SECTION 01: ENGINE

CONTENTS

LIST OF ILLUSTRATIONS

1. ENGINE

1.1 Description

This vehicle may be powered by a 6-cylinder, four-cycle, Detroit Diesel Series 60 engine or a 4 cylinder, four cycle, Detroit Diesel, Series 50 engine, both equipped with an electronic control system (DDEC III). Two volumes of charge are used in the Series 60 engine: 11 liters or 12.7 liters, and one (8.5 liters) in the Series 50 engine. Summary information on the Electronic Control System is given in this section. Complete maintenance and repair information on the engine will be found in the current DDEC III Service Manual #6SE483. Engine controls, accessories and related components are covered in the applicable sections of this maintenance manual. Engine removal and installation procedures are given at the end of this section. The DDEC system is self-diagnostic, It can identify faulty components and other engine-related problems by providing the technician with a diagnostic code. Refer to DDEC Troubleshooting Guide # 6SE492 for more complete information on diagnosis of components and system problems published by Detroit Diesel.

DDEC III (**D**etroit **D**iesel **E**lectronic **C**ontrol) controls the timing and amount of fuel injection by the electronic unit injectors (EUI). The system also monitors several engine functions using electrical sensors which send electrical signals to the Electronic Control Module (ECM). The ECM computes the electrical signals and determines the correct fuel output and timing for optimum power, fuel economy and emissions. The ECM also has the ability to display warnings or shut down the engine completely (depending on option selection) in the event of damaging engine conditions, such as low oil pressure, low coolant, or high oil temperature.

The system components are divided in two categories: engine-mounted components and engine-related components.

2. ENGINE-MOUNTED COMPONENTS

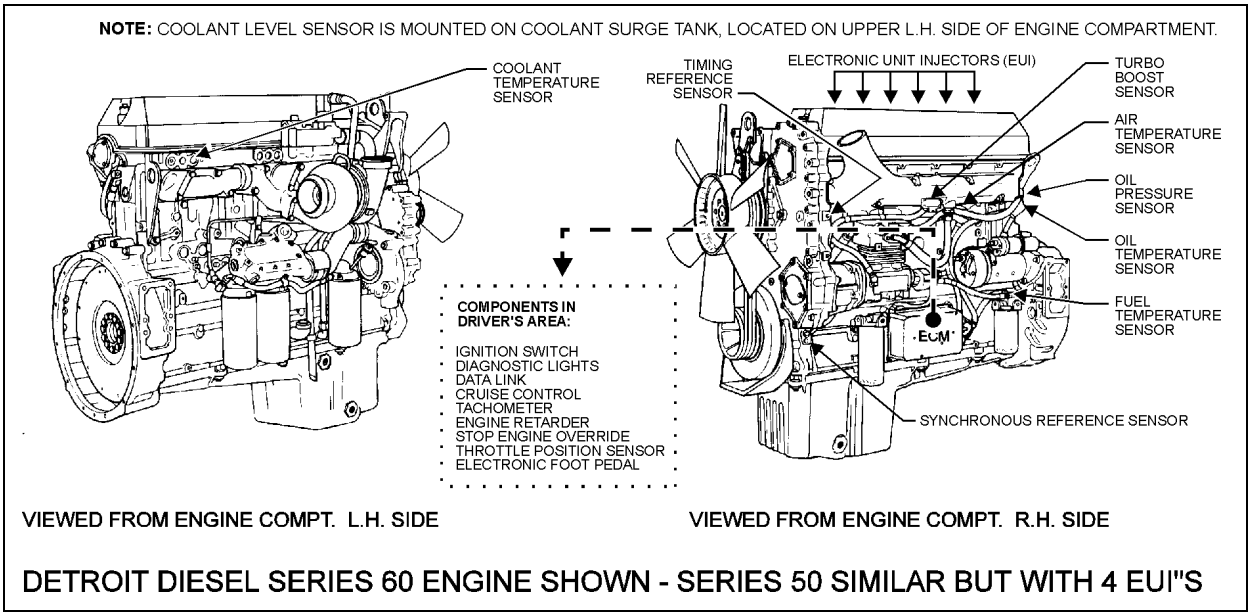

FIGURE 1: DETROIT DIESEL SERIES 60 ENGINE 01015

Engine-mounted components are as follows:

- Electronic Control Module
- Electronic Unit Injector
- Synchronous Reference Sensor
- Timing Reference Sensor
- Turbo Boost Pressure Sensor
- Coolant Temperature Sensor
- Fuel Temperature Sensor
- Air Temperature Sensor
- Oil Pressure Sensor
- Oil Temperature Sensor

2.1 Electronic Control Module

The Electronic Control Module is mounted on the starter side of the engine (Fig. 2). It is considered the *"Brain"* of the DDEC III system because it provides overall monitoring and control of the engine by comparing input data from the various sensors to a set of calibration data stored in the EEPROM (**E**lectrically **E**rasable, **P**rogrammable, **R**ead-**O**nly **M**emory) within the Electronic Control Module. After comparing the input data with the calibrations data, the ECM sends high current command pulses to the Electronic Unit Injectors (EUI) to initiate fuel injection. The ECM also receives feedback regarding the start and end of injection for a given cylinder.

The EEPROM within the Electronic Control Module is factory programmed by Detroit Diesel. Reprogramming must be done at a Detroit Diesel authorized service center. However, some changes may be performed to the cruise control and road speed limit using a diagnostic data reader (see item #4 *"DDEC III DIAGNOSTIC CODES"* in this section).

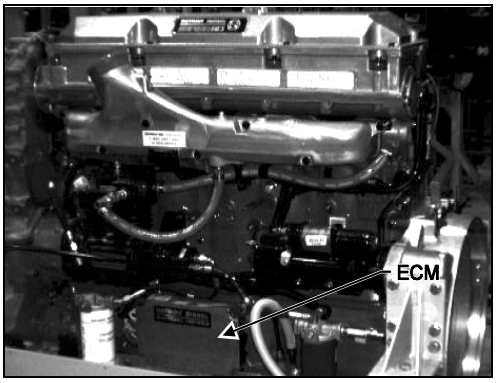

FIGURE 2: ELECTRONIC CONTROL MODULE (ECM) 01018

2.2 Electronic Unit Injector

The Electronic Unit Injector is a compact unit that injects diesel fuel directly into the combustion chamber (Fig. 3). The amount of fuel injected and beginning of injection timing is determined by the Electronic Control Module (ECM). The ECM sends a command pulse which activates the injector solenoid. The EUI performs four functions:

- Creates the high-fuel pressure required for efficient injection
- Meters and injects the exact amount of fuel required to handle the load
- Atomizes the fuel for mixing with the air in the combustion chamber
- Permits continuous fuel flow for component cooling

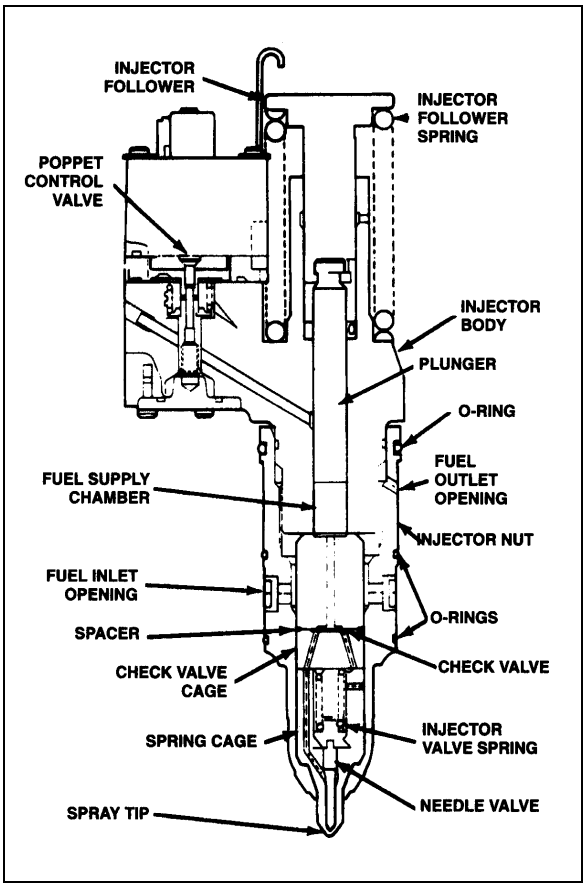

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FIGURE 3: ELECTRONIC UNIT INJECTOR CROSS-SECTION

2.3 Synchronous Reference Sensor

The Synchronous Reference Sensor (SRS) is an electronic component that is mounted to the rear of the gear case (Fig. 4). It extends through a hole in the gear case and is positioned near the rear of the bull gear. A bolt, inserted through a hole in the SRS bracket, secures the SRS assembly to the gear case. The SRS connector is black. The SRS sends a signal to the ECM. This signal is generated by a raised metal pin on the rear of the bull gear (Fig. 5).

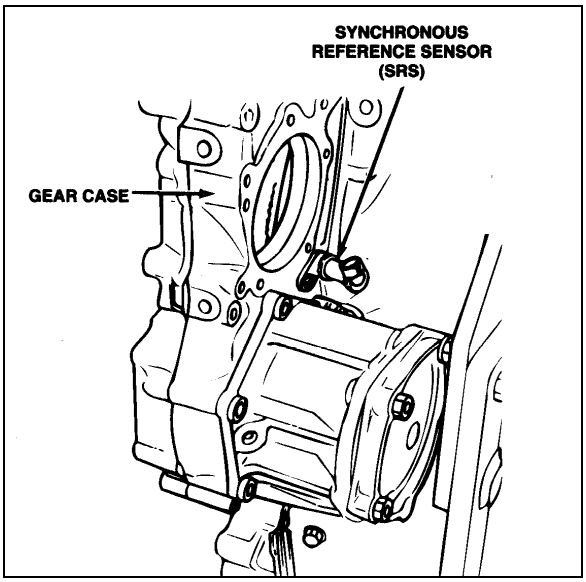

FIGURE 4: SRS LOCATION 01020

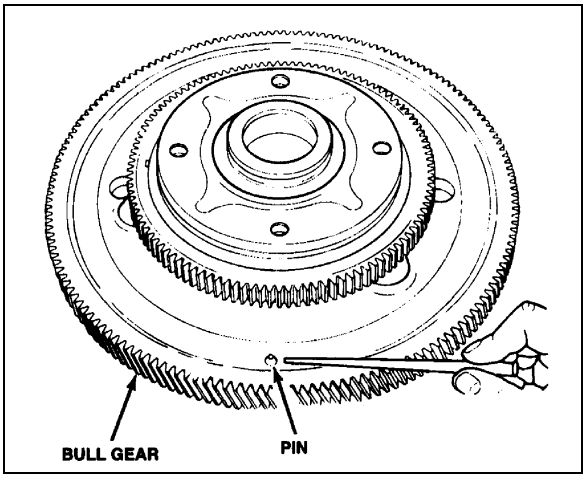

FIGURE 5: BULL GEAR 01021

The bull gear pin passes by the SRS as the number one piston reaches 45° before Top-Dead-Center. This information is used by the ECM to determine engine speed.

The SRS is non-serviceable and must be replaced as a unit. No adjustment is required.

2.4 Timing Reference Sensor

The Timing Reference Sensor (TRS) is an electronic component that is mounted on the left side of the gear case, near the crankshaft center line (Fig. 6).

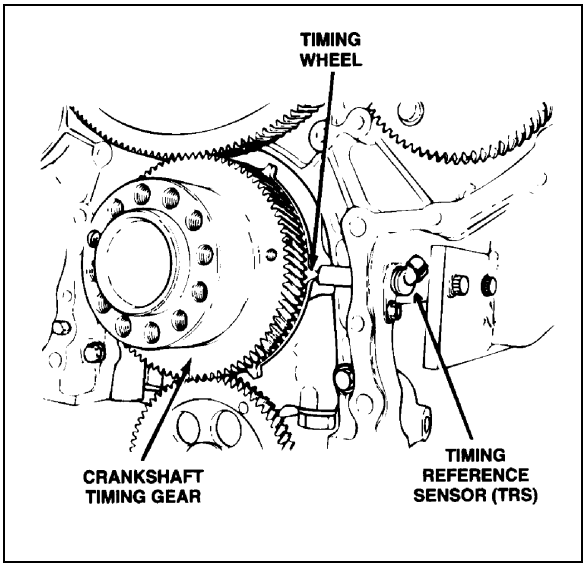

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FIGURE 6: TIMING REFERENCE SENSOR AND RELATED PARTS

The TRS sensor extends through an opening in the gear case and is positioned near the timing wheel gear teeth. A bolt, inserted through a hole in the TRS bracket, secures the TRS assembly to the gear case. The TRS connector is Gray.

The TRS sensor sends a signal to the ECM. This is generated by a series of evenly spaced teeth on the timing wheel, rotating by the crankshaft. A tooth passes by the TRS as each cylinder reaches 10° before Top-Dead-Center. These signals are used by the ECM to determine injector solenoid operation time. The TRS is non-serviceable and must be replaced as a unit. No adjustment is required.

2.5 Turbo Boost Pressure Sensor

The Turbo Boost Pressure Sensor is mounted to the intake manifold with two bolts. A rubber O-ring is used to seal the sensor to the manifold (Fig. 7). This device is a pressure sensor that sends an electrical signal to the ECM. The ECM uses this information to compute the amount of air entering the engine. Fuel supply is regulated by the turbo boost sensor information to control engine exhaust. The turbo boost sensor is non-serviceable and must be replaced as an assembly. No adjustment is required.

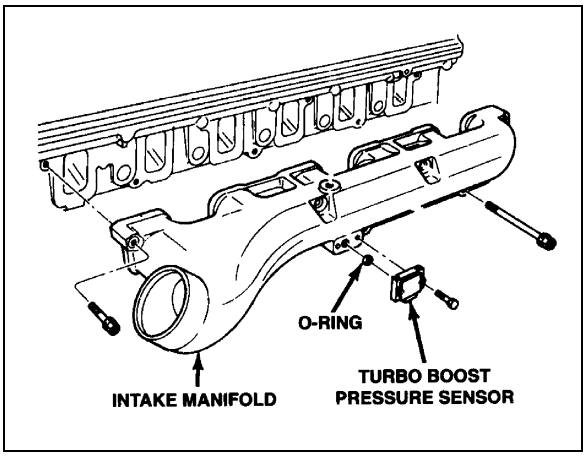

FIGURE 7: TURBO BOOST PRESSURE SENSOR 01023

2.6 Coolant Temperature Sensor

The coolant temperature sensor is mounted on the radiator side of the engine (Fig. 1). The sensor protects the engine in case of overheating by sensing coolant temperature.

2.7 Fuel Temperature Sensor

The Fuel Temperature Sensor (FTS) is installed on the secondary fuel filter (Fig. 8). The FTS sends an electrical signal to the ECM indicating

fuel inlet temperature. The ECM uses this information to calculate fuel consumption.

The FTS is non-serviceable and must be replaced as a unit. No adjustment is required.

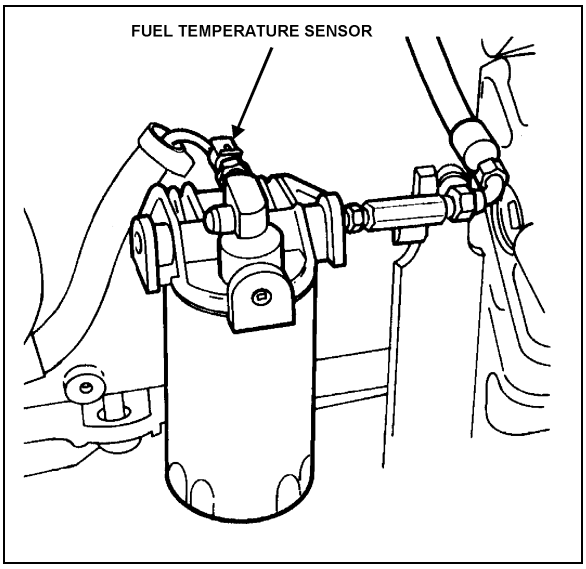

FIGURE 8: ENGINE FUEL TEMPERATURE SENSOR
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2.8 Air Temperature Sensor

The Air Temperature Sensor (Fig. 1) located on the engine (starter side) near the intake manifold, provides input data to vary hot idle speed and injection timing. This helps to improve cold starts and reduces white exhaust.

2.9 Oil Pressure Sensor

The Oil Pressure Sensor (OPS) is installed in the main engine oil gallery. A typical location is the left rear corner of the cylinder block (Fig. 9).

The OPS sends an electrical signal to the ECM indicating the engine oil pressure at any given speed. A low oil pressure signal exceeding seven seconds is used by the ECM to begin the stop engine or warning function. The OPS is non-serviceable and must be replaced as a unit. No adjustment is required.

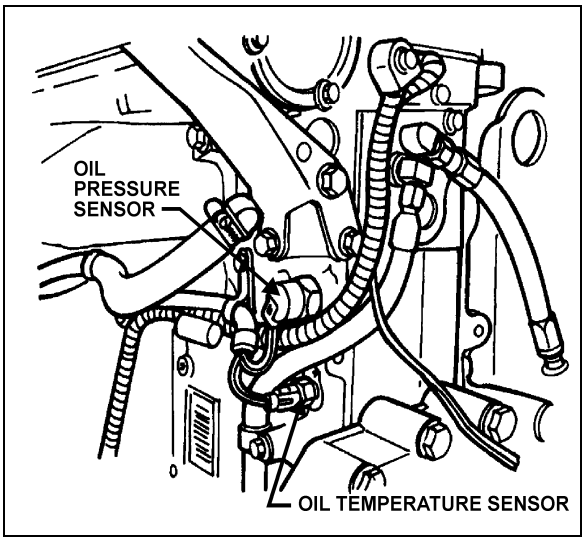

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FIGURE 9: ENGINE OIL PRESSURE AND OIL TEMPERATURE SENSOR

2.10 Oil Temperature Sensor

The Oil Temperature Sensor (OTS) is installed on the main engine oil gallery. A typical location is the left rear corner of the cylinder block as shown in Figure 9. The OTS sends an electrical signal to the ECM indicating engine oil temperature. The ECM uses this information to modify engine speed for better cold weather starts and faster warm-ups. Oil temperatures exceeding engine specifications for two seconds or more will illuminate the *"Check Engine"* light. The OTS is non-serviceable and must be replaced as a unit. No adjustment is required.

3. ENGINE-RELATED COMPONENTS

Engine-related components:

- Coolant Level System (CLS)
- Electronic Foot Pedal Assembly (EFPA) and Throttle Position Sensor
- Cruise Control Switch (CCS)
- Diagnostic System Accessories (DSA)

3.1 Coolant Level System (CLS)

The coolant level system consists of a conductivity probe mounted in the surge tank and an electronic interface module located, inside the rear junction box. Coolant level is determined by the change in impedance of the probe and its brass mount when it is immersed in coolant. The electronic device in the module conditions the signal to levels compatible with DDEC. Low coolant level will trigger the warning engine functions. The probe and the electronic interface module are non-serviceable items and if found defective, they should be replaced as units. No adjustment is required.

3.2 Electronic Foot Pedal Assembly (EFPA) & Throttle Position Sensor

The Electronic Foot Pedal Assembly (EFPA) connects the accelerator pedal to a Throttle Position Sensor (TPS). The (TPS) is a device that sends an electrical signal to the Electronic Control Module (ECM) varying in voltage, depending on how far down the pedal is depressed. The system is installed in the space normally occupied by the mechanical foot pedal. The (EFPA) has maximum and minimum stops that are built into the unit during manufacturing (Fig. 10).

The (TPS) converts the operator's foot pedal input into a signal for the ECM. The (EFPA) is shown in Figure 10.

When installed by the equipment manufacturer, the TPS should not require adjustment. If the TPS is suspected of being misadjusted, first check that the sensor is installed in accordance with the manufacturer's specifications. It is recommended that the idle count be at 50 or higher with a full throttle count of up to 200.

The TPS is self-calibrating and therefore has no optimum closed throttle or wide open throttle count value. If the counts are within the 50 to 200 range, the sensor is properly set.

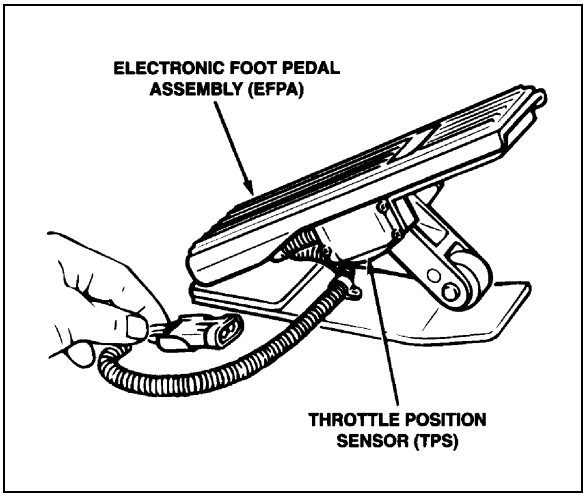

FIGURE 10: ELECTRONIC FOOT PEDAL ASSEMBLY 01026

Monitor the (TPS) as the controls move it through its full stroke. Be sure there is no misalignment or obstruction preventing the smooth movement of the TPS through the full stroke. Using a diagnostic data reader, check that the idle and full throttle position counts do not fall within the error zones. The error zones occur when the idle position is less than 14 counts, or when the full throttle position is more than 233 counts. Should these conditions occur, the ECU will signal diagnostic codes of 21-12 for idle error and 21-23 for wide open throttle error.

3.3 Cruise Control Switches (CCS)

The four cruise control switches are located in the driver's area on the L.H. side control panel.

1. **Cruise On/Off:** This is the main switch that actuates the ECM memory in order to use the speed regulating mode.

2. **Cruise Set:** This switch is used to set the cruise control speed or to decrease the set speed by 2 MPH at each application.

Note: ***Cruise control system will not accept speed settings, nor will the "Resume" switch operate below 20 mph (32 km/h) and the engine speed must be above 1100 RPM.***

3. **Cruise Resume:** Each time this switch is actuated, the speed will be increased by 2 mph (3,5 km/h). This switch allows the driver to return to the last regulated speed following a brake or *"DECEL"* switch application.

Note: ***On-off switch must be in the "ON" position in order to return to the last regulated speed.***

4. **Cruise Decel:** Will cancel the cruise temporarily like a brake application but without actuating brake light. Set speed is still in memory for resume.

For additional information, see your *"Operator's Manual".*

3.4 Diagnostic System Accessories (DSA)

The DDEC III engine Diagnostic System Accessories include the following:

- *"Check Engine"* warning light;
- *"Stop Engine"* warning light;
- *"Stop Engine Override"* switch; and
- Diagnostic Data Link (DDL) connectors.

1. *"**Check Engine"*** **Warning Light:** This light, mounted on the central dashboard panel, illuminates to indicate that a problem is currently being detected and that a code has been stored in the ECM memory. This light also has a 5-second bulb check when the ignition is first turned on. The Check Engine Light illuminates when the temperature at coolant sensors reaches 217°F (103°C) and the temperature at oil sensors reaches 239°F (115°C). In extremely hot weather and high altitude, the coolant temperature can reach 215°F (102°C) and more when climbing a long grade at full throttle. If this situation occurs, the *"Check engine"* light will come on (at 217°F - 103°C) and the engine overtemperature protection system (EOP) will be activated. If the cooling system is properly maintained, the temperature should stabilize below the shut back temperature of 222°F (106°C) so the vehicle can operate normally.

Note: ***Engine is not considered "overheating" when below 215°F (102°C).***

2. *"**Stop Engine"*** **Warning Light:** This light, also mounted on the central dashboard panel, illuminates to indicate that a major engine problem is occurring (with the exception of a 5-second bulb check when the ignition is first turned on). The Stop Engine Light illuminates when temperature at coolant sensors reaches 222°F (106°C) and the temperature at oil sensors reaches 260°F (127°C). When sensors reach those temperatures, the engine will shut down after 30 seconds. This 30-second delay period may be repeated using the *"Stop Engine Override"* switch.

Note: ***Once engine is stopped, it can not be restarted until the malfunction is corrected.***

3. ***"Stop Engine Override"*** **Switch:** This switch, mounted on the L.H. lower switch panel, is used when the *"Stop Engine"* warning light is illuminated. Push down rocker switch to reset the 30 second delay period and the shutdown procedure. This switch can be repeatedly depressed, **i.e. one (1) pulse is sufficient for each 30 second period**, for engine power in an emergency situation.

Note: ***The*** **"Stop Engine Override"** ***switch will be operative only if it has been depressed before the end of the 30 second delay period.***

Caution: ***The*** **"Stop Engine Override"** ***must be used only in emergency situations to bring vehicle to a safe stop. Excessive use of this switch could cause serious damage to the engine.***

4. **Diagnostic Data Link (DDL) Connectors:** The driver's side connector is located at rear of L.H. side control panel on XL Coaches and on L.H. lateral console on XL Shells; the remote connector is located in steering compartment (Fig. 11). They are used to connect the Diagnostic Data Reader (DDR) for reading codes or to access pertinent data on the engine condition. This enables a more complete analysis of any defect found in the DDEC system operation. For more information, see *"Detroit Diesel Troubleshooting Guide #6SE492".*

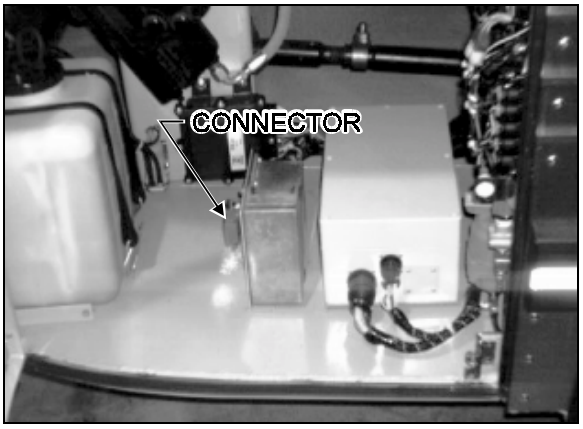

FIGURE 11: DDL REMOTE CONNECTOR
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4. DDEC III DIAGNOSTIC CODES

4.1 Reading Diagnostic Codes - Flash Method:

DDEC III makes use of two types of codes; active and inactive. The difference between the two are as follows:

1. **Active Codes:** These are the codes which are currently keeping the *"Check Engine"* or *"Stop Engine"* light illuminated. Active codes are flashed via the *"Stop Engine"* warning light when checked with the *"Stop Engine Override"* switch.

2. **Inactive Codes:** These are all the codes logged in the ECM (whether or not they are currently turning *"ON"* the *"Stop Engine"* or *"Check Engine"* lights). Inactive codes are flashed via the *"Check Engine"* warning light when checked with the *"Stop Engine Override"* switch.

In most instances, only the DDR can provide the information necessary for a quick diagnosis of a problem. However, if you do not have a DDR available, the following procedure will let you "read out" codes. Make sure the starter selector switch (located on rear junction box in engine compartment) is in the normal position. Momentarily depress the *"Stop Engine Override"* switch with the ignition *"ON"* and the engine idling or not running. Active codes will be flashed on the *"Stop Engine"* warning light, followed by the inactive codes being flashed on the *"Check Engine"* warning light. The cycle repeats itself until the operator depresses the *"Stop Engine Override"* switch i.e.: A code "43" consists of four flashes, followed by a short pause, then three flashes in quick succession.

4.2 DDEC III Diagnostic Codes List

DDC Code Number (Flashed)	Description	DDC Code Number (Flashed)	Description
11	Variable speed governor sensor voltage low	12	Variable speed governor sensor voltage high
13	Coolant level circuit failed low	14	Intercooler temperature circuit failed high
14	Coolant temperature circuit failed high	14	Oil temperature circuit failed high
15	Intercooler temperature failed low	15	Coolant temperature circuit failed low
15	Oil temperature circuit failed low	16	Coolant level circuit failed high
17	Bypass position circuit failed high	18	Bypass position circuit failed low
21	EFPA circuit failed low	22	EFPA circuit failed low
23	Fuel temperature circuit failed high	24	Fuel temperature circuit failed low
25	Reserved for "no codes"	26	Aux. shutdown #1 active
26	Aux. shutdown #2 active	27	Air temperature circuit failed high
28	Air temperature circuit failed low	31	Aux. output #3 open circuit (high side)
31	Aux. output #3 short to ground (high side)	31	Aux. output #4 open circuit (high side)
31	Aux. output #4 short to ground (high side)	32	SEL open circuit
32	SEL short to battery	33	Turbo boost pressure circuit failed high
34	Turbo boost pressure circuit failed low	35	Oil pressure circuit failed high
36	Oil pressure circuit failed high	37	Fuel pressure circuit failed high

DDC Code Number (Flashed)	Description	DDC Code Number (Flashed)	Description
38	Fuel pressure circuit failed low	41	Too many SRS (missing TRS)
42	Too few SRS (missing SRS)	43	Coolant level low
44	Intercooler temperature high	44	Coolant temperature high
44	Oil temperature high	45	Oil pressure low
46	Battery voltage low	47	Fuel pressure high
48	Fuel pressure low	52	A/D conversion fail
53	Nonvolatile checksum incorrect	53	EEPROM write error
54	Vehicle speed sensor fault	55	J1939 data link fault
55	Proprietary link fault (master)	55	Proprietary link fault (receiver)
56	J1587 data link fault	57	J1922 data link fault
58	Torque overload	61	Response time long
62	Aux. output #1 short to battery	62	Aux. output #1 open circuit
62	Aux. output #2 short to battery	62	Aux. output #2 open circuit
62	Aux. output #5 short to battery	62	Aux. output #5 open circuit
62	Aux. output #6 short to battery	62	Aux. output #6 open circuit
62	Aux. output #7 short to battery	62	Aux. output #7 open circuit
62	Aux. output #8 short to battery	62	Aux. output #8 open circuit
63	PWM #1 short to battery	63	PWM #1 open circuit
63	PWM #2 short to battery	63	PWM #2 open circuit
63	PWM #3 short to battery	63	PWM #3 open circuit
63	PWM #4 short to battery	63	PWM #4 open circuit
64	Turbo speed circuit failed	65	Reserved for air filter differential pressure circuit failed high
65	Reserved for air filter differential pressure circuit failed low	66	Reserved for oil filter differential pressure circuit failed high

DDC Code Number (Flashed)	Description	DDC Code Number (Flashed)	Description
66	Reserved for oil filter differential pressure circuit failed low	67	Coolant pressure circuit failed high
67	Coolant pressure circuit failed low	68	Idle validation circuit fault (grounded circuit)
68	Idle validation circuit fault (open circuit)	71	Injector response time short
72	Vehicle overspeed	72	Reserved for vehicle overspeed (absolute)
73	Reserved for air differential pressure high	74	Oil differential pressure high
75	Battery voltage high	76	Engine overspeed with engine brake
77	All other faults not listed	81	Timing actuator (dual fuel) failed high
81	Oil level circuit failed high	81	Crankcase pressure circuit failed high
82	Timing actuator (dual fuel) failed low	82	Oil level circuit failed low
82	Crankcase pressure circuit failed low	83	Oil level high
83	Crankcase pressure high	84	Oil level low
84	Crankcase pressure low	85	Engine overspeed
86	Pump pressure circuit failed high	86	Barometric pressure circuit failed high
87	Pump pressure circuit failed low	87	Barometric pressure circuit failed high
88	Coolant pressure low	--	CEL short to battery
--	CEL open circuit	--	Clock Module failure
--	Clock module abnormal rate		

5. ENGINE OIL LEVEL

Check the oil level daily with the engine stopped. If the engine has just been stopped and is warm, wait at least 10 minutes to allow the oil to drain back to the oil pan before checking. Wipe the dipstick clean, then check oil level. The level should always be within the safe range on the dipstick (Fig. 12) . Add the proper grade of oil to maintain the correct level on the dipstick. All diesel engines are designed to consume some oil, so a periodic addition of oil is normal.

Warning: ***Touching a hot engine can cause serious burns.***

Caution: ***Do not overfill. Oil may be blown out through the crankcase breather if the crankcase is overfilled.***

Caution: ***Clean end of tube before removing the dipstick to prevent oil contamination.***

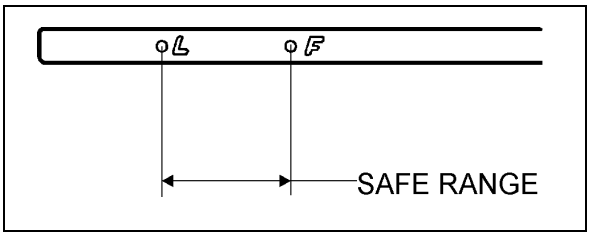

FIGURE 12: ENGINE OIL LEVEL DIPSTICK 01027

Caution: ***If the oil level is constantly above normal and excess lube oil has not been added to the crankcase, consult with an authorized Detroit Diesel service outlet for the cause. Fuel or coolant dilution of lube oil can result in serious engine damage.***

The vehicle is provided with an oil reserve tank in the engine compartment. To adjust oil level, open the tank drain valve and allow oil to discharge into the engine until it reaches the *"Full"* mark on the dipstick, then close the valve. Check reserve tank oil level through the level sight tube on the side of the tank and top-up if necessary (Fig. 13).

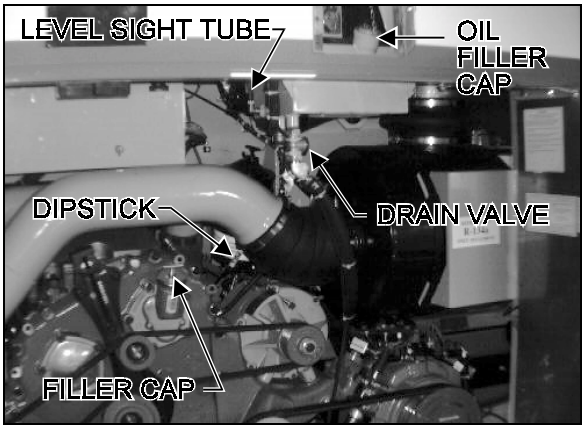

FIGURE 13: OIL RESERVE TANK 01033

6. ENGINE OIL AND FILTER CHANGE

Both the oil and filter should be changed every 12,500 miles (20 000 km) or once a year, whichever comes first. However, more frequent changes may be required when the engine is subject to high level of contamination and/or overheating. Change intervals may be decreased or gradually increased with experience on specific lubricants until the most practical service condition has been established. Always refer to the lubricant manufacturer's recommendations (analysis of drained oil can be helpful).

Caution: ***Do not use solvent to dilute the engine oil when draining oil. Dilution of the fresh oil can occur which may be detrimental to the engine.***

Change engine oil with the vehicle on a flat and level surface and with the parking brake applied. It is best to drain the oil when the engine is still warm.

1. From under the vehicle, remove the engine drain plug on the oil pan. Allow oil to drain (Fig. 14).

Warning: ***Hot engine oil can cause serious burns. Wear coveralls with sleeves pulled down and gloves to protect hands.***

2. Reinstall the drain plug.

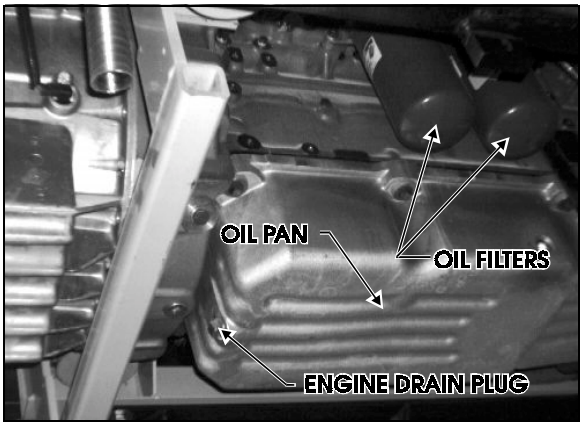

FIGURE 14: ENGINE OIL DRAIN PLUG 01029

3. Remove the spin-on filter cartridge using a 1/2" drive socket wrench and extension.

4. Dispose of the used oil and filter in an environmentally responsible manner in accordance with state and/or federal (EPA) recommendations.

5. Clean the filter adapter with a clean rag.

6. Lightly coat the filter gasket (seal) with clean engine oil.

7. Install the new filter on the adapter and tighten manually until the gasket touches the mounting adapter head. Tighten full-flow filters an additional two-thirds of a turn manually. Then, tighten bypass filter one full turn manually.

Caution: ***Overtightening may distort or crack the filter adapter.***

8. Remove the engine oil filler cap and pour oil in the engine until it reaches the *"FULL"* mark on the dipstick (Fig. 13).

9. Start and run the engine for a short period and check for leaks. After any leaks have been corrected, stop the engine long enough for oil from various parts of the engine to drain back to the crankcase (approximately 20 minutes).

   Add oil as required to bring the level within the safe range on the dipstick (Fig. 12).

7. RECOMMENDED ENGINE OIL TYPE

To provide maximum engine life, lubricants should meet the following specifications:

SAE Viscosity Grade: 15W-40
API Classification: CG-4
HT/HS Viscosity: 3.7 cP minimum

Note: ***Monograde oils should not be used in these engines regardless of API Service Classification.***

Note: ***The use of supplemental oil additives are discouraged from use in Detroit Diesel Engines.***

Synthetic oils

Synthetic oils may be used in Detroit Diesel engines provided they are API licensed and meet the performance and chemical requirements of non-synthetic oils outlined previously. Synthetic oils do not permit extension of recommended oil drain intervals.

Lubricant Selection World Wide

Oils meeting API CD or CC specifications may be used if they also meet military specification MIL-L-2104 E or F. Oil which meets European CCMC D4 specifications may also be used. Modification of drain intervals may be necessary, depending on fuel quality. Contact Detroit Diesel Corporation for further guidance.

8. WELDING PRECAUTION

Caution: ***Precautions must be taken to prevent damage to the DDEC electronic control system when welding. Disconnect battery power, ground cables and the 6-pin power connector at the ECM (Electronic Control Module) before welding. Failure to isolate the DDEC system from high current flow can result in severe ECM damage.***

9. POWER PLANT ASSEMBLY REMOVAL (AUTO. / MAN. TRANS.)

To access the engine or engine-related components, the vehicle power plant assembly must be removed as a whole unit by means of a slide-out cradle. The power plant assembly includes the engine, transmission (including retarder if so equipped), air compressor, alternator and transmission oil cooler.

Remove the power plant assembly as follows:

Caution: ***Tag hoses and cables before disconnecting in order to facilitate reinstallation. Plug all openings to prevent dirt from entering the system.***

Note: ***No parts within the ECM are serviceable. If found defective, replace the complete ECM unit.***

1. Disconnect the battery or batteries from the starting system by removing one or both of the battery cables from each battery system. With the electrical circuit disrupted, accidental contact with the starter button will not produce an engine start. In addition, the Electronic Unit Injectors (EUI) will be disabled, preventing any fuel delivery to the injector tips.

Warning: ***Due to the heavy load of the rear bumper assembly, it must be adequately supported before attempting to remove it.***

2. Remove the rear bumper assembly from the vehicle. Refer to Section 18, *"BODY"*, under heading *"Rear Bumper Removal and Installation"*.

3. Drain the engine cooling system. Refer to Section 05, *"COOLING"* under heading *"Draining Cooling System".*

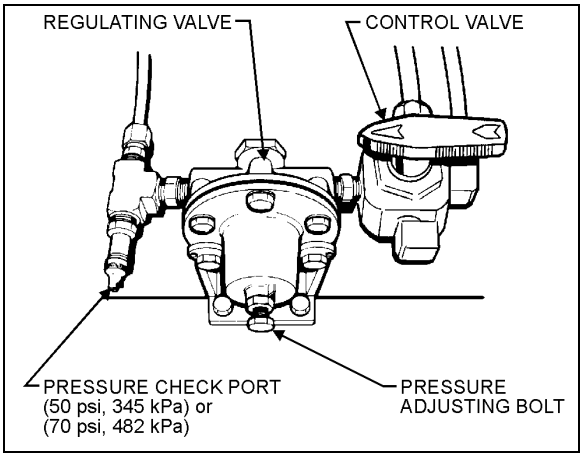

FIGURE 15: BELT TENSIONER CONTROL VALVE
12018

4. Locate the belt tensioner control valve (4, Figs. 15 & 16). Turn handle counter-clockwise in order to reverse pressure in belt tensioner air bellows and release tension on belts. Remove belts.

5. Exhaust all air from the air system. (if necessary, refer to Section 12, *"BRAKES & AIR SYSTEM"*).

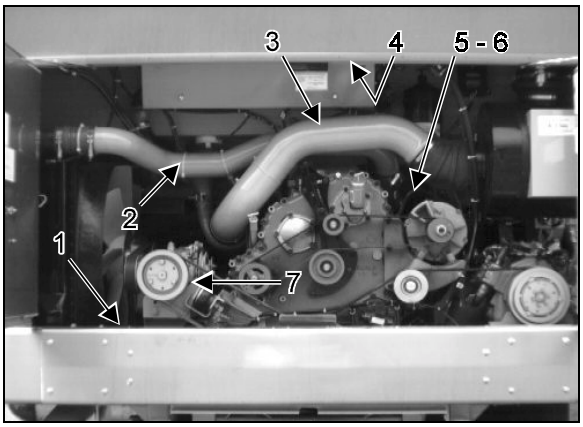

FIGURE 16: POWER PLANT ASSEMBLY REMOVAL
01014B

6. Disconnect and remove the engine air intake duct mounted between air cleaner housing and turbocharger inlet (3, Fig. 16).

Caution: ***To avoid damage to turbocharger, cover the turbocharger inlet opening to prevent foreign material from entering.***

7. Disconnect and remove the air intake duct mounted between the air cooler outlet and the intake engine (2, Fig. 16).

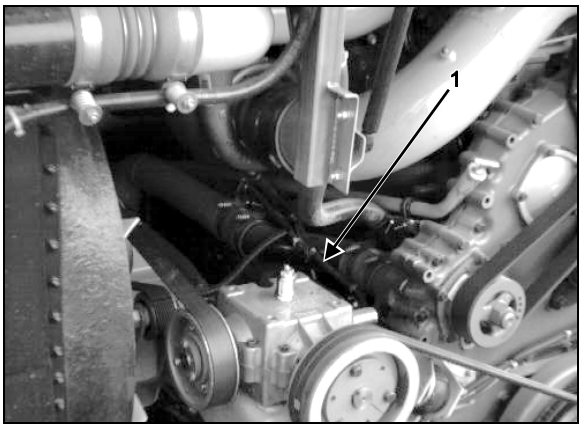

FIGURE 17: ELECTRIC FAN CLUTCH CONNECTOR
01031

8. Disconnect and remove the section of coolant pipe assembly mounted between the radiator outlet and the water pump inlet (1, Fig. 16).

9. Disconnect the coolant delivery hose located inside of engine close to the water pump.

10. Disconnect the electric fan clutch connector located next to water pump (1, Fig. 17).

11. Dismantle the air bellow from the upper bracket tensioner for the fan drive assembly. Remove the upper bracket (7, Fig. 16).

12. If necessary, remove the fan drive system from the engine compartment by removing the four retaining bolts, washers and nuts securing the fan drive to the radiator floor.

13. Disconnect and remove the air intake duct mounted between the turbocharger outlet and the air cooler inlet.

14. Disconnect two vent hoses from the thermostat housing and from the coolant pipe assembly.

15. Disconnect and remove the section of coolant pipe assembly mounted between the thermostat housings and the radiator inlet.

16. Disconnect and remove the small hose connected from the heater line valve to the water pump.

17. Disconnect the small heater hose located on the cylinder head at the back of the engine.

18. Disconnect temperature sensor for the pyrometer located above the exhaust pipe, close to the turbocharger (optional).

19. Disconnect and remove the exhaust pipe mounted between the turbocharger outlet and the exhaust bellows. If necessary, refer to Section 4, under heading *"Exhaust System".*

Caution: ***To avoid damage to turbocharger, cover the turbocharger outlet opening to prevent foreign material from entering.***

20. Disconnect the block heater connector above the power steering pump (R.H. side).

21. Disconnect the steel-braided air line from the A/C compressor air bellows.

22. Disconnect the engine oil pressure steel-braided hose from the mechanical oil pressure gauge and the cable of the gauge water temperature (5 & 6, Fig. 16).

23. Disconnect the oil delivery hose from the valve located at the reserve tank exit.

24. Disconnect the power steering pump supply and discharge hoses. Cap hose openings immediately to limit fluid loss. Remove retaining clips from cradle.

25. Close engine fuel supply shutoff valve on primary fuel filter. Disconnect the fuel line connected to the inlet port. On vehicles equipped with the optional water separator fuel filter, disconnect the connector and remove cable ties from cradle.

26. Disconnect the air compressor discharge, governor steel-braided air lines and the manual filling air lines from compressor. Remove retaining clips.

27. Disconnect the hose connecting the compressor head to the septic reservoir.

28. Disconnect ground cables from rear subframe ground stud, located close to the starting motor.

29. Disconnect positive cable (red terminal) from starting motor solenoid.

30. Disconnect the power plant wiring harness main connectors from EMC and remove retaining clips from engine compartment back wall.

31. On vehicles equipped with an automatic transmission with output retarder, disconnect steel-braided air line from pressure regulator output. On XL-40 & 45E vehicles, the pressure regulator is mounted on the curb side rear wheel housing, inside the engine compartment. On XL-45 vehicles, the regulator is mounted inside R.H. side rear service compartment (rear L.H. corner).

32. Disconnect fuel return line from bulkhead fixed on engine cylinder head end.

33. On vehicles equipped with an electrically operated cold starting aid, disconnect the delivery hose from the starting aid cylinder solenoid valve. Remove cable ties securing hoses.

34. Disconnect turbo boost pressure gauge air line (if vehicle is so equipped) from engine air intake.

35. (Only if vehicle is equipped with an output retarder). Remove the transmission rubber damper assembly above transmission by removing: nut, bushing, rubber damper, rubber damper guide, bolt and washer. Remove the rubber damper bracket from transmission

36. Disconnect connectors from transmission - On left side: four at rear and one close to yoke - On right side: close to output retarder's solenoid valve.

37. From under the vehicle, disconnect the propeller shaft as detailed in Section 09 *"PROPELLER SHAFT".*

Manual Transmission:

- **Disconnect gear shift linkage.**
- **Remove clutch slave cylinder from transmission without disconnecting the hydraulic hose.**

38. Inspect the power plant assembly to ensure that nothing will interfere when sliding out the cradle.

39. Remove the six retaining bolts, washers and nuts securing the power plant cradle to the vehicle rear subframe (Fig. 19).

Note: ***Check if any spacer(s) have been installed between power plant cradle and vehicle rear subframe, and if so, note position of each washer for reinstallation purposes.***

40. Using a forklift, with a minimum capacity of 4,000 lbs (1 800 kg), slightly raise the power plant cradle. Pull engine out slowly from the engine compartment. Make sure all lines, wiring and controls are disconnected and are not tangled.

Caution: ***Due to the minimum clearance between the power plant equipment and the top of the engine compartment, extreme care should be used to raise the power plant cradle, just enough to free the cradle. Clearance between power plant cradle and mounting rail should range between 1/4" and 1/2" (6-12 mm).***

10. POWER PLANT ASSEMBLY INSTALLATION (AUTO. / MAN. TRANS.)

To install a power plant assembly, follow the same procedure as in step **9.**, except in reverse order. Then proceed with the following:

1. Torque the power plant cradle mounting bolts to 113-144 lbf•ft (153-195 N•m).

2. (only if the vehicle is equipped with an automatic transmission with retarder).

- Install the bracket from transmission (torque screw to 71-81 lbf•ft [96-110 N•m]).

- Install the transmission rubber damper assembly above transmission by assembling: bolt, washer, rubber damper guide, rubber damper, bushing and nut. Respect rubber damper tolerance (Fig. 18).

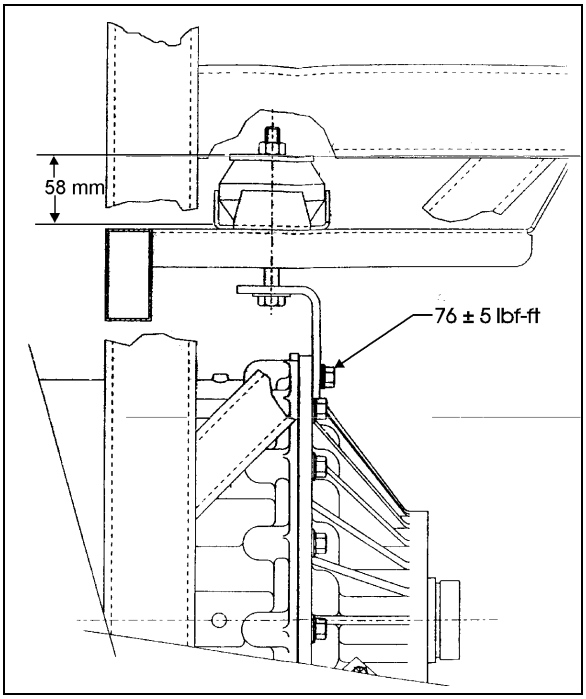

FIGURE 18: RUBBER DAMPER TOLERANCE 07014

3. If fan drive has been removed, reinstall and align as per Section 05, *"COOLING"*, under heading *"Fan Drive Alignment".*

4. Refill cooling system with recuperated fluid (refer to Section 05, *"COOLING"*).

5. After engine fuel system has been drained, it will aid restarting if fuel filters are filled with fuel oil (refer to Section 03, *"FUEL SYSTEM"*).

6. After work has been completed start engine for a visual check. Check fuel, oil, cooling, pneumatic and hydraulic system connections for leakage. Test operation of engine controls and accessories.

11. ENGINE MOUNTS

The power plant assembly is mounted to the cradle by means of four rubber mounts. Two rubber mounts are located at the front of the engine while the other two are mounted on each side of the flywheel housing (Fig. 19).

It is recommended that new rubber mounts be installed at each major overhaul.

12. JAKE BRAKE

Refer to Technical Publications web site for The Jake Brake "Maintenance Manual" and "Tune-up instruction for Models 760/760A/765 Engine Brakes".

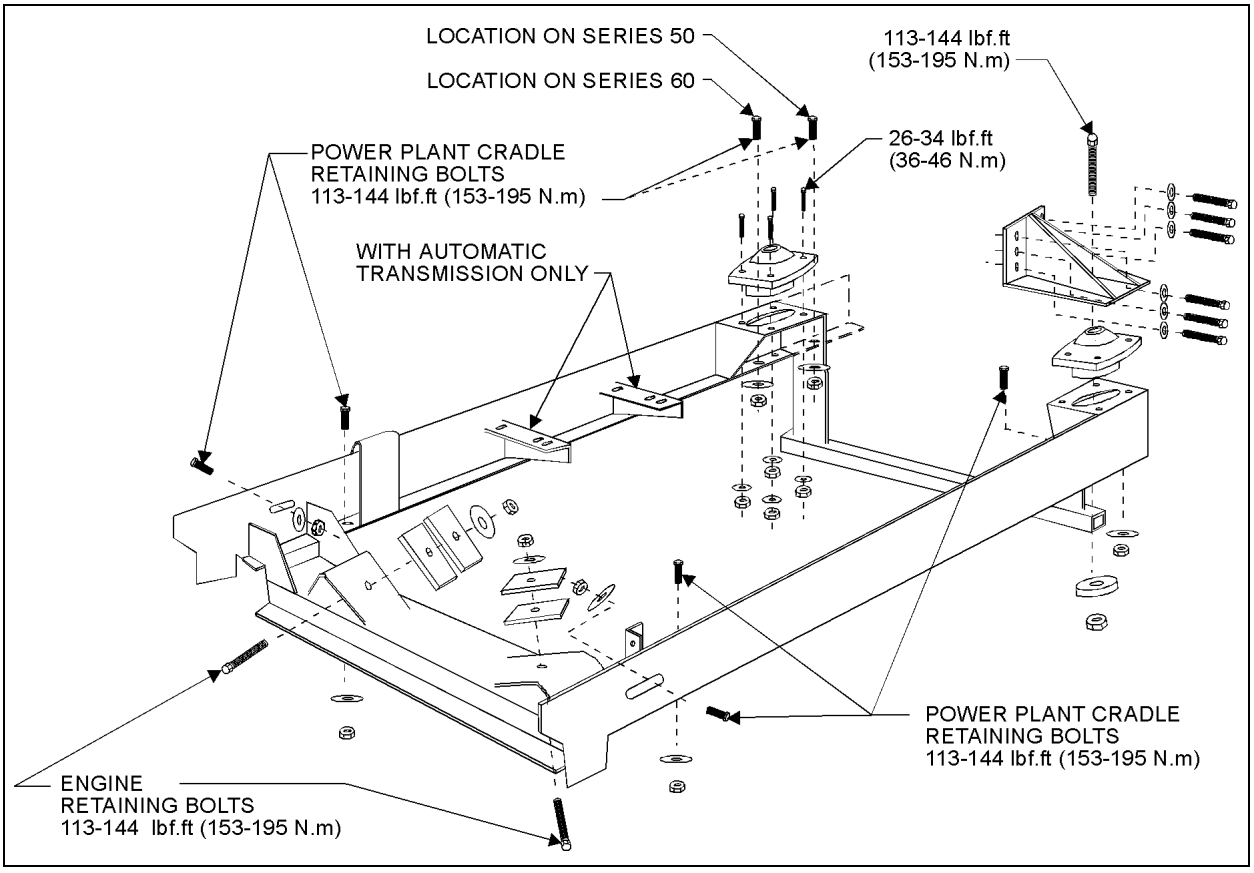

FIGURE 19: POWER PLANT CRADLE INSTALLATION 01032A

13. SPECIFICATIONS

Series 60 Engines

Make.....Detroit Diesel
Type .....Diesel four cycle/in-line engine
Description .....Turbo/Air to air intercooled
No. of cylinders 6
Operating range .....1200-2100 RPM
Maximum RPM 2100

Model 11.1 Liter
Bore & stroke .....5.12 X 5.47 in (130 X 139 mm)
Horsepower.....325 BHP

Model 12.7 Liter
Bore & stroke .....5.12 X 6.30 in (130 X 160 mm)
Horsepower.....400 BHP (Coach), 470 BHP (Shells)

Series 50 Engines

Make.....Detroit Diesel
Type ..... Diesel four cycle/in-line engine
Description .....Turbo/Air to air intercooled
No. of cylinders 4
Operating range .....1200-2100 RPM
Maximum RPM 2100
Displacement .....8,5 liters
Bore & stroke .....5.12 X 6.30 in (130 X 160 mm)
Horsepower.....315 BHP

Lubricants

Heavy-duty engine oil SAE Viscosity Grade 15W-40, API Classification CG-4, HT/HS Viscosity 3.7 cP and meeting MIL-L-2104 E or F specifications. Synthetic oil may be used if it meets the performance and chemical requirements of non-synthetic oils outlined previously. Some engine operating conditions may require exceptions to this recommendation.

Caution: ***To avoid possible engine damage, do not use single grade (monograde) lubricants in Detroit Diesel four-cycle Series 50 and 60 engines, regardless of API classification.***

Capacity

Oil reserve tank.....10 quarts/9.5 liters

Engine oil level quantity (Series 60)

Oil Pan Capacity, Low Limit.....26 quarts/25 liters
Oil Pan Capacity, High Limit.....32 quarts/30 liters
Total Engine Oil Capacity With Filters.....41 quarts/39 liters

Engine oil level quantity (Series 50)

Oil Pan Capacity, Low Limit.....19 quarts/18 liters
Oil Pan Capacity, High Limit.....22 quarts/21 liters
Total Engine Oil Capacity With Filters.....28 quarts/26 liters

Engine Oil Filters

Make..... AC Rochester Div. GM # PF-2100
Make..... Detroit Diesel # 25014505
Type .....Full Flow
Prévost P/N..... 510458

Torque specification

Engine oil filter.....Tighten 2/3 of a turn after gasket contact

Filters

Engine Air Cleaner Filter

Make.....Nelson # 70337-N
Prévost P/N..... 530197

Engine Primary Fuel Filter

Make.....AC Rochester Div. GM # TP-915D
Make..... Detroit Diesel # 25014274
Prévost P/N..... 510137

Engine Primary Fuel Filter With Water Separator (Optional)

Make..... Racor S 3202
Prévost P/N..... 531390

Engine Secondary Fuel Filter

Make.....AC Rochester Div. GM # TP-916D
Make..... Detroit Diesel # 25014342
Prévost P/N..... 510128

Engine Coolant Filter/Conditioner

Make..... Nalco Chemical Company # DDF3000
Make..... Detroit Diesel # 23507545
Prévost P/N..... 550630