SEBU8311-02
January 2010

Operation and Maintenance Manual

402D-403D-404D Industrial Engine

GG (Engine)
GH (Engine)
GJ (Engine)
GK (Engine)
GL (Engine)
GM (Engine)
GN (Engine)
GP (Engine)
GQ (Engine)
GS (Engine)

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Before Starting Engine

Before the initial start-up of an engine that is new, serviced or repaired, make provision to shut the engine off, in order to stop an overspeed. This may be accomplished by shutting off the air and/or fuel supply to the engine.

Overspeed shutdown should occur automatically for engines that are controlled electronically. If automatic shutdown does not occur, press the emergency stop button in order to cut the fuel and/or air to the engine.

Inspect the engine for potential hazards.

Before starting the engine, ensure that no one is on, underneath, or close to the engine. Ensure that the area is free of personnel.

If equipped, ensure that the lighting system for the engine is suitable for the conditions. Ensure that all lights work correctly, if equipped.

All protective guards and all protective covers must be installed if the engine must be started in order to perform service procedures. To help prevent an accident that is caused by parts in rotation, work around the parts carefully.

Do not bypass the automatic shutoff circuits. Do not disable the automatic shutoff circuits. The circuits are provided in order to help prevent personal injury. The circuits are also provided in order to help prevent engine damage.

See the Service Manual for repairs and for adjustments.

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Engine Starting

⚠ WARNING

Do not use aerosol types of starting aids such as ether. Such use could result in an explosion and personal injury.

If a warning tag is attached to the engine start switch or to the controls, DO NOT start the engine or move the controls. Consult with the person that attached the warning tag before the engine is started.

All protective guards and all protective covers must be installed if the engine must be started in order to perform service procedures. To help prevent an accident that is caused by parts in rotation, work around the parts carefully.

Start the engine from the operator's compartment or from the engine start switch.

Always start the engine according to the procedure that is described in the Operation and Maintenance Manual, “Engine Starting” topic in the Operation Section. Knowing the correct procedure will help to prevent major damage to the engine components. Knowing the procedure will also help to prevent personal injury.

To ensure that the jacket water heater (if equipped) and/or the lube oil heater (if equipped) is working correctly, check the water temperature gauge and the oil temperature gauge during the heater operation.

Engine exhaust contains products of combustion which can be harmful to your health. Always start the engine and operate the engine in a well ventilated area. If the engine is started in an enclosed area, vent the engine exhaust to the outside.

Note: The engine is equipped with an automatic device for cold starting for normal conditions of operation. If the engine will be operated in very cold conditions, then an extra cold starting aid may be required. Normally, the engine will be equipped with the correct type of starting aid for your region of operation.

The 400 Series engines are equipped with a glow plug starting aid in each individual cylinder that heats the intake air in order to improve starting.

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Engine Stopping

To avoid overheating of the engine and accelerated wear of the engine components, stop the engine according to this Operation and Maintenance Manual, “Engine Stopping” topic (Operation Section).

Use the Emergency Stop Button (if equipped) ONLY in an emergency situation. DO NOT use the Emergency Stop Button for normal engine stopping. After an emergency stop, DO NOT start the engine until the problem that caused the emergency stop has been corrected.

404D-15 Engine

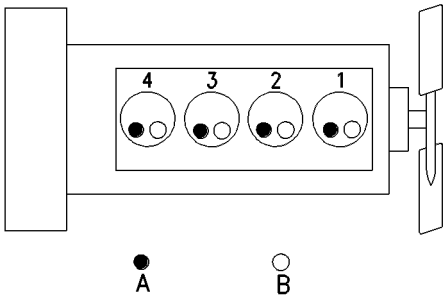

Illustration 19 g00296424

(A) Exhaust valves
(B) Inlet valves

Table 7

404D-15 Engine Specifications	
Maximum Operating Speed (rpm)	3000 rpm
Cylinders and Arrangement	In-Line four cylinder
Bore	77 mm (3.03 inch)
Stroke	81 mm (3.19 inch)
Displacement	1.508 L (92.024 in^3)
Aspiration	NA(1)
Compression Ratio	23.5:1
Firing Order	1-3-4-2
Rotation that is viewed from the flywheel	Counterclockwise
Valve Lash Setting (Inlet)	0.20 mm (0.008 inch)
Valve Lash Setting (Exhaust)	0.20 mm (0.008 inch)
Injection	Indirect

(1) Naturally Aspirated

404D-22 Engine

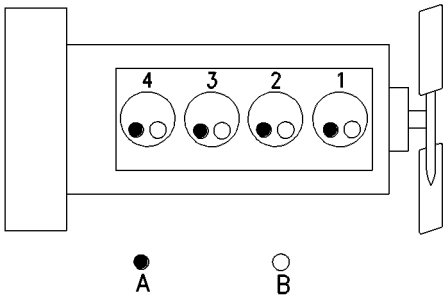

Illustration 20 g00296424

(A) Exhaust valves
(B) Inlet valves

Table 8

404D-22 Engine Specifications	
Maximum Operating Speed (rpm)	3000 rpm
Cylinders and Arrangement	In-Line four cylinder
Bore	84.0 mm (3.31 inch)
Stroke	100.0 mm (3.94 inch)
Displacement	2.216 L (135.229 in^3)
Aspiration	NA(1)
Compression Ratio	23.3:1
Firing Order	1-3-4-2
Rotation that is viewed from the flywheel	Counterclockwise
Valve Lash Setting (Inlet)	0.20 mm (0.008 inch)
Valve Lash Setting (Exhaust)	0.20 mm (0.008 inch)
Injection	Indirect

(1) Naturally Aspirated

Refer to the OEM manual for your type of controls. Use the following procedure to start the engine.

1. Move the throttle lever to the low idle position before you start the engine.

NOTICE
Do not operate the glow plugs for more than 60 seconds at one time. Damage to the glow plugs could occur.

2. Turn the engine start switch to the HEAT position. Hold the engine start switch in the HEAT position for 6 seconds until the glow plug indicator light illuminates. This will activate the glow plugs and aid in the starting of the engine.

NOTICE
Do not crank the engine for more than 30 seconds. Allow the electric starting motor to cool for two minutes before cranking the engine again.

3. While the glow plug indicator light is illuminated, turn the engine start switch to the START position and crank the engine.

4. When the engine starts, release the engine start switch.

5. Slowly move the throttle lever to the low idle position and allow the engine to idle. Refer to the Operation and Maintenance Manual, “After Starting Engine” topic.

Note: If the glow plug indicator light illuminates rapidly for 2 to 3 seconds, or if the glow plug indicator light fails to illuminate, a malfunction exists in the cold start system. Do not use ether or other starting fluids to start the engine.

6. If the engine does not start, release the engine start switch and allow the electric starting motor to cool. Then, repeat steps 2 through step 5.

7. Turn the engine start switch to the OFF position in order to stop the engine.

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Starting with Jump Start Cables

⚠ WARNING

Improper jump start cable connections can cause an explosion resulting in personal injury.

Prevent sparks near the batteries. Sparks could cause vapors to explode. Do not allow jump start cable ends to contact each other or the engine.

Note: If it is possible, first diagnose the reason for the starting failure. Make any necessary repairs. If the engine will not start only due to the condition of the battery, either charge the battery, or start the engine with jump start cables.
The condition of the battery can be rechecked after the engine has been switched OFF.

NOTICE
Using a battery source with the same voltage as the electric starting motor. Use ONLY equal voltage for jump starting. The use of higher voltage will damage the electrical system.

Do not reverse the battery cables. The alternator can be damaged. Attach ground cable last and remove first.

When using an external electrical source to start the engine, turn the generator set control switch to the “OFF” position. Turn all electrical accessories OFF before attaching the jump start cables.

Ensure that the main power switch is in the OFF position before attaching the jump start cables to the engine being started.

1. Turn the start switch to the OFF position. Turn off all the engine's accessories.

2. Connect one positive end of the jump start cable to the positive cable terminal of the discharged battery. Connect the other positive end of the jump start cable to the positive cable terminal of the electrical source.

403D-07 Engine

Table 19

403D-07 Engine Refill Capacities		
Compartment or System	**Liters**	**Quarts**
Engine Only	1.2	1.3
External System Per OEM(1)		
Total Cooling System(2)		

(1) The External System includes a radiator or an expansion tank with the following components: heat exchanger and piping. Refer to the OEM specifications. Enter the value for the capacity of the External System in this row.

(2) The Total Cooling System capacity includes the capacity of the Engine plus the External System. Enter the value for the capacity of the Total Cooling System in this row.

403D-11 Engine

Table 20

403D-11 Engine Refill Capacities		
Compartment or System	**Liters**	**Quarts**
Engine Only	1.9	2.0
External System Per OEM(1)		
Total Cooling System(2)		

(1) The External System includes a radiator or an expansion tank with the following components: heat exchanger and piping. Refer to the OEM specifications. Enter the value for the capacity of the External System in this row.

(2) The Total Cooling System capacity includes the capacity of the Engine plus the External System. Enter the value for the capacity of the Total Cooling System in this row.

403D-15 and 403D-15T Engines

Table 21

403D-15 and 403D-15TEngines Refill Capacities		
Compartment or System	**Liters**	**Quarts**
Engine Only	2.6	2.7
External System Per OEM(1)		
Total Cooling System(2)		

(1) The External System includes a radiator or an expansion tank with the following components: heat exchanger and piping. Refer to the OEM specifications. Enter the value for the capacity of the External System in this row.

(2) The Total Cooling System capacity includes the capacity of the Engine plus the External System. Enter the value for the capacity of the Total Cooling System in this row.

404D-15 Engine

Table 22

404D-15 Engine Refill Capacities		
Compartment or System	**Liters**	**Quarts**
Engine Only	2.4	2.5
External System Per OEM(1)		
Total Cooling System(2)		

(1) The External System includes a radiator or an expansion tank with the following components: heat exchanger and piping. Refer to the OEM specifications. Enter the value for the capacity of the External System in this row.

(2) The Total Cooling System capacity includes the capacity of the Engine plus the External System. Enter the value for the capacity of the Total Cooling System in this row.

404D-22, 404D-22T and 404D-22TA Engines

Table 23

404D-22,404D-22T and 404D-22TA Engines Refill Capacities		
Compartment or System	**Liters**	**Quarts**
Engine Only	3.6	3.8
External System Per OEM(1)		
Total Cooling System(2)		

(1) The External System includes a radiator or an expansion tank with the following components: heat exchanger and piping. Refer to the OEM specifications. Enter the value for the capacity of the External System in this row.

(2) The Total Cooling System capacity includes the capacity for the Engine plus the External System. Enter the value for the capacity of the Total Cooling System in this row.

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Fluid Recommendations

General Lubricant Information

Because of government regulations regarding the certification of exhaust emissions from the engine, the lubricant recommendations must be followed.

Engine Manufacturers Association (EMA) Oils

The “Engine Manufacturers Association Recommended Guideline on Diesel Engine Oil” is recognized by Perkins. For detailed information about this guideline, see the latest edition of EMA publication, “EMA DHD -1”.

Table 36

Perkins Specification for Distillate Diesel Fuel (1)				
Property	**UNITS**	**Requirements**	**“ASTM”Test**	**“ISO”Test**
Aromatics	%Volume	35% maximum	D1319	“ISO”3837
Ash	%Weight	0.02% maximum	D482	“ISO”6245
Carbon Residue on 10% Bottoms	%Weight	0.35% maximum	D524	“ISO”4262
Cetane Number (2)	-	40 minimum	D613/D6890	“ISO”5165
Cloud Point	°C	The cloud point must not exceed the lowest expected ambient temperature.	D2500	“ISO”3015
Copper Strip Corrosion	-	No. 3 maximum	D130	“ISO”2160
Density at 15 °C (59 °F) (3)	Kg / M 3	801 minimum and 876 maximum	No equivalent test	“ISO 3675 ”“ISO 12185”
Distillation	°C	10% at 282 °C (539.6 °F) maximum 90% at 360 °C (680 °F) maximum	D86	“ISO”3405
Flash Point	°C	legal limit	D93	“ISO”2719
Thermal Stability	-	Minimum of 80% reflectance after aging for 180 minutes at 150 °C (302 °F)	D6468	No equivalent test
Pour Point	°C	6 °C (42.8 °F) minimum below ambient temperature	D97	“ISO”3016
Sulfur (1)(4)	%mass	The level of sulfur that is in the fuel is controlled by emissions regulations. Refer to Tables 37 and 38 for more information.	D5453/D26222	“ISO 20846 ”“ISO 20884”
Kinematic Viscosity (5)	“MM”2“/S (cSt)”	The viscosity of the fuel that is delivered to the fuel injection pump. “1.4 minimum/4.5 maximum”	D445	“ISO”3405
Water and sediment	% weight	0.1% maximum	D1796	“ISO”3734
Water	% weight	0.1% maximum	D1744	No equivalent test
Sediment	% weight	0.05% maximum	D473	“ISO”3735
Gums and Resins (6)	mg/100mL	10 mg per 100 mL maximum	D381	“ISO”6246

(continued)

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Aftercooler Core - Clean/Test (Air-To-Air Aftercooler)

1. Remove the core. Refer to the OEM information for the correct procedure.

2. Turn the aftercooler core upside-down in order to remove debris.

⚠ WARNING

Personal injury can result from air pressure.

Personal injury can result without following proper procedure. When using pressure air, wear a protective face shield and protective clothing.

Maximum air pressure at the nozzle must be less than 205 kPa (30 psi) for cleaning purposes.

3. Pressurized air is the preferred method for removing loose debris. Direct the air in the opposite direction of the fan's air flow. Hold the nozzle approximately 6 mm (.25 inch) away from the fins. Slowly move the air nozzle in a direction that is parallel with the tubes. This will remove debris that is between the tubes.

4. Pressurized water may also be used for cleaning. The maximum water pressure for cleaning purposes must be less than 275 kPa (40 psi). Use pressurized water in order to soften mud. Clean the core from both sides.

NOTICE

Do not use a high concentration of caustic cleaner to clean the core. A high concentration of caustic cleaner can attack the internal metals of the core and cause leakage. Only use the recommended concentration of cleaner.

5. Back flush the core with a suitable cleaner.

6. Steam clean the core in order to remove any residue. Flush the fins of the aftercooler core. Remove any other trapped debris.

7. Wash the core with hot, soapy water. Rinse the core thoroughly with clean water.

8. Dry the core with compressed air. Direct the air in the reverse direction of the normal flow.

9. Inspect the core in order to ensure cleanliness. Pressure test the core. If necessary, repair the core.

10. Install the core. Refer to the OEM information for the correct procedure.

11. After cleaning, start the engine and accelerate the engine to high idle rpm. This will help in the removal of debris and drying of the core. Stop the engine. Use a light bulb behind the core in order to inspect the core for cleanliness. Repeat the cleaning, if necessary.

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Aftercooler Core - Inspect

Note: Adjust the frequency of cleaning according to the effects of the operating environment.

Inspect the aftercooler for these items: damaged fins, corrosion, dirt, grease, insects, leaves, oil, and other debris. Clean the aftercooler, if necessary.

For air-to-air aftercoolers, use the same methods that are used for cleaning radiators.

⚠ WARNING

Personal injury can result from air pressure.

Personal injury can result without following proper procedure. When using pressure air, wear a protective face shield and protective clothing.

Maximum air pressure at the nozzle must be less than 205 kPa (30 psi) for cleaning purposes.

After cleaning, start the engine and accelerate the engine to high idle rpm. This will help in the removal of debris and drying of the core. Stop the engine. Use a light bulb behind the core in order to inspect the core for cleanliness. Repeat the cleaning, if necessary.

Inspect the fins for damage. Bent fins may be opened with a “comb”.

Note: If parts of the aftercooler system are repaired or replaced, a leak test is highly recommended.

Inspect these items for good condition: Welds, mounting brackets, air lines, connections, clamps, and seals. Make repairs, if necessary.

Periodic cleaning of the engine is recommended. Steam cleaning the engine will remove accumulated oil and grease. A clean engine provides the following benefits:

- Easy detection of fluid leaks
- Maximum heat transfer characteristics
- Ease of maintenance

Note: Caution must be used in order to prevent electrical components from being damaged by excessive water when the engine is cleaned. Pressure washers and steam cleaners should not be directed at any electrical connectors or the junction of cables into the rear of the connectors. Avoid electrical components such as the alternator, and the starter. Protect the fuel injection pump from fluids in order to wash the engine.

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Engine Air Cleaner Element (Dual Element) - Clean/Replace

NOTICE
Never run the engine without an air cleaner element installed. Never run the engine with a damaged air cleaner element. Do not use air cleaner elements with damaged pleats, gaskets or seals. Dirt entering the engine causes premature wear and damage to engine components. Air cleaner elements help to prevent air-borne debris from entering the air inlet.

NOTICE
Never service the air cleaner element with the engine running since this will allow dirt to enter the engine.

Servicing the Air Cleaner Elements

If the air cleaner element becomes plugged, the air can split the material of the air cleaner element. Unfiltered air will drastically accelerate internal engine wear. Your Perkins dealer has the proper air cleaner elements for your application. Consult your Perkins dealer for the correct air cleaner element.

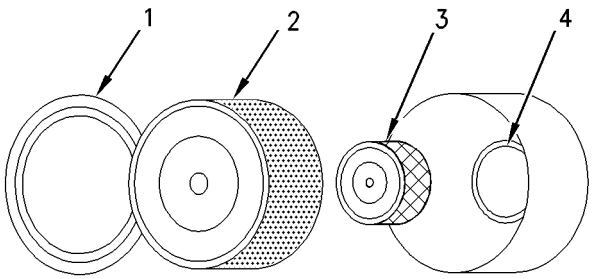
- Check the precleaner (if equipped) daily for accumulation of dirt and debris. Remove any dirt and debris, as needed.
- Operating conditions (dust, dirt and debris) may require more frequent service of the air cleaner element.
- The air cleaner element may be cleaned up to six times if the element is properly cleaned and inspected.
- The air cleaner element should be replaced at least one time per year. This replacement should be performed regardless of the number of cleanings.

Replace the dirty paper air cleaner elements with clean air cleaner elements. Before installation, the air cleaner elements should be thoroughly checked for tears and/or holes in the filter material. Inspect the gasket or the seal of the air cleaner element for damage. Maintain a supply of suitable air cleaner elements for replacement purposes.

Dual Element Air Cleaners

The dual element air cleaner contains a primary air cleaner element and a secondary air cleaner element. The primary air cleaner element can be used up to six times if the element is properly cleaned and inspected. The primary air cleaner element should be replaced at least one time per year. This replacement should be performed regardless of the number of cleanings.

The secondary air cleaner element is not serviceable or washable. The secondary air cleaner element should be removed and discarded for every three cleanings of the primary air cleaner element. When the engine is operating in environments that are dusty or dirty, air cleaner elements may require more frequent replacement.



g00736431
Illustration 39

(1) Cover
(2) Primary air cleaner element
(3) Secondary air cleaner element
(4) Turbocharger air inlet

1. Remove the cover. Remove the primary air cleaner element.
2. The secondary air cleaner element should be removed and discarded for every three cleanings of the primary air cleaner element.

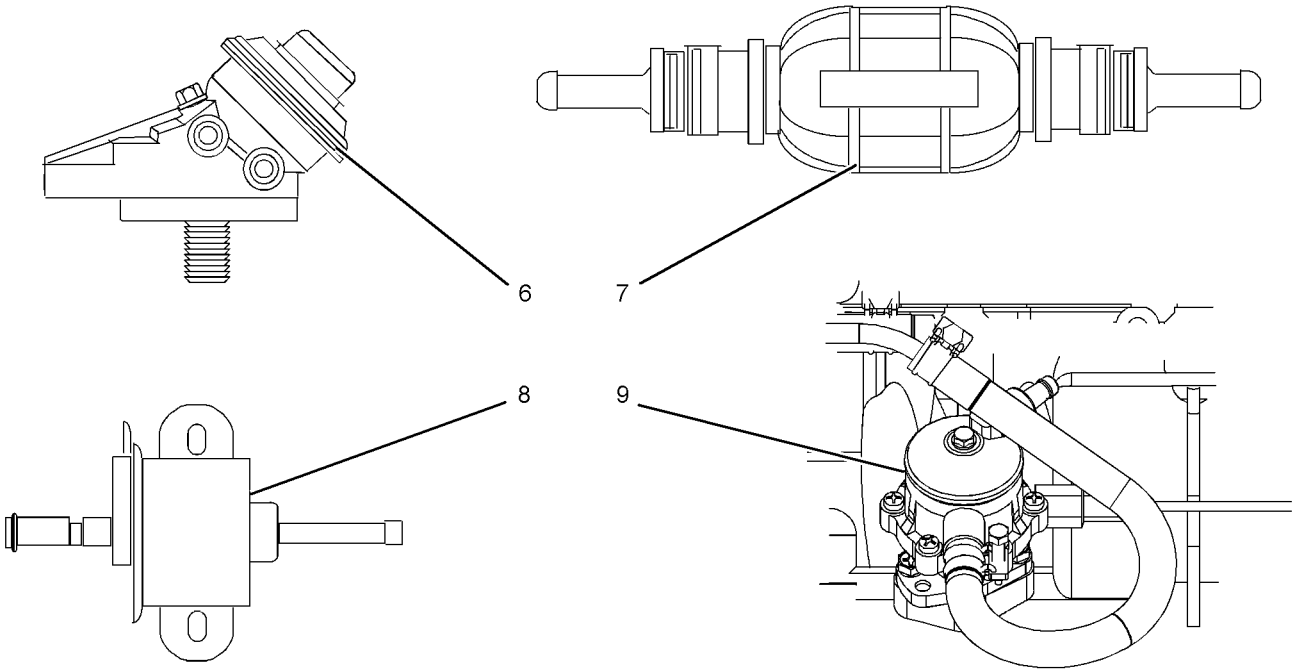


Illustration 53 g01301853

(6) Hand priming pump
(7) In-line priming pump
(8) Electrical priming pump
(9) Fuel transfer pump

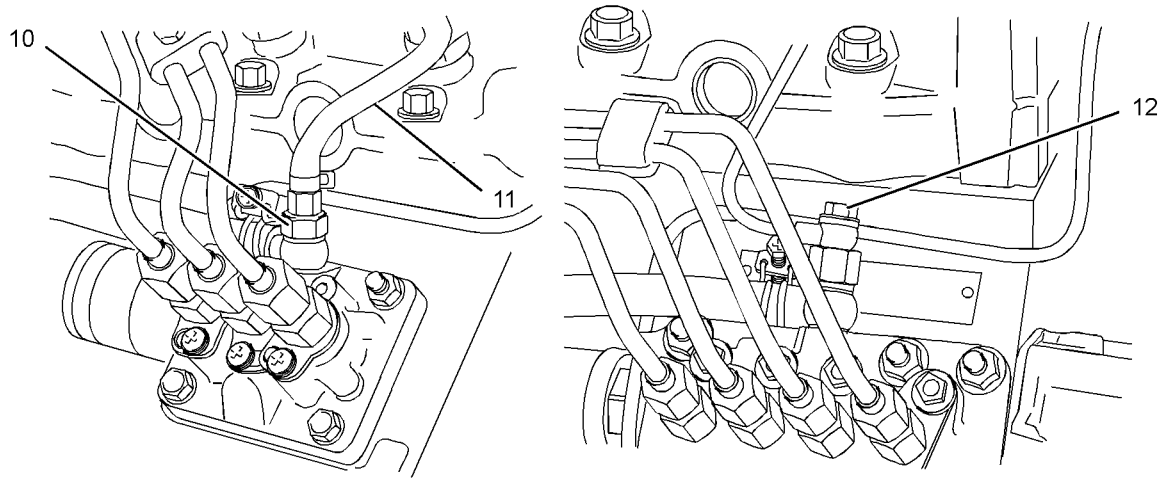


Illustration 54 g01304597

(10) Connector bolt
(11) Fuel return line
(12) Connector bolt

Hand Priming Pump 6

In order to identify the hand priming pump, refer to illustration 53.

1. Ensure that fuel valve (2) for the fuel filter that has an element is in the ON position. Refer to illustration 50.
2. Loosen vent screw (3 4 or 5) on the fuel filter.