Detroit Diesel Dd15 Engine Manual

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If you are the author of this material, then please contact us in order to provide users with a pleasant and convenient alternative, after reading, buying aThe site administration does not bear any responsibility for illegal actions, and any damage incurred by the copyright holders. Since its founding in 1938, Detroit Diesel has produced more than 5 million units, of which at least 1 million is still in operation. In 1965, Detroit Diesel went into “free swimming”, and in 1970 entered a new stage of development, merging with the developer of gas turbines Allison Division. In 1987, the company revolutionized the market by launching a series of power units with electronic control system DDEC. The innovation allowed to reduce the consumption of oil and fuel, and automate the work of engines. Some series for example, S50, S149 are no longer produced, but the company continues their service. The most popular among the manufacturers of equipment are the following product lines. The series immediately received electronic control and is characterized by economy and low level of vibration. The power range is 9515846 hp. For this purpose, the company has about 200 dynamometer stands in Europe and the USA. In this segment, Detroit Diesel achieved phenomenal success. Well assume youre ok with this, but you can optout if you wish. This manual was written primarily for persons servicing and overhauling the engine. In addition, this manual contains all of the instructions essential to the operators and users. Basic maintenance and overhaul procedures are common to all DD15 Engines, and apply to all engine models. This manual is divided into numbered sections. Section one covers the engine less major assemblies. The following sections

cover a complete system such as the fuel system, lubrication system, or air system. Each section is divided into subsections which contain complete maintenance and operating instructions for a specific engine subassembly.http://xn--80adpfaaeictf0c6c7i.xn--p1ai/public/bosch-logixx-8-sensitive-manual.xml

Each section begins with a table of contents. Pages and illustrations are numbered consecutively within each section. This manual comes in PDF format, all pages can be printed easily.To purchase a catalog online, please add the product to your cart, fill in the contact form online. Our managers proceed your order the same day. Hardware Level 10. Instant download Its a diagnostic system designed for Allison Product Families transmissions. The scan tool is available with worldwide shipping. Order the latest version with worldwide shipping or Download. NOTE Mark the location of the stud bolts. The stud bolts must be replaced in their original location during installation. 4. Remove rocker cover gasket from the rocker cover. All information subject to change without notice. EYE INJURY To avoid injury from flying debris when using compressed air, wear adequate eye protection face shield or safety goggles and do not exceed 276 kPa 40 psi air pressure. 2. Blow dry with compressed air. 3. Check the rocker cover, breather passage and seal for damage. Replace as necessary. 4. Inspect the bolts. Replace if damaged. 16 All information subject to change without notice. ENGINE EXHAUST To avoid injury from inhaling engine exhaust, always Engine operate the engine in a wellventilated area.The intake and exhaust camshafts are timed to each other, through a geartrain, to the crankshaft. The camshaft housing houses the camshafts and valve train. It has internal oil passages to supply oil from the block to the camshaft and rocker bearings along with pressurized oil to the engine brake rockers via the engine brake solenoids through the exhaust shaft. The camshaft housing is made of aluminium material. 1. Camshaft Bearing Cap 6. Intake Rocker Arm 11. Gasket 2. Bolt 120 mm 7. Exhaust Rocker Arm 12. Exhaust Camshaft Lobes 3. Bolt 108 mm 8. Exhaust Camshaft and Gear 13. Exhaust Camshaft Brake Cam Lobe 4. Bolt 63 mm 9. Intake Camshaft and Gear 14. Intake Camshaft Lobes 5.

Engine Brake Solenoid Figure 21 10. Camshaft Housing 15. Intake Camshaft Tone Wheel Camshaft Housing and Related Parts All information subject to change without notice. Engine braking is controlled electronically by the engine control system with an electric solenoid. When activated, the solenoid allows oil pressure to activate a piston on the exhaust rocker arm. Engine braking is accomplished with a single exhaust valve in each cylinder. The exhaust camshaft uses a separate engine brakeonly lobe that allows for double valve activation for high efficiency braking. The exhaust valve is first operated toward the completion of the intake stroke, closed during the compression stroke and opened a second time when the compression stroke is completed. The engine brake system is enabled using the following components For EPA07 engines 24 Engine brake solenoid valve in front of engine applies low engine braking. Engine brake solenoid valve in rear of engine applies medium engine braking. For high, both front and rear solenoids are activated. Six exhaust rocker arms with actuator pistons. Six brake rocker arms which are actuated by the brake cam lobes. Exhaust camshaft has one brake cam lobe per cylinder. Oil for cylinders 1 and 2 is supplied by the Front Engine Brake Solenoid Valve. Oil for cylinders 3 to 6 are supplied by the Rear Engine Brake Solenoid Valve. 1. Exhaust Rocker Arm 7. Exhaust Camshaft 2. Exhaust Rocker Arm with Actuator Piston 8. Actuator Piston 3. Brake Rocker Arm 9. Exhaust Valve 4. Oil Passage for Cylinders 1 and 2 10. Brake Cam Lobe 5. Oil Passage for Cylinders 3, 4, 5 and 6 11. Engine Brake Solenoid Valve, Front 6. Exhaust Rocker Arm Shaft 12. Engine Brake Solenoid Valve, Rear Figure 22 EPA07 Engine Brake For EPA10 engines Engine brake solenoid valve in front of engine applies low engine braking. For medium engine braking, both front and rear solenoids are activated. For high, both front and rear solenoids are activated, along with EGR.

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Oil for cylinders 1 through 3 is supplied by the Front Engine Brake Solenoid Valve. Oil for cylinders

4 through 6 are supplied by the Rear Engine Brake Solenoid Valve. 1. Exhaust Rocker Arm 7. Exhaust Camshaft 2. Exhaust Rocker Arm with Actuator Piston 8. Actuator Piston 3. Brake Rocker Arm 9. Exhaust Valve 4. Oil Passage for Cylinders 1, 2 and 3 10. Brake Cam Lobe 5. Oil Passage for Cylinders 4, 5 and 6 11. Engine Brake Solenoid Valve, Rear Figure 23 26 EPA10 Engine Brake All information subject to change without notice. Refer to OEM procedures. 4. Remove the air cleaner and the turbocharger inlet pipe and hose. Refer to OEM procedures. 5. Remove air cleaner housing. Refer to OEM procedures. 6. Remove the rocker cover. Refer to section 1.2. 7. Remove the two 14pin fuel injector harness connectors 1 from the camshaft housing housing 2. NOTE Top Dead Center TDC can be confirmed by installing camshaft timing tool. For the DD13 use Camshaft Timing Tool W470589034000. For the EPA07 DD15 use Camshaft Timing Tool W470589054000. For the EPA10 DD15 use Camshaft Timing Tool W470589104000. 8. Using Engine Barring tool J46392, rotate the crankshaft to TDC on cylinder No. 1. All information subject to change without notice. Refer to section. 10. To accurately locate TDC, install the flywheel housing crankshaft TDC Locating Pin W470589001500 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. 28 All information subject to change without notice. The increment procedure needs to be followed to prevent the rocker shaft from breaking. 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. When removing the EPA10 exhaust rocker shaft, ensure the rockers are in the up position.

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NOTE The engine brake solenoids do not have to be removed unless damaged. NOTE Mark cap position for proper reassembly. 212 All information subject to change without notice. Remove the remaining bolts 1 from the camshaft bearing caps 2. 21. Using tool Cam Bearing Cap Puller J48883 and Injector Unit Pump Puller J46375, remove the camshaft bearing caps 1 from the camshaft housing. Use care not to damage intake cam tone wheel when handling. 214 All information subject to change without notice. If damage is found, replace the intake camshaft. Tighten the two bolts. 216 All information subject to change without notice. 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 W470589054000 1 for EPA07 DD15, W470589104000 for EPA10 DD15, and W470589034000 for EPA10 DD13 to the front of the camshaft housing and into the grooves cut into the camshafts. If so, repeat this procedure at Step 3. 7. Verify that the marks on the gear teeth match the marks on the timing tool. NOTICE The camshaft caps are numbered and need to be installed correctly. 8. Install the seven camshaft caps onto intake and exhaust camshafts. 9. The first and seventh camshaft caps hold the engine brake solenoid to camshaft cap. Replace the Orings on the solenoid prior to reinstallation. Install the engine brake solenoid. 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 uses 28 bolts, with two external bolts at the rear of the camshaft housing. 218 All information subject to change without notice. Install the 30 bolts to camshaft caps; finger tighten the bolts. Refer to section. 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.

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Hold the number five idler gear with a screwdriver. Check the lash between the camshaft gear and idler gear number five. 220 All information subject to change without notice. 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. 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 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. If the rocker shaft bolt is fully torqued without using the increment procedure the rocker shaft can break. Refer to section. 26. Lash the valves and engine brakes. Refer to section 14.15. 27. Install the fuel injector wiring harness. Refer to section. 28. Install the rocker cover. Refer to section 1.4. 29. Reconnect the battery power to the engine. Refer to OEM procedures. 224 All information subject to change without notice. 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 27.1. All information subject to change without notice. Exhaust Gas Recirculation Cooler Water Manifold Assembly 25. Bolt 8. Gasket 17. Clamps 26. Lifting Bracket Mounting Bolt 9. Seal Ring 18. Hot Pipe 27. Front Lifting Bracket Figure 24 226 EPA10 DD13 EGR Cooler Water Manifold and Related Parts All information subject to change without notice. Exhaust Gas Recirculation Cooler Water Manifold Assembly 25. Bolt 8. Gasket 17. Clamps 26. Bolt 9. Seal Ring 18.

Hot Pipe Figure 25 EPA10 DD13 EGR Cooler Water Manifold and Related Parts All information subject to change without notice. Failure to perform this procedure could cause severe engine damage. 1. Remove the marmon clamps 2 and EGR hot pipe 3 and inspect for any signs of liquid or moisture. No further action is required. Refer to section. 230 All information subject to change without notice. Exhaust Gas Cooler 21. Clamp 6. Bolt 14. Strap 22. Hose 7. Lifting Bracket 15. Shim 23. Mixer Pipe 8. Connecting Tube 16. Clamp 24. Coolant Delivery Pipe 25. Seal Ring Figure 26 EPA10 DD15 EGR Cooler and Related Parts All information subject to change without notice. Failure to perform this procedure could cause severe engine damage. 1. Remove the clamps 2, exhaust pipe 4 and gaskets 3 from the EGR cooler 1 and inspect and inspect for any signs of liquid or moisture. Refer to section. All information subject to change without notice. Refer to section. 234 All information subject to change without notice. The camshaft housing is made of aluminium material. Remove as follows 1. Steam clean the engine. 2. Remove the rocker cover. Refer to section 1.2. 3. Disconnect the fuel injector harness 1 from the camshaft housing 2. 4. Remove the following high pressure fuel line components PERSONAL INJURY To prevent the escape of high pressure fuel that can penetrate skin, ensure the engine has been shut down for a minimum of 10 minutes before servicing any component within the high pressure circuit. Refer to section 2.2. 6. Disconnect the intake manifold temperature sensor 2. 34 All information subject to change without notice. Remove the bolt 2 securing the doser coolant line 1 and the Pclip to the camshaft housing 3. 11. Remove the remaining two bolts 29 and 30 securing the camshaft housing to the cylinder head. 12. Attach a lifting device to the camshaft housing and lift the camshaft housing off of the cylinder head. 36 All information subject to change without notice.

PERSONAL INJURY To avoid injury when removing or installing a heavy engine component, ensure the component is properly supported and securely attached to an adequate lifting device to prevent the component from falling. 3. Ensuring that no oil gets into the bearing cap dowel pin hole, lubricate the camshaft housing camshaft journals. 4. Install the camshaft assemblies into the camshaft housing. Refer to section 1.4. 7. Prime the fuel system. Refer to section 1.2. 2. Bar the engine to top dead center TDC with Engine Barring Tool J46392 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. If the marks do not match, research the root cause of incorrect camshaft timing. 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 rear Camshaft Timing Tool W470589054000

for EPA07 DD15, W470589104000 for EPA10 DD15, and W470589034000 for DD13 1 into the grooves cut into the camshafts to verify correct cam timing. Any resistance felt while 46 All information subject to change without notice. Install a bolt into the tool to hold it into place. The gear train consists of intake and exhaust camshaft gears, idler gears No. 1, 2, 3, 4, and 5, crankshaft gear, oil pump gear, fuel pump gear, air compressor gear, and Axial Power Turbine APT gear. Level A consists of the outermost gears closest to the flywheel, Level B consists of the middle gears, and Level C consists of the innermost gears closest to the block.

The gears in the gear train are both directly and indirectly driven by the crankshaft gear. Level A The outermost gears include the crankshaft gear which drives the outer idler gear number one and the oil pump gear. Idler gear number four is on the crankshaft gear and the axial power turbine drives the idler gear number four when the Axial Power Turbine APT is creating power. These gears are all helical cut. NOTE On the DD13, there is no Axial Power Turbine APT and no Idler gear number four. The position of the idler gear number four is covered by a plate, and sealed with an Oring. Level B The middle gears include idler gear number one, which drives the air compressor gear and the idler gear number two. Idler gear number two drives the high pressure fuel pump and idler gear number three. These gears are all straight cut. Level C The innermost gears include inner idler gear number three which drives idler gear number five. Idler gear number five drives both intake and exhaust camshafts. Gear train noise is an indication of excessive gear lash, chipped or burred gear teeth. A rattling noise usually indicates excessive gear lash. A whining noise indicates too little gear lash. Therefore, when noise develops in a gear train, the gear train needs to be inspected. If the engine is equipped with a singlecylinder air compressor, it will be mounted to the front of the air compressor. If the engine is equipped with a two cylinder air compressor, then the power steering pump will be mounted on the back of the gear case to the fuel pump. Install and lock Crankshaft TDC Locating Tool J48630 into place with bolt. 3. Install spindle into idler gear number five. 4. Install idler gear number five onto the cylinder head using Shoulder Bolt J47486. 5. Install two bolts into idler gear number five and hand tighten. Refer to section 41.2. 17. Install the thrust washers and spindle onto the idler gear number one. Refer to section 41.4.

NOTE When installing idler gear number four, verify that the part number on the gear is facing the block. 20. On the DD15, with the cone of the idler gear number four facing outward, install the thrust washer onto the spindle then install the spindle onto the idler gear number four. 21. On the DD15, install the assembled thrust washer, spindle and idler gear number four onto the cylinder block. NOTE Tool J47487 should remove with ease. If not, check gears for proper installation. 22. Remove the idler gear number three tool J47487. 23. Check that the idler gear number one is flush with the rear side of the crankshaft gear and that the idler gear number four on the DD15 is flush with the front side of the crankshaft gear. 24. Install the camshaft housing. Refer to section 3.3. 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. 510 All information subject to change without notice. Install Camshaft Timing Tool 1 W470589054000 for EPA07 DD15 shown, W470589104000 for EPA10 DDl5, and W470589034000 for DD13 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 2.4. 29. Rotate the camshafts until the mark on the inside of the gear aligns with the mark on Camshaft Timing Tool W470589054000 for EPA07 DD15, W470589104000 for EPA10 DDl5, and W470589034000 for DD13. Install Camshaft Timing Tool 1 W470589054000 for EPA07 DD15 shown, W470589104000 for EPA10 DDl5, and W470589034000 for DD13 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 solenoid to camshaft cap. 512 All information subject to change without notice. Prior to engine brake solenoid installation, replace the Orings on the engine brake solenoids. NOTE There are 30 bolts retaining the camshaft assemblies; fourteen 120 mm M10 bolts, seven 108 mm M10 bolts and nine 63 mm M8 bolts. 34. Install the thirty bolts to camshaft caps; finger tighten the bolts. Refer to figure for proper bolt placement. Check and adjust as follows 1. Remove the camshaft housing if not already removed. NOTE Rotating idler gear number five counterclockwise viewed from front of engine will result in zero lash. Rotating idler gear number five clockwise viewed from front of engine will result in maximum lash. 10. Install a magnetic basedial indicator gauge on engine block. 11. Set the dial indicator on the number five gear tooth. Refer to section 3.3. 518 All information subject to change without notice. The water manifold is attached to the cylinder head by a total of nineteen bolts, including two that are shared with the coolant outlet elbow. Refer to section. NOTE Hold water manifold doser coolant line fitting with a separate wrench while removing the coolant lines. 6. Disconnect and remove doser coolant lines and remove retaining clips. 7. Disconnect EGR cooler vent line. 8. Disconnect the outlet coolant temperature sensor electrical harness connector. 9. Remove EGR actuator coolant outlet line. 10. Remove upper radiator hose. 11. Remove four coolant outlet elbow bolts 1 and remove the coolant outlet elbow 2. Remove and discard the gasket 4. 12. Remove EGR cooler. Refer to section. All information subject to change without notice. All information subject to change without notice.Refer to section. 14. Install the exhaust manifold heat shields. Refer to section. 15. Install the air cleaner. Refer to OEM procedures. 16. Fill engine with coolant to the correct level.

ENGINE EXHAUST To avoid injury from inhaling engine exhaust, always operate the engine in a wellventilated area. Engine exhaust is toxic. 17. Start the engine and check for leaks. Removal of DD13 Exhaust Gas Recirculation Cooler Water Manifold Assembly, refer to section. Inspection of the DD13 EGR Cooler Water Manifold Assembly, refer to section. Testing and Inspection of the DD13 EGR Cooler Water Manifold Assembly, refer to section. NOTICE If the cold boost pipe is damaged on the interior the pipe needs to be replaced. Air is then routed through the manifold and into the cylinders. The mating surfaces of the manifold and the cylinder head are machined. The intake manifold is sealed to the cylinder head with six rubber and steel gaskets. If the manifold is removed, new gaskets must be installed to maintain seal under higher boost pressure. An intake manifold air temperature sensor is installed to the intake manifold. The Exhaust Gas Recirculation EGR mixer, intake throttle valve and adaptor installed to the air inlet of the intake manifold. CAC ducting is installed on the intake throttle valve adaptor. For EPA07 engines, there is a pressure combination sensor in the cold boost pipe, and a temperature sensor in the intake throttle adaptor. For EPA10 engines, these sensors are combined. The combination sensor is located in the Cold Boost Pipe, and is used to measure air pressure and air temperature. Turbocharger Outlet Pipe 4. Air Temperature Sensor EPA10 Engine Plug Only 15. Gasket, Intake Manifold 5. Gasket 16. Seal Ring 6. EGR Throttle Valve 17. Intake Manifold Temperature Sensor 7. Cold Boost Pipe 18. Gasket, Cold Boost Pipe 8. Flanged Screw, Intake Manifold to Cylinder Head 19. Bolt, Cold Boost Pipe to Intake Manifold 9. Flanged Screw, Intake Manifold to Cylinder Head 20. Bolt 10. Isolator Gasket 21. Shield 11. Intake Manifold 22. Bracket to Oil Coolant Module 23.

Charge Air Pressure Sensor EPA10 Combination Sensor Figure 81 84 DD13 Air Intake Manifold and Related Parts All information subject to change without notice. Bolt, Cold Boost Pipe to Intake Manifold 2. Adaptor 10. Seal Ring, Charge Air Sensor 18. Cold Boost Pipe 3. Gasket 11. Clamp, turbocharger outlet pipe 19. Bolt, Combination Temperature and Pressure Sensor 4. EGR Throttle Valve 12. Turbocharger Outlet Pipe 20. Charge Air Pressure Sensor 5. Air Temperature Sensor Guard 13.Intake Manifold Air Temperature Sensor 21. Bracket to Oil Coolant Module 6. Bolt 14. Intake Manifold 22. Shield 15. Gasket, Intake Manifold 23. Air Temperature Sensor ICooler Out 7. Bolt, Intake Manifold to Cylinder Head 16. Gasket, Cold Boost Pipe 8. Isolator Gasket Figure 82 DD15 Air Intake Manifold and Related Parts All information subject to change without notice. Refer

to section. 3. Remove the polyVbelts. Refer to section 40.1. 4. Remove the Exhaust Gas Recirculation EGR mixer pipe and delivery pipe, refer to section. 5. Remove cold boost pipe. Refer to section 7.2. 6. Remove the fuel filter module. Refer to section. 7. Remove the oil coolant module. Refer to section 26.2 8. Disconnect the high pressure fuel lines connected to the common rail and output side of the high pressure fuel pump. Refer to section. 9. Disconnect and remove the fuel line connected to the common rail and base of the fuel filter housing. 10. Disconnect and remove the air intake pressure sensor electrical harness connectors from the two air intake sensors. 11. Identify the bolt locations prior to removal of bolts. 12. Remove the thirteen flanged screws and isolator gaskets securing the air intake manifold to cylinder head. 13. Remove the air intake manifold and six gaskets from the cylinder head. Discard gaskets. 86 All information subject to change without notice.

EYE INJURY To avoid injury from flying debris when using compressed air, wear adequate eye protection face shield or safety goggles and do not exceed 276 kPa 40 psi air pressure. 3. Blow dry with compressed air. Secure air intake manifold to cylinder head. Refer to section 26.3. 5. Install fuel module. Refer to section. 6. Install cold boost pipe. Refer to section 7.4. 7. Install exhaust gas recirculation EGR mixer pipe and delivery pipe. Refer to section. 8. Install the polyVbelts. Refer to section 40.3. 9. Prime fuel system. Refer to section. 10. Fill the cooling system. Refer to OEM specifications. The turbocharger consists of a turbine and a compressor which are attached to a shaft. The exhaust gas flows to the turbine wheel and causes it to turn. This turning motion is transmitted to the shaft and the compressor impeller. The intake air from the air filter is compressed by the compressor impeller and flows over a charge air pipe to the charge air cooler. The compressed air is cooled in the charge air cooler, permitting a more dense charge of air to be delivered to the engine, and therefore, engine output is increased. The charge air then passes from charge air cooler into the intake manifold. The turbocharger is mounted on the exhaust outlet flange of the engine exhaust manifold. The advantages are as follows Increases the engine performance and torque Reduction of the fuel consumption compared to a similarly powered naturally aspirated engine Reduction of emissions. Electronic Proportioning Valve Figure 91 94 EPA10 DD13 Turbocharger and Related Parts All information subject to change without notice. PERSONAL INJURY To avoid injury from hot surfaces, wear protective gloves, or allow engine to cool before removing any component. PERSONAL INJURY To avoid injury from contact with rotating parts when an engine is operating with the air inlet piping removed, install an air inlet screen shield over the turbocharger air inlet.