SUBJECT: UPDATE TIMING TOOL NUMBERS

ADDITIONS, REVISIONS, OR UPDATES

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<th>Platform</th>
<th>Section Title</th>
<th>Change</th>
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<td>EPA07/10 DD Platform</td>
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NOTE: Page numbers are based on the most recent version of the individual publication and may be adjusted throughout the annual print cycle.
REMOVAL OF CAMSHAFT AND ROCKERSHAFT/ENGINE BRAKE ASSEMBLY

<table>
<thead>
<tr>
<th>Tool Number</th>
<th>Tool Name</th>
<th>Engine</th>
</tr>
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<tbody>
<tr>
<td>W470589034000</td>
<td>Cam Timing Tool</td>
<td>EPA07 DD13*</td>
</tr>
<tr>
<td>W470589114000</td>
<td>Cam Timing Tool</td>
<td>EPA07/EPA10 DD13</td>
</tr>
<tr>
<td>W470589054000</td>
<td>Cam Timing Tool</td>
<td>EPA07 DD15</td>
</tr>
<tr>
<td>W470589104000</td>
<td>DD15 Cam Timing Tool</td>
<td>EPA07/EPA10 DD15/16</td>
</tr>
<tr>
<td>J-46392 or W904589046300</td>
<td>Engine Barring Tool</td>
<td>DD Platform</td>
</tr>
<tr>
<td>W470589001500</td>
<td>TDC Locating Pin</td>
<td>DD Platform</td>
</tr>
<tr>
<td>W470589044000</td>
<td>Intake Rocker Arm Lifter / Spacer Tool</td>
<td>DD13</td>
</tr>
<tr>
<td>W470589074000</td>
<td>Exhaust Rocker Arm Lifter / Spacer Tool</td>
<td>DD13</td>
</tr>
<tr>
<td>W470589004000</td>
<td>Intake / Exhaust Rocker Arm Lifter / Spacer Tool</td>
<td>DD15</td>
</tr>
<tr>
<td>J-48883</td>
<td>Cam Bearing Cap Puller</td>
<td>DD Platform</td>
</tr>
<tr>
<td>J-46375</td>
<td>Injector Unit Pump Puller</td>
<td>DD Platform</td>
</tr>
</tbody>
</table>

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

Table 1  Tools Used in Procedures

Remove as follows:

1. Turn engine OFF, (key OFF, 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 .
7. Remove the two 14-pin fuel injector harness connectors (1) from the camshaft housing (2).
NOTE:
Top Dead Center (TDC) can be confirmed by installing camshaft timing tool.

8. Using Engine Barring tool, rotate the crankshaft to TDC on cylinder No. 1.

9. Remove the Crankshaft Position Sensor (CKP) (1) from the rear of the flywheel housing. Refer to section.

10. To accurately locate TDC, install the flywheel housing crankshaft TDC Locating Pin into the CKP sensor hole located in the rear of the flywheel housing. The plastic tip will protrude into the cutout in the tone wheel. TDC can be verified by the proper installation of the camshaft timing tool.
11. When the TDC dot (3) between two teeth on the flywheel aligns with the edge of pointer (2), the engine is at TDC firing stroke.

12. For EPA07 DD13:
   [a] Disconnect both 14-pin injector harness connectors (8).
   [b] Disconnect the 24 electrical terminals at the fuel injectors (7).
   [c] Disconnect two wiring terminals at each engine brake solenoid (6).
   [d] Loosen the Allen screws holding the intermediate frame (5) to the camshaft housing (1).
   Remove the intermediate frame.
13. **For EPA10 engines:**

   [a] Remove the fuel injector electrical harness clips (2) from the 14-pin electrical connectors.

   [b] Remove the bolts securing the two-piece fuel injector electrical harness (1 and 3) and remove the harness from the camshaft housing.

14. Remove the engine brake solenoids from the camshaft housing.

<table>
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<tr>
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<tr>
<td>Ensure when loosening the rocker shaft bolts that the bolts are loosened from the inside bolts outward, in 1/2 turn increments. The increment procedure needs to be followed to prevent the rocker shaft from breaking.</td>
</tr>
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15. Completely loosen all of the adjusting screws on all of the rocker arms.

16. Loosen the seven bolts securing the intake rocker shaft to the camshaft bearing caps.

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<tr>
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<tr>
<td>Make sure that the camshaft housing is not damaged during removal of the intake/exhaust rocker shaft assemblies.</td>
</tr>
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</table>

17. Using the Intake Rocker Arm Lifter / Spacer tool, remove the intake rocker shaft assembly.

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18. Loosen the seven bolts securing the exhaust rocker shaft to the camshaft caps.
19. Using the Exhaust Rocker Arm Lifter / Spacer tool, remove the exhaust rocker shaft assembly. When removing the EPA10 exhaust rocker shaft, ensure the rockers are in the up position.

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

NOTE:
Mark cap position for proper reassembly.

20. Remove the remaining bolts (1) from the camshaft bearing caps (2).
21. Using tool Cam Bearing Cap Puller and Injector Unit Pump Puller, remove the camshaft bearing caps (1) from the camshaft housing.

22. Remove the intake and exhaust camshaft assemblies (1 and 2) from the camshaft housing (3). Use care not to damage intake cam tone wheel when handling.
INSTALLATION OF THE CAMSHAFT AND ROCKER SHAFT/ENGINE BRAKE ASSEMBLY

Service Tools Used in the Procedure

<table>
<thead>
<tr>
<th>Tool Number</th>
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<tbody>
<tr>
<td>W470589001500</td>
<td>TDC Locating Pin</td>
<td>DD Platform</td>
</tr>
<tr>
<td>W470589034000</td>
<td>Cam Timing Tool</td>
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<td>W470589104000</td>
<td>DD15 Cam Timing Tool</td>
<td>EPA07/EPA10 DD15/16</td>
</tr>
</tbody>
</table>

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

Table 2 Tools Used in Procedures

Install as follows:

1. Verify that the crankshaft is at top dead center (TDC) on cylinder number one using TDC Locating Pin, installed in crankshaft position sensor (CKP) hole located in the flywheel housing.

2. Install Camshaft Timing Tool to the rear of the camshaft housing. Tighten the two bolts.
3. Locate the etched triangle on the camshaft gear teeth and mark the teeth with a paint pen.

4. Lubricate the lower camshaft bearing surfaces and camshaft journals before installing the camshafts. Install the exhaust and intake camshaft gear assemblies into the camshaft housing.

5. Align the marked gear teeth with the marks on the timing tool.

6. Install 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 at Step 3.
7. Verify that the marks on the gear teeth match the marks on the timing tool.

<table>
<thead>
<tr>
<th>NOTICE</th>
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<tr>
<td>The camshaft caps are numbered and need to be installed correctly.</td>
</tr>
</tbody>
</table>

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

9. The first and seventh camshaft caps hold the engine brake solenoids to camshaft cap. Replace the O-rings on the solenoids prior to reinstallation. Install the engine brake solenoids.

**NOTE:**
There are 30 bolts retaining the DD13 camshaft assemblies (shown); 14 120 mm (M10) bolts, seven 108 mm (M10) bolts and nine 63 mm (M8) bolts. The DD15 and DD16 uses 28 bolts, with two external bolts at the rear of the camshaft housing.

10. Install the 30 bolts to camshaft caps; finger tighten the bolts. Refer to figure for proper bolt placement.

![Diagram of engine parts with bolt placement indications]

- 120 mm (14 QTY.)
- 108 mm (7 QTY.)
- 63 mm (9 QTY.)
11. Using the torque sequence shown below, torque the M10 camshaft cap bolts to the following:
   - 20 N·m (15 lb·ft)
   - Then torque to 50-55 N·m (37-40 lb·ft).

12. Using the torque sequence shown below, torque the nine 63 mm M8 bolts to 30 N·m (22 lb·ft).

13. Remove TDC Locating Pin from CKP sensor hole in the flywheel housing.


15. Install a dial indicator onto gear case and zero out the dial indicator.

16. Position the stem of dial indicator to rest between the teeth on the camshaft gear.

17. Hold the number five idler gear with a screwdriver. Check the lash between the camshaft gear and idler gear number five.
18. The dial indicator should read 0.051 - 0.257 mm (0.002 - 0.010 in.). If the gear lash is excessive between either camshaft gear and the number five idler gear, inspect the number five idler gear spindle, camshaft gear and camshaft housing. Repair as necessary.

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>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 do not line up. This results in insufficient lubrication and damage to the camshaft journals. Incorrect shaft installation may also result in the engine brakes not functioning and cause damage to the rocker arm bushings.</td>
</tr>
</tbody>
</table>

**EXHAUST**

**INTAKE**

\(d030046\)
NOTICE:
The markings on the front of the rockers shafts **must** face the front of the engine for proper rocker arm lubrication and engine brake operation.

**NOTICE:**
Ensure when tightening the rocker shaft bolts that the bolts are drawn down from the inside bolts outward, in 1/2 turn increments, before final torque. If the rocker shaft bolt is fully torqued without using the increment procedure, the rocker shaft can break.

**NOTE:**
On EPA10 engines the intake and exhaust rocker shafts are marked "TOP FRONT" and "TOP REAR." Top front must face towards the front of the engine.

19. Remove timing tools.
20. Using the Intake Rocker Arm Lifter / Spacer Intake, install the intake rocker shaft assembly to the camshaft cap and secure with seven clamping blocks and bolts.

21. Using the torque sequence shown below, torque the bolts to 50-55 N·m (36-41 lb·ft) +90°.
22. 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.

23. Using the torque sequence shown below, torque the bolts to 50-55 N·m (36-41 lb·ft) +90°.

24. Remove timing tools.
25. Install the fuel injectors, if removed. Refer to section .
26. Lash the valves and engine brakes. Refer to section .
27. Install the fuel injector wiring harness. Refer to section .
28. Install the rocker cover. Refer to section .
29. Reconnect the battery power to the engine. Refer to OEM procedures.
30. Install air cleaner housing. Refer to OEM procedures.
31. Install the turbocharger inlet pipe and hose, and air cleaner. Refer to OEM procedures.
32. Prime lubrication system. Refer to section .
CAMSHAFT TIMING VERIFICATION

<table>
<thead>
<tr>
<th>Tool Number</th>
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<th>Engine</th>
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</thead>
<tbody>
<tr>
<td>J-46392 or W904589046300</td>
<td>Engine Barring Tool</td>
<td>DD Platform</td>
</tr>
<tr>
<td>W470589001500</td>
<td>TDC Locating Pin</td>
<td>DD Platform</td>
</tr>
</tbody>
</table>

Table 3  Tools Used in Procedures

Verify the camshaft timing as follows:

1. Remove the rocker cover. Refer to section.

2. Bar the engine to top dead center (TDC) with Engine Barring Tool (3) 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).

3. Locate the mark on the camshaft and mark the top of the corresponding gear tooth with a light colored paint pen.

4. Remove the Crankshaft Position Sensor (CKP) from the flywheel housing. Refer to section.
5. Install the flywheel TDC Locating Pin, through the crankshaft position sensor hole in the flywheel housing and engage into the flywheel notch.

6. Install the rear Camshaft Timing Tool (1) onto the camshaft housing.
7. Install the front Camshaft Timing Tool (1) into the grooves cut into the cams and pin it into the camshaft housing with a bolt.

8. Verify that the marks on the gear teeth match the marks on the timing tool. If the marks do not match, research the root cause of incorrect camshaft timing.
TIMING THE CAMSHAFTS WITH THE GEAR TRAIN INSTALLED

<table>
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<tr>
<td>W470589104000</td>
<td>DD15 Cam Timing Tool</td>
<td>EPA07/EPA10 DD15/16</td>
</tr>
</tbody>
</table>

Table 4 Tools Used in Procedures

Time as follows:

1. Bar the crankshaft over to TDC cylinder No. 1 and lock with TDC Locking Pin through the crankshaft position sensor hole.
2. Install the rear Camshaft Timing Tool (1) onto the rear of the camshaft housing.

3. Locate the mark on the camshafts and mark the top of the corresponding gear tooth with a light colored paint pin.
4. Lubricate the camshafts and camshaft housing journals with clean engine oil.

NOTE:
The intake camshaft has the tone wheel and must be installed on the intake side of the engine.

5. Install the camshafts into the camshaft housing in their respective locations lining up the marked cam gear teeth with the mark on the timing plate.
6. Install the front Camshaft Timing Tool (1) into the grooves cut into the camshafts to verify correct cam timing. Any resistance felt while installing or removing could indicate the camshafts being out of time. Install a bolt into the tool to hold it into place.

![Image of engine part]

**INSTALLATION AND TIMING OF ENGINE GEAR TRAIN**

<table>
<thead>
<tr>
<th>Tool Number</th>
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</tr>
</thead>
<tbody>
<tr>
<td>J-46392 or W904589046300</td>
<td>Engine Barring Tool</td>
<td>DD Platform</td>
</tr>
<tr>
<td>J-48630</td>
<td>Crankshaft TDC Locating Tool</td>
<td>DD Platform</td>
</tr>
<tr>
<td>J-47486</td>
<td>Shoulder Bolt</td>
<td>DD Platform</td>
</tr>
<tr>
<td>J-47487</td>
<td>Cantilever For Idler 3 Tool</td>
<td>DD Platform</td>
</tr>
<tr>
<td>W470589001500</td>
<td>TDC Locating Pin</td>
<td>DD Platform</td>
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* Can be used on EPA10 with modification (refer to tool letter 10 TL-9)

**Table 5  Tools Used in Procedures**

Install and time the gear train as follows:

**NOTE:**
Coat the inside of the gears, bushings and gear train with clean oil before installation.

1. Install the crankshaft gear on the crankshaft.
2. Rotate the crankshaft to top dead center (TDC) on cylinder number one. Install and lock Crankshaft TDC Locating Tool into place with bolt.

![Image](J-48630)

3. Install spindle into idler gear No. 5.
4. Install idler gear No. 5 onto the cylinder head using Shoulder Bolt.
5. Install two bolts into idler gear No. 5 and hand tighten. Remove the Shoulder Bolt. Torque to 60-65 N·m (44-48 lb·ft).
6. Install the spindle into idler gear No. 3.
7. Install Cantilever For Idler 3 Tool onto idler gear number three.

![Image](J-47487)

8. Install two bolts into the spindle and idler gear No. 3; snug the bolts.
NOTE:
When idler gear No. 3 and Cantilever For Idler 3 Tool are installed to the gear case, Cantilever For Idler 3 Tool should come off of the gear with ease. If the timing tool is not easily removed, that is an indication that the gears are not timed.

9. Check the gear lash between idler gear No. 3 and idler gear No. 5.

10. Install a dial indicator onto gear case and position the stem to rest between the teeth on large gear of idler gear No. 3; zero out the dial indicator.

11. Hold idler gear No. 5 with a screw driver to check gear lash.

12. The lash reading on the dial indicator should be 0.079 - 0.305 mm (0.003-0.012 in.).

13. When correct gear lash is established, torque idler gear No. 3 to 60–65 N·m (44-48 lb·ft).

14. Install the spindle and gear plate onto the idler gear No. 2.

15. Install the spindle, idler gear No. 2, and the gear plate onto the cylinder block. Torque to 100 N·m (73 lb·ft).

16. Remove the air compressor to the cylinder block (if installed). Refer to section.

17. Install the thrust washers and spindle onto the idler gear No. 1.

NOTE:
For ease of installation on idler gear No. 1, roll the gear into idler gear No. 2.

18. Install the spindle, thrust washers, idler gear No. 1, and gear plate onto the cylinder block by engaging the teeth of idler gear No. 1 into the crankshaft gear teeth first, then roll upward into idler gear No. 2. Torque to 100 N·m (73 lb·ft).

19. Install the air compressor. Refer to section.

NOTE:
When installing idler gear No. 4, verify that the part number on the gear is facing the block.

20. On the DD15 and DD16, with the cone of the idler gear No. 4 facing outward, install the thrust washer onto the spindle then install the spindle onto the idler gear No. 4.

21. On the DD15 and DD16, install the assembled thrust washer, spindle and idler gear No. 4 onto the cylinder block. Torque to 100 N·m (73 lb·ft).

NOTE:
Tool J-47487 should remove with ease. If not, check gears for proper installation.

22. Remove the Cantilever For Idler 3 Tool.

23. Check that the idler gear No. 1 is flush with the rear side of the crankshaft gear and that the idler gear No. 4 on the DD15 and DD16 is flush with the front side of the crankshaft gear.

24. Install the camshaft housing. Refer to section.

25. Lubricate the camshaft journals and install the camshafts into the camshaft housing.

26. Mark the camshafts TDC indicator triangle located on the inside of the camshaft gear with a suitable marker.
27. Install Camshaft Timing Tool (1) into the holes at the rear of the camshaft housing and secure to the camshaft housing with two bolts.

28. Install both of the intake and exhaust camshafts into the camshaft housing. Refer to section.

29. Rotate the camshafts until the mark on the inside of the gear aligns with the mark on Camshaft Timing Tool.
30. Install Camshaft Timing Tool (1) into the holes at the slot in the front of the camshaft housing and secure to the camshaft housing with one bolt.

31. Ensure timing marks on the camshaft gears are at TDC and aligned to the marks on the tool.

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

**NOTE:**
The first and seventh camshaft caps hold the engine brake solenoids to camshaft cap.

33. Prior to engine brake solenoid installation, replace the O-rings on the engine brake solenoids.

**NOTE:**
There are 30 bolts retaining the camshaft assemblies; 14 120 mm (M10) bolts, seven 108 mm (M10) bolts and nine 63 mm (M8) bolts.
34. Install the 30 bolts to camshaft caps; finger tighten the bolts. Refer to figure below for proper bolt placement.

35. Using torque sequence shown below, torque the 120 mm and 108 mm (M10) camshaft cap bolts to the following:

- 20 N·m (15 lb·ft)
- Then torque to 50-55 N·m (37-40 lb·ft)
36. Using the torque sequence, torque the nine 63 mm (M8) bolts to 30 N·m (22 lb·ft).

37. Verify correct camshaft timing by checking that the marks on the camshaft gears still align with the timing tool.

38. Remove timing tools from gears and camshaft housing.

39. Install the camshaft cover and two bolts to the rear of the cylinder head. Torque the camshaft cover bolts to 30 N·m (22 lb·ft).
ADDITIONAL SERVICE INFORMATION

Additional service information is available in Power Service Literature.