YMMS: 2017 Volvo VNL Series
Engine: Volvo D13 VECTRO (OBD) 6 CYL
VIN:

Oct 27, 2020
License:
Odometer:

DESCRIPTION & OPERATION

AFTERTREATMENT CONTROL MODULE (ACM)

Fig 1: Aftertreatment Control Module (ACM)

Following aftertreatment SCR system components are controlled by ACM.

- Aftertreatment Diesel Exhaust Fluid (DEF) dosing valve, tank heater valve, line heaters valve, pump, return valve, and tank level sensor.

Following SCR system components are also monitored through ACM.

- Aftertreatment DEF Dosing Pressure, Tank Temperature, Tank Level, Intake/Outlet Temperature, Differential Pressure and NOx Sensors.

AFTERTREATMENT DEF QUALITY - DRIVER WARNING & INDUCEMENT

AFTERTREATMENT DEF QUALITY - DRIVER WARNING & INDUCEMENT INFORMATION

Triggers	Diagnostic Trouble Codes	Inducement
DEF Quality is Good	None	None
DEF Quality Is Not Good DTC Initial Detected 1 2	SPN 4094 FMI 18 SPN 5246 FMI 15	None
DEF Quality Is Not Good DTC Initial Detected + 1 hour	SPN 4094 FMI 18 SPN 5246 FMI 16	Torque Reduction of 25%
Poor DEF Quality DTC Initial Detected + 4 hours	SPN 4094 FMI 18 SPN 5246 FMI 16	Torque Reduction of 25%
Diesel Fuel Refueling Takes Place with Parking Brake ON (More than 15% fuel level increase). Engine is OFF or vehicle is not running for more than 20 minutes (Back Stop Feature)	SPN 4094 FMI 18 SPN 5246 FMI 0	Road Speed Limit (RSL)3 5 MPH (8 km/h)
Key Cycle Before Completion of Evaluation/DEF Dilution Confirmed. Temporary Exit from 5 MPH (8 km/h) Inducement	SPN 4094 FMI 1 SPN 4094 FMI 18	Torque Reduction of 25%

1. This is on basis of measured confirmed NOx sensor evaluation versus predicted SCR NOx conversion.

2. DEF dilution in water of 50/50 proportion defines poor DEF Quality.

3. Ensure vehicle is not moving before 5 MPH (8 km/h) RLS (Road Speed Limit) becomes active.

Exit conditions for DEF Quality "5 MPH (8 km/h) road speed limit" Inducement.
First Restart: Reduce torque to 25%, until you evaluate correct DEF quality. If DEF quality is poor when performing next monitoring cycle, then 5 MPH (8 km/h) resumed for 20 minutes 1 once vehicle is stopped. Use Tech Tool for exiting 5 MPH (8 km/h) RSL when one engine starts again.
With Tech Tool Diagnostic Trouble Code (DTC) Clearing: Reduce torque to 25%, until proper DEF quality is evaluated. If DEF quality is poor during next monitoring cycle, then 5 MPH (8 km/h) resumed for 20 minutes 1 once vehicle is stopped.

1. Chronological time (not engine run time).

AFTERTREATMENT DEF TANK LEVEL - DRIVER WARNING & INDUCEMENT

Size of DEF tanks should not be less than twice diesel fuel tank mileage or hour range.
A permanent aftertreatment DEF tank level gauge is present on vehicle instrument cluster.

NOTE: *When tampering is repeated, or an improperly repaired fault is present, it can cause inducement level to return*

back to highest level inducement previously attained.

AFTERTREATMENT DEF TANK LEVEL - DRIVER WARNING & INDUCEMENT INFORMATION

Triggers	Diagnostic Trouble Codes	Inducement
Aftertreatment DEF Tank Level Gauge is Between 100% to 12%	None	None
Less than =12% Aftertreatment DEF Tank Level Gauge	SPN 5246 FMI 15 SPN 1761 FMI 11	None
Aftertreatment DEF Tank Level Gauge is 0 percent (approximately 1% DEF Remaining)	SPN 5246 FMI 16 SPN 1761 FMI 18	Torque Reduction of 25%
Aftertreatment DEF Tank Gauge is at 0% DEF Pump Pressure Is Not Adequate Diesel Fuel Refueling More Than 15%. Engine is OFF or Vehicle Not Running for More Than 20 minutes	SPN 5246 FMI 0 SPN 4095 FMI 7 SPN 1761 FMI 18	Road Speed Limit (RSL)1 is 5 MPH (8 km/h)
No fuel in tank and refueling takes place while parking brake is applied **NOTE:** *Fill DEF tank to more than 18% of capacity to prevent Back Stop feature.*	SPN 5246 FMI 0 SPN 1761 FMI 18	Road Speed Limit (RSL)1 is 5 MPH (8 km/h)
Back Stop Feature	SPN 5246 FMI 0 SPN 1761 FMI 18	Road Speed Limit (RSL)1 is 5 MPH (8 km/h)

1 Ensure vehicle is stopped before activation of 5 MPH (8 km/h) RSL (Road Speed Limit).

AFTERTREATMENT DIESEL EXHAUST FLUID (DEF)

WARNING: *DIESEL EXHAUST FLUID (DEF).*

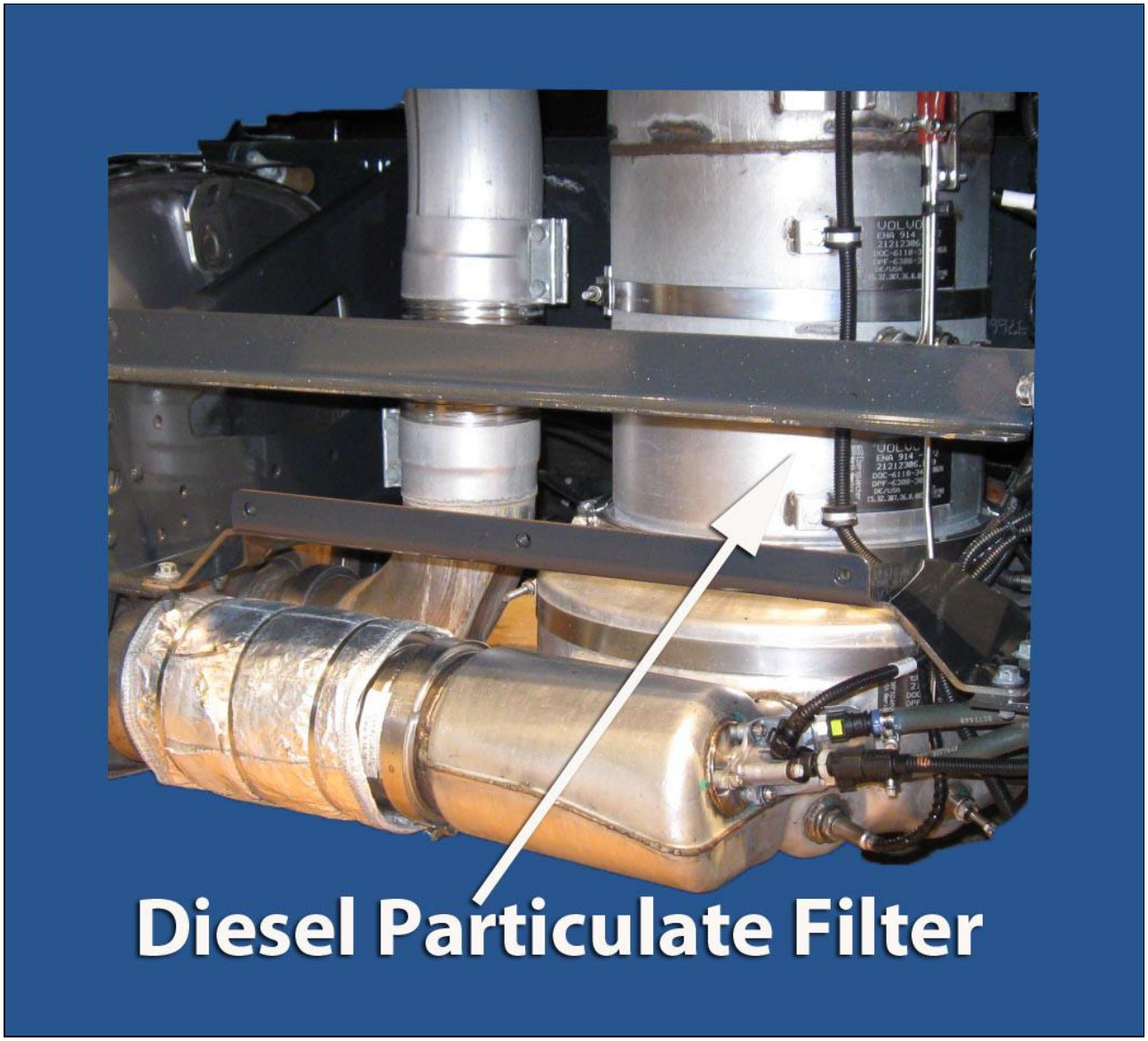
CAUTION: *DIESEL EXHAUST FLUID.*

For urea crystals and deionized water, see Aftertreatment DEF, is used as solution. If urea is heated, it converts into ammonia and carbon dioxide as it is a nitrogen compound. It is colorless, not flammable and freezes at 12°F (-11°C). Handle DEF correctly to avoid danger. But, it is highly corrosive to metal, particularly copper and aluminum.

AFTERTREATMENT DIESEL PARTICULATE FILTER (DPF)

Particulates (soot), hydrocarbons (HC) and carbon monoxide (CO) emissions are reduced through aftertreatment DPF with DOC (diesel oxidation catalyst) and particulate trap.
To stop aftertreatment DPF clogging, use only Ultra Low Sulphur Diesel (sulphur limited to 15 components per million). DO NOT exceed more than 5% biodiesel blend.
In aftertreatment DPF system, soot gets trapped in catalyzed ceramic monolith particulate filter with noble metal coating. Aftertreatment hydrocarbon doser injecting diesel fuel to burn exhaust gases through catalytic reaction. This doser regenerates aftertreatment DPF either actively or passively, thus reducing amount of soot and extending aftertreatment DPF life.

Fig 2: Aftertreatment Diesel Particulate Filter (DPF)



Aftertreatment DPF system uses passive aftertreatment DPF regeneration as its first preference, as a result, soot from monolith is removed by a catalytic reaction which DO NOT consume additional fuel. While removing soot, regeneration of passive aftertreatment DPF sometimes is not enough, when duty cycle is more "stop-and-go", a forced stationary regeneration is needed.
Connect an engine turbocharger compressor bypass valve to compressor side of turbocharger. This is done to increase exhaust gas temperature (EGT) and maintain it during heat mode required by forced stationary regeneration. Under this process, component of warm charge air is recirculated from turbocharger outlet to inlet. Bypass valve is turned ON or OFF through a solenoid valve.
DPF is frame-installed behind right front wheel. There are 2 NOx sensors used with US2010 emissions engines, one is positioned on DPF outlet pipe and other on pipe after, see SCR System.
Trapped particles are constantly oxidized by aftertreatment DPF, some of trapped particles are inorganic material (ash) and not possible to oxidize. Service aftertreatment DPF because there is possibilities for ash buildup, filter blockage, and exhaust gas back pressure creation. If not serviced, there is risk of high fuel consumption which results to derate, heavy wear or damage to engine, and damage to aftertreatment DPF.

AFTERTREATMENT DIESEL PARTICULATE FILTER (DPF) SYSTEM

1. Simplified Concept.
   In order to obey US2010 emissions particulate matter regulations, US2010 emissions engines uses an aftertreatment DPF system. Most of particulate matters present in engine exhaust get trapped in aftertreatment DPF, thus particulate matter has to be oxidized. In order to oxidize accumulated particulate matter, following 2 processes are used by aftertreatment DPF system.

   A. Passive Regeneration of Aftertreatment DPF.

   B. Forced Stationary Regeneration of Aftertreatment DPF with aftertreatment hydrocarbon doser if passive regeneration is inadequate.

   During maintenance of system's ability to initiate forced stationary regeneration (when it is required), aftertreatment operating conditions is maximized by system for passive regeneration. If passive regeneration is inadequate, forced stationary regeneration is used as backup. Main motive is to decrease forced stationary regenerations.

2. Strategy.

   A. When exhaust gas temperature (EGT) at DPF inlet and NOx to particulate matter ratio are high enough to oxidize particulate matter, passive regeneration occurs, which is a slow reaction and can be a continuous if starts.

   B. Forced stationary regeneration completely oxidizes accumulated particulate matter within 25 minutes (approx). It is faster process. Forced stationary regeneration is controlled by ECM using input from ACM. ECM determines.

3. Activation.
   Engine operation has no effect of passive regeneration, even driver remains unaware of it.
   If warning light flashes and "regeneration needed" message is displayed, then driver MUST start forced stationary regeneration using dashboard switch. Engine notification is MUST before starting stationary regeneration.

4. Deactivation.

   A. Passive regeneration: ignition turned OFF.

   B. Forced stationary regeneration: ignition turned OFF or parking brake is OFF, vehicle speed more than 1 MPH (2 km/hr), gear engaged/pedal.

5. After-Market Service.

   WARNING: *DIESEL PARTICULATE FILTER (DPF) & SELECTIVE CATALYST REDUCTION (SCR) TEMPERATURE SENSORS.*

   Residue left from non combusted particulate matter that can accumulate in filter is referred as "ash". Ash is also produced by consumption of lubrication oil by engine. Clean filters to prevent engine from excessive back pressure. DPF is set to meet or go beyond regulations of EPA service interval, which is 150,000 Mi. (240 000 km) or 4,500 hours. Replace DPF filter within 250,000 Mi. (400,000 km). Only skilled technician can determine if ash collection is high and if filter from DPF is need to be removed and replaced. Use Tech Tool to start manual stationary aftertreatment DPF regeneration if ash collection is low for removal of filter.

NOTE: *Aftertreatment DOC cannot be serviced.*

AFTERTREATMENT FUEL INJECTOR (AFI)

AFI injector is used with DPF muffler systems to inject diesel fuel into exhaust stream. This will increase exhaust temperature at a level required to allow active regeneration. When passive regeneration is not enough to prevent filter to reach certain soot levels, active regeneration mode is used. By using engine ECU or a service technician can trigger active regeneration manually in suitable location.

AFTERTREATMENT HYDROCARBON DOSING SYSTEM

Diesel fuel is injected into exhaust stream by aftertreatment hydrocarbon doser, in order to bring EGT in range required for active aftertreatment DPF regeneration, if passive DPF regeneration is not sufficient for preventing high soot level in filter. Driver is notified by ECM when a forced stationary regeneration is required so it can be started using dashboard switch. It can also be started manually by service technician in a safe location. When engine is running, aftertreatment hydrocarbon doser is used for heating up system and bring engine in compliance with requirements of US2010 emissions. When engine is idle, adjust engine timing and fuel delivery to increase EGT.

AFTERTREATMENT HYDROCARBON DOSING SYSTEM COMPONENTS (PREVIOUS VERSION)

Continuous air purge systems are present in engines having a compact and VBOC DPF systems, these engines are compliant to US2010 emissions regulations. These systems are used for removal of remaining fuel in doser after aftertreatment DPF regeneration. During engine operation, air flow is constant through doser. With engine OFF, air is provided by secondary vehicle air system, which is OFF. Following are main components of system.

- Pressure regulator (chassis-mounted) with inlet filter.
- Inspect valve assembly (doser-mounted).
- Supply tubes and hoses for air and fuel.
- Air dryer cartridge with coalescing element.
- Air shut-off valve.

In-line filter located on pressure regulator inlet receives air from secondary air system. Pressure regulator is used to reduce air pressure from chassis pressure, 90-120 Psi. (620-825 kPa), to approximately 32 Psi. (220 kPa). In order to prevent back-flow to regulator, air from regulator is made to flow through one-way Inspect valve containing a filter screen. Air then flows to engine exhaust stream through doser. Doser Inspect valve receives fuel through one-way Inspect valve. Air and fuel flow to doser is controlled through ECM. When ignition is OFF, shutoff valve prevents air leakage into fuel system.

AFTERTREATMENT HYDROCARBON DOSING SYSTEM COMPONENTS (NEW VERSION)

- Dosing module of aftertreatment hydrocarbon.
- Aftertreatment hydrocarbon doser.
- Supply tubes and hoses for air and fuel.
- Pressure regulator (chassis-mounted) with inlet filter.
- Air dryer cartridge with coalescing element.

There are 3 non-serviceable valves in aftertreatment hydrocarbon dosing module.

- Aftertreatment fuel shutoff valve.
- Aftertreatment purge air valve.

- Aftertreatment hydrocarbon dosing control valve.
- Aftertreatment fuel pressure sensor is a serviceable part.

In-line filter mounted on pressure regulator inlet receives air from secondary air system. Pressure regulator can reduce air pressure from chassis pressure, 90-120 Psi. (620-825 kPa), to approximately 32 Psi. (220 kPa). When performing air purge operation, voltage signal is sent by ECM to open aftertreatment purge air valve, thus allow air pressure to flow into aftertreatment hydrocarbon dosing module. Then aftertreatment hydrocarbon dosing control valve receives signal allowing purge air pressure to be monitored by a signal from aftertreatment fuel pressure sensor to ECM. This input is used by ECM to determine proper operation of system.
ECM sends a voltage signal for opening aftertreatment fuel shutoff valve during aftertreatment DPF regeneration, thus allowing fuel to flow into aftertreatment hydrocarbon dosing module. Aftertreatment fuel pressure sensor sends a reference signal to ECM after monitoring fuel pressure value. A signal is sent to aftertreatment hydrocarbon dosing control valve from ECM which controls quantity of fuel through air/fuel line to be delivered to aftertreatment hydrocarbon doser.

AFTERTREATMENT SELECTIVE CATALYTIC REDUCTION (SCR) SYSTEM

SCR system with DEF dosing is used by US2010 engines to comply with US2010 NOx emission regulations. All heavy duty diesel engines built after January 1, 2010 is under these regulations. As compared to US2007 standards, NEW US2010 standards require 83% reduction in NOx emissions. NOx emissions is reduced by aftertreatment SCR system.
DEF is added to exhaust stream by SCR system. From DEF tank, DEF pump pulls and transfers it to aftertreatment DEF dosing valve. DEF is injected into exhaust gases by dosing valve, between aftertreatment DPF and aftertreatment SCR catalyst. After that, treated exhaust goes to SCR catalyst where DEF is converted into ammonia and carbon dioxide by heat present in exhaust system. In SCR catalyst, ammonia acts as active substance for chemical reaction. For this chemical reaction to occur, temperatures MUST be more than 390°F (200°C), this causes NOx into harmless nitrogen gas and water vapor, this is a natural occurring process in environment.
ECM determines amount of DEF and when it requires to added to exhaust gases based on current engine load. Then signal is sent to aftertreatment control module (ACM), which controls aftertreatment DEF pump and DEF dosing valve. This process cause high reduction of emissions under all engine operating conditions.

AFTERTREATMENT SELECTIVE CATALYTIC REDUCTION (SCR) SYSTEM COMPONENTS & FUNCTION

Fig 3: Aftertreatment Selective Catalytic Reduction (SCR) System Components

Fig 4: Aftertreatment DEF Tank & DEF Pump

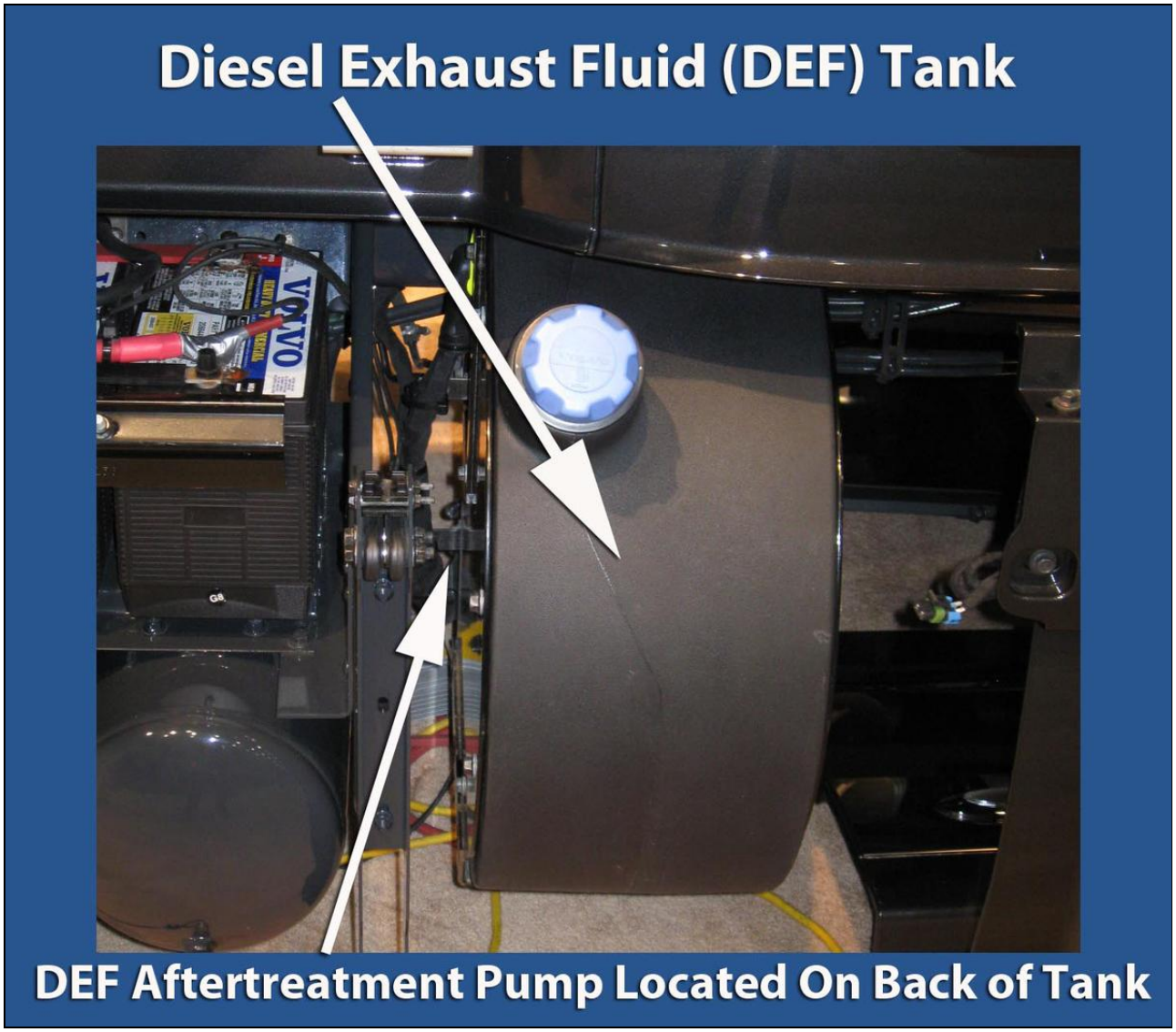
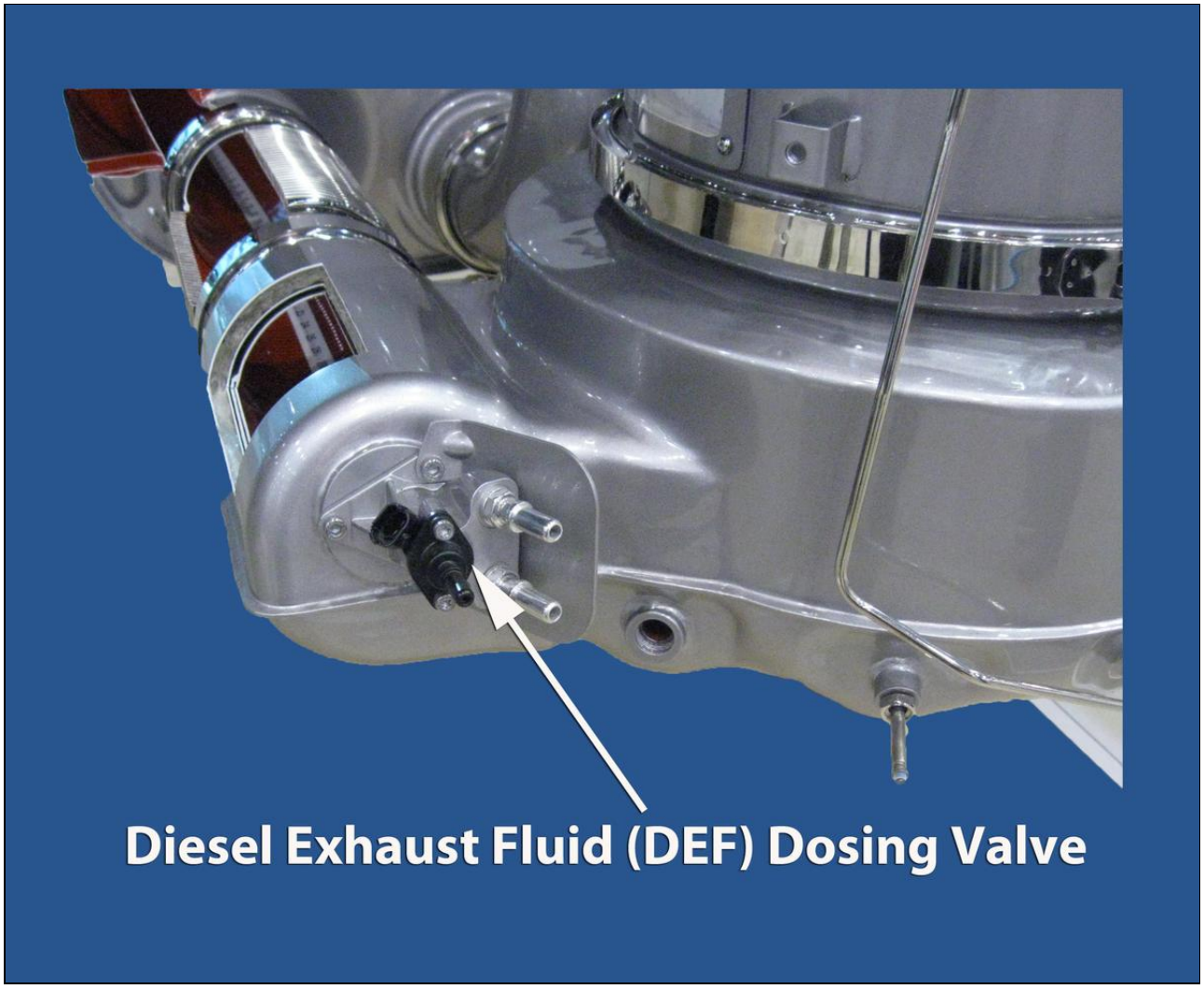


Fig 5: Aftertreatment DEF Dosing Valve



ACM receives a signal from aftertreatment DEF tank level sensor, which conveys ACM that DEF quantity in DEF tank is above minimum required level. ACM than runs DEF pump to create system pressure up to 130 Psi. (900 kPa).
After SCR system reaches certain conditions, a signal is sent by ECM to ACM. And ACM opens DEF dosing valve, which injects DEF to exhaust pipe before SCR catalyst. Pump motor speed adjustments are done in order to maintain pressure of 130 Psi. (900 kPa) as required by DEF system. For keeping stable pressure, a constant overflow of DEF is circulated through backflow orifice.
DEF is converted into ammonia and carbon dioxide due to high exhaust gas temperature. Chemical reaction occurs in SCR catalyst due to ammonia which converts exhaust gases to nitrogen gas and water vapor.
Nitrogen oxide (NOx) level in exhaust gases is measured by NOx sensor. If required emissions level is not maintained by system, a warning light on instrument panel appears and ECM stores DTC.
EGT of exhaust gas going into SCR catalyst is measured by DPF outlet temperature sensor. DPF outlet temperature and NOx sensor signals are monitored by ACM, it also calculates required amount of DEF dosing and activate DEF dosing valve. After valve is activated, accurate amount of DEF is injected into exhaust stream.
DEF is temperature sensitive. DEF tank heating loop contains hot engine coolant and heats DEF to thaw it if frozen. This prevents it from freezing during engine operation. DEF pump is also heated by heating loops. Lines to and from tank are electrically heated and insulated.

For continuous monitoring of temperature in DEF tank, a temperature sensor is installed in tank. When temperature is less than 50°F (10°C), ACM opens DEF tank heating valve, thus allowing passage of hot engine through DEF pump, and DEF tank heating loop. After temperature reaches near 60°F (15°C), DEF tank temperature sensor sends a signal to ACM for closing valve and to stop heating. If AAT (Ambient Air Temperature) falls to 40°F (4°C) or below, DEF line heaters activates from time to time for keeping lines from freezing.
If system detects a fault affecting DEF injection process, MIL (Malfunction Indicator Light) appears on instrument panel in cab and DTC is stored in ECM.
DEF level in tank is indicated by gauge on instrument panel in cab. If level is low, see Aftertreatment DEF Tank Low Level, indicator appears.
When engine is OFF, DEF system purges DEF system partially. Activation of aftertreatment DEF return valve and DEF dosing valve initiates purging. It is active for 60 seconds when engine stops.

AFTERTREATMENT TAMPERING - DRIVER WARNING & INDUCEMENT

AFTERTREATMENT TAMPERING - DRIVER WARNING & INDUCEMENT INFORMATION

Triggers	Diagnostic Trouble Codes	Inducement
No Fault	None	None
Tampering Fault Detected	See SCR System Tampering Types, for SCR Tampering DTC	None
Second Drive Cycle with Active DTC	Tampering DTC SPN 5246 FMI 15	None
Driving 1 Hour with Confirmed Active DTC	Tampering DTC SPN 5246 FMI 16	Torque Reduction of 25%
Driving 4 hours with Confirmed Active DTC	Tampering DTC SPN 5246 FMI 16	Torque Reduction of 25%
Diesel Fuel Refueling Takes Place while Parking Brake is ON (More than 15% fuel level increase). Engine is OFF or vehicle is not running for more than 20 minutes (Back Stop Feature)	Tampering DTC SPN 5246 FMI 0	Road Speed Limit (RSL) 5 MPH (8 km/h) (1)

(1) Ensure vehicle is stopped prior to activation of 5 MPH (8 km/h) RSL.

SCR SYSTEM TAMPERING TYPES

SCR System Tampering Type	Diagnostic Trouble Code
Disconnected Aftertreatment Control Module	SPN 1231 FMI 9
Disconnected Pre-SCR NOx Sensor	SPN 3216 FMI 9
Disconnected Post-SCR NOx Sensor	SPN 3226 FMI 9
Disconnected DEF Pump	SPN 4334 FMI 5

Disconnected DEF Dosing Valve	SPN 5394 FMI 5
Disconnected DEF Level Sensor	SPN 1761 FMI 5
Disconnected DEF Supply Line to DEF Pump	SPN 5392 FMI 31
Blocked or Plugged DEF Return Line	SPN 5485 FMI 11
Blocked or Plugged DEF Dosing Line	SPN 5394 FMI 14

DISCHARGE RECIRCULATION VALVE (DRV)

In some situation, Diesel Oxidation Catalyst (DOC) cannot oxidize, or burn, hydrocarbons (fuel) being injected into exhaust flow as exhaust temperature is not hot enough. At lower torque level condition, additional heat is required. There automatic activation of heat mode as required during active regenerations.
Turbocharger effectiveness is required in one procedure of achieving higher exhaust temperatures. This requires use of DRV valve which allows boosted air to be recirculated back into turbocharger compressor inlet. With this function, exhaust temperature could increase and DOC temperature is maintained to a level which supports active regeneration.

EMISSIONS AFTERTREATMENT SYSTEM (EATS)

Engine and exhaust components and sensors are components of aftertreatment system, working together to minimize emissions to meet emission requirements of heavy truck industry US2010. Following report describes main aftertreatment systems and components, which include DPF (Diesel Particulate Filter) aftertreatment system, exhaust gas recirculation (EGR) system and aftertreatment selective catalytic reduction (SCR) system. It also describes their participation for improving fuel economy and lowering emissions.

EMISSION CONTROL SENSORS

Feedback provided by many sensors throughout EATS system is important for engine control unit, otherwise it could not provide total control of emissions system. These include monitoring of turbocharger, EGR system, engine coolant, engine position and DPF muffler. Also, any chassis-mounted sensors are needed, including ambient air temperature and turbocharger wheel speed sensor. Following are examples of some of main engine sensors. Though, sensors will vary depending on DPF system used.

DIESEL PARTICULATE FILTER

- Pre-Oxidation Catalyst Temperature Sensor.
- Downstream Oxidation Catalyst Temperature Sensor.
- Downstream DPF Temperature Sensor.
- Differential Pressure Sensor.
- NOx Sensor.
- AFI Pressure Sensor.

EGR SYSTEM

- EGR Temperature Sensor.
- EGR Flow Sensor (Differential Pressure Sensor).

ENGINE COOLANT

Coolant Temperature Sensor.

ENGINE POSITION

- Camshaft Speed Sensor.
- Crankshaft Speed Sensor.

INLET AIR SENSORS

- Inlet Air Temperature Sensors.
- Inlet Air Humidity Sensors.
- Ambient Air Temperature Sensors.
- Ambient Air Pressure Sensors.

TURBOCHARGER

- Turbocharger Wheel Speed Sensor.
- VGT Position Sensor.
- Boost Pressure Sensor.
- Boost Temperature Sensor.

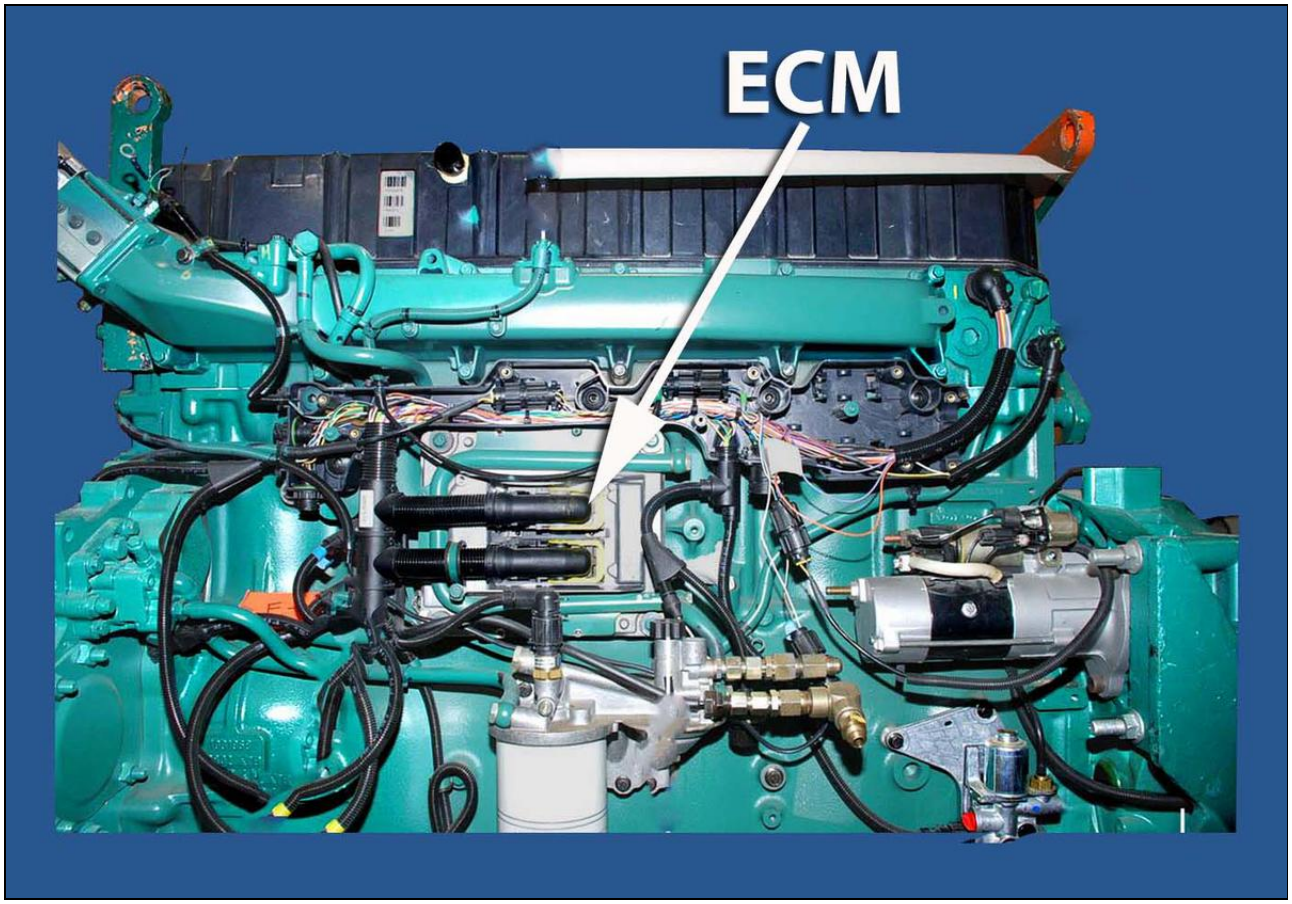
ENGINE CONTROL MODULE (ECM)

Aftertreatment system is controlled by ECM, which monitors elapsed time, distance traveled, fuel consumption, DPF soot accumulation, and other sensor signals to determine right conditions to initiate aftertreatment DPF regeneration.
All valves and components are monitored by ECM that are required to ensure aftertreatment DPF regeneration is controlled and successful. These includes (however not limited).

- Engine turbocharger compressor bypass valve.
- Turbocharger actuator and EGR valve position.

Successful aftertreatment DPF regeneration requires control of these and other components.

Fig 6: Engine Control Module



ENGINE TURBOCHARGER COMPRESSOR BYPASS VALVE

For efficient aftertreatment DPF regeneration, additional heat is required by lower torque levels. High EGT (Exhaust Gas Temperatures) is created by engine turbocharger compressor bypass valve by reducing effectiveness of turbocharger. Boosted air is circulated back into turbocharger compressor inlet by bypass valve, thus causes high EGT and maintains aftertreatment DOC temperature at a level allowing DPF regeneration.

EXHAUST AFTER TREATMENT SYSTEM (EATS)

EATS includes many engine and exhaust components and sensors working together to lower emissions to meet tough 2007 emission requirements for heavy truck industry. In following section you will find concise description of each of main components and interaction of these components with each other to allow EATS system to lower emissions and provide optimal fuel economy. List of various modes of operation that emission system passes through during normal engine operation is also described.

EATS OPERATIONAL MODES DEFINITIONS

ACTIVE REGENERATION MODE

Hydrocarbon aftertreatment fuel injector introduces fuel into exhaust flow and increases DPF filter temperature to a controlled value nearly 1067°F - 1157°F (575°C - 625°C). With this increased temperature, oxygen oxidation (burning) of soot is allowed to occur in DPF. If passive regeneration mode is not adequate to allow filter to reach certain soot levels, active regeneration mode is used.

HEAT MODE

Engine control mode allowing exhaust temperature to achieve minimum temperature is needed to allow hydrocarbon aftertreatment fuel injection active regeneration mode. Heat mode is active if an active regeneration is required.

NORMAL MODE

Normal calibration of engine helps to control it. Engine exhaust forms Particulate Matter (PM) or soot. Most of this soot is get trapped in Diesel Particulate Filter (DPF). Removal and oxidation of soot is necessary.
In normal mode, passive regeneration can occur but no active regeneration is in progress.

PASSIVE REGENERATION

Sufficient filter temperature and NOx/soot ratio causes a continuous, slow oxidation (burning) process of soot. Engine exhaust provides required heat under normal engine operating conditions.

SERVICE MODE

> **WARNING:** *DIESEL PARTICULATE FILTER (DPF) & SELECTIVE CATALYST REDUCTION (SCR) TEMPERATURE SENSORS.*

This mode must be performed by a qualified service technician at service center. Technician concludes whether filter ash accumulation is extreme and if filter required removal from DPF or external cleaning/replacement. If ash accumulation is lower than removal level, service technician could use Scan tool to start a manual stationary regeneration.

HANDLING AFTERTREATMENT DEF

> **CAUTION:** *DIESEL EXHAUST FLUID.*

While handling DEF, ensure electrical connectors are connected or wrapped in a cover to protect (if disconnected).
During replacement of DEF Pump or DEF Dosing Valve:

- Ensure system is depressurized.
- Prior to disconnecting electrical connectors, disconnect aftertreatment DEF lines to prevent DEF spillage into connectors.
- Ensure exposed connectors are wrapped in protective cover.
- Ensure system is sealed to prevent DEF from crystallization if system requires to be disconnected for several hours. Six Cap Plugs Set (21376772) is used to plug fittings on DEF pump.

CLEANING TOOLS & CLOTHING

> **CAUTION:** *DIESEL EXHAUST FLUID.*

DEF Spills:

> **WARNING:** *DIESEL EXHAUST FLUID (DEF).*

Dispose of DEF following proper regulations instead of regular drainage system.
If DEF come in contact with skin, apply plenty of water and remove contaminated clothing, if of eye contact, apply water to eyes for several minutes and seek medical attention if required.
Let DEF to keep away from other chemicals.
Since DEF is not flammable, exposure to high temperature can break it into ammonia and carbon dioxide.
DEF is highly corrosive to certain metals like copper and aluminum.
Spilled DEF on vehicle may form White crystals, thus clean spilled DEF with water.

MISFILLING DIESEL OR AFTERTREATMENT DEF TANKS

Accidents can happens, although diesel fuel and aftertreatment DEF caps are clearly labeled and filler necks and nozzles are different.
Due to contamination, vehicle will not work if diesel or DEF is filled in incorrect tank.
When DEF is misfiled in Diesel Tank, following results.

- Poor performance of engine or will not run.
- Possible damage to injectors.
- Corrosion of exhaust system between turbocharger and Aftertreatment DPF may occur.
- On Board Diagnostic (OBD) DTC.
- Expensive repairs.

When Diesel Misfilled in Aftertreatment DEF Tank, following results.

- Diesel may damage aftertreatment SCR system.
- Diesel (chemical damage) may damage SCR Catalyst.
- Non-compliant emissions.
- On Board Diagnostic (OBD) DTC.
- Expensive repairs.

PARTICULATE FILTER

- Diesel Particulate Filter (DPF) with oxidation catalyst and particulate trap significantly reduces emission of particulate (soot), hydrocarbons (HC) and carbon monoxide (CO).
- Use of Ultra Low Sulphur Diesel (ULSD) meeting a limit of 15 parts per million sulphur is necessary for prevention of DPF fouling. Maximum acceptable blending of biodiesel is 5 percent.
- In DPF system, a catalyzed ceramic monolith trap soot within it (particulate filter with unique noble metal coating). Regeneration of particulate filter is done either passively, or actively through a "hydrocarbon injector". This injector injects small quantity of diesel fuel and reburns exhaust gases with catalytic reaction to reduce soot quantity and extend function of filter.
- DPF system provides primarily "passive" regeneration to increase fuel economy. During this process, soot is chemically removed out of monolith by continuing catalytic reaction process that uses no extra fuel.
- If duty cycle is more "stop-and-go", removal of soot passively could be inadequate, and "active" regeneration will sometimes occur. This process introduced extra diesel fuel into exhaust stream at turbocharger outlet by a "hydrocarbon injector". Fuel moves to precatalyst, where a chemical reaction takes place and increases temperatures in monolith to oxidation level, and soot is consumed easily.

- Active regeneration takes nearly 20-30 minutes and consumes 1 or 2 liter of fuel. Driver can postpone regeneration until later if one is not desired. Discharge Recirculation Valve (DRV) is connected on compressor side of turbocharger to increase exhaust temperature and to keep it during regeneration. It returns a part of warm charge air from outlet to inlet of turbo. A solenoid valve is used to control ON/OFF of DRV.
- There are two options of muffler with particulate filter.
    1. Compact DPF that is frame mounted behind right front wheel. This contain NOx sensor mounted on a separate pipe.
    2. Vertical DPF that can be mounted behind cab for certain chassis configurations. It includes NOx sensor.
- Trapped particles in filter module is continuously oxidized by particulate filter. A small quantity of particulate trapped in filter contains inorganic material (ash). Oxidization of ash is not possible. Filter servicing is necessary otherwise this ash will eventually build up and block filter, causing exhaust gas back pressure. This will result in increased fuel consumption and may also cause de-rate and possibly excessive engine wear or damage and damage particulate filter itself.

> **NOTE:** *Always replace gaskets whenever they are loosened.*

SYSTEM COMPONENTS & OPERATIONS

EXHAUST GAS RECIRCULATION (EGR) SYSTEM

EGR system recirculates exhaust gases into combustion chamber, for reducing emissions of nitrogen oxide (NOx).
Content of NOx is increased due to high combustion temperature. Cooled exhaust gases are recirculated, to decrease combustion chamber temperature and to reduce content of NOx emissions.
For this, ensure pressure is more than exhaust side than in inlet side and is controlled through VGT.
An EGR valve, located on exhaust manifold, is controlled by oil pressure, and regulates recirculation of exhaust gases.
From exhaust manifold, component of exhaust gas is redirected into EGR cooler through Venturi tube, which is used to measure gas flow, and then goes to EGR mixing chamber. In mixing chamber, exhaust gas mixes with intake air, which is cooled by charge air cooler before going into intake manifold.
ECM controls amount of exhaust gases to be recirculated, which is dependent on engine load, engine coolant temperature (ECT) and some other factors.

Fig 7: Exhaust Gas Recirculation (EGR) System Components

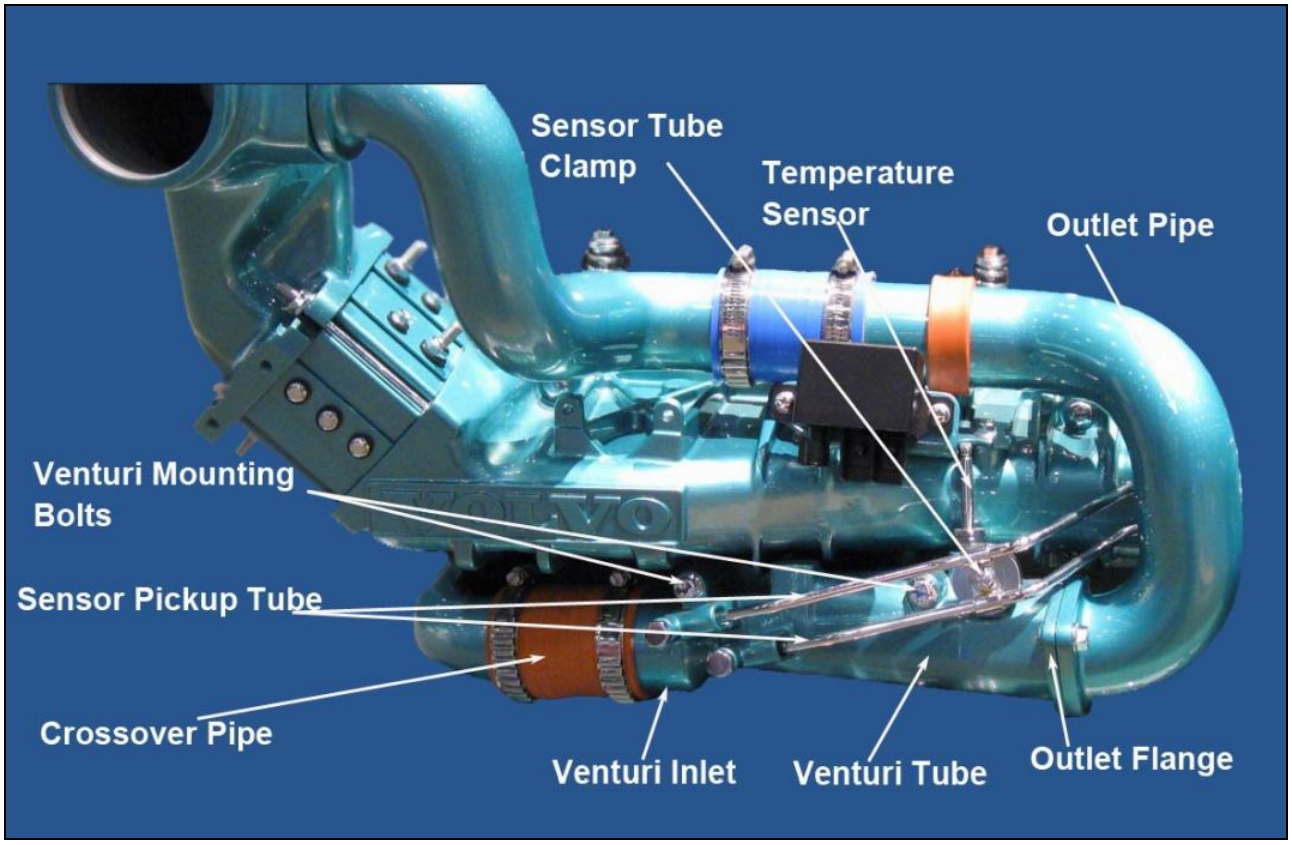
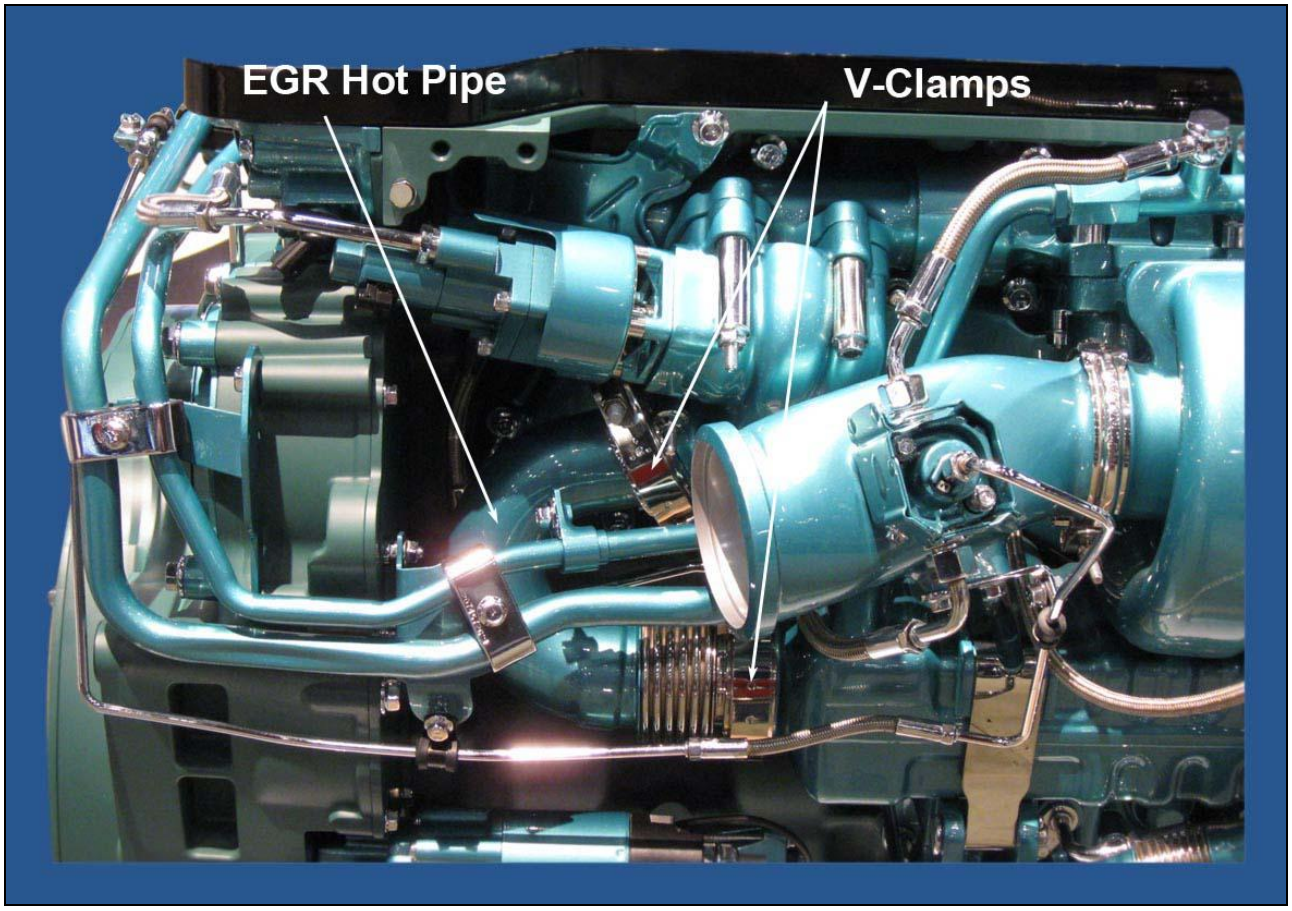


Fig 8: EGR Hot Pipe & Clamp



VARIABLE GEOMETRY TURBOCHARGER (VGT)

EGR is driven by VGT, which is used to regulate charge air pressure. Use of turbocharger helps to reduce emissions, increase power output and provides best possible fuel consumption. Turbocharger performance is controlled through gas speed entering turbine. An electronic actuator controls gas speed. Turbocharger bearing housing and actuator get cooling through engine coolant. See Figure
VGT contains set of vanes and a sliding nozzle ring that keeps enough back pressure in exhaust manifold. This enables proper operation of EGR system. Exhaust gases can be pushed into pressurized intake air at EGR mixer by using back pressure.
Exhaust back pressure is controlled by turbocharger sliding nozzle ring for enhancing brake and proper functioning of EGR system. Turbocharger acts as exhaust brake when variable geometry nozzle mechanism is closed.