UNITED STATES MARINE CORPS
Logistics Operations School
Marine Corps Combat Service Support Schools
Training Command
PSC Box 20041
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AIM 5402

STUDENT OUTLINE

REPAIR CUMMINS NHC DIESEL ENGINE

LEARNING OBJECTIVE

1. TERMINAL LEARNING OBJECTIVE: Given a Cummins NHC engine, the required tools, shop supplies, repair parts, TM 9-2320-260-20, TM 9-2320-260-34-1, and TM 9-2320-272-34-1, per information contained in the references, repair the engine. (5.4.3)

2. ENABLING LEARNING OBJECTIVES: Given a Cummins NHC engine, the required tools, shop supplies, repair parts, TM 9-2320-260-20, TM 9-2320-260-34-1, and TM 9-2320-272-34-1, per information contained in the references:

1. disassemble the engine, (5.4.3a)

2. inspect the disassembled components for serviceability, (5.4.3b)

3. repair or replace the unserviceable components, (5.4.3c)

4. assemble the engine from serviceable components, and (5.4.3d)

5. perform the final engine run-in adjustments. (5.4.3e)

OUTLINE

1. DESIGN CHARACTERISTICS AND PRINCIPLES OF OPERATION OF THE CUMMINS NHC DIESEL ENGINE

a. Design Characteristics

(1) Specifications of the Cummins NHC engine.

(a) The "N" represents four valves per cylinder.
(b) The "H" represents the series of the engine.

(c) The "C" represents custom rated. Custom rated means the engine was built to a customer's requirements.

(2) The NHC diesel engine is manufactured by the Cummins Engine Company and is a proven engine. It has been in commercial trucks for many years.

(3) The Cummins NHC is a six cylinder, in-line, liquid cooled, diesel engine.

(4) The NHC operates on the four stroke cycle with overhead valves.

(5) The NHC incorporates four valves per cylinder: two intake valves and two exhaust valves.

(6) This engine is naturally aspirated; it does not have a turbocharger or blower.

b. Principles of Operation

(1) Typical of diesel engines, this is a compression ignition engine which means fuel in the combustion chamber is ignited by heat (1000 degrees Fahrenheit or higher) created by compression of the air in the cylinder.

(2) The engine produces 240/250 horsepower at 2100 rpm. The engine horsepower can be changed by recalibrating the engine fuel pump. The fuel pump must be calibrated on an injection pump test stand only. It cannot be recalibrated on the engine.

(3) The peak torque is 685 foot-pounds at 1500 rpm.

(4) The full-load governed speed is 2140 rpm, which means the truck is in gear, fully loaded, and running at top speed.

(5) The no-load governed speed is 2300 to 2400 rpm. To obtain maximum no-load speed, the truck would be in neutral and the throttle fully open.

2. NOMENCLATURE, PURPOSE AND LOCATION OF THE ENGINE COMPONENTS

a. Vibration Damper

(1) The vibration damper removes engine crankshaft vibrations and prevents crystallization of the crankshaft.

(2) The vibration damper is bolted to the crankshaft flange, which is bolted to the crankshaft.

b. Fan Drive Hub-M809 Series. The fan drive hub operates the cooling fan and is belt driven.

c. Fan Drive Clutch-M939 Series. The fan drive clutch operates the cooling fan. It is belt driven and air controlled by a relay valve located in the water manifold.

d. Accessory Drive Pulley

(1) The accessory drive pulley drives the fan drive hub or fan drive clutch and the water pump.

(2) The accessory drive pulley contains the valve and injector adjusting marks, (V-S Marks).

e. Water Pump. The water pump is of the centrifugal type and is belt driven.

f. Air Compressor

(1) The air compressor has one cylinder and is manufactured by the Cummins Engine Company.

(2) The air compressor is gear driven by the accessory drive gear and is timed to the engine to reduce vibration.

g. Fuel Pump

(1) The fuel pump draws fuel from the tank, delivers the fuel to the injectors, and controls minimum to maximum speed of the engine.

(2) The fuel pump is bolted to the air compressor and is not timed.

h. Oil Pumps

(1) The main oil pump and scavenger pump are combined in the same housing.

(2) The oil pump is driven by the camshaft gear but is not timed.

(3) The oil filter is bolted to the oil pump and is the full-flow type.

i. Oil Cooler

(1) The oil cooler is used to keep the engine oil at a moderate operating temperature.

(2) The oil cooler housing contains a tubular element which has a constant flow of engine coolant through the tubes to dissipate heat.

j. Oil Lines. The oil lines provide a means of transferring oil from the pump to the oil pan and from the oil pan back to the oil pump.

k. Intake Manifold. The intake manifold is made of cast aluminum and is constructed in two sections. The elbow contains the cold weather starting aid.

l. Water Manifold

(1) The water manifold collects coolant from the cylinder heads and directs it to the thermostat housing, which sends the coolant to the by-pass tube or the radiator.

(2) The water manifold incorporates the following:

(a) the thermostat housing and thermostat,

(b) the coolant temperature sending unit,

(c) the heater connections and vent lines, and

(d) the air actuator for the fan drive clutch on M939 Series trucks.

m. Crankcase Breather System

(1) The crankcase breather tube is located on one of the rocker levers covers, depending on the type of truck the engine is in.

(2) Some models may have a positive type, while others emit vapors into the atmosphere.

n. Surge Tank. The surge tank provides a means of filling the cooling system with coolant and removes air from the cooling system.

o. Fuel Crossover Connectors. The fuel crossover connectors provide a means of transferring fuel from one cylinder head to another head.

p. Rocker Lever Housings

(1) The rocker lever housings contain the valves and injector rocker levers.

(2) The rocker lever housings are bolted to the cylinder heads.

q. Cylinder Heads

(1) The engine has three cylinder heads, one head per two cylinders.

(2) The cylinder heads incorporate the following:

(a) replaceable exhaust valve seats,

(b) replaceable valve guides,

(c) fuel passages,

(d) crosshead guides, and

(e) one injector tube per cylinder.

r. Crossheads. The crossheads are used to open two intake or two exhaust valves at the same time.

s. Fuel Injectors. The fuel injectors are located in the cylinder heads, with one injector per cylinder.

t. Push Tubes

(1) The push tubes transfer movement from the cam followers to the rocker levers.

(2) There are three push tubes per cylinder: two valve push tubes and one injector push tube.

u. Cam Followers

(1) The NHC engine incorporates three cam follower housings.

(2) Each housing contains six roller followers.

(3) Three roller followers are utilized for each cylinder.

v. Camshaft

(1) The camshaft is constructed of drop forged steel and has seven bearing journals.

(2) The camshaft contains eighteen cam lobes, three lobes per cylinder; two valve lobes and one injector lobe.

w. Piston Assembly

(1) The piston contains four rings: three compression rings and one oil ring.

(2) The piston also incorporates the combustion chamber, located in the piston head.

(3) The piston head has four cutouts. These are valve reliefs required to compensate for close tolerances.

x. Piston Pin

(1) The piston pin is the full-floating type and can be either of a tubular or solid design.

(2) Make sure only one design is used throughout the engine.

y. Connecting Rod

(1) The connecting rod is made of drop-forged molybdenum steel and constructed with the I-beam design for strength.

(2) The connecting rod has a drilled passage through the center to supply lubrication from the rod journal to the piston pin.

z. Engine Block. The engine block is a one piece casting of chrome-nickel alloy type metal and has seven chrome-nickel alloy main bearing caps.

aa. Crankshaft. The crankshaft is constructed of drop forged carbon steel. It has thirteen hardened steel journals; seven main journals and six rod journals. It also has twelve integral counterweights.

bb. Cylinder Liners

(1) The cylinder liners provide a machined surface between the piston and the block for the piston to travel in.

(2) The cylinder liners are the wet type. This means that the engine coolant comes in direct contact with them and provides the necessary cooling.

3. FLOW OF FUEL THROUGH THE PT-G FUEL SYSTEM

a. The NHC Engine Utilizes the PT-G Fuel System. Decoded, the letters mean the following:

(1) P - Pressure

(2) T - Time

(3) G - Governor Controlled

b. Flow of Fuel Through the System

(1) Fuel is drawn from the fuel tank by the gear pump.

(2) This fuel passes through a filter bolted to the left side of the truck.

(3) From the filter, the fuel enters the gear pump.

(4) From the gear pump, the fuel goes to the pulsation damper to remove surges created by the gear pump. The pulsation damper is bolted to the gear pump.

(5) After the fuel enters the pulsation damper and returns through the gear pump, the fuel then goes through drilled passages in the pump body to the magnetic fuel filter.

(6) Fuel from the magnetic fuel filter then travels through drilled passages in the pump body to the governor assembly.

(7) From the governor assembly, fuel goes through the idle passage or the throttle shaft, depending on the demands of the engine.

(8) After going through the idle passage or throttle shaft, fuel then goes through the electrical shutdown and emergency shutdown valves located on the top of the fuel pump.

(9) From the emergency shutdown valve, fuel then goes through a steel fuel line to the fuel inlet manifold located on the front of number one cylinder head.

(10) Fuel pressure at idle is about 20 psi and fuel pressure at full governed rpm is about 175-178 psi.

c. Flow of Fuel Through the Injectors

(1) Fuel enters the inlet manifold passage at the front of number one cylinder head.

(2) Fuel under low pressure surrounds the injectors that are sealed by "O" rings inside the cylinder head.

(3) The injectors contain an inlet orifice that determines the amount of fuel that enters the injectors.

(4) After the fuel enters the injectors, the downward movement of the injector rocker lever forces the injector plunger down, forcing fuel out of the injector cup by overcoming combustion chamber pressure.

(5) Only a small percentage of the fuel entering the fuel inlet manifold is used to operate the engine. The rest of the fuel is used to cool the injectors and flows back to the fuel tank to be cooled and to be recycled back through the system.

4. PROCEDURAL STEPS USED TO DISASSEMBLE THE CUMMINS NHC DIESEL ENGINE INTO SUBASSEMBLIES

a. Detailed instructions for disassembling the Cummins NHC diesel engine are contained in TM 9-2320-260-20, TM 9-2320-260-34-1 or TM 9-2320-272-34-1. Follow those instructions carefully to effect those disassembly procedures on the training aid engine to which you have been assigned.

b. Have the instructor assigned to your station check your work at each point designated in this student outline.

c. Disassemble the Engine Into Subassemblies

(1) Disconnect the exhaust system from the exhaust manifold.

(2) Disconnect and tag all electrical connections.

(3) Remove the oil dipstick, tube, and bracket.

(4) Remove the oil cooler.

(5) Remove the exhaust manifold.

(6) Remove the alternator and bracket as an assembly.

(7) Remove the fan drive hub assembly.

(8) Remove the power steering pump and bracket as an assembly.

(9) Remove the water pump, clamp ring, and pump support plate.

(10) Remove the starter.

(11) Remove the crankcase ventilation tube.

(12) Remove the water header plates and hand hole cover.

STOP! Have Instructor Initial.

MOUNT ENGINE ON THE REBUILD STAND.

(13) Drain the engine oil, including the oil filter.

(14) Remove the oil filter.

(15) Remove the water manifold.

(16) Remove the vibration damper.

(17) Remove the accessory drive pulley.

(18) Remove the fuel pump and lines.

(19) Remove the accessory drive unit with the air compressor.

(20) Remove the oil pump and lines (do not loosen fittings).

(21) Remove the intake manifold.

(22) Remove the rocker lever housing covers.

STOP! Have Instructor Initial.

(23) Remove the rocker lever housings.

(24) Remove the fuel injectors.

(25) Remove the push tubes.

(26) Remove the crossheads.

(27) Remove the fuel crossovers.

(28) Remove the cylinder heads.

(29) Remove the cam follower housings (discard shims).

(30) Remove the crankshaft flange.

(31) Remove the flywheel.

(32) Remove the flywheel housing.

STOP! Have Instructor Initial.

(33) Remove the oil pan (turn the engine pan-side up).

(34) Remove the rear cover and seal.

(35) Remove the front cover.

(36) Remove the camshaft.

(37) Remove the piston and connecting rod assemblies. (Turn the engine to a vertical position, with the front of the engine up.)

(38) Remove the cylinder liners. (Rotate the engine so that the pan-side is down.)

(39) Remove the main bearing caps and thrust rings. (Rotate the engine 180 degrees with the pan-side up.) Remove and number the back side of the lower bearing shells with a grease pencil.

STOP! Have Instructor Initial.

(40) Remove the crankshaft. (Have instructor present.)

(41) Remove the dowel rings.

(42) Remove the upper main bearings. Number the back side of the upper bearing shell with a grease pencil.

(43) Make sure all the engine subassemblies and components are stored out of the way and on the work tables.

STOP! Have Instructor Initial.

5. PROCEDURAL STEPS USED TO REPAIR CUMMINS NHC DIESEL ENGINE SUBASSEMBLIES

a. Detailed instructions for inspection and repair of the Cummins NHC diesel engine subassemblies are contained in TM 9-2320-260, TM 9-2320- 260-34-1 or TM 9-2320-272-34-1. Follow those instructions carefully to effect those inspections and repair procedures on the training aid engine to which you have been assigned.

b. Have the instructor assigned to your station check your work at each point designated in this student outline.

c. Repair Cylinder Block

(1) Clean the cylinder block.

STOP! Have Instructor Initial.

(2) Inspect the cylinder block.

(3) Measure the camshaft bushings. GO _____ NO GO

(4) Measure the upper cylinder liner counterbore. Diameter

(5) Measure and note the depth of the cylinder liner counterbore in four places.

(6) Obtain average depth of cylinder liner counterbore.

(7) Measure the cylinder liner flange thickness. Thickness ____Difference of average counterbore depth and flange thickness

(8) Measure the clearance between the liner and the lower counterbore. Clearance _____ Lower counterbore diameter

(9) Measure the diameter of the main bearing bores. Diameter

(10) Inspect and measure the main bearing shells. Upper Lower

STOP! Have Instructor Initial.

d. Cylinder Liner Repair

(1) Clean the cylinder liners.

(2) Inspect the cylinder liners.

(3) Measure the inside diameter of the liner.

(4) Inspect the liner ring grooves.

STOP! Have Instructor Initial.

e. Crankshaft Repair

(1) Clean the crankshaft.

(2) Inspect the crankshaft.

(3) Measure the main bearing journals.

(4) Measure the connecting rod journals.

(5) Measure the distance between the thrust flange and the web. The distance must be within 3.001-3.006 inches.

(6) Measure the rear sealing surface.

STOP! Have Instructor Initial.

f. Camshaft Repair

(1) Clean the camshaft.

(2) Inspect the camshaft.

(3) Measure the journal diameter.

(4) Measure the thickness of the camshaft thrust ring.

STOP! Have Instructor Initial.

g. Piston and Connecting Rod Repair

(1) Remove the piston rings.

(2) Remove the piston from the connecting rod.

(3) Clean the pistons.

(4) Inspect the pistons.

(a) Measure the piston ring grooves. GO _____ NO GO

(b) Measure the piston skirt diameter.

(c) Measure the piston pin bores. GO _____ NO GO

(5) Measure the piston pin.

(6) Repair the pistons (if necessary).

(7) Clean the connecting rods.

(8) Inspect the connecting rods.

(a) Measure the crankpin bearing bore. Connecting rods with capscrews must have a crankpin bore with a diameter between 3.3157 and 3.3167 measured at two points 30 degrees from center line. Diameter

(b) Measure the piston pin bushings. GO _____ NO GO

(c) Check the connecting rod alinement. Bend

Twist GO _____ NO GO

(9) Inspect the connecting rod bearing shells. For connecting rods with capscrews, the bearings are between 0.093 and 0.0947 of an inch. Upper _____ Lower

STOP! Have Instructor Initial.

(10) Assemble the piston to the connecting rod.

(11) Install the piston rings.

STOP! Have Instructor Initial.

h. Front Gearcase Cover Repair

(1) Remove all seals from the gearcase cover.

(2) Remove the camshaft thrust plate. (Give the shims to an instructor.)

(3) Clean the gearcase cover.

(4) Inspect the gearcase cover.

(a) Measure the accessory drive bushing. GO ____ NO GO

(b) Inspect the camshaft thrust plate.

STOP! Have Instructor Initial.

i. Cylinder Head Repair

(1) Disassemble the cylinder head.

(2) Using cleaning solvent, clean the head and dry it thoroughly.

(3) Inspect the cylinder head.

(a) Check for cracks, breaks, distortions, or broken out areas.

(b) Measure the cylinder head for warpage. GO____ NO GO

(c) Measure the cylinder head height.

(d) Inspect the valve seat inserts. Valve seat width

(e) Inspect the injector sleeves.

(f) Inspect the valve guides. GO _____ NO GO

(g) Inspect the valves. Rim thickness ___ Stem diameter

(h) Inspect the valve springs.

1 9 coil spring free length should be 2.685 inches and should have a minimum of 147.25 to a maximum of 162.75 foot-pounds of resistance when compressed to 1.724 inches.

2 9 1/2 coil spring free length should be 2.920 inches and should have a minimum of 155 to a maximum of 189 foot-pounds of resistance when compressed to 1.765 inches.

3 Free length _____ Compressed resistance

(i) Inspect the crosshead guides. Diameter

(j) Inspect the crossheads. GO _____ NO GO

(k) Measure injector tip protrusion and seat pattern. Torque the capscrews in the following steps:

1 Step one: 12 inch-pounds.

2 Step two: 48 inch-pounds.

3 Step three: 96 inch-pounds.

4 Step four: 144 inch-pounds.

5 Protrusion _____ Seat pattern width

STOP! Have Instructor Initial.

(3) Assemble the cylinder head.

(4) Vacuum test the cylinder head. Pass _____ Fail

STOP! Have Instructor Initial.

j. Rocker Lever Housing Repair

(1) Disassemble the rocker lever housings.

(2) Clean the rocker lever housings.

(3) Inspect the rocker lever housings.

(a) Measure the shaft bores. GO _____ NO GO

(b) Measure the rocker lever bushings. GO ____ NO GO

(c) Measure the rocker lever shaft.

STOP! Have Instructor Initial.

(4) Assemble the rocker lever housings.

STOP! Have Instructor Initial.

k. Inspect the Push Tubes

(1) Using cleaning solvent, clean the push tubes and dry them thoroughly.

(2) Check the ball ends of the push tubes for out-of-round.
Pass _____ Fail

(3) Check the seat patterns. Pass _____ Fail

(4) Measure the push tubes for bends. GO _____ NO GO

l. Cam Follower Housing Repair

(1) Disassemble the cam follower housing.

(2) Clean the cam follower housing.

(3) Inspect the cam follower housing.

(a) Measure the shaft diameters.

(b) Measure the bushings. GO _____ NO GO

(c) Inspect the socket for out-of-round. Pass Fail

STOP! Have Instructor Initial.

(4) Assemble the cam follower housing.

STOP! Have Instructor Initial.

m. Inspect the Lubricating Oil Pump.

n. Inspect the Vibration Damper. Pass _____ Fail

o. Rear Cover Repair

(1) Remove the seal.

(2) Clean the rear cover.

(3) Inspect the rear cover.

p. Rocker Lever Housing Cover Repair

(1) Clean the rocker lever housing covers.

(2) Inspect the rocker lever housing covers.

q. Oil Pan Repair

(1) Remove the drain plug.

(2) Clean the oil pan.

(3) Inspect the oil pan.

r. Intake Manifold Repair

(1) Clean the intake manifold.

(2) Inspect the intake manifold.

s. Exhaust Manifold Repair

(1) Clean the exhaust manifold.

(2) Inspect the exhaust manifold.

t. Flywheel and Flywheel Housing Repair

(1) Clean the flywheel and flywheel housing.

(2) Inspect the flywheel and flywheel housing.

u. Oil Cooler Repair

(1) Disassemble the oil cooler.

(2) Clean the oil cooler.

(3) Inspect the oil cooler.

(4) Assemble the oil cooler.

STOP! Have Instructor Initial.

v. Clean and Inspect the Fan Drive Hub Assembly.

w. Water Manifold Repair

(1) Disassemble the water manifold.

(2) Clean the water manifold.

(3) Inspect the water manifold.

(4) Assemble the water manifold.

x. Clean and Inspect the Water Pump, Clamp Ring, and the Support Plate.

y. Clean and Inspect the Air Compressor and Accessory Drive.

z. Clean and Inspect the Fuel Pump.

aa. Clean and Inspect Any Other Component Not Covered.

bb. STOP! Do not proceed any further. Make sure all the engine subassemblies and components are stored out of the way and on the work tables.

Have Instructor Initial.

6. PROCEDURAL STEPS USED TO ASSEMBLE THE CUMMINS NHC DIESEL ENGINE

a. Detailed instructions for reassembly of the Cummins NHC diesel engine are contained in TM 9-2320-260-20, TM 9-2320-260-34-1, or TM 9-2320-272-34-1. Follow those instructions carefully to effect those reassembly procedures on the training aid engine to which you have been assigned.

b. Have the instructor assigned to your station check your work at each point designated in this student outline.

c. Assemble the Engine

(1) Install the crankshaft and main bearings.

(a) Install the upper main bearings halves.

(b) Install the dowel rings.

STOP! Have Instructor Initial.

(c) Install the crankshaft. (Have instructor present).

(d) Install the upper thrust rings.

(e) Install the lower main bearing halves.

STOP! Have Instructor Initial.

(f) Install the main bearing caps.

1 If the capscrews are 1 inch, follow the instructions in TM 9-2320-260-34-1.

2 If the capscrews are 3/4 inch, follow the steps listed in TM 9-2320-272-34-1.

(g) Check crankshaft end play.

STOP! Have Instructor Initial.

(2) Install the cylinder liners.

(a) Measure the cylinder liner protrusion.

(b) Measure the cylinder liner for out-of-round. Top _____ Bottom

STOP! Have Instructor Initial.

(3) Install the piston and connecting rod assemblies. Connecting rod side clearance: GO _____NO GO

STOP! Have Instructor Initial.

(4) Install the camshaft. Gear backlash:

(5) Install the cylinder heads.

(6) Install the fuel crossovers. Tighten the capscrews securely.

STOP! Have Instructor Initial.

(7) Install the cam followers.

(8) Perform injector timing.

STOP! Have Instructor Initial.

(9) Install the accessory drive and air compressor.

(10) Install the fuel pump and lines.

(11) Install the lubricating oil pump.

(12) Check the gear backlash: Accessory drive gear __ Oil pump gear

STOP! Have Instructor Initial.

(13) Install the oil filter.

(14) Install the front cover.

(a) Install the accessory drive seal and crankshaft seal.

(b) Align the front cover flush to within .004 inch with the bottom of the block. L. _____ R.

(c) Check the camshaft end play. After determining the amount of shims required to obtain the correct end play, use a dial indicator mounted to the rear of the block, and measure the camshaft end play.

(d) Torque the thrust plate capscrews to 15 to 20 foot-pounds.

STOP! Have Instructor Initial.

(15) Install the crankshaft flange.

(a) Check for roundness.

(b) Check for wobble.

STOP! Have Instructor Initial.

(16) Install the vibration damper.

(a) Check for roundness.

(b) Check for wobble.

STOP! Have Instructor Initial.

(17) Install the accessory drive pulley.

(a) Torque a flanged retaining nut to 300-310 foot pounds.

(b) Torque a nut that does not have a flange to 90-110 foot pounds.

(18) Install the rear cover.

(a) Install the rear main seal.

(b) Install the rear cover. Do not tighten the capscrews.

(c) Using a dial indicator mounted on the rear of the crankshaft so the plunger contacts the outer lip of the housing, aline the rear cover to within .010 inch runout. Reading ___.

(d) Aline the rear cover to 0.004 inch flush with the pan rail. L._____ R.

(e) Torque the capscrews to 24 to 29 foot-pounds.

STOP! Have Instructor Initial.

(19) Install the flywheel housing.

(a) Aline the flywheel housing. 12 to 6 ___ 3 to 9 _____.

(b) Check flywheel housing face runout _____.

STOP! Have Instructor Initial.

(20) Install the flywheel.

(21) Install the oil pan and oil lines.

(a) Place the gasket on the block with "PAN SIDE" up.

(b) Install the oil pan and pickup tube.

(c) Torque the four capscrews mounting the pan to the rear cover 15 to 20 foot-pounds.

(d) Torque the 32 capscrews mounting the pan to the block and front cover to 35 to 40 foot-pounds.

(e) Torque the six capscrews mounting the pan to the flywheel housing to 70 to 80 foot-pounds.

(f) Tighten the oil pick-up line adapter capscrews to 10-15 foot- pounds.

(g) Tighten the oil return line capscrews to 5-10 foot pounds

STOP! Have Instructor Initial.

(22) Install the water pump, water pump support, and belt.

(23) Install the fan drive hub assembly.

(24) Install the water manifold. Torque the capscrews to 30 foot pounds.

(25) Install the oil cooler. Torque the oil cooler capscrews and air compressor coolant line clamp capscrew of water pump support to 30 foot-pounds.

(26) Install the injectors.

(27) Install and adjust the valve crossheads. Torque the locknuts to 25 to 30 foot-pounds.

STOP! Have Instructor Initial.

(28) Install the push tubes.

(29) Install the rocker lever housings. Torque the capscrews to 55 to 65 foot-pounds.

STOP! Have Instructor Initial.

(30) Perform injector and valve adjustment.

(a) Injector and valve adjustment for the Top Stop injector. Check that no. 1 cylinder is on the compression stroke.

1 Aline 1-6VS mark, adjust injector No. 3 and cylinder no. 5 valves.

2 Aline 2-5VS mark, adjust injector No. 6 and cylinder no. 3 valves.

3 Aline 3-4VS mark, adjust injector No. 2 and cylinder no. 6 valves.

4 Aline 1-6VS mark, adjust injector No. 4 and cylinder no. 2 valves.

5 Aline 2-5VS mark, adjust injector No. 1 and cylinder no. 4 valves.

6 Aline 3-4VS mark, adjust injector No. 5 and cylinder no. 1 valves.

7 Torque the injector adjusting screw to 5 to 6 inch-pounds. Torque the locknuts to 30 to 35 foot-pounds.

8 Adjust the valves according to the data plate. Torque the locknut to 35 to 40 foot-pounds.

(b) Injector and valve adjustment for the PTD type injector. Check that No. 1 cylinder is on the compression stroke.

1 Aline 1-6VS mark, adjust cylinder No. 1 injector and valves.

2 Aline 2-5VS mark, adjust cylinder No. 5 injector and valves.

3 Aline 3-4VS mark, adjust cylinder No. 3 injector and valves.

4 Aline 1-6VS mark, adjust cylinder No. 6 injector and valves.

5 Aline 2-5VS mark, adjust cylinder No. 2 injector and valves.

6 Aline 3-4VS mark, adjust cylinder No. 4 injector and valves.

7 Torque the injector adjusting screw to 72 inch-pounds. Torque the locknut to 30 to 35 foot-pounds.

8 Adjust the valves according to the data plate. Torque the locknuts to 35 to 40 foot-pounds.

STOP! Have Instructor Initial.

(31) Install the rocker lever housing covers. Torque the capscrews to 10 to 15 foot-pounds for steel covers or 12-17 foot pounds for aluminum covers.

(32) Install the intake manifold.

(33) Install the alternator and bracket.

(34) Install the starter.

(35) Install the power steering pump and belts.

(36) Install fan drive and alternator belts.

NOTE: At this time, place the engine back in the run stand. You must have an instructor present.

(37) Install the water header plates. Torque the capscrews to 96 inch pounds.

(38) Install the exhaust manifold.

(39) Install the oil dipstick, tube, and connector.

(40) Install the hand hole cover.

(41) Install the crankcase breather tube.

(42) Connect all electrical connections.

(43) Fill the engine lubrication system to the correct level.

(44) Install the exhaust muffler.

STOP! Have Instructor Initial.

(45) Connect the start cart.

(46) Perform engine run-in. Instructor must be present.

(47) Disconnect the start cart.

(48) Drain the coolant from the block.

Timing Code	Piston Travel Inches	Push Rod Travel (Inches) Nominal	Fast	Slow
A	-0.2032	-0.0415	-0.0395	-0.0435
B	-0.2032	-0.0295	-0.0275	-0.0315
C	-0.2032	-0.0335	-0.0315	-0.0355
D	-0.2032	-0.036	-0.034	-0.038
E	-0.2032	-0.029	-0.028	-0.030
Y	-0.2032	-0.039	-0.037	-0.041
Z	-0.2032	-0.026	-0.024	-0.028
AA	-0.2032	-0.031	-0.030	-0.032
AC	-0.2032	-0.028	-0.027	-0.029
AF	-0.2032	-0.045	-0.044	-0.046
AH	-0.2032	-0.035	-0.034	-0.036
AI	-0.2032	-0.034	-0.033	-0.035
AK	-0.2032	-0.041	-0.040	-0.042
AN	-0.2032	-0.046	-0.045	-0.047
AQ	-0.2032	-0.042	-0.041	-0.043
AS	-0.2032	-0.036	-0.035	-0.037
AT	-0.2032	-0.030	-0.029	-0.031
AU	-0.2032	-0.049	-0.048	-0.050
AV	-0.2032	-0.050	-0.049	-0.051
AW	-0.2032	-0.060	-0.059	-0.061
AX	-0.2032	-0.055	-0.054	-0.056
AY	-0.2032	-0.040	-0.039	-0.041
AZ	-0.2032	-0.059	-0.058	-0.060
BA	-0.2032	-0.028	-0.027	-0.029
BB	-0.2032	-0.100	-0.099	-0.101
BC	-0.2032	-0.024	-0.023	-0.025
BD	-0.2032	-0.095	-0.094	-0.096
BH	-0.2032	-0.052	-0.051	-0.053
BI	-0.2032	-0.105	-0.104	-0.106

NOTE: Reference engine data plate for timing code.

CAM FOLLOWER GASKET

SPECIFICATIONS

GASKET PART NO.	THICKNESS INCHES	CHANGE IN PUSH ROD TRAVEL
9266-A*	0.006 to 0.008	0.0015 to 0.002
3011272	0.020 to 0.024	0.005 to 0.006
120819	0.027 to 0.033	0.007 to 0.008
3011273	0.037 to 0.041	0.009 to 0.010

* Must not be used alone.

STUDENT REFERENCES:

TM 9-2320-260-20
TM 9-2320-260-34-2-1
TM 9-2320-272-34-1