Rocker Shaft and Camshaft Procedures

Additions, Revisions, or Updates

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<tr>
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<th>Platform</th>
<th>Section Title</th>
<th>Change</th>
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<tr>
<td>DDC-SVC-MAN-0081</td>
<td>DD Platform</td>
<td>Removal of the Rocker Shaft Assembly</td>
<td>Separate the combined rocker shaft and camshaft procedures into stand-alone procedures under individual task titles.</td>
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<tr>
<td>DDC-SVC-MAN-0181</td>
<td>EuroIV</td>
<td>Removal of the Camshafts</td>
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<td>Installation of the Rocker Shaft Assembly</td>
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</tbody>
</table>
# 2 Removal of the Rocker Shaft Assembly

<table>
<thead>
<tr>
<th>Tool Number</th>
<th>Tool Name</th>
<th>Tool Graphic</th>
</tr>
</thead>
<tbody>
<tr>
<td>W470589034000</td>
<td>Camshaft Timing Tool - EPA07 DD13*</td>
<td><img src="image1" alt="Tool Graphic" /></td>
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<tr>
<td>W470589114000</td>
<td>Camshaft Timing Tool - EPA07/EPA10 DD13</td>
<td><img src="image2" alt="Tool Graphic" /></td>
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<tr>
<td>W470589054000</td>
<td>Camshaft Timing Tool - EPA07</td>
<td><img src="image3" alt="Tool Graphic" /></td>
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<tr>
<td>W470589104000</td>
<td>DD15 Camshaft Timing Tool - EPA07/EPA10 DD15/16</td>
<td><img src="image4" alt="Tool Graphic" /></td>
</tr>
<tr>
<td>J-46392 or W904589046300</td>
<td>Engine Barring Tool</td>
<td><img src="image5" alt="Tool Graphic" /></td>
</tr>
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</table>
## Service Tools Used in the Procedure

<table>
<thead>
<tr>
<th>Tool Number</th>
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</tr>
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<tbody>
<tr>
<td>W470589001500</td>
<td>Top Dead Center Locating Pin</td>
<td><img src="d580136" alt="Tool Graphic" /></td>
</tr>
<tr>
<td>W470589044000</td>
<td>Intake Rocker Arm Lifter/Spacer Tool - DD13</td>
<td><img src="d580138" alt="Tool Graphic" /></td>
</tr>
<tr>
<td>W470589074000</td>
<td>Exhaust Rocker Arm Lifter/Spacer Tool - DD13</td>
<td><img src="d580138" alt="Tool Graphic" /></td>
</tr>
<tr>
<td>W470589004000</td>
<td>Intake/Exhaust Rocker Arm Lifter/Spacer Tool - DD15</td>
<td><img src="d580046" alt="Tool Graphic" /></td>
</tr>
</tbody>
</table>

* Can be used on EPA10 with modification (refer to tool letter 10 TL-9)

Remove as follows:

1. Turn engine OFF.
2. Steam clean the engine.
3. Disconnect the battery power to the engine. Refer to OEM procedures.
4. Remove the air filter and the turbocharger inlet pipe and hose. Refer to OEM procedures.
5. Remove air filter housing. Refer to OEM procedures.
6. Remove the rocker cover. Refer to section "Removal of the Rocker Cover".
7. Using the engine barring tool (J-46392 or W904589046300), rotate the crankshaft until the TDC dot (3) between two teeth on the flywheel aligns with the edge of pointer (2), the engine is at TDC firing stroke.
8. Remove the Crankshaft Position (CKP) sensor (1) from the rear of the flywheel housing. Refer to section "Removal of the Crankshaft Position Sensor".

9. To accurately locate TDC, install the flywheel housing crankshaft TDC locating pin (W47058901500) into the CKP sensor hole located in the rear of the flywheel housing. The plastic tip will protrude into a cutout in the tone wheel. TDC can be verified by the proper installation of the camshaft timing tool. See tool list below:
   - W47058901500 - EPA07 DD13
   - W470589114000 - EPA07/EPA10 DD13
   - W470589054000 - EPA07
   - W470589104000 - EPA07/EPA10 DD15/DD16
10. Remove the fuel injector wiring harness.  
    Refer to section "Removal of the One-Piece Fuel Injector Wiring Harness - Three-Filter System".  
    Refer to section "Removal of the One-Piece Fuel Injector Wiring Harness - Two-Filter System".  
    Refer to section "Removal of the Two-Piece Fuel Injector Wiring Harness - Two-Filter System".  
11. Remove the engine brake solenoids from the camshaft housing.  

**NOTICE:** Ensure when loosening the rocker shaft bolts that the bolts are loosened from the inside bolts outward, in ½ turn increments. The increment procedure needs to be followed to prevent the rocker shaft from breaking.  

12. Completely loosen all of the adjusting screws on all of the rocker arms.  
13. Loosen the seven bolts securing the intake rocker shaft to the camshaft bearing caps.  

**NOTICE:** Make sure that the camshaft housing is not damaged during removal of the intake/exhaust rocker shaft assemblies.  

14. Using the intake rocker arm lifter/spacer tool (DD13 - W470589044000) or (DD15/DD16 - W470589004000), remove the intake rocker shaft assembly.  

**NOTICE:** Ensure when loosening the rocker shaft bolts that the bolts are loosened from the inside bolts outward, in ½ turn increments. The increment procedure needs to be followed to prevent the rocker shaft from breaking.  

15. Loosen the seven bolts securing the exhaust rocker shaft to the camshaft caps.  

**NOTICE:** When removing the EPA10 exhaust rocker shaft, ensure the rockers are in the UP position.  

16. Using the exhaust rocker arm lifter/spacer tool (W470589074000), remove the exhaust rocker shaft assembly.
3 Removal of the Camshafts

Table 2.

<table>
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<tr>
<th>Tool Number</th>
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<tbody>
<tr>
<td>J-48883</td>
<td>Camshaft Bearing Cap Puller</td>
<td><img src="d580141" alt="image" /></td>
</tr>
<tr>
<td>J-46375</td>
<td>Injector Unit Pump Puller</td>
<td><img src="d580140" alt="image" /></td>
</tr>
</tbody>
</table>

Remove as follows:

1. Remove the rocker shaft assemblies. Refer to section "Removal of the Rocker Shaft Assembly".

**NOTE:** The engine brake solenoids do not have to be removed unless they are damaged.

**NOTE:** Mark the camshaft bearing cap position for proper reassembly.

2. Remove the bolts (1) from the camshaft bearing caps (2).

3. Using the camshaft bearing cap puller tool (J-48883) and injector unit pump puller tool (J-46375), remove the camshaft bearing caps (1) from the camshaft housing.
4. Using care not to damage the intake camshaft tone wheel, remove the intake and exhaust camshaft assemblies (1 and 2) from the camshaft housing (3).

**NOTICE:** Damage to the intake camshaft tone wheel will result in a check engine light.
### 4 Installation of the Camshafts

**Table 3. Service Tools Used in the Procedure**

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<tr>
<td>J-46392 or W904589046300</td>
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<td><img src="d580077" alt="d580077" /></td>
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<tr>
<td>W470589034000</td>
<td>Camshaft Timing Tool - EPA07 DD13*</td>
<td><img src="d580115" alt="d580115" /></td>
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<tr>
<td>W470589114000</td>
<td>Camshaft Timing Tool - EPA07/EPA10 DD13</td>
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<tr>
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<td>DD15 Camshaft Timing Tool - EPA07/EPA10 DD15/16</td>
<td><img src="d580115" alt="d580115" /></td>
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<td>Top Dead Center Locating Pin</td>
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* Can be used on EPA10 with modification (refer to tool letter 10 TL-9)

Install as follows:

1. Bar the engine to Top Dead Center (TDC) with engine barring tool (J-46392 or W904589046300) on cylinder No.1 with the No. 6 valve in overlap. The dot (2) that is located inside the flywheel tone ring is aligned with the edge of the pointer (1).
2. Insert the locating pin in the Crankshaft Position Sensor (CKP) hole located in flywheel housing.

3. Install camshaft timing tool (1) to the rear of the camshaft housing. Tighten the two bolts.
4. Locate the etched triangle on the camshaft gear teeth and mark the teeth with a paint pen.
5. Lubricate the lower camshaft bearing surfaces and camshaft journals with clean engine oil before installing the camshafts.

**NOTE:** The intake camshaft has a tone wheel (3) mounted to the gear that is not serviceable.

6. Install the exhaust (1) and intake (2) camshaft gear assemblies into the camshaft housing.

7. Align the marked gear teeth with the marks on the timing tool.
8. Install the camshaft timing tool to the front of the camshaft housing and into the grooves cut into the camshafts. Secure timing tool to the camshaft housing with a bolt.
   a. At this point the front timing tool should slide into the camshaft grooves easily with no drag.
   b. If there is excessive drag when installing the tool, the camshafts are out of time. If so, repeat this procedure. Go to step 4.

9. Verify that the marks on the gear teeth match the marks on the timing tool.

**NOTE:** The camshaft caps are numbered and need to be installed correctly.

10. Install the seven camshaft caps onto intake and exhaust camshafts.

**NOTICE:** When installing the engine brake solenoids, do not use the bolt to pull the solenoid into the camshaft cap. Damage will occur to the O-rings on the solenoid.

11. The first and seventh camshaft caps hold the engine brake solenoids to the camshaft cap. Replace the O-rings on the solenoids prior to reinstallation and lubricate with clean engine oil. Seat the engine brake solenoids into the camshaft caps by hand.

**NOTE:** EPA07 DD15 uses 28 bolts to hold the camshaft cap and housing to the cylinder head.

12. Install the 30 bolts to camshaft caps; finger-tighten the bolts.

13. Using the torque sequence shown below, torque the twenty one M10 camshaft cap bolts to the following:
   a. Torque all bolts to 20 N·m (15 lb·ft).
   b. Then torque bolts to 50 to 55 N·m (37 to 40 lb·ft).
14. Using the torque sequence shown below, torque the nine 63 mm M8 bolts to 30 N·m (22 lb·ft).

15. Remove TDC locating pin from Crankshaft Position (CKP) sensor hole in the flywheel housing.
16. Install crankshaft position sensor. Refer to section "Installation of the Crankshaft Position Sensor".
17. Install a dial indicator onto gear case and zero out the dial indicator.
18. Position the stem of dial indicator to rest between the teeth on the camshaft gear.
19. Hold the number five idler gear with a screwdriver. Check the lash between the camshaft gear and idler gear number five.
20. The dial indicator should read 0.051 - 0.257 mm (0.002 - 0.010 in.). If the gear lash is excessive between the exhaust or intake camshaft gear and the number five idler gear, inspect the number five idler gear spindle, camshaft gear and camshaft housing. Repair as necessary.
21. Remove timing tools.

**NOTICE:** Failure to remove the engine barring tool prior to starting the engine will cause damage to the flywheel.

22. Remove the engine barring tool from the bottom of the flywheel housing.
23. Install the rocker shafts. Refer to section "Installation of the Rocker Shafts".
5 Installation of the Rocker Shafts

Table 4.

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<tr>
<td>W470589004000</td>
<td>Intake/Exhaust Rocker Arm Lifter/Spacer Tool - DD15</td>
<td>d580046</td>
</tr>
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</table>

Install as follows:

**NOTICE:** The camshaft journal area is lubricated by oil that has to travel through the rocker shaft. If the rocker shaft is installed incorrectly, oil passages will not line up. This results in insufficient lubrication and will damage the camshaft journals. Incorrect shaft installation can also result in the engine brakes not functioning which will cause damage to the rocker arm bushings.

**NOTICE:** The marking grooves (1) on the rocker shafts must face the REAR of the engine for proper lubrication and engine brake operation.

Rear:
NOTE: Starting with EPA10 engines the intake and exhaust rocker shafts are each marked "TOP FRONT." Top Front must face towards the front of the engine.
NOTICE: When tightening the rocker shaft bolts, ensure that the bolts are drawn down from the inside bolts outward, in 1/2 turn increments, before final torque. The rocker shaft can break if the rocker shaft bolt is fully torqued without using the increment procedure.

1. Install the intake and exhaust camshafts. Refer to section "Installation of the Camshafts".
2. Using the Intake Rocker Arm Lifter / Spacer tool, install the intake rocker shaft assembly to the camshaft cap and secure with seven clamping blocks and bolts.
3. Using the torque sequence shown below, torque the bolts to 50 to 55 N·m (36 to 41 lb·ft) +90°.
   a. Figure below displays the old style intake rocker arm used on DD13 prior to engine serial number HDE0079072 and the DD15 & DD16 prior to engine serial number HDE0077481.
   b. Figure below shows the current intake bridged rocker arm; the rocker arms are not backwards compatible.
NOTE: After initial torquing of each bolt, apply a paint mark to the head of the bolts to ensure that the proper 90° turn has been achieved.

4. Using the exhaust rocker arm lifter/spacer tool, install the exhaust rocker shaft assembly to the camshaft cap and secure with seven clamping blocks and bolts.
5. Using the torque sequence shown below, torque the bolts to 50 to 55 N·m (36 to 41 lb·ft) +90°.

6. Remove timing tools.
7. Install the fuel injectors, if removed.
   Refer to section "Installation of the Fuel Injector - Two-Filter System".
   Refer to section "Installation of the Fuel Injector - Three-Filter System".
8. Lash the valves and engine brakes. Refer to section "Valve Lash Adjustments".
9. Install the fuel injector wiring harness.
   Refer to section "Installation of the Two-Piece Fuel Injector Wiring Harness - Two-Filter System".
   Refer to section "Installation of the One-Piece Fuel Injector Wiring Harness - Three-Filter System".
   Refer to section "Installation of the Two-Piece Fuel Injector Wiring Harness - Three-Filter System".
10. Install the rocker cover. Refer to section "Installation of the Rocker Cover".
11. Reconnect the battery power to the engine. Refer to OEM procedures.
12. Install air cleaner housing. Refer to OEM procedures.
13. Install the turbocharger inlet pipe and hose, and air cleaner. Refer to OEM procedures.
14. Prime lubrication system. Refer to section "Priming the Engine Lubrication System".