (70 lb-ft) |
| Auxiliary Drive Cover Plate | Torque | 55 N•m (41 lb-ft) |
| Camshaft | End Play | 0.08—0.23 mm (0.003—0.009 in.) |
| Balancer Shaft | End Play | 0.05—0.26 mm (0.002—0.010 in.) |
| Timing Gear Backlash Specifications | | |
| Camshaft-to-Upper Idler | Backlash | 0.08—0.75 mm (0.0030—0.0291 in.) |
| Injection Pump-to-Upper Idler | Backlash | 0.08—0.75 mm (0.0030—0.0291 in.) |
| Upper Idler-to-Crankshaft | Backlash | 0.06—0.58 mm (0.0025—0.0226 in.) |
| Crankshaft-to-Lower Idler | Backlash | 0.07—0.60 mm (0.0026—0.0236 in.) |
| Oil Pump-to-Lower Idler | Backlash | 0.08—0.60 mm (0.0032—0.0235 in.) |
| Balancer Shaft-to-Oil Pump (4-Cyl. Only) | Backlash | 0.06—0.65 mm (0.0025—0.0254 in.) |
| Lower Idler-to-Balancer Shaft (4-Cyl. Only) | Backlash | 0.07—0.65 mm (0.0028—0.0253 in.) |
| Camshaft-to-Auxiliary Drive | Backlash | 0.05—0.68 mm (0.0021—0.0266 in.) |

Item Measurement Specification Camshaft Thrust Plate Clearance 0.08—0.23 mm (0.003—0.009 in.) Camshaft Thrust Plate Thickness 3.96—4.01 mm (0.156—0.158 in.) Camshaft Bearing Bores and **Journals** Camshaft Journal OD 55.872—55.898 mm (2.1997—2.2007 in.) Camshaft Bore, Front No. 1 in ID 59.961—59.987 mm Block (Without Bushing) (2.3607—2.3617 in.) Camshaft Bore, Front No. 1 in ID 55.961—55.987 mm Block (With Bushing) (2.2031—2.2042 in.) Camshaft Bore, All Except No. 1 ID 55.986—56.012 mm (2.2042—2.2052 in.) Camshaft Journal-to-Bushing, No. Oil Clearance 0.063-0.115 mm 1 Bore (With Bushing) (0.0025—0.0045 in.) Camshaft Journal-to-Bushing, All Oil Clearance 0.088-0.140 mm Except No. 1 Bore (0.0035—0.0055 in.) Camshaft Intake Lobe Height 7.05—7.31 mm (0.278—0.288 in.) Camshaft Exhaust Lobe Height 6.89—7.15 mm (0.271—0.281 in.) Fuel Supply Pump Camshaft Lobe Diameter 41.15—41.41 mm (1.62—1.63 in.) Camshaft Follower OD 31.61-31.64 mm (1.245—1.246 in.) Camshaft Follower Bore in Block ID 31.70—31.75 mm (1.248—1.250 in.) Camshaft Follower-to-Bore Clearance 0.06—0.13 mm (0.002—0.005 in.) Fuel Supply Pump Push Rod OD 9.891—9.917 mm (0.3894—0.3904 in.) Fuel Supply Pump Push Rod Bore in ID 10.00—10.05 mm (0.3937—0.3957 Block in.)

Repair and General OEM Specifications

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|-------------|--|---------------|--|
| | Item | Measurement | Specification |
| | Balancer Shaft Bushing (New) | ID | 40.177—40.237 mm (1.5818—1.5841 in.) |
| | Balancer Shaft Journal | OD | 40.135—40.161 mm (1.5801—1.5811 in.) |
| | Balancer Shaft Journal-to-Bushing | Oil Clearance | 0.016—0.102 mm (0.0006—0.0040 in.) |
| | Cylinder Block Bore ID for Balancer Shaft Bushing | ID | 43.262—43.288 mm (1.7032—1.7042 in.) |
| | Balancer Shaft Thrust Plate (New) | Thickness | 2.97—3.02 mm (0.117—0.119 in.) |
| | Balancer Shaft Thrust Plate-to-Gear | Clearance | 0.05—0.26 mm (0.002—0.010 in.) |
| | Upper Idler Gear Bushing (30 mm Wide Gear) | ID | 69.802—69.832 mm (2.7481— 2.7493 in.) |
| | Upper Idler Gear Bushing (22 mm Wide Gear) | ID | 44.49—44.54 mm (1.751-1.753 in.) |
| | Lower Idler Gear Bushing | ID | 44.489—44.539 mm (1.7515— 1.7535 in.) |
| 6 0 8 | Upper Idler Gear Shaft (30 mm Wide Gear) | OD | 69.757—69.777 mm (2.7463— 2.7471 in.) |
| | Upper Idler Gear Shaft (22 mm Wide Gear) | OD | 44.43—44.46 mm (1.749-1.750 in.) |
| | Lower Idler Gear Shaft | OD | 44.437—44.463 mm (1.7495— 1.7505 in.) |
| | Upper Idler Gear Bushing-to-Shaft | Oil Clearance | 0.075—0.125 mm (0.0030—0.0049 in.) |
| | Lower Idler Gear Bushing-to-Shaft | Oil Clearance | 0.026—0.102 mm (0.0010—0.0040 in.) |
| | Upper Idler Gear | End Play | 0.070—0.170 mm (0.0027—0.0066 in.) |
| | Lower Idler Gear | End Play | 0.070—0.330 mm (0.0027—0.0129 in.) |

| Item | Measurement | Specification |
|---|-------------|-------------------------------|
| Lower and Upper Idler Shaft Spring Pin Protrusion | Protrusion | 2.79—4.83 mm (0.11—0.19 in.) |
| Front Plate Countersunk TORX® Screws | Torque | 25 N•m (18 lb-ft) |
| Front Plate Threaded Studs | Torque | 35 N•m (26 lb-ft) |
| Balancer Shaft Thrust Plate Cap Screws | Torque | 40 N•m (29.5 lb-ft) |
| Balancer Shaft Removable Weights (One-Bolt Weights) | Torque | 58 N•m (43 lb-ft) |
| Balancer Shaft Removable Weights (Two-Bolt Weights) | Torque | 40 N•m (30 lb-ft) |
| Oil Pump Drive Gear Staked Nut | Torque | 50 N•m (37 lb-ft) |
| Lower Idler Gear Cap Screw (Lubricated Threads) | Torque | 70 N•m (53 lb-ft) |
| Camshaft Thrust Plate Cap Screws | Torque | 35 N•m (26 lb-ft) |
| Upper Idler Gear Cap Screw | Torque | 70 N•m (53 lb-ft) |
| Injection Pump Drive Gear Cover | Torque | 6 N•m (4.5 lb-ft) (54 lb-in.) |
| Timing Gear Cover-to-Front Plate and Cylinder Block Cap Screws and Nuts | Torque | 35 N•m (26 lb-ft) |
| Oil Pan-to-Timing Gear Cover | Torque | 35 N•m (26 lb-ft) |
| Mechanical Tachometer Adapter (Stanadyne DB2) | Torque | 122 N•m (90 lb-ft) |
| Mechanical Tachometer Adapter (Stanadyne DB4) | Torque | 203 N•m (150 lb-ft) |
| Mechanical Tachometer Adapter (Lucas) | Torque | 81 N•m (60 lb-ft) |
| | | |

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Repair and General OEM Specifications

| Item | Measurement | Specification | |
|-----------------------------------|-------------|-----------------------------------|--|
| Mechanical Tachometer Cover Plate | Torque | 6 N•m (4.5 lb-ft) (54 lb-in.) | |
| Magnetic Pick-Up Sensor | Torque | 15 N•m (11 lb-ft) | |
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| | | | |
| | | | |
| | | DPSG,OUO1004,2726 -19-26APR00-5/5 | |

Lubrication System Specifications

| Item | Measurement | Specification |
|--|---|--|
| Oil Filter Header Cap Screws (High, Front and Rear Mounted) | Torque | 35 N•m (26 lb-ft) |
| Oil Filter Header-to-Bracket Cap Screws (Left Hand and Remote Mounted) | Torque | 73 N•m (54 lb-ft) |
| Oil Cooler Cover Cap Screw | Torque | 35 N•m (26 lb-ft) |
| Turbocharger Oil Inlet Line | Torque | 18 N•m (13 lb-ft) |
| Remote Oil Filter Line End Nuts | Torque | 66 N•m (49 lb-ft) |
| Oil Cooler-to-Housing Allen Head Cap Screws | Torque | 12 N•m (106 lb-in.) |
| Oil Cooler Elbow Adapter Cap Screws | Torque | 35 N•m (26 lb-ft) |
| Oil Cooler Cover Cap Screws (Remote Filter Applications) | Torque | 35 N•m (26 lb-ft) |
| Oil Cooler Line End Nuts (Remote Filter Applications) | Torque | 66 N•m (49 lb-ft) |
| Oil Cooler Drain Plug | Torque | 5 N•m (60 lb-in.) |
| Oil Bypass Valve Springs | Free Length Spring Load at 29 mm (1.14 in.) Compressed Length | 51 mm (2.00 in.) 87.8 N (20 lb-force) |
| Oil Pressure Regulating Valve Spring Specifications | | |
| 4-Cylinder Engines (Except for Saran Engines Listed Below) | Spring Free Length | 115.5 mm (4.55 in.) |
| 4-Cylinder Engines (Except for Saran Engines Listed Below) | Spring Load at 42.5 mm (1.68 in.) | 40.5—49.4 N (9.1—11.1 lb-force) |
| 6-Cylinder Engines and CD4045HF157/158, CD4045TF157/158 and CD4045TF257/258 | Spring Free Length | 119 mm (4.68 in.) |

| Item | Measurement | Specification |
|---|-----------------------------------|---|
| 6-Cylinder Engines and CD4045HF157/158, CD4045TF157/158 and CD4045TF257/258 | Spring Load at 42.5 mm (1.68 in.) | 60.1—73.4 N (13.5—16.5 lb-force) |
| Oil Pressure Regulating Valve | Torque | 95 N•m (70 lb-ft) |
| Oil Fill Tube Cap Screws | Torque | 35 N•m (26 lb-ft) |
| Oil Pump Pick-Up Tube Cap Screws | Torque | 35 N•m (26 lb-ft) |
| Oil Pump Gears | Thickness | 35.975—36.025 mm (1.4163—1.4183 in.) |
| Oil Pump Gears | Axial Clearance | 0.045—0.165 mm (0.0018—0.0065 in.) |
| Oil Pump Gears | Radial Clearance | 0.131—0.211 mm (0.005—0.008 in.) |
| Oil Pump Drive Shaft | OD | 16.017—16.037 mm (0.6306—0.6314 in.) |
| Oil Pump Bushing in Housing | ID | 16.052—16.102 mm (12.316—12.332 in.) |
| Oil Pump Idler Shaft | OD | 12.316—12.332 mm (0.4849—0.4855 in.) |
| Oil Pump Idler Gear | ID | 12.355—12.363 mm (0.4864—0.4867 in.) |
| Oil Pump Drive Gear "Staked" Nut | Torque | 50 N•m (37 lb-ft) |
| Oil Pump-to-Front Plate and Oil Pump Pick-Up Tube Cap Screws | Torque | 35 N•m (26 lb-ft) |
| Oil Pump Lower Idler Gear Cap Screw (Lubricated Threads) | Torque | 70 N•m (53 lb-ft) |
| Oil Pan Cap Screws | | |
| M8 Cap Screws | Torque | 35 N•m (26 lb-ft) |
| M10 Cap Screws up to 110 mm | Torque | 70 N•m (52 lb-ft) |

Repair and General OEM Specifications

| Item | Measurement | Specification |
|--|-------------|-----------------------------------|
| M10 Cap Screws 110 mm and Above | Torque | 60 N•m (44 lb-ft) |
| M10 Cap Screws on PE4045DLV50 and PE4045TLV50 Engines Only | Torque | 44 N•m (33 lb-ft) |
| RE70330 (Option Code 1924) Oil Pan | Torque | 20 N•m (15 lb-ft) |
| Oil Pan Drain Plug | | |
| Plug with Copper Washer | Torque | 70 N•m (52 lb-ft) |
| Plug with O-Ring | Torque | 50 N•m (37 lb-ft) |
| | | |
| | | |
| | | |
| | | DPSG,OUO1004,2730 -19-26APR00-3/3 |

06 200 23

Cooling System Specifications

| Item | Measurement | Specification |
|---|-------------------|--|
| Water Manifold/Thermostat Cover Cap Screws (Single Thermostat) | Torque | 70 N•m (52 lb-ft) |
| Thermostat Cover-to-Water Manifold Cap Screws (6010 Series Tractors with Single Thermostat) | Torque | 30 N•m (22 lb-ft) |
| Water Manifold-to-Cylinder Head Cap Screws (6010 Series Tractors with Single Thermostat) | Torque | 35 N•m (26 lb-ft) |
| Water Pump Impeller Bore | ID | 11.973—11.999 mm (0.4714—0.4724 in.) |
| Water Pump Bearing Shaft (Impeller End) | OD | 12.025—12.038 mm (0.4734—0.4739 in.) |
| Water Pump Bearing Shaft (Pulley End) | OD | 39.997—40.013 mm (1.5747—1.5753 in.) |
| Water Pump Housing Bearing Bore | ID | 61.961—61.987 mm (2.4394—2.4404 in.) |
| Water Pump Impeller (Standard Flow) | Position | 2.46—2.58 mm (0.096—0.102 in.) below end of shaft |
| Water Pump Impeller (High Flow) | Position | Flush $\pm~0.13~\text{mm}$ (0.005 in.) with end of shaft |
| Water Pump Housing-to-Impeller | Minimum Clearance | 0.27 mm (0.010 in.) |
| Water Pump Pulley Cap Screws | Torque | 15 N•m (11 lb-ft) |
| Water Pump-to-Timing Cover Cap Screws | Torque | 16 N•m (12 lb-ft) |
| Water Pump Inlet Elbow Cap Screws | Torque | 35 N•m (26 lb-ft) |
| Fan-to-Pulley Hub M8 Cap Screws | Torque | 35 N•m (26 lb-ft) |
| Fan-to-Pulley Hub M10 Cap Screws | Torque | 70 N•m (52 lb-ft) |
| Belt Tensioner-to-Timing Cover and Engine Cap Screws | Torque | 50 N•m (37 lb-ft) |

| Item | Measurement | Specification |
|--|---------------------------------------|---|
| Belt Tensioner Pulley Cap Screw | Torque | 40 N•m (29 lb-ft) |
| Belt Tensioner | Spring Tension | 18—22 N•m (13—16 lb-ft) |
| 8-Rib Poly-Vee Belt | New Belt Tension Used Belt Tension | 535—715 N (120—160 lb-force) 400—580 N (90—130 lb-force) |
| Fan Drive (Option Codes 2301 and 2302) | | |
| Bearing Housing | ID | 38.018—38.038 mm (1.4968— 1.4976 in.) |
| Bearing | OD | 38.087—38.100 mm (1.4995— 1.5000 in.) |
| Shaft | OD | 18.948—18.961 mm (0.7460— 0.7465 in.) |
| Hub | ID | 18.910—18.936 mm (0.7445— 0.7455 in.) |
| Fan Drive (Option Codes 2303, 2304, 2312, 2313, and 2314) | | |
| Bearing Housing | ID | 47.573—47.599 mm (1.8730— 1.8740 in.) |
| Bearing | OD | 47.612—47.625 mm (1.8745— 1.8750 in.) |
| Shaft | OD | 25.387—25.400 mm (0.9995— 1.0000 in.) |
| Hub | ID | 25.337—25.353 mm (0.9975— 0.9985 in.) |
| Fan Drive | | |
| Rear Housing Face-to-Hub Front Face (Option Codes 2301 and 2303) | Distance | 110.85—110.87 mm (4.364—4.365 in.) |

Repair and General OEM Specifications

| Item | Measurement | Specification |
|--|-------------|------------------------------------|
| Rear Housing Face-to-Hub Front Face (Option Codes 2302, 2304, 2312, 2313 and 2314) | Distance | 106.65—106.67 mm (4.199—4.200 in.) |
| Fan Drive Idler Cap Screw | Torque | 50 N•m (37 lb-ft) |
| Fan Drive Assembly-to-Timing Cover Cap Screws | Torque | 70 N•m (52 lb-ft) |
| Fan Pulley-to-Pulley Hub M8 Cap Screws | Torque | 35 N•m (26 lb-ft) |
| Fan Pulley-to-Pulley Hub M10 Cap Screws | Torque | 70 N•m (52 lb-ft) |
| Rear Housing Face-to-Hub Front Face | Distance | 123.5 mm (4.862 in.) |
| Fan Drive Assembly (2254 Combine) | | |
| Fan Idler Axle Shaft-to-Block | Torque | 340 N•m (251 lb-ft) |
| Fan Idler-to-Shaft Retaining Nut | Torque | 225 N•m (166 lb-ft) |
| Fan Drive Bracket-to-Block Cap Screw | Torque | 340 N•m (251 lb-ft) |
| Fan Drive Bracket-to-Cylinder Head Cap Screws | Torque | 140 N•m (103 lb-ft) |
| Upper Fan Drive Bracket-to-Lower Bracket Cap Screws/Nuts | Torque | 140 N•m (103 lb-ft) |
| Coolant Heater Lock Nut | Torque | 35 N•m (26 lb-ft) |
| Cold Start Switch | Torque | 5 N•m (44 lb-in.) |
| | | |
| | | |
| | | |
| | | DPSG,OUO1004,2734 -19-26APR00-3/3 |

Air Intake and Exhaust System Specifications

| Item | Measurement | Specification |
|--|--------------------------|--|
| Turbocharger (AiResearch/Garret) | Radial Bearing Clearance | 0.08—0.18 mm (0.003—0.007 in.) maximum |
| Turbocharger (CZ) | Radial Bearing Clearance | 0.37—0.46 mm (0.015—0.018 in.) maximum |
| Turbocharger (AiResearch/Garret) | Axial Bearing End Play | 0.025—0.102 mm (0.001—0.004 in.) |
| Turbocharger (CZ) | Axial Bearing End Play | 0.11—0.16 mm (0.004—0.006 in.) |
| Turbocharger | Actuator End Play | 0.05—0.056 mm (0.002—0.022 in.) |
| Turbocharger-to-Exhaust Manifold Nuts | Torque | 70 N•m (52 lb-ft) |
| Turbocharger Oil Return Pipe Cap Screws | Torque | 24 N•m (18 lb-ft) |
| Turbocharger Oil Inlet Line (At Turbocharger) | Torque | 24 N•m (18 lb-ft) |
| Turbocharger Oil Inlet Line (At Oil Filter Header) | Torque | 18 N•m (13 lb-ft) |
| Turbocharger Air Inlet Hose Clamp | Torque | 6 N•m (4.5 lb-ft) (54 lb-in.) |
| Exhaust Adapter-to-Turbocharger Clamp | Torque | 7.5 N•m (5.5 lb-ft) (66 lb-in.) |
| Turbocharger Exhaust Elbow | Torque | 47 N•m (35 lb-ft) |
| Exhaust Manifold-to-Cylinder Head Cap Screws | Torque | 70 N•m (52 lb-ft) |
| Air Intake Pipe-to-Cylinder Head | Torque | 70 N•m (52 lb-ft) |
| Air Intake Pipe Hose Clamp | Torque | 6 N•m (4.5 lb-ft) (54 lb-in.) |
| | | |

Starting and Charging Systems Specifications

| Item | Measurement | Specification |
|--|-------------|-----------------------------------|
| Alternator Strap or Tensioner Support-to-Timing Gear Cover | Torque | 25 N•m (18 lb-ft) |
| Tensioner Support or Alternator Strap Support-to-Alternator Bracket | Torque | 70 N•m (52 lb-ft) |
| Alternator Bracket-to-Block | Torque | 70 N•m (52 lb-ft) |
| Alternator Pulley Nut | Torque | 80 N•m (60 lb-ft) |
| | | |
| | | |
| | | DPSG,OUO1004,1144 -19-18NOV99-1/1 |



Group 210 Diagnostic Specifications

Dynamometer Test Specifications

Power ratings for various injection pump options are provided for OEM applications on the charts that follow. For Construction Equipment applications, refer to SP458 Specifications Handbook. For North American Agricultural applications, refer to DB1216 Specifications Handbook. If specifications are not listed in handbooks, refer to factory DTAC for assistance.

Continued on next page

RG,100,JW7641 -19-10JAN00-1/8



NOTE: The power specifications shown below apply to Dubuque, Torreon and Saran-built OEM engines. Specifications are subject to change. Refer to factory DTAC for assistance.

Engine speeds listed are as preset to factory specification. In most cases, slow idle speed will be reset depending upon specific vehicle application requirements. Refer to your machine technical manual for engine speeds that are different from those preset at the factory.

Power ratings specify flywheel power without fan.

| | | POWER RATI | NGS ON DYNAM | OMETER FOR O | EM ENGINES | | |
|--------------|----------------------------------|---|--|------------------------|-------------------|-----------------|-----------------------|
| Engine Model | Injection Pump Option Code | Original Injection Pump (Part No.) | Replaced By Injection Pump (Part No.) | Governor Regulation | Rated Speed (rpm) | Fast Idle (rpm) | Power Rating kW (BHP) |
| 4045DF120 | 16MR | RE504463 | | STD | 2500 | 2700 | 63 (85) |
| | 16MS | RE504464 | | STD | 2500 | 2700 | 63 (85) |
| 4045DF150 | 1601 | RE61649 | RE67557 | STD | 2500 | 2700 | 60 (80) |
| | 1601 | RE67557 | | STD | 2500 | 2700 | 60 (80) |
| | 1602 | RE59809 | | STD | 2500 | 2700 | 63 (85) |
| | 1603 | RE63555 | RE67558 | 3—5% | 1800 | 1870 | 53 (71) |
| | 1603 | RE67558 | RE505070 | 3—5% | 1800 | 1870 | 53 (71) |
| | 1603 | RE505070 | RE506132 | 3—5% | 1800 | 1870 | 53 (71) |
| | 1603 | RE506132 | | 3—5% | 1800 | 1870 | 53 (71) |
| | 1663 | RE71089 | RE500949 | STD | 2500 | 2700 | 60 (80) |
| | 1663 | RE500949 | | STD | 2500 | 2700 | 60 (80) |
| | 1671 | RE67559 | RE502714 | STD | 2500 | 2700 | 60 (80) |
| | 1671 | RE502714 | | STD | 2500 | 2700 | 60 (80) |
| | 1673 | RE60085 | RE67560 | 3—5% | 1800 | 1870 | 53 (71) |
| | 1673 | RE67560 | RE506130 | 3—5% | 1800 | 1870 | 53 (71) |
| | 1673 | RE506130 | | 3—5% | 1800 | 1870 | 53 (71) |
| | 1674 | RE60089 | RE67561 | 3—5% | 1800 | 1870 | 53 (71) |
| | 1674 | RE67561 | RE506131 | 3—5% | 1800 | 1870 | 53 (71) |
| | 1674 | RE506131 | | 3—5% | 1800 | 1870 | 53 (71) |
| | 1691 | RE61649 | RE500831 | STD | 2500 | 2700 | 60 (80) |
| | 1691 | RE500831 | RE500948 | STD | 2500 | 2700 | 60 (80) |
| | 1691 | RE500948 | | STD | 2500 | 2700 | 60 (80) |
| | 16BG | RE69778 | RE502712 | STD | 2500 | 2700 | 63 (85) |
| | 16BG | RE502712 | | STD | 2500 | 2700 | 63 (85) |
| | 16BH | RE500873 | RE502715 | STD | 2500 | 2700 | 63 (85) |
| | 16BH | RE502715 | | STD | 2500 | 2700 | 63 (85) |
| | 16BJ | RE500589 | | STD | 2250 | 2450 | 36 (48) |
| | 16CL | RE501364 | RE502713 | STD | 2200 | 2400 | 58 (78) |
| | 16CL | RE502713 | | STD | 2200 | 2400 | 58 (78) |
| | 16DL | RE70452 | | STD | 2400 | 2600 | 61 (82) |
| | 16EN | RE502019 | | STD | 2500 | 2700 | 60 (80) |
| | 16GB | RE502711 | | STD | 2500 | 2700 | 60 (80) |
| | 16GC | RE502716 | | STD | 2500 | 2700 | 60 (80) |
| | 16HJ | RE500948 | | STD | 2500 | 2700 | 60 (80) |

Continued on next page

RG,100,JW7641 -19-10JAN00-2/8

| Engine Model | Injection Pump Option Code | Original Injection Pump (Part No.) | Replaced By Injection Pump (Part No.) | Governor Regulation | Rated Speed (rpm) | Fast Idle (rpm) | Power Rating |
|--------------|----------------------------------|---|--|------------------------|-------------------|-----------------|--------------|
| | 16HK | RE500949 | | STD | 2500 | 2700 | 60 (80) |
| | 16HV | RE503258 | | STD | 2250 | 2450 | 36 (48) |
| | 16KE | RE503560 | | STD | 2500 | 2700 | 52 (70) |
| | 16LM | RE502711 | | STD | 2500 | 2700 | 53 (71) |
| | 16LN | RE67558 | RE505070 | 3—5% | 1800 | 1870 | 53 (71) |
| | 16LN | RE505070 | RE506132 | 3—5% | 1800 | 1870 | 53 (71) |
| | 16LN | RE506132 | | 3—5% | 1800 | 1870 | 53 (71) |
| | 16RB | RE503729 | | 3—5% | 1500 | 1560 | 44 (59) |
| | 16RC | RE504693 | | 3—5% | 1500 | 1560 | 44 (59) |
| 4045DF151 | 1663 | RE71089 | RE500949 | STD | 2500 | 2700 | 60 (80) |
| | 1663 | RE500949 | | STD | 2500 | 2700 | 60 (80) |
| 4045DF152 | 1601 | RE67557 | | STD | 2500 | 2700 | 60 (80) |
| | 16GB | RE502711 | | STD | 2500 | 2700 | 60 (80) |
| 4045DF153 | 16AY | RE500505 | | STD | 2400 | 2600 | 62 (83) |
| 4045DF154 | 16AY | RE500505 | | STD | 2400 | 2600 | 62 (83) |
| | 16JS | RE500505 | | STD | 2400 | 2600 | 62 (83) |
| 4045DF157 | 16AA | RE503729 | | 3—5% | 1500 | 1560 | 44 (59) |
| | 16BB | RE504693 | | 3—5% | 1500 | 1560 | 44 (59) |
| 4045DF158 | 1673 | RE67560 | | 3—5% | 1800 | 1870 | 53 (71) |
| 10 1021 100 | 1674 | RE67561 | | 3—5% | 1800 | 1870 | 53 (71) |
| | 16AA | RE503729 | | 3—5% | 1500 | 1560 | 44 (59) |
| | 16BB | RE504693 | | 3—5% | 1500 | 1560 | 44 (59) |
| | 16CC | RE503731 | | 3—5% | 1800 | 1870 | 53 (71) |
| | 16DD | RE504694 | | 3—5% | 1800 | 1870 | 53 (71) |
| 4045DFM50 | 16HR | RE503164 | | STD | 2500 | 2700 | 63 (85) |
| +0+0D1 W00 | 16HS | RE503165 | | STD | 2500 | 2700 | 63 (85) |
| | 16HT | RE503166 | | 3—5% | 1800 | 1870 | 48 (64) |
| | 16HU | RE503167 | | 3—5% | 1800 | 1870 | 48 (64) |
| 4045HF120 | 16GR | RE503050 | | 3—5% | 1500 | 1560 | 102 (137) |
| 4043111 120 | 16LW | RE503832 | | 3—5% | 1500 | 1560 | 102 (137) |
| 4045HF150 | 1610 | RE68826 | | STD | 2400 | 2600 | 102 (137) |
| 4043111 130 | 1611 | RE60237 | | 3—5% | 1800 | 1870 | 95 (127) |
| | 160B | RE68827 | | 3—5% | 1800 | 1870 | |
| | 160C | RE69588 | | STD | 2400 | 2600 | 95 (127) |
| | 16GR | RE503050 | | 3—5% | 1500 | 1560 | 104 (140) |
| | 16LW | RE503050 RE503832 | + | 3—5% | 1500 | 1560 | 100 (134) |
| | 16QZ | | | 3—5% | 1800 | 1870 | |
| | | RE503050 | + | | + | + | 111 (149) |
| 4045UE457 | 16RA | RE503832 | + | 3—5% | 1800 | 1870 | 111 (149) |
| 4045HF157 | 16GR | RE503050 | | 3—5% | 1500 | 1560 | 100 (134) |
| 404EUU4E0 | 16LW | RE503832 | | 3—5% | 1500 | 1560 | 100 (134) |
| 4045HF158 | 16GR 16LW | RE503050 RE503832 | | 3—5% 3—5% | 1500 | 1560 1560 | 100 (134) |

| Engine Model | Injection Pump Option Code | Original Injection Pump (Part No.) | Replaced By Injection Pump (Part No.) | Governor Regulation | Rated Speed (rpm) | Fast Idle (rpm) | Power Ratin kW (BHP) |
|--------------|----------------------------------|---|--|------------------------|-------------------|-----------------|-------------------------|
| Engine Model | 16ME | RE503739 | 140.) | 3—5% | 1800 | 1870 | 123 (170) |
| | 16MF | RE504698 | RE504966 | 3—5% | 1800 | 1870 | 123 (170) |
| | 16MF | RE504966 | 112004300 | 3—5% | 1800 | 1870 | 123 (170) |
| 4045TF120 | 16MT | RE503733 | | 3—5% | 1500 | 1560 | 70 (94) |
| 104311 120 | 16MU | RE505050 | | 3—5% | 1500 | 1560 | 70 (94) |
| 4045TF150 | 1605 | RE61668 | RE69781 | STD | 2500 | 2700 | 86 (115) |
| 404011 100 | 1605 | RE69781 | INEGOTO! | STD | 2500 | 2700 | 86 (115) |
| | 1606 | RE64133 | | STD | 2400 | 2600 | 93 (125) |
| | 1656 | RE63610 | RE67562 | 3—5% | 1800 | 1870 | 75 (100) |
| | 1656 | RE67562 | 11207302 | 3—5% | 1800 | 1870 | 75 (100) |
| | 1675 | RE60091 | RE69782 | STD | 2500 | 2700 | 86 (115) |
| | 1675 | RE69782 | 11203702 | STD | 2500 | 2700 | 86 (115) |
| | 1676 | RE60093 | | STD | 2500 | 2700 | 86 (115) |
| | 1677 | RE60096 | RE67563 | 3—5% | 1800 | 1870 | 75 (100) |
| | 1677 | RE67563 | KE07303 | 3—5% | 1800 | 1870 | 75 (100) |
| | 1692 | RE61668 | RE500881 | STD | 2500 | 2700 | 86 (115) |
| | 1692 | RE500881 | RE502416 | STD | 2500 | 2700 | 86 (115) |
| | 1692 | RE502416 | KE302410 | STD | 2500 | 2700 | 1 1 |
| | 1694 | RE67863 | RE69779 | STD | 2500 | 2700 | 86 (115) |
| | | | RE09779 | STD | + | + | 75 (100) |
| | 1694 | RE69779 | DE60700 | + | 2500 | 2700 | 75 (100) |
| | 1695 | RE69739 | RE69780 | STD | 2500 | 2700 | 75 (100) |
| | 1695 | RE69780 | | STD | 2500 | 2700 | 75 (100) |
| | 16AB | RE69779 | | STD | 2500 | 2700 | 75 (100) |
| | 16BF | RE500848 | | STD | 2200 | 2400 | 73 (98) |
| | 16CE | RE501180 | | STD | 2500 | 2700 | 75 (100) |
| | 16CM | RE501365 | | STD | 2200 | 2400 | 66.6 (89) |
| | 16GL | RE502706 | | STD | 2300 | 2500 | 78 (105) |
| | 16LP | RE67562 | | 3—5% | 1800 | 1870 | 75 (100) |
| | 16LZ | RE503735 | | 3—5% | 1800 | 1870' | 70 (94) |
| | 16MA | RE504696 | RE504931 | 3—5% | 1800 | 1870 | 82 (110) |
| | 16MA | RE504931 | | 3—5% | 1800 | 1870 | 82 (110) |
| | 16MT | RE503733 | RE505050 | 3—5% | 1500 | 1560 | 70 (94) |
| | 16MT | RE505050 | | 3—5% | 1500 | 1560 | 70 (94) |
| | 16MU | RE504695 | RE505050 | 3—5% | 1500 | 1560 | 70 (94) |
| | 16MU | RE505050 | | 3—5% | 1500 | 1560 | 70 (94) |
| 045TF151 | 1677 | RE67563 | | 3—5% | 1800 | 1870 | 75 (100 |
| | 16CU | RE501192 | | STD | 2200 | 2400 | 79.5 (107) |
| | 16NH | RE505411 | | 3—5% | 1800 | 2240 | 75 (100) |
| 045TF152 | 16AX | RE500551 | | STD | 2400 | 2600 | 76 (102) |
| 045TF154 | 1605 | RE69781 | | STD | 2500 | 2700 | 86 (115) |
| 1045TF155 | 16AX | RE500551 | | STD | 2400 | 2600 | 76 (102) |
| | 16JT | RE500551 | | STD | 2400 | 2600 | 76 (102) |

Continued on next page

RG,100,JW7641 -19-10JAN00-4/8

| Engine Model | Injection Pump Option Code | Original Injection Pump (Part No.) | Replaced By Injection Pump (Part No.) | Governor Regulation | Rated Speed (rpm) | Fast Idle (rpm) | Power Rating |
|--------------|----------------------------------|---|--|------------------------|-------------------|-----------------|--------------|
| 4045TF157 | 16GQ | RE503048 | | 3—5% | 1500 | 1560 | 83 (111) |
| | 16LV | RE503830 | | 3—5% | 1500 | 1560 | 83 (111) |
| 4045TF158 | 16GQ | RE503048 | | 3—5% | 1500 | 1560 | 83 (111) |
| | 16LZ | RE503735 | | 3—5% | 1800 | 1870 | 82 (110) |
| | 16MA | RE504696 | | 3—5% | 1800 | 1870 | 82 (110) |
| | 16MT | RE503733 | | 3—5% | 1500 | 1560 | 70 (94) |
| | 16MU | RE504695 | RE505050 | 3—5% | 1500 | 1560 | 70 (94) |
| | 16MU | RE505050 | | 3—5% | 1500 | 1560 | 70 (94) |
| 4045TF220 | 16GQ | RE503048 | | 3—5% | 1500 | 1560 | 83 (111) |
| | 16LV | RE503830 | | 3—5% | 1500 | 1560 | 83 (111) |
| | 16MV | RE503736 | | 3—5% | 1800 | 1870 | 100 (134) |
| | 16MW | RE505051 | | 3—5% | 1800 | 1870 | 100 (134) |
| | 16NT | RE504465 | | STD | 2500 | 2700 | 86 (115) |
| | 16NU | RE504466 | | STD | 2500 | 2700 | 86 (115) |
| 4045TF250 | 1606 | RE64133 | | STD | 2400 | 2600 | 93 (125) |
| 404311 230 | 1608 | RE67564 | | 3—5% | 1800 | 1870 | 84 (113) |
| | 1667 | RE59968 | | STD | 2400 | 2600 | 93 (125) |
| | 1682 | RE67566 | | 3—5% | 1800 | 1870 | 84 (113) |
| | 1683 | RE60124 | | STD | 2400 | 2600 | 93 (125) |
| | 160R | RE70941 | | 3—5% | 1800 | 1870 | 84 (113) |
| | 16CV | RE501346 | | STD | 2200 | 2400 | 85 (114) |
| | 16GQ | RE501346 | | 3—5% | 1500 | 1560 | <u> </u> |
| | | | | | | 1 | 83 (111) |
| | 16LQ | RE67564 | | 3—5% | 1800 | 1870 | 84 (113) |
| | 16LV | RE503830 | | 3—5% | 1500 | 1560 | 83 (111) |
| | 16MB | RE503737 | | 3—5% | 1800 | 1870 | 91(122) |
| | 16MC | RE504932 | | 3—5% | 1800 | 1870 | 91 (122) |
| 4045TF251 | 1606 | RE64133 | | STD | 2400 | 2600 | 93 (125) |
| 4045TF257 | 16GQ | RE503048 | | 3—5% | 1500 | 1560 | 83 (111) |
| | 16LV | RE503830 | | 3—5% | 1500 | 1560 | 83 (111) |
| 4045TF258 | 16GQ | RE503048 | | 3—5% | 1500 | 1560 | 83 (111) |
| | 16LV | RE503830 | | 3—5% | 1500 | 1560 | 83 (111) |
| | 16MB | RE503737 | | 3—5% | 1800 | 1870 | 91 (122) |
| | 16MC | RE504932 | | 3—5% | 1800 | 1870 | 91 (122) |
| | 16MV | RE503736 | | 3—5% | 1800 | 1870 | 100 (134) |
| | 16MW | RE504682 | | 3—5% | 1800 | 1870 | 100 (134) |
| 4045TFM50 | 16HM | RE503163 | | 3—5% | 1800 | 1870 | 71 (95) |
| | 16HN | RE503162 | | 3—5% | 1800 | 1870 | 71 (95) |
| | 16HP | RE503861 | | STD | 2500 | 2700 | 101 (135) |
| | 16HQ | RE503860 | | STD | 2500 | 2700 | 101 (135) |
| | 16LK | RE503160 | | STD | 2600 | 2800 | 112 (150) |
| | 16LL | RE503161 | | STD | 2600 | 2800 | 112 (150) |
| 6068DF150 | 1613 | RE59861 | | STD | 2500 | 2700 | 93 (125) |

CTM104 (19JUN00)

| Engine Model | Injection Pump Option Code | Original Injection Pump (Part No.) | Replaced By Injection Pump (Part No.) | Governor Regulation | Rated Speed (rpm) | Fast Idle (rpm) | Power Rating |
|--------------|----------------------------------|---|--|------------------------|-------------------|-----------------|--------------|
| | 1678 | RE60101 | | STD | 2500 | 2700 | 93 (125) |
| | 16LR | RE59861 | | STD | 2500 | 2700 | 93 (125) |
| 6068HF120 | 16GT | RE503051 | | 3—5% | 1500 | 1560 | 155 (208) |
| | 16LY | RE503834 | | 3—5% | 1500 | 1560 | 155 (208) |
| | 16RL | RE506085 | | 3—5% | 2100 | 2200 | 197 (264) |
| | 16SJ | RE506627 | | 3—5% | 2100 | 2200 | 197 (264) |
| 6068HF150 | 1621 | RE66575 | | STD | 2400 | 2600 | 157 (210) |
| | 160D | RE69589 | | STD | 2400 | 2600 | 157 (210) |
| | 16CY | RE501345 | | STD | 2200 | 2400 | 143 (192) |
| | 16GT | RE503051 | | 3—5% | 1500 | 1560 | 153 (205) |
| | 16LY | RE503836 | | 3—5% | 1500 | 1560 | 153 (205) |
| | 16ML | RE503746 | | 3—5% | 1800 | 1870 | 187 (251) |
| | 16MM | RE504702 | RE505049 | 3—5% | 1800 | 1870 | 187 (251) |
| | 16MM | RE505049 | | 3—5% | 1800 | 1870 | 187 (251) |
| | 16QV | RE503051 | | 3—5% | 1800 | 1870 | 166 (223) |
| | 16QW | RE503836 | | 3—5% | 1800 | 1870 | 166 (223) |
| 6068HF157 | 16GT | RE503051 | | 3—5% | 1500 | 1560 | 153 (205) |
| | 16LY | RE503836 | | 3—5% | 1500 | 1560 | 153 (205) |
| 6068HF158 | 16GT | RE503051 | | 3—5% | 1500 | 1560 | 153 (205) |
| | 16LY | RE503836 | | 3—5% | 1500 | 1560 | 153 (205) |
| | 16ML | RE503746 | | 3—5% | 1800 | 1870 | 187 (251) |
| | 16MM | RE504702 | RE505049 | 3—5% | 1800 | 1870 | 187 (251) |
| | 16MM | RE505049 | | 3—5% | 1800 | 1870 | 187 (251) |
| 6068HF250 | 1622 | RE59521 ^a | | STD | 2400 | 2600 | 168 (225) |
| | 1623 | RE66761 ^a | | 3—5% | 1800 | 1870 | 148 (198) |
| 6068TF120 | 16MX | RE503740 | | 3—5% | 1500 | 1560 | 105 (141) |
| | 16MY | RE505052 | | 3—5% | 1500 | 1560 | 105 (141) |
| 6068TF150 | 1614 | RE61669 | RE69789 | STD | 2500 | 2700 | 127 (170) |
| | 1614 | RE69789 | | STD | 2500 | 2700 | 127 (170) |
| | 1680 | RE60105 | RE69790 | STD | 2500 | 2700 | 127 (170) |
| | 1680 | RE69790 | | STD | 2500 | 2700 | 127 (170) |
| | 1681 | RE67571 | | 3—5% | 1800 | 1870 | 112 (150) |
| | 1688 | RE67572 | | 3—5% | 1800 | 1870 | 112 (150) |
| | 1696 | RE67864 | RE69787 | STD | 2500 | 2700 | 116 (155) |
| | 1696 | RE69787 | | STD | 2500 | 2700 | 116 (155) |
| | 1697 | RE68740 | RE69788 | STD | 2500 | 2700 | 116 (155) |
| | 1697 | RE69788 | 1 | STD | 2500 | 2700 | 116 (155) |
| | 16BE | RE63559 | RE501302 | STD | 2200 | 2400 | 117 (157) |
| | 16BE | RE501302 | | STD | 2200 | 2400 | 117 (157) |
| | 16CN | RE501522 | | STD | 2100 | 2300 | 110.5 (148) |
| | 16CP | RE501523 | | STD | 2200 | 2400 | 94 (126) |

Continued on next page

RG,100,JW7641 -19-10JAN00-6/8

| Engine Model | Injection Pump Option Code | Original Injection Pump (Part No.) | Replaced By Injection Pump (Part No.) | Governor Regulation | Rated Speed (rpm) | Fast Idle (rpm) | Power Rating |
|--------------|----------------------------------|---|--|------------------------|-------------------|-----------------|--------------|
| | 16DK | RE70938 | | STD | 2100 | 2300 | 96 (129) |
| | 16DY | RE501758 | | STD | 2500 | 2700 | 116 (155) |
| | 16GM | RE502693 | | STD | 2300 | 2500 | 110 (148) |
| | 16GN | RE502704 | | STD | 2400 | 2600 | 116 (155) |
| | 16LS | RE67572 | | 3—5% | 1800 | 1870 | 112 (150) |
| | 16MG | RE503742 | | 3—5% | 1800 | 1870 | 123 (165) |
| | 16MH | RE504967 | | 3—5% | 1800 | 1870 | 123 (165) |
| 6068TF151 | 1681 | RE67571 | RE505358 | 3—5% | 1800 | 1870 | 112 (150) |
| 6068TF151 | 1681 | RE505358 | | 3—5% | 1800 | 2240 | 112 (150) |
| | 1696 | RE69787 | | STD | 2500 | 2700 | 116 (155) |
| | 16NJ | RE505358 | | 3—5% | 1800 | 2240 | 112 (150) |
| 6068TF152 | 1696 | RE69787 | | STD | 2500 | 2700 | 116 (155) |
| | 16JU | RE69787 | | STD | 2500 | 2700 | 116 (155) |
| 6068TF157 | 16GS | RE503049 | | 3—5% | 1500 | 1560 | 120 (161) |
| | 16LX | RE503834 | | 3—5% | 1500 | 1560 | 120 (161) |
| 6068TF158 | 16GS | RE503049 | | 3—5% | 1500 | 1560 | 120 (161) |
| | 16JV | RE503872 | | 3—5% | 1500 | 1560 | 100 (134) |
| | 16JW | RE503874 | | 3—5% | 1500 | 1560 | 100 (134) |
| | 16MG | RE503742 | | 3—5% | 1800 | 1870 | 123 (165) |
| | 16MH | RE504966 | RE504967 | 3—5% | 1800 | 1870 | 123 (165) |
| | 16MH | RE504967 | | 3—5% | 1800 | 1870 | 123 (165) |
| | 16MX | RE503740 | | 3—5% | 1500 | 1560 | 105 (141) |
| | 16MY | RE504699 | RE505052 | 3—5% | 1500 | 1560 | 105 (141) |
| | 16MY | RE505052 | 1.1200002 | 3—5% | 1500 | 1560 | 105 (141) |
| 6068TF159 | 16PD | RE70938 | | STD | 2100 | 2250 | 96 (129) |
| 6068TF220 | 16GS | RE503049 | | 3—5% | 1500 | 1560 | 121 (162) |
| | 16KK | RE502694 | | STD | 2500 | 2700 | 127 (170) |
| | 16LX | RE503836 | | 3—5% | 1500 | 1560 | 121 (162) |
| | 16RK | RE506083 | | 3—5% | 2600 | 2700 | 138 (185) |
| | 16RJ | RE506084 | | 3—5% | 2100 | 2200 | 172 (231) |
| | 16SG | RE506625 | | 3—5% | 2100 | 2200 | 172 (231) |
| | 16SH | RE506626 | | 3—5% | 2600 | 2700 | 138 (185) |
| 6068TF250 | 1615 | RE62366 | RE69791 | STD | 2400 | 2600 | 138 (185) |
| 500011 200 | 1615 | RE69791 | 11200701 | STD | 2400 | 2600 | 138 (185) |
| | 1619 | RE67573 | | 3—5% | 1800 | 1870 | 124 (166) |
| | 1668 | RE59969 ^a | | STD | 2400 | 2600 | 138 (185) |
| | 1685 | RE67574 | | 3—5% | 1800 | 1870 | 124 (166) |
| | 1686 | RE60131 | RE69792 | STD | 2400 | 2600 | 138 (185) |
| | 1686 | RE69792 | 11200102 | STD | 2400 | 2600 | 138 (185) |
| | 16CW | RE501344 | | STD | 2200 | 2400 | 106 (142) |
| | 16CX | RE70390 | | STD | 2300 | 2500 | 128 (172) |

| | | POWER RATI | NGS ON DYNAM | OMETER FOR C | EM ENGINES | | |
|--------------|----------------------------------|---|--|------------------------|-------------------|-----------------|-----------------------|
| Engine Model | Injection Pump Option Code | Original Injection Pump (Part No.) | Replaced By Injection Pump (Part No.) | Governor Regulation | Rated Speed (rpm) | Fast Idle (rpm) | Power Rating kW (BHP) |
| | 16GS | RE503049 | | 3—5% | 1500 | 1560 | 120 (161) |
| | 16LT | RE69791 | | STD | 2400 | 2600 | 138 (185) |
| | 16LU | RE67573 | | 3—5% | 1800 | 1870 | 124 (166) |
| | 16LX | RE503834 | | 3—5% | 1500 | 1560 | 120 (161) |
| | 16MJ | RE503744 | | 3—5% | 1800 | 1870 | 142 (190) |
| | 16MK | RE504701 | RE504968 | 3—5% | 1800 | 1870 | 142 (190) |
| | 16MK | RE504968 | | 3—5% | 1800 | 1870 | 142 (190) |
| 6068TF251 | 1615 | RE62366 | | STD | 2400 | 2600 | 138 (185) |
| 6068TF257 | 16GS | RE503049 | | 3—5% | 1500 | 1560 | 120 (161) |
| | 16LX | RE503834 | | 3—5% | 1500 | 1560 | 120 (161) |
| 6068TF258 | 16GS | RE503049 | | 3—5% | 1500 | 1560 | 120 (161) |
| | 16LX | RE503834 | | 3—5% | 1500 | 1560 | 120 (161) |
| | 16MJ | RE503744 | | 3—5% | 1800 | 1870 | 142 (190) |
| | 16MK | RE504701 | RE504968 | 3—5% | 1800 | 1870 | 142 (190) |
| | 16MK | RE504968 | | 3—5% | 1800 | 1870 | 142 (190) |
| 6068TFM50 | 16FA | RE502619 | | STD | 2600 | 2800 | 168 (225) |
| | 16FB | RE502620 | | STD | 2600 | 2800 | 168 (225) |
| | 16FC | RE502621 | | STD | 2400 | 2600 | 130 (175) |
| | 16FD | RE502622 | | STD | 2400 | 2600 | 130 (175) |
| | 16FE | RE502623 | | 3—5% | 1800 | 1870 | 115 (154) |
| | 16FF | RE502624 | | 3—5% | 1800 | 1870 | 115 (154) |

RG,100,JW7641 -19-10JAN00-8/8

Intake Manifold Pressure (Turbocharger Boost) Specifications

| Machine Model | Engine Model | Rated Power at Full Load Rated Speed kW (hp) | Full Load Rated Speed rpm | Turbo Boost Pressure at Full Load Rated Speed kPa (bar) (psi) |
|---------------------------------|--------------|---|---------------------------------|---|
| Des Moines, Iowa | | • | | |
| 4700 Sprayer (138 kW) | T06068TN050 | 138 (185) | 2400 | 113—137 kPa (1.1—1.4 bar) (16—20 psi) |
| | PE6068TN050 | 138 (185) | 2400 | 113—137 kPa (1.1—1.4 bar) (16—20 psi) |
| | PE6068TN053 | 138 (185) | 2400 | 144-176 kPa (1.4—1.8 bar) (21—25 psi) |
| 4700 Sprayer (149 kW) | PE6068TN052 | 149 (200) | 2400 | 144-176 kPa (1.4—1.8 bar) (21—25 psi) |
| 6700/6700S Sprayer | T04045TN050 | 79 (106) | 2200 | 72—88 kPa (0.7—0.9 bar) (10—13 psi) |
| | PE4045TN050 | 79 (106) | 2200 | 72—88 kPa (0.7—0.9 bar) (10—13 psi) |
| 9935 Cotton Picker | T06068TN051 | 117 (157) | 2200 | 79—97 kPa (0.8—1.0 bar) (12—14 psi) |
| 7455 Cotton Stripper | T06068TN051 | 117 (157) | 2200 | 79—97 kPa (0.8—1.0 bar) (12—14 psi) |
| East Moline, Illinois | • | | | |
| 9400 Combine | T06068HH050 | 138 (185) | 2200 | 93—113 kPa (0.9—1.1 bar) (14—16 psi) |
| 9410 Combine | T06068HH051 | 143 (192) | 2200 | 94—116 kPa (0.9—1.2 bar) (14—17 psi) |
| 9450 Combine | T06068HH052 | 143(192) | 2200 | 95 kPa (1.0 bar) (14 psi) |
| Horizontina, Brazil | | | | |
| 1170 Combine | CD6068TCQ50 | 133 (178) | 2200 | 95—117 kPa (1.0—1.2 bar) (14—17 psi) |
| Zweibrucken, Germany | | | , | |
| 2254 Combine | CD6068HZ050 | 144 (193) | 2200 | 94—116 kPa (0.9—1.2 bar) (14—17 psi) |
| 3200/3400 Telescopic Handler | CD4045TZ050 | 79.5 (106.5) | 2200 | 68—82 kPa (0.7—0.8 bar) (10—12 psi) |
| Ottumwa, Iowa | • | | • | |
| 4890 Windrower | T04045TE050 | 75 (100.5) | 2500 | 81—99 kPa (0.8—1.0 bar) (11—14 psi) |
| 4990 Windrower | T06068TE050 | 128 (172) | 2300 | 111 kPa (1.1 bar) (16 psi) |
| Waterloo, Iowa | • | , | • | |
| 7210 (Syncro Plus) Tractor | T06068TRW50 | 88 (118) PTO | 2100 | 49—61 kPa (0.5—0.6 bar) (7—9 psi) |
| 7210 (Power Quad) Tractor | T06068TRW53 | 88 (118) PTO | 2100 | 49—61 kPa (0.5—0.6 bar) (7—9 psi) |
| 7410 (Syncro Plus) Tractor | T06068TRW54 | 96 (129) PTO | 2100 | 58—70 kPa (0.6—0.7 bar) (8—10 psi) |
| 7410 (Power Quad) Tractor | T06068TRW51 | 96 (129) PTO | 2100 | 58—70 kPa (0.6—0.7 bar) (8—10 psi) |
| 7510 (Power Quad) Tractor | T06068TRW70 | 105 (141) PTO | 2100 | 65—79 kPa (0.6—0.8 bar) (9—11 psi) |
| 7610 Tractor | T06068TRW52 | 105 (141) PTO | 2100 | 65—79 kPa (0.7—0.8 bar) (9—12 psi) |
| | T06068TRW72 | 110 (148) | 2100 | 70—85 kPa (0.7—0.9 bar) (10—12 psi) |

| TURBO BOOST PRESSURES (JOHN DEERE AGRICULTURAL EQUIPMENT) | | | | | | | | |
|---|----------------|---|---------------------------------|---|--|--|--|--|
| Machine Model | Engine Model | Rated Power at Full Load Rated Speed kW (hp) | Full Load Rated Speed rpm | Turbo Boost Pressure at Full Load Rated Speed kPa (bar) (psi) | | | | |
| Mannheim, Germany (Eur | ropean Market) | ' | | | | | | |
| 6110 Tractor (Direct Fan Drive) | CD4045TL058 | 58 (79) | 2300 | 51—63 kPa (0.5—0.6 bar) (7—9 psi) | | | | |
| 6110 Tractor (Viscous Fan Drive) | CD4045TL050 | 59 (80) | 2300 | 51—63 kPa (0.5—0.6 bar) (7—9 psi) | | | | |
| 6205 Tractor (Classic Series) | CD4045TL064 | 78(105) | 2300 | 68—83 kPa (0.7—0.8 bar) (10—12 psi) | | | | |
| 6210 Tractor (Direct Fan Drive) | CD4045TL059 | 65 (88) | 2300 | 58—71 kPa (0.6—0.7 bar) (8—10 psi) | | | | |
| 6210 Tractor (Viscous Fan Drive) | CD4045TL051 | 66 (90) | 2300 | 58—71 kPa (0.6—0.7 bar) (8—10 psi) | | | | |
| 6310 Tractor (Direct Fan Drive) | CD4045TL060 | 73 (99) | 2300 | 68—83 kPa (0.7—0.8 bar) (10—12 psi) | | | | |
| 6310 Tractor (Viscous Fan Drive) | CD4045TL052 | 74 (100) | 2300 | 68—83 kPa (0.7—0.8 bar) (10—12 psi) | | | | |
| 6310 Tractor (ECU Level 4) | CD4045TLA50 | 77 (103) | 2300 | 68—83 kPa (0.7—0.8 bar) (10—12 psi) | | | | |
| 6405 Tractor (Advantage Series) | CD4045TL064 | 78 (105) | 2300 | 72—88 kPa (0.7—.09 bar) (10—13 psi) | | | | |
| 6410 Tractor (Direct Fan Drive) | CD4045TL061 | 76 (103) | 2300 | 69—84 kPa (0.7—0.8 bar) (10—12 psi) | | | | |
| 6410 Tractor (Viscous Fan Drive) | CD4045TL053 | 77 (105) | 2300 | 69—84 kPa (0.7—0.8 bar) (10—12 psi) | | | | |
| 6410 Tractor (ECU Level 4) | CD4045TLA51 | 77 (103) | 2300 | 69—84 kPa (0.7—0.8 bar) (10—12 psi) | | | | |
| 6610 Tractor | CD6068TL050 | 84 (114) | 2300 | 49—61 kPa (0.5—0.6 bar) (7—9 psi) | | | | |
| 6610 Tractor (ECU Level 4) | CD6068TLA50 | 88 (118) | 2300 | 49—61 kPa (0.5—0.6 bar) (7—9 psi) | | | | |
| 6810 Tractor | CD6068TL051 | 92 (125) | 2100 | 67—82 kPa (0.7—0.8 bar) (10—12 psi) | | | | |
| 6810 Tractor (ECU Level 4) | CD6068TLA51 | 96 (129) | 2100 | 67—82 kPa (0.7—0.8 bar) (10—12 psi) | | | | |
| 6910 Tractor | CD6068TL052 | 99 (135) | 2100 | 71—87 kPa (0.7—0.9 bar) (10—13 psi) | | | | |
| 6910 Tractor (107 kW) | CD6068TL054 | 107 (143) | 2100 | 79—96 kPa (0.8—1.0 bar) (11—14 psi) | | | | |
| 6910 Tractor (ECU Level 4) | CD6068TLA52 | 107 (143) | 2100 | 58—70 kPa (0.6—0.7 bar) (8—10 psi) | | | | |
| 6910 Tractor (ECU Level 4, Boost) | CD6068TLA53 | 115 (154) | 2100 | 65—79 kPA (0.7—0.8 bar) (9—11 psi) | | | | |

| Machine Model | Engine Model | Rated Power at Full Load Rated Speed kW (hp) | Full Load Rated Speed rpm | Turbo Boost Pressure at Full Load Rated Speed kPa (bar) (psi) |
|--------------------------------|---------------------|---|---------------------------------|---|
| Mannheim, Germany (N | orth American Marke | t) | | |
| 6110/6110L Tractor | CD4045TL063 | 48 (65) PTO | 2300 | 54—67 kPa (0.5—0.7 bar) (8—10 psi) |
| 6210/6210L Tractor | CD4045TL054 | 54 (72) PTO | 2300 | 61—75 kPa (0.6—0.8 bar) (9—11 psi) |
| 6310/6310L/6310S Tractor | CD4045TL055 | 60 (80) PTO | 2300 | 72—88 kPa (0.7—0.9 bar) (10—13 psi) |
| 6405 Tractor | CD4045TL062 | 67 (90) PTO | 2300 | 72—88 kPa (0.7—0.9 bar) (10—13 psi) |
| 6410/6410L/6410S Tractor | CD4045TL056 | 67 (90) PTO | 2300 | 84—102 kPa (0.8—1.0 bar) (12—15 psi) |
| 6510L/6510S Tractor | CD4045TL057 | 71 (95) PTO | 2300 | 88—108 kPa (0.9—1.1 bar) (13—16 psi) |
| 6605 Tractor | CD6068TL053 | 75 (100) PTO | 2300 | 49—60 kPa (0.5—0.6 bar) (7—9 psi) |
| Saltillo, Mexico | • | • | | |
| 5715 Tractor | PE4045TP050 | 67 (90) | 2400 | 54—66 kPa (0.5—0.7 bar) (8—10 psi) |
| | PE4045TP059 | 67 (90) | 2400 | 48—59 kPa (0.5—0.6 bar) (7—9 psi) |
| 7405 Tractor | CD6068TP051 | 96 (129) | 2100 | 65-79 kPa (0.7-0.8 bar) (9-11 psi) |
| | PE6068TP051 | 96 (129) | 2100 | 65-79 kPa (0.7-0.8 bar) (9-11 psi) |
| 7410 Tractor | CD6068TP052 | 103 (138) | 2100 | 72—88 kPa (0.7—0.9 bar) (10—13 psi) |
| 7500 Tractor | PE6068TP052 | 103 (138) | 2100 | 72—88 kPa (0.7—0.9 bar) (10—13 psi) |
| 6400 Tractor | PE4045TP054 | 78 (105) | 2300 | 72—88 kPa (0.7—0.9 bar) (10—13 psi) |
| Tekirdag, Turkey | | | | |
| 5715 Tractor | CD4045TTK20 | 67 (90) | 2400 | 54—66 kPa (0.5—0.6 bar) (8—10 psi) |
| Cameco | | | | |
| 404 Veg Sprayer | TO4045TT850 | 79 (106) | 2200 | 72—88 kPa (0.7—0.9 bar) (10—13 psi) |
| SP2252 Cane Loader | PE6068TT850 | 138 (185) | 2400 | 110—134 kPa (1.1—1.3 bar) (16—19 psi) |
| Kanaf 100 Loader | PE6068TT850 | 138 (185) | 2400 | 110—134 kPa (1.1—1.3 bar) (16—19 psi) |
| Kanaf Harvester | PE6068TT850 | 138 (185) | 2400 | 110—134 kPa (1.1—1.3 bar) (16—19 psi) |
| 220 4WD Tractor | PE6068TT850 | 138 (185) | 2400 | 110—134 kPa (1.1—1.3 bar) (16—19 psi) |
| Pineapple Harvester/Sprayer | PE6068TT850 | 138 (185) | 2400 | 110—134 kPa (1.1—1.3 bar) (16—19 psi) |

Continued on next page

DPSG,OUO1004,2748 -19-02MAY00-3/11

| | TURBO BOOST F | PRESSURES (JOHN D | DEERE CONSTRUCT | ION EQUIPMENT) |
|--|---------------|---|---------------------------------|---|
| Machine Model | Engine Model | Rated Power at Full Load Rated Speed kW (hp) | Full Load Rated Speed rpm | Turbo Boost Pressure at Full Load Rated Speed kPa (bar) (psi) |
| Davenport, Iowa | | • | • | |
| 344H Loader | CD4045TF152 | 63 (84) | 2200 | 50—62 kPa (0.5—0.6 bar) (7—9 psi) |
| 444H Loader, TC 44H Tool Carrier | T04045TDW50 | 85 (114) | 2200 | 79—97 kPa (0.8—1.0 bar) (11—14 psi) |
| 544H Loader, TC 54H Tool Carrier | T06068TDW50 | 97 (130) | 2100 | 62—83 kPa (0.6—0.8 bar) (9—12 psi) |
| 624H Loader, TC 62H Tool Carrier | T06068HDW50 | 127 (170) | 2200 | 91—111 kPa (0.9—1.1 bar) (13—16 psi) |
| LX100 Loader (Hitachi Construction) | T06068TDW53 | 103 (138) | 2100 | 62—76 kPa (0.6—0.8 bar) (9—11 psi) |
| LX120 Loader (Hitachi Construction) | T06068HDW70 | 127 (170) | 2200 | 91—111 kPa (0.9—1.1 bar) (13—16 psi) |
| 540G Cable Skidder, 548G Grappel Skidder (558205—) | T06068TDW51 | 94 (126) | 2200 | 52—64 kPa (0.5—0.6 bar) (7—9 psi) |
| 540G-II Cable Skidder, 548G-II Grapple Skidder | T06068TDW54 | 94 (126) | 2200 | 52—64 kPa (0.5—0.6 bar) (7—9 psi) |
| 640G/648GX Skidder (558325—) | T06068TDW52 | 117 (151) | 2200 | 94—114 kPa (0.9—1.1 bar) (14—17 psi) |
| 640G-II Cable Skidder, 648G-II Grapple Skidder | T06068TDW55 | 117 (151) | 2200 | 94—114 kPa (0.9—1.1 bar) (14—17 psi) |
| 670C Motor Grader | T06068HDW53 | 112 (150) | 2000 | 94—114 kPa (0.9—1.1 bar) (14—17 psi) |
| 670CH/672CH Motor Grader | T06068HDW55 | 127 (170) | 2000 | 105—125 kPa (1.1—1.3 bar) (15—18 psi) |
| 690E LC Excavator (559603—) | T06068TDW56 | 107 (143) | 2100 | 62—76 kPa (0.6—0.8 bar) (9—11 psi) |
| Dubuque | | ' | | |
| 310E Backhoe Loader (Alt Comp) | T04045TT056 | 58 (78) | 2200 | 44—54 kPa (0.4—0.5 bar) (6—8 psi) |
| 310E Backhoe Loader | T04045TT055 | 66 (89) | 2200 | 56—68 kPa (0.6—0.7 bar) (8—10 psi) |
| 310SE Backhoe Loader | T04045TT050 | 66 (89) | 2200 | 56—68 kPa (0.6—0.7 bar) (8—10 psi) |
| 315SE Backhoe Loader | T04045TT060 | 66 (89) | 2200 | 56—68 kPa (0.6—0.7 bar) (8—10 psi) |
| 410E Backhoe Loader | T04045TT053 | 73 (98) | 2200 | 66—80 kPa (0.7—0.8 bar) (10—12 psi) |
| 710D Backhoe Loader | T06068TT050 | 92 (123) | 2200 | 53—65 kPa (0.5—0.7 bar) (8—9 psi) |
| | T06068TT055 | 92 (123) | 2200 | 53—65 kPa (0.5—0.7 bar) (8—9 psi) |
| 450G Series IV Crawler Dozer (840461—) | T04045TT061 | 58 (78) | 2100 | 38—47 kPa (0.4—0.5 bar) (6—7 psi) |
| 450GTC Series IV Crawler Dozer (840461—) | T04045TT067 | 58 (78) | 2100 | 38—47 kPa (0.4—0.5 bar) (6—7 psi) |

| Machine Model | Engine Model | Rated Power at Full Load Rated Speed kW (hp) | Full Load Rated Speed rpm | Turbo Boost Pressure at Full Load Rated Speed kPa (bar) (psi) |
|---|--------------------------|---|---------------------------------|---|
| 455 GTC Crawler Loader (840461—) | T04045TT067 | 58 (78) | 2100 | 38—47 kPa (0.4—0.5 bar) (6—7 psi) |
| 455 G Series IV Crawler Loader (840461—) | T04045TT061 | 58 (78) | 2100 | 38—47 kPa (0.4—0.5 bar) (6—7 psi) |
| 550G Crawler Dozer (840461—) | T04045TT062 | 66 (89) | 2100 | 51—63 kPa (0.5—0.6 bar) (7—9 psi) |
| 550GTC Crawler Dozer (840461—) | T04045TT068 | 66 (89) | 2100 | 51—63 kPa (0.5—0.6 bar) (7—9 psi) |
| 555G Crawler Loader (840461—) | T04045TT063 | 67.1 (90) | 2100 | 63—77 kPa (0.6—0.8 bar) (9—11 psi) |
| 555 GTC Crawler Loader | T04045TT069 | 74 (99) | 2100 | 63—77 kPa (0.6—0.8 bar) (9—11 psi) |
| 650G Crawler Dozer (840461—) | T04045TT063 | 74 (99) | 2100 | 63—77 kPa (0.6—0.8 bar) (9—11 psi) |
| 650GTC Crawler Dozer (840461—) | T04045TT069 | 74 (99) | 2100 | 63—77 kPa (0.6—0.8 bar) (9—11 psi) |
| 450H LGP Crawler Dozer | T04045TT058 | 60 (80) | 2200 | 54 kPa (0.5 bar) (9 psi) |
| 450H/STD, LT Crawler Dozer | T04045TT053 | 73 (98) | 2200 | 66—80 kPa (0.7—0.8 bar) (10—12 psi) |
| 450H Alt Comp Crawler Dozer | T04045TT057 | 56 (75) | 2200 | 46 kPa (0.5 bar) (7 psi) |
| 550H Crawler Dozer | T04045TT064 | 63 (84) | 2200 | 47 kPa (0.5 bar) (7 psi) |
| 550H LGP Crawler Dozer | T04045TT065 | 66 (89) | 2200 | 47 kPa (0.5 bar) (7 psi) |
| 650H Crawler Dozer | T04045TT066 | 73 (98) | 2200 | 56 kPa (0.6 bar) (8 psi) |
| 750C Crawler Dozer (831372—) | T06068TT052 | 110 (148) | 2100 | 80 kPa (0.8 bar) (12 psi) |
| 643G Feller Buncher | T06068TT053 | 120 (161) | 2200 | 90—110 kPa (0.9—1.1 bar) (13—16 psi) |
| 643H Feller Buncher | PE6068TT058 | 120 (161) | 2200 | 90—110 kPa (0.9—1.1 bar) (13—16 psi) |
| 653E Feller Buncher | T06068TT053 (751314—) | 120 (161) | 2200 | 90—110 kPa (0.9—1.1 bar) (13—16 psi) |
| 653G Feller Buncher (120 kW) | T06068TT053 | 120 (161) | 2200 | 90—110 kPa (0.9—1.1 bar) (13—16 psi) |
| | PE6068TT059 | 120 (161) | 2200 | 90—110 kPa (0.9—1.1 bar) (13—16 psi) |
| 653G Feller Buncher (140 kW) | PE6068HT057 | 140 (188) | 2200 | 90—110 kPa (0.9—1.1 bar) (13—16 psi) |
| 843G Feller Buncher | T06068HT050 | 140 (188) | 2200 | 90—110 kPa (0.9—1.1 bar) (13—16 psi) |
| | PE6068HT050 | 140 (188) | 2200 | 90—110 kPa (0.9—1.1 bar) (13—16 psi) |
| 843H Feller Buncher | PE6068HT056 | 140 (188) | 2200 | 90—110 kPa (0.9—1.1 bar) (13—16 psi) |
| DX75 HST Crawler Dozer (Japan) | TO4045TT070 | 60 (80) | 2200 | 50 kPa (0.5 bar) (7 psi) |
| 650H Forest Fire Plow | T04045TT083 | 73 (98) | 2200 | 56 kPa (0.6 bar) (8 psi) |
| Saltillo (Mexico) | | | | |
| 110 Excavator | T04045TT054 | 63 (84) | 2200 | 50—62 kPa (0.5—0.6 bar) (7—9 psi) |

| | TURBO BOOST | PRESSURES (JOHN I | DEERE CONSTRUCT | ION EQUIPMENT) |
|------------------------|--------------|---|---------------------------------|---|
| Machine Model | Engine Model | Rated Power at Full Load Rated Speed kW (hp) | Full Load Rated Speed rpm | Turbo Boost Pressure at Full Load Rated Speed kPa (bar) (psi) |
| | PE4045TP052 | 63 (84) | 2200 | 50-62 kPa (0.5-0.6 bar) (7-9 psi) |
| 120 Excavator | T04045TT051 | 69 (93) | 2200 | 63—77 kPa (0.6—0.8 bar) (9—11 psi) |
| | PE4045TP051 | 69 (93) | 2200 | 63—77 kPa (0.6—0.8 bar) (9—11 psi) |
| 160LC Excavator | T04045TT055 | 81 (109) | 2300 | 89—109 kPa (0.9—1.1 bar) (13—16 psi) |
| | T06068HT052 | 81 (109) | 2300 | 89—109 kPa (0.9—1.1 bar) (13—16 psi) |
| Kernersville (Deere-Hi | tachi) | | | |
| 200LC Excavator | T06068TT051 | 110 (148) | 2150 | 68—84 kPa (0.7—0.8 bar) (10—12 psi) |
| | PE6068TT051 | 110 (148) | 2150 | 68—84 kPa (0.7—0.8 bar) (10—12 psi) |
| 230LC Excavator | T06068HT051 | 134 (180) | 2100 | 82—102 kPa (0.8—1.0 bar) (12—15 psi) |
| | PE6068HT051 | 134 (180) | 2100 | 82—102 kPa (0.8—1.0 bar) (12—15 psi) |
| 270LC Excavator | T06068HT052 | 141 (189) | 2150 | 85—105 kPa (0.9—1.1 bar) (12—15 psi) |

| TU | IRBO BOOST PRESS | URES (JOHN DEERE (| COMMERCIAL AND | CONSUMER EQUIPMENT) |
|--|------------------|---|---------------------------------|---|
| Machine Model | Engine Model | Rated Power at Full Load Rated Speed kW (hp) | Full Load Rated Speed rpm | Turbo Boost Pressure at Full Load Rated Speed kPa (bar) (psi) |
| Augusta | | | | |
| 5510/5510N Tractor | CD4045TLV50 | 56 (75) PTO | 2400 | 54—66 kPa (0.5—0.7 bar) (8—10 psi) |
| | PE4045TLV50 | 56 (75) PTO | 2400 | 54—66 kPa (0.5—0.7 bar) (8—10 psi) |
| 5510 Tractor (No Air Heater Option) | PE4045TLV50 | 67 (90) | 2400 | 56—66 kPa (0.6—0.7 bar) (8—10 psi) |

Continued on next page

DPSG,OUO1004,2748 -19-02MAY00-6/11

| Engine Number | Injection Pump Option Code | Injection Pump Part No. | Replacement Injection Pump | Rated Power at Full Load Rated Speed kW (hp) | Full Load Rated Speed rpm | Turbo Boost Pressure at Full Load Rated Speed kPa (bar) (psi) |
|---------------|-------------------------------------|-------------------------------|----------------------------------|---|------------------------------------|---|
| 4045HF120 | 16GR | RE503050 | | 102 (137) | 1500 | 123—150 kPa (1.2—1.5 bar) (18—22 psi) |
| | 16LW | RE503832 | | 102(137) | 1500 | 123—150 kPa (1.2—1.5 bar) (18—22 psi) |
| 4045HF150 | 1610 | RE68826 | | 104 (140) | 2400 | 99—121 kPa (1.0—1.2 bar) (14—18 psi) |
| | 1611 | RE60237 | | 95 (127) | 1800 | 85—103 kPa (0.9—1.0 bar) (12—15 psi) |
| | 160B | RE68827 | | 95 (127) | 1800 | 85—103 kPa (0.9—1.0 bar) (12—15 psi) |
| | 160C | RE69588 | | 104 (140) | 2400 | 99—121 kPa (1.0—1.2 bar) (14—18 psi) |
| | 16GR | RE503050 | | 102 (137) | 1500 | 123—150 kPa (1.2—1.5 bar) (18—22 psi) |
| | 16LW | RE503832 | | 102 (137) | 1500 | 123—150 kPa (1.2—1.5 bar) (18—22 psi) |
| | 16QZ | RE503050 | | 111 (149) | 1800 | 151-184 kPa (1.5—1.8 bar) (22—27 psi) |
| | 16RA | RE503832 | | 111 (149) | 1800 | 151-184 kPa (1.5—1.8 bar) (22—27 psi) |
| 4045HF157 | 16GR | RE503050 | | 102 (137) | 1500 | 123—150 kPa (1.2—1.5 bar) (18—22 psi) |
| | 16LW | RE503832 | | 102 (137) | 1500 | 123—150 kPa (1.2—1.5 bar) (18—22 psi) |
| 4045HF158 | 16GR | RE503050 | | 102 (137) | 1500 | 123—150 kPa (1.2—1.5 bar) (18—22 psi) |
| | 16LW | RE503832 | | 102 (137) | 1500 | 123—150 kPa (1.2—1.5 bar) (18—22 psi) |
| | 16ME | RE503739 | | 123 (165) | 1800 | 143—157 kPa (1.4—1.6 bar) (21—23 psi) |
| | 16MF | RE504966 | | 123 (165) | 1800 | 143—157 kPa (1.4—1.6 bar) (21—23 psi) |
| 4045TF120 | 16MT | RE503733 | | 70 (94) | 1500 | 63—77 kPa (0.6—0.8 bar) (9—11 psi) |
| | 16MU | RE505050 | | 70 (94) | 1500 | 63—77 kPa (0.6—0.8 bar) (9—11 psi) |
| 4045TF150 | 1605 | RE61668 | RE69781 | 86 (115) | 2500 | 97—119 kPa (1.0—1.2 bar) (14—17 psi) |
| | 1605 | RE69781 | | 86 (115) | 2500 | 97—119 kPa (1.0—1.2 bar) (14—17 psi) |
| | 1606 | RE64133 | | 93 (125) | 2400 | 109—133 kPa (1.1—1.3 bar) (16—19 psi) |
| | 1656 | RE63610 | RE67562 | 75 (100) | 1800 | 65—79 kPa (0.7—0.8 bar) (9—12 psi) |
| | 1656 | RE67562 | | 75 (100) | 1800 | 65—79 kPa (0.7—0.8 bar) (9—12 psi) |
| | 1675 | RE60091 | RE69782 | 86 (115) | 2500 | 96—118 kPa (1.0—1.2 bar) (14—18 psi) |
| | 1675 | RE69782 | | 86 (115) | 2500 | 96—118 kPa (1.0—1.2 bar) (14—18 psi) |
| | 1676 | RE60093 | RE61668 | 86 (115) | 2500 | 91—119 kPa (0.9—1.1 bar) (13—17 psi) |
| | 1677 | RE60096 | RE67653 | 75 (100) | 1800 | 65-79 kPa (0.7-0.8 bar) (9-12 psi) |
| | 1677 | RE67563 | | 75 (100) | 1800 | 65—79 kPa (0.7—0.8 bar) (9—12 psi) |
| | 1692 | RE500881 | | 86 (115) | 2500 | 97—119 kPa (1.0—1.2 bar) (14—17 psi) |
| | 1692 | RE502416 | | 86 (115) | 2500 | 97—119 kPa (1.0—1.2 bar) (14—17 psi) |
| | 1692 | RE61668 | | 86 (115) | 2500 | 97—119 kPa (1.0—1.2 bar) (14—17 psi) |
| | 1694 | RE67863 | RE69779 | 75 (100) | 2500 | 81—99 kPa (0.8—1.0 bar) (12—14 psi) |
| | 1694 | RE69779 | | 75 (100) | 2500 | 81—99 kPa (0.8—1.0 bar) (12—14 psi) |
| | 1695 | RE69739 | RE69780 | 75 (100) | 2500 | 81—99 kPa (0.8—1.0 bar) (12—14 psi) |
| | 1695 | RE69780 | | 75 (100) | 2500 | 81—99 kPa (0.8—1.0 bar) (12—14 psi) |
| | 16AB | RE69779 | | 75 (100) | 2500 | 81—99 kPa (0.8—1.0 bar) (12—14 psi) |
| | 16BF | RE500848 | | 73 (98) | 2200 | 66—80 kPa (0.7—0.8 bar) (10—12 psi) |
| | 16CE | RE501180 | | 75 (100) | 2500 | 81—99 kPa (0.8—1.0 bar) (12—14 psi) |
| | 16CM | RE501365 | | 66.5 (89) | 2200 | 56—68 kPa (0.6—0.7 bar) (8—10 psi) |
| | 16GL | RE502706 | | 78 (105) | 2300 | 80—94 kPa (0.8—0.9 bar) (12—14 psi) |
| | 16LP | RE67562 | | 75 (101) | 1800 | 65—79 kPa (0.7—0.8 bar) (9—11 psi) |

CTM104 (19JUN00)

| Engine Number | Injection Pump Option Code | Injection Pump Part No. | Replacement Injection Pump | Rated Power at Full Load Rated Speed kW (hp) | Full Load Rated Speed rpm | Turbo Boost Pressure at Full Load Rated Speed kPa (bar) (psi) |
|---------------|-------------------------------------|-------------------------------|----------------------------------|---|------------------------------------|---|
| | 16LZ | RE503735 | | 82 (110) | 1800 | 85—99 kPa (0.9—1.0 bar) (12—14 psi) |
| | 16MA | RE504696 | | 82 (110) | 1800 | 85—99 kPa (0.9—1.0 bar) (12—14 psi) |
| | 16MT | RE503733 | | 70 (94) | 1500 | 63—77 kPa (0.6—0.8 bar) (9—11 psi) |
| | 16MU | RE505050 | | 70 (94) | 1500 | 63—77 kPa (0.6—0.8 bar) (9—11 psi) |
| 4045TF151 | 16CU | RE501192 | | 80 (107) | 2200 | 68—82 kPa (0.7—0.8 bar) (10—12 psi) |
| | 16NH | RE505411 | | 75 (101) | 1800 | 65—79kPa (0.7—0.8 bar) (9—11 psi) |
| 4045TF152 | 16AX | RE500551 | | 76 (102) | 2400 | 75—91 kPa (0.8—.09 bar) (11—13 psi) |
| 4045TF154 | 1605 | RE69781 | | 86 (115) | 2500 | 97—119 kPa (1.0—1.2 bar) (14—17 psi) |
| 4045TF155 | 16AX | RE500551 | | 76 (102) | 2400 | 75—91 kPa (0.8—0.9 bar) (11—13 psi) |
| | 16JT | RE500551 | | 76) 102) | 2400 | 75—91 kPa (0.8—0.9 bar) (11—13 psi) |
| 4045TF157 | 16GQ | RE503048 | | 83 (111) | 1500 | 102—116 kPa (1.0—1.2 bar) (15—17 psi) |
| | 16LV | RE503830 | | 83 (111) | 1500 | 102—116 kPa (1.0—1.2 bar) (15—17 psi) |
| 4045TF158 | 16GQ | RE503048 | | 83 (111) | 1500 | 102—116 kPa (1.0—1.2 bar) (15—17 psi) |
| | 16LZ | RE503735 | | 82 (110) | 1800 | 85—99 kPa (0.9—1.0 bar) (12—14 psi) |
| | 16MA | RE504696 | | 82 (110) | 1800 | 85—99 kPa (0.9—1.0 bar) (12—14 psi) |
| | 16MT | RE503733 | | 70 (94) | 1500 | 63—77 kPa (0.6—0.8 bar) (9—11 psi) |
| | 16MU | RE505050 | | 70 (94) | 1500 | 63—77 kPa (0.6—0.8 bar) (9—11 psi) |
| 4045TF220 | 16GQ | RE503048 | | 83 (111) | 1500 | 102—116 kPa (1.0—1.2 bar) (15—17 psi) |
| | 16LV | RE503830 | | 83 (111) | 1500 | 102—116 kPa (1.0—1.2 bar) (15—17 psi) |
| | 16MV | RE503736 | | 100 (134) | 1800 | 117—131 kPa (1.2—1.3 bar) (17—19 psi) |
| | 16MW | RE504682 | | 100 (134) | 1800 | 117—131 kPa (1.2—1.3 bar) (17—19 psi) |
| | 16NT | RE504465 | | 86 (115) | 2500 | 86—100 kPa (0.9—1.0 bar) (12—15 psi) |
| | 16NU | RE504466 | | 86 (115) | 2500 | 86—100 kPa (0.9—1.0 bar) (12—15 psi) |
| 4045TF250 | 1606 | RE64133 | | 93 (125) | 2400 | 109—133 kPa (1.1—1.3 bar) (16—19 psi) |
| | 1608 | RE67564 | | 84 (113) | 1800 | 82—100 kPa (0.8—1.0 bar) (12—15 psi) |
| | 1667 | RE59968 | | 93 (125) | 2400 | 109—133 kPa (1.1—1.3 bar) (16—19 psi) |
| | 1682 | RE67566 | | 84 (113) | 1800 | 82—100 kPa (0.8—1.0 bar) (12—15 psi) |
| | 1683 | RE60124 | | 93 (125) | 2400 | 109—133 kPa (1.1—1.3 bar) (16—19 psi) |
| | 160R | RE70941 | | 84 (113) | 1800 | 82—100 kPa (0.8—1.0 bar) (12—15 psi) |
| | 160CV | RE501346 | | 85 (114) | 2200 | 79—97 kPa (0.8—1.0 bar) (12—14 psi) |
| | 16GQ | re503048 | | 83 (111) | 1500 | 102—116 kPa (1.0—1.2 bar) (15—17 psi) |
| | 16LQ | RE67564 | | 84 (113) | 1800 | 82—100 kPa (0.8—1.0 bar) (12—15 psi) |
| | 16LV | RE503830 | | 83 (111) | 1500 | 102—116 kPa (1.0—1.2 bar) (15—17 psi) |
| | 16MB | RE503737 | | 91 (122) | 1800 | 104—118 kPa (1.0—1.2 bar) (15—17 psi) |
| | 16MC | RE504932 | | 91 (122) | 1800 | 104—118 kPa (1.0—1.2 bar) (15—17 psi) |
| 4045TF251 | 1606 | RE64133 | | 93 (125) | 2400 | 109—133 kPa (1.1—1.3 bar) (16—19 psi) |
| 4045TF257 | 16GQ | RE503048 | | 83 (111) | 1500 | 102—116 kPa (1.0—1.2 bar) (15—17 psi) |
| | 16LV | RE503830 | | 83 (111) | 1500 | 102—116 kPa (1.0—1.2 bar) (15—17 psi) |
| 4045TF258 | 16GQ | RE503048 | | 83 (111) | 1500 | 102—116 kPa (1.0—1.2 bar) (15—17 psi) |
| | 16LV | RE503830 | | 83 (111) | 1500 | 102—116 kPa (1.0—1.2 bar) (15—17 psi) |
| | 16MB | RE503737 | | 91 (122) | 1800 | 104—118 kPa (1.0—1.2 bar) (15—17 psi) |
| | 16MC | RE504932 | | 91 (122) | 1800 | 104—118 kPa (1.0—1.2 bar) (15—17 psi) |

| Engine Number | Injection Pump Option Code | Injection Pump Part No. | Replacement Injection Pump | Rated Power at Full Load Rated Speed kW (hp) | Rated | Turbo Boost Pressure at Full Load Rated Speed kPa (bar) (psi) |
|---------------|-------------------------------------|-------------------------------|----------------------------------|---|-------|---|
| | 16MV | RE503736 | | 100 (134) | 1800 | 117—131 kPa (1.2—1.3 bar) (17—19 psi) |
| | 16MW | RE504682 | | 100 (134) | 1800 | 117—131 kPa (1.2—1.3 bar) (17—19 psi) |
| 4045TFM50 | 16HM | RE503163 | | 73 (98) | 1800 | 52 kPa (0.5 bar) (8 psi) |
| | 16HN | RE503162 | | 73 (98) | 1800 | 52 kPa (0.5 bar) (8 psi) |
| | 16HP | RE503861 | | 101 (135) | 2500 | 106 kPa (1.0 bar) (15 psi) |
| | 16HQ | RE503860 | | 101 (135) | 2500 | 106 kPa (1.0 bar) (15 psi) |
| | 16LK | RE503160 | | 111 (149) | 2600 | 142 kPa (1.4 bar) (21 psi) |
| | 16LL | RE503161 | | 111 (149) | 2600 | 142 kPa (1.4 bar) (21 psi) |
| 6068HF150 | 1621 | RE66575 | | 157 (210) | 2400 | 108—132 kPa (1.1—1.3 bar) (16—19 psi) |
| | 160D | RE69589 | | 157 (210) | 2400 | 108—132 kPa (1.1—1.3 bar) (16—19 psi) |
| | 16CY | RE501345 | | 143 (192) | 2200 | 94—116 kPa (0.9—1.2 bar) (14—17 psi) |
| | 16ML | RE503746 | | 187 (251) | 1800 | 153—167 kPa (1.5—1.7 bar) (22—24 psi) |
| | 16MM | RE505049 | | 187 (251) | 1800 | 153—167 kPa (1.5—1.7 bar) (22—24 psi) |
| | 16GT | RE503051 | | 155 (208) | 1500 | 138—152 kPa (1.4—1.5 bar) (20—22 psi) |
| | 16LY | RE503836 | | 155 (208) | 1500 | 138—152 kPa (1.4—1.5 bar) (20—22 psi) |
| | 16QV | RE503051 | | 166 (223) | 1800 | 151—165 kPa (1.5—1.7 bar) (22—24 psi) |
| | 16QW | RE503836 | | 166 (223) | 1800 | 151—165 kPa (1.5—1.7 bar) (22—24 psi) |
| 6068HF157 | 16GT | RE503051 | | 155 (208) | 1500 | 138—152 kPa (1.4—1.5 bar) (20—22 psi) |
| | 16LY | RE503836 | | 155 (208) | 1500 | 138—152 kPa (1.4—1.5 bar) (20—22 psi) |
| 6068HF158 | 16GT | RE503051 | | 155 (208) | 1500 | 138—152 kPa (1.4—1.5 bar) (20—22 psi) |
| | 16LY | RE503836 | | 155 (208) | 1500 | 138—152 kPa (1.4—1.5 bar) (20—22 psi) |
| | 16ML | RE503746 | | 187 (251) | 1800 | 153—167 kPa (1.5—1.7 bar) (22—24 psi) |
| | 16MM | RE505049 | | 187 (251) | 1800 | 153—167 kPa (1.5—1.7 bar) (22—24 psi) |
| 6068HF250 | 1622 | RE59521 | | 168 (225) | 2400 | 117—143 kPa (1.2—1.4 bar) (17—21 psi) |
| | 1623 | RE66761 | | 148 (198) | 1800 | 100—122 kPa (1.0—1.2 bar) (15—18 psi) |
| 6068TF120 | 16MX | RE503740 | | 105 (141) | 1500 | 85—99 kPa (0.9—1.0 bar) (12—14 psi) |
| | 16MY | RE505052 | | 105 (141) | 1500 | 85—99 kPa (0.9—1.0 bar) (12—14 psi) |
| 6068TF150 | 1614 | RE61669 | RE69789 | 127 (170) | 2500 | 95—116 kPa (1.0—1.2 bar) (14—17 psi) |
| | 1614 | RE69789 | | 127 (170) | 2500 | 95—114 kPa (1.0—1.1 bar) (14—17 psi) |
| | 1680 | RE60105 | RE69790 | 127 (170) | 2500 | 95—116 kPa (1.0—1.2 bar) (14—17 psi) |
| | 1680 | RE69790 | | 127 (170) | 2500 | 95—114 kPa (1.0—1.1 bar) (14—17 psi) |
| | 1681 | RE67571 | | 112 (150) | 1800 | 80—98 kPa (0.8—1.0 bar) (12—14 psi) |
| | 1688 | RE67572 | | 112 (150) | 1800 | 80—98 kPa (0.8—1.0 bar) (12—14 psi) |
| | 1696 | RE67864 | RE69787 | 116 (155) | 2500 | 85—105 kPa (0.8—1.1 bar) (12—15 psi) |
| | 1696 | RE69787 | | 116 (155) | 2500 | 85—105 kPa (0.8—1.1 bar) (12—15 psi) |
| | 1697 | RE68740 | RE69788 | 116 (155) | 2500 | 85—105 kPa (0.8—1.1 bar) (12—15 psi) |
| | 1697 | RE69788 | | 116 (155) | 2500 | 85—105 kPa (0.8—1.1 bar) (12—15 psi) |
| | 16BE | RE63559 | RE501302 | 117 (157) | 2200 | 79—97 kPa (0.8—1.0 bar) (12—14 psi) |
| | 16BE | RE501302 | | 117 (157) | 2200 | 79—97 kPa (0.8—1.0 bar) (12—14 psi) |
| | 16CN | RE501522 | | 110.5 (148) | 2100 | 76—94 kPa (0.8—0.9 bar) (11—14 psi) |
| | 16CP | RE501523 | | 94 (126) | 2200 | 52—64 kPa (0.5—0.6 bar) (7—9 psi) |
| | 16DK | RE70938 | | 96 (129) | 2100 | 58-70 kPa (0.6-0.7 bar) (8-10 psi) |

| | TURBO B | OOST PRESSU | JKE2 (JOHN DI | ERE OEM/OUT | SIDE EQUIPI | MENT MANUFACTURERS) |
|---------------|-------------------------------------|-------------------------------|----------------------------------|---|------------------------------------|---|
| Engine Number | Injection Pump Option Code | Injection Pump Part No. | Replacement Injection Pump | Rated Power at Full Load Rated Speed kW (hp) | Full Load Rated Speed rpm | Turbo Boost Pressure at Full Load Rated Speed kPa (bar) (psi) |
| | 16DY | RE501758 | | 116 (155) | 2500 | 85—105 kPa (0.8—1.1 bar) (12—15 psi) |
| | 16GM | RE502693 | | 110 (148) | 2300 | 67—81 kPa (0.7—0.8 bar) (10—12 psi) |
| | 16GN | RE5027047 | | 116 (156) | 2400 | 77—91 kPa (0.8—0.9 bar) (11—13 psi) |
| | 16LS | RE67572 | | 112 (150) | 1800 | 80—98 kPa (0.8—1.0 bar) (12—14 psi) |
| | 16MG | RE503742 | | 123 (165) | 1800 | 78—82 kPa (0.8 bar) (11—12 psi) |
| | 16MH | RE504967 | | 123 (165) | 1800 | 78—82 kPa (0.8 bar) (11—12 psi) |
| 6068TF151 | 1681 | RE67571 | RE505358 | 112 (150) | 1800 | 80—98 kPa (0.8—1.0 bar) (12—14 psi) |
| | 1681 | RE505358 | | 112 (150) | 1800 | 80—98 kPa (0.8—1.0 bar) (12—14 psi) |
| | 1696 | RE69787 | | 116 (155) | 2500 | 85—105 kPa (0.9—1.1 bar) (12—15 psi) |
| | 16NJ | RE505358 | | 112 (150) | 1800 | 80—98 kPa (0.8—1.0 bar) (12—14 psi) |
| 6068TF152 | 1696 | RE69787 | | 116 (155) | 2500 | 85—105 kPa (0.9—1.1 bar) (12—15 psi) |
| | 16JU | RE69787 | | 116 (155) | 2500 | 85—105 kPa (0.9—1.1 bar) (12—15 psi) |
| 6068TF157 | 16GS | RE503049 | | 121 (162) | 1500 | 86—100 kPa (0.9—1.0 bar) (12—15 psi) |
| | 16LX | RE503834 | | 121 (162) | 1500 | 86—100 kPa (0.9—1.0 bar) (12—15 psi) |
| 6068TF158 | 16GS | RE503049 | | 121 (162) | 1500 | 86—100 kPa (0.9—1.0 bar) (12—15 psi) |
| | 16MG | RE503742 | | 123 (165) | 1800 | 78—82 kPa (0.8 bar) (11—12 psi) |
| | 16MH | RE504967 | | 123 (165) | 1800 | 78—82 kPa (0.8 bar) (11—12 psi) |
| | 16MX | RE503740 | | 105 (141) | 1500 | 85—99 kPa (0.9—1.0 bar) (12—14 psi) |
| | 16MY | RE505052 | | 105 (141) | 1500 | 85—99 kPa (0.9—1.0 bar) (12—14 psi) |
| 6068TF159 | 16PD | RE70938 | | 96 (129) | 2100 | 58—70 kPa (0.6—0.7 bar) (8—10 psi) |
| 6068TF220 | 16KK | RE502694 | | 127 (170) | 2500 | 75—89 kPa (0.8—0.9 bar) (11—13 psi) |
| 6068TF250 | 1615 | RE62366 | RE69791 | 138 (185) | 2400 | 110—134 kPa (1.1—1.3 bar) (16—19 psi) |
| | 1615 | RE69791 | | 138 (185) | 2400 | 110—134 kPa (1.1—1.3 bar) (16—19 psi) |
| | 1619 | RE67573 | | 124 (166) | 1800 | 88—108 kPa (0.9—1.1 bar) (13—16 psi) |
| | 1668 | RE59969 | | 138 (185) | 2400 | 115—141 kPa (1.2—1.4 bar) (17—20 psi) |
| | 1685 | RE67574 | | 124 (166) | 1800 | 88—108 kPa (0.9—1.1 bar) (13—16 psi) |
| | 1686 | RE60131 | RE69792 | 138 (185) | 2400 | 110—134 kPa (1.1—1.3 bar) (16—19 psi) |
| | 1686 | RE69792 | | 138 (185) | 2400 | 110—134 kPa (1.1—1.3 bar) (16—19 psi) |
| | 16CW | RE501344 | | 106 (142) | 2200 | 74—88 kPa (0.7—0.9 bar) (11—13 psi) |
| | 16CX | RE70390 | | 128 (172) | 2300 | 100—122 kPa (1.0—1.2 bar) (15—18 psi) |
| | 16GS | RE503049 | | 121 (162) | 1500 | 86—100 kPa (0.9—1.0 bar) (12—15 psi) |
| | 16LT | RE69791 | | 138 (185) | 2400 | 110—134 kPa (1.1—1.3 bar) (16—19 psi) |
| | 16LU | RE67573 | | 124 (166) | 1800 | 88—108 kPa (0.9—1.1 bar) (13—16 psi) |
| | 16LX | RE503834 | | 155 (208) | 1500 | 138—152 kPa (1.4—1.5 bar) (20—22 psi) |
| | 16MJ | RE503744 | | 142 (190) | 1800 | 109—123 kPa (1.1—1.2 bar) (16—18 psi) |
| | 16MK | RE504968 | | 142 (190) | 1800 | 109—123 kPa (1.1—1.2 bar) (16—18 psi) |
| 6068TF251 | 1615 | RE62366 | | 138 (185) | 2400 | 110—134 kPa (1.1—1.3 bar) (16—19 psi) |
| 6068TF257 | 16GS | RE503049 | | 121 (162) | 1500 | 86-100 kPa (0.9—1.0 bar) (12—15 psi) |
| | 16LX | RE503834 | | 155 (208) | 1500 | 138—152 kPa (1.4—1.5 bar) (20—22 psi) |
| 6068TF258 | 16GS | RE503049 | | 121 (162) | 1500 | 86-100 kPa (0.9—1.0 bar) (12—15 psi) |
| | 16LX | RE503834 | | 155 (208) | 1500 | 138—152 kPa (1.4—1.5 bar) (20—22 psi) |
| | 16MJ | RE503744 | | 142 (190) | 1800 | 109—123 kPa (1.1—1.2 bar) (16—18 psi) |

| | TURBO B | OOST PRESSI | JRES (JOHN DE | ERE OEM/OUT | SIDE EQUIPA | MENT MANUFACTURERS) |
|------------------------------------|-------------------------------------|-------------------------------|----------------------------------|---|------------------------------------|---|
| Engine Number | Injection Pump Option Code | Injection Pump Part No. | Replacement Injection Pump | Rated Power at Full Load Rated Speed kW (hp) | Full Load Rated Speed rpm | Turbo Boost Pressure at Full Load Rated Speed kPa (bar) (psi) |
| | 16MK | RE504968 | | 142 (190) | 1800 | 109—123 kPa (1.1—1.2 bar) (16—18 psi) |
| 6068TFM50 | 16FA | RE502619 | | 168 (225) | 2600 | 155 kPa (1.6 bar) (22 psi) |
| | 16FB | RE502620 | | 168 (225) | 2600 | 155 kPa (1.6 bar) (22 psi) |
| | 16FC | RE502621 | | 130 (174) | 2400 | 104 kPa (1.0 bar) (15 psi) |
| | 16FD | RE502622 | | 130 (174) | 2400 | 104 kPa (1.0 bar) (15 psi) |
| | 16FE | RE502623 | | 110 (148) | 1800 | 90 kPa (0.9 bar) (13 psi) |
| | 16FF | RE502624 | | 110 (148) | 1800 | 90 kPa (0.9 bar) (13 psi) |
| T04045TF151 (MCII) | 1677 | RE67563 | | 75 (101) | 1800 | 65—79 kPa (0.7—0.8 bar) (9—12 psi) |
| CD4045TF152 (LIEBHERR) | 16AX | RE500511 | | 76 (102) | 2400 | 75—91 kPa (0.8—0.9 bar) (11—13 psi) |
| CD4045TF251 (LUCASSEN YOUNG) | 1606 | RE64133 | | 93 (125) | 2400 | 108—132 kPa (1.1—1.3 bar) (16—19 psi) |
| T06068TF151 (MCII) | 1681 | RE67571 | | 112 (150) | 1800 | 80—98 kPa (0.8—1.0 bar) (12—14 psi) |

DPSG,OUO1004,2748 -19-02MAY00-11/11

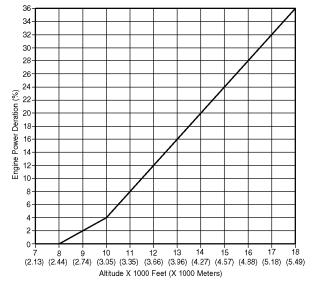
Effects of Altitude and Temperature on Engine Performance

Altitude, fuel temperature, air temperature, and humidity may affect engine performance. As a general rule, atmospheric changes will usually cause a decrease in engine power by the percentages shown in chart below.

ATMOSPHERIC CHANGE % POWER DECREASE

| Fuel Temperature Rise of 1°C (1.8°F) above 40°C (104°F) 0.29 |
|--|
| Air Temperature Rise of 5.5°C (10°F) above 25°C (77°F) 0.50 |
| Naturally Aspirated Engines: |
| Altitude Rise of 300 m (1000 ft) above 180 m (600 ft) |
| Turbocharged Engines: |
| Altitude Rise of 300 m (1000 ft) above 180 m (600 ft) |
| Relative Humidity Rise of 10% above 0% 0.07 |

NOTE: This data does not apply to engines with electronic fuel control systems. In these engines, the ECU compensates for changes in altitude and temperature and adjusts engine performance.



Turbocharged Engines

RG9094 -UN-27MAR98

RG,RG34710,1064 -19-08JUN99-1/1

Engine Diagnostic Specifications

| Item | Measurement | Specification | |
|---|--|--|--|
| Engine Compression Pressure Test | Engine Compression Pressure: Minimum Maximum Difference between Cylinders | 2400 kPa (24 bar) (350 psi) 350 kPa (3.5 bar) (50 psi) | |
| Minimum Oil Pressure—No Load at Slow Idle and 93°C (200°F) Oil Temperature | Minimum Pressure | 100 kPa (1.0 bar) (14 psi) | |
| Minimum Oil Pressure—Full Load at Rated Speed and 105°C (220°F) Oil Temperature | Minimum Pressure | 275 kPa (2.75 bar) (40 psi) | |
| Cooling System | Test Pressure | 70 kPa (0.7 bar) (10 psi) | |
| | | | |
| | | | |
| | | | |

DPSG,OUO1004,2737 -19-26APR00-1/1

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