



Clean Cities Transportation

March 30-31, 2011

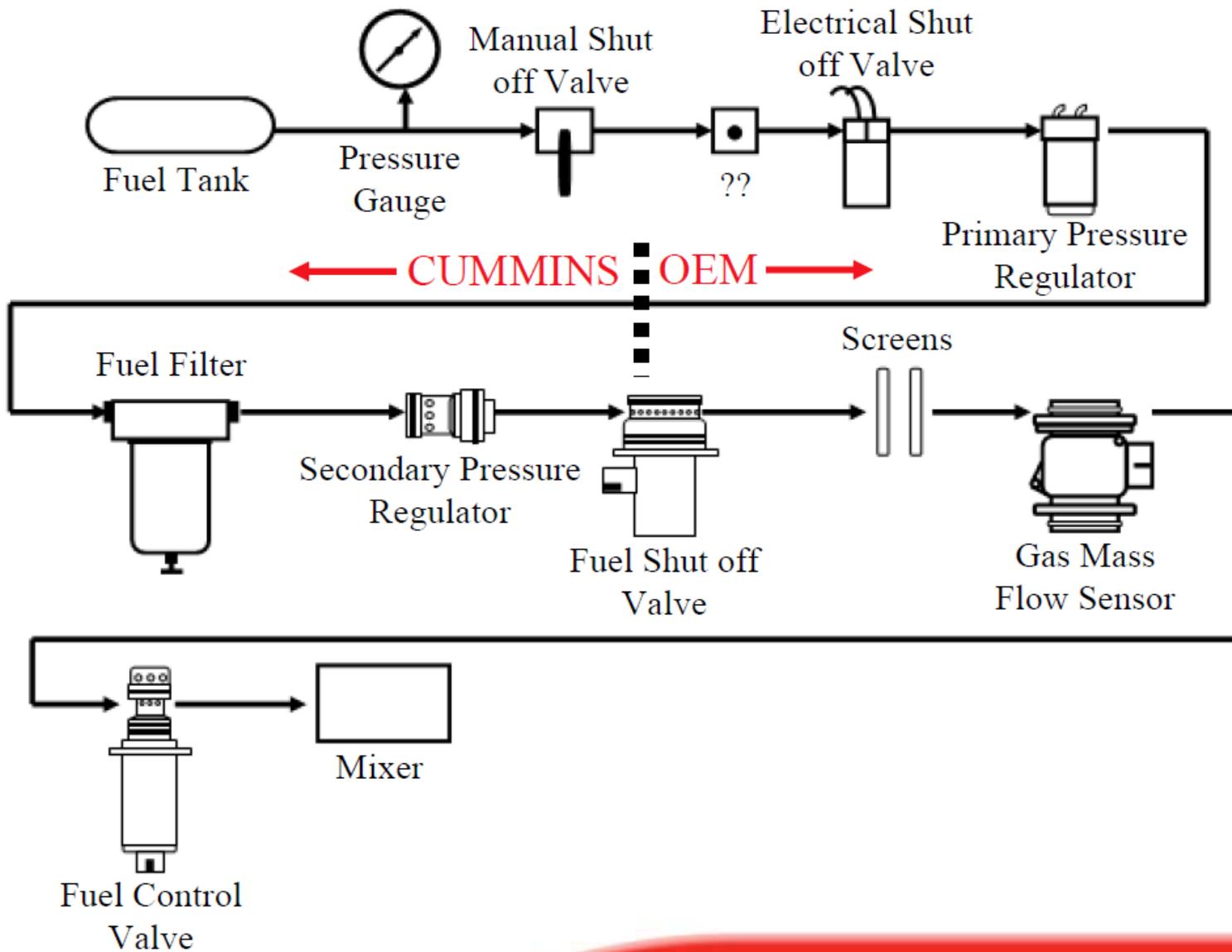
Workshop for Almaty

Peter Rusinov

Field Service Engineer



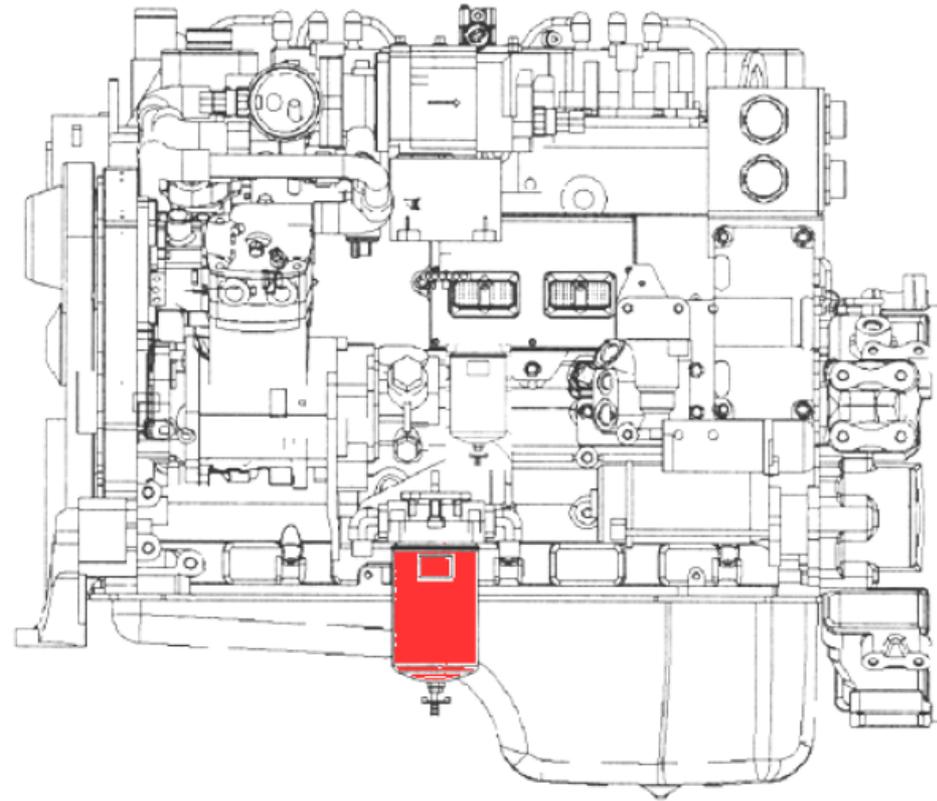
Fuel Flow



Fuel Flow

Fuel Filter

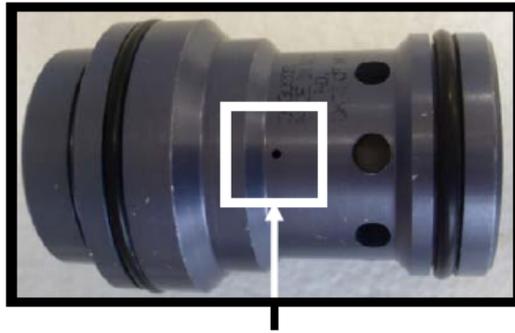
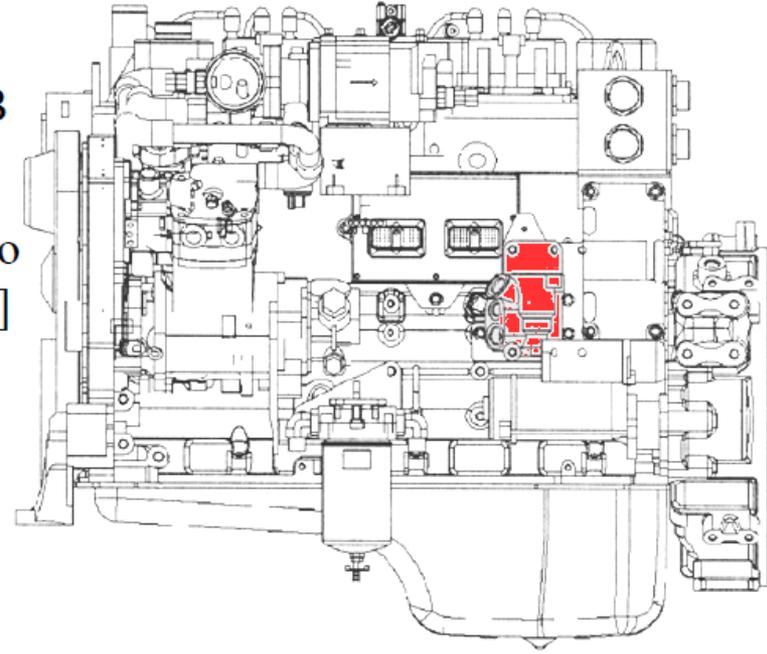
- Mounted:- On engine or off engine
- The fuel filter is the first component in the flow that is Cummins responsibility
- Filters fuel at pressures of approx 100Psig
- Filter captures particles 0.1 micron and larger
- Coalescent type filter collects oil droplets as gas passes through the filter
- When oil droplets form together they fall to the bottom of the filter
- Always install dry
- Interval period for draining the fuel filter is dependent on the fueling station
- The drain interval **must** be adjusted to the time required to accumulate no more than one ounce of oil in the fuel filter. See maintenance guidelines



Fuel Flow

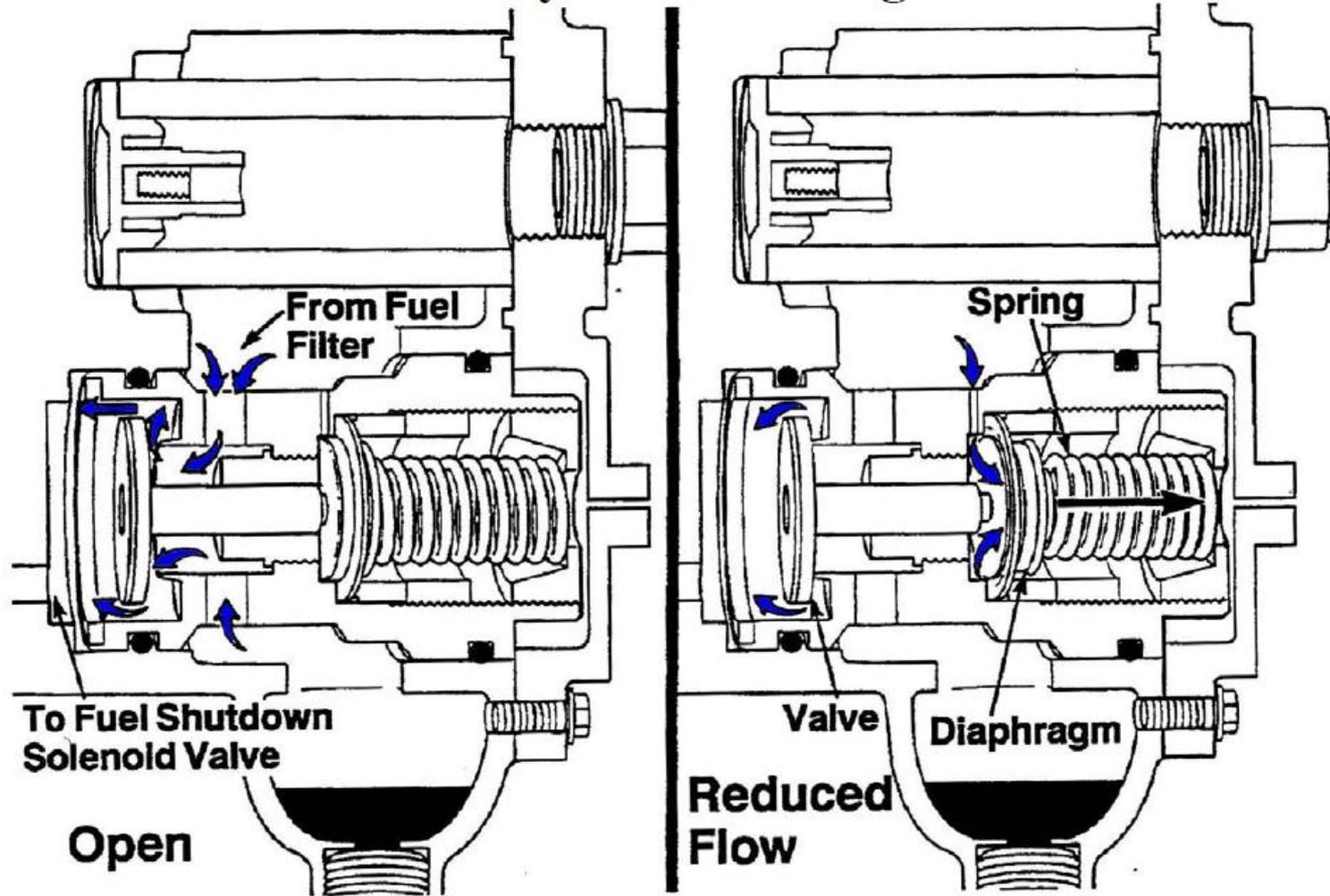
Secondary Pressure Regulator

- Mounted:- Intake side
- Reduces the primary pressure to approx [45 - 60Psig B Plus] and [55 - 70Psig C Plus]
- Regulator P/n vary between applications so take care to fit the correct regulator [distinguished by colour and P/n]



- Hole at the outlet side of the regulator applies pressure to the regulator diaphragm whilst the remainder of the gas also applies pressure to the outlet side of the valve
- These two pressures are acting on the valve to try and close it
- Ambient air pressure enters the valve body on the backside of the regulator. This helps to provide resistance to the regulator as the valve floats within the regulator

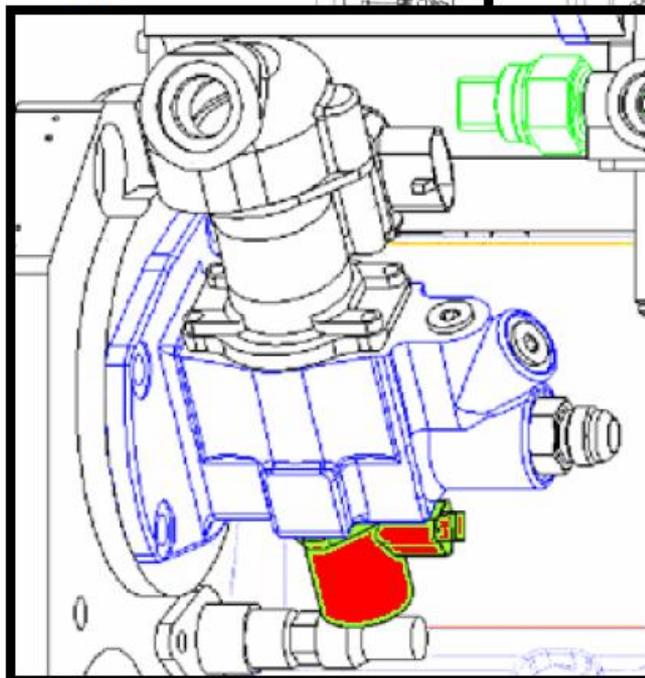
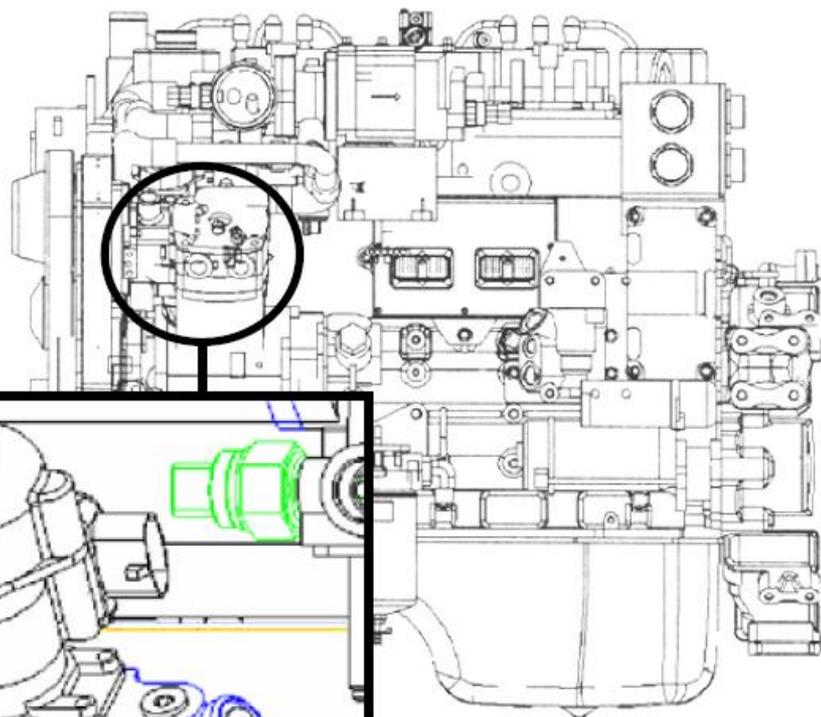
Fuel Flow Secondary Pressure Regulator



Fuel Flow

Fuel Shut off Valve [FSV]

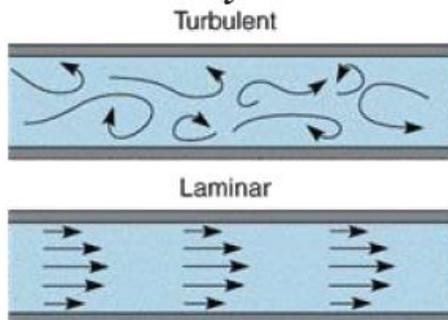
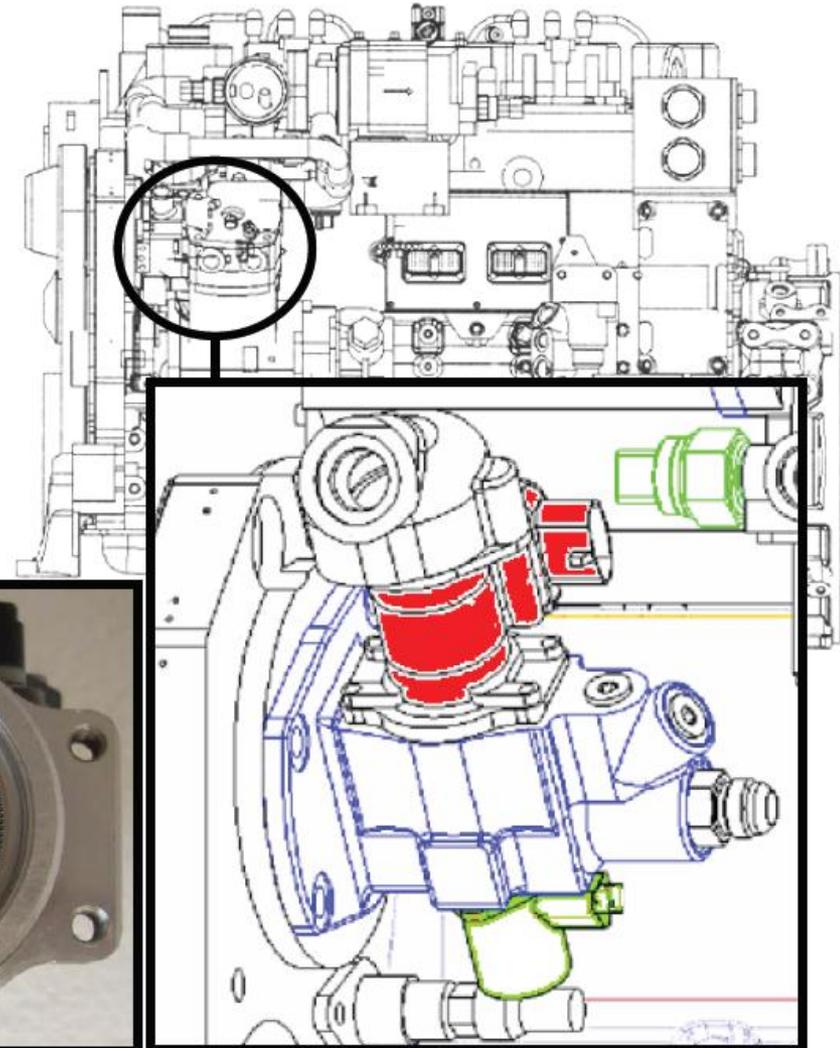
- Mounted:- Intake side front
- 12V normally closed
- The FSV needs to see 75rpm and crank synchronisation
- The ECM then supplies 9.5V or more and the valve opens
- B engine also incorporates a filter screen to calm fuel flow prior to the GMF



Fuel Flow

Gas Mass Flow Sensor [GMF]

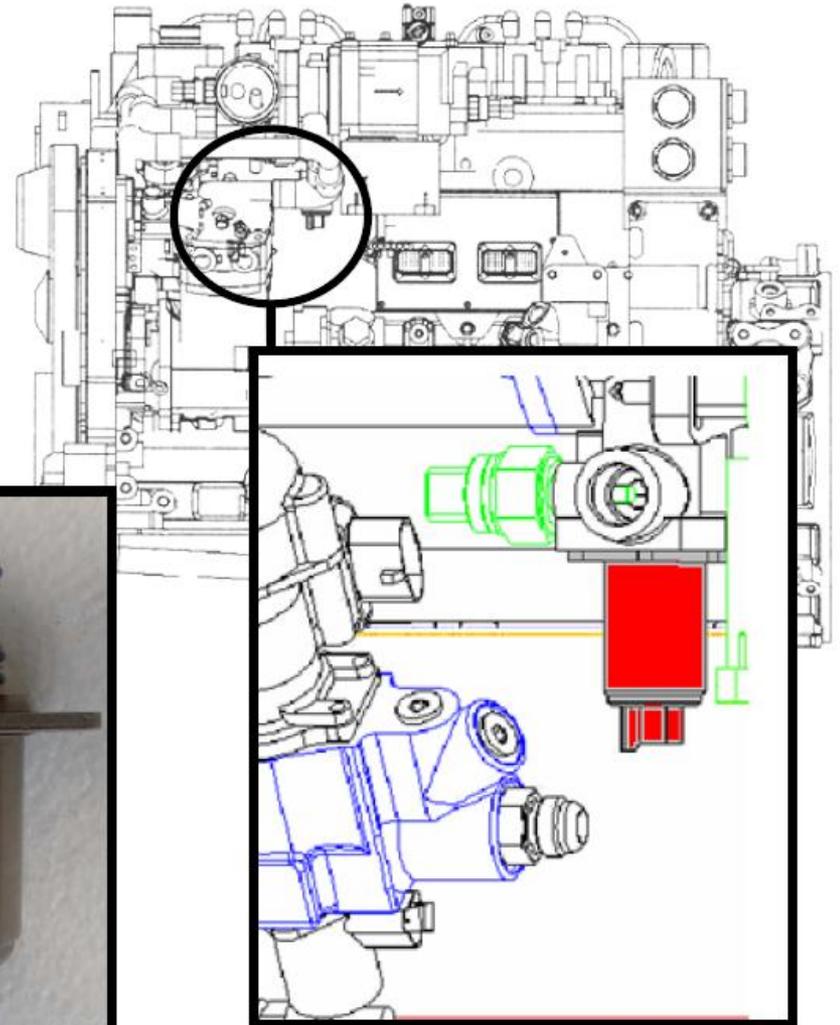
- Mounted:- Fuel housing or intake manifold inlet elbow
- GMF provides the ECM with fuel flow compensation and deviation values
- Must see stable fuel flow past the sensor wires or incorrect reading can be taken
- Filter screens help create a steady flow of fuel [Laminar flow]
- Both B & C engine have screen on entry to GMF, however B has a second screen directly after the FSV



Fuel Flow

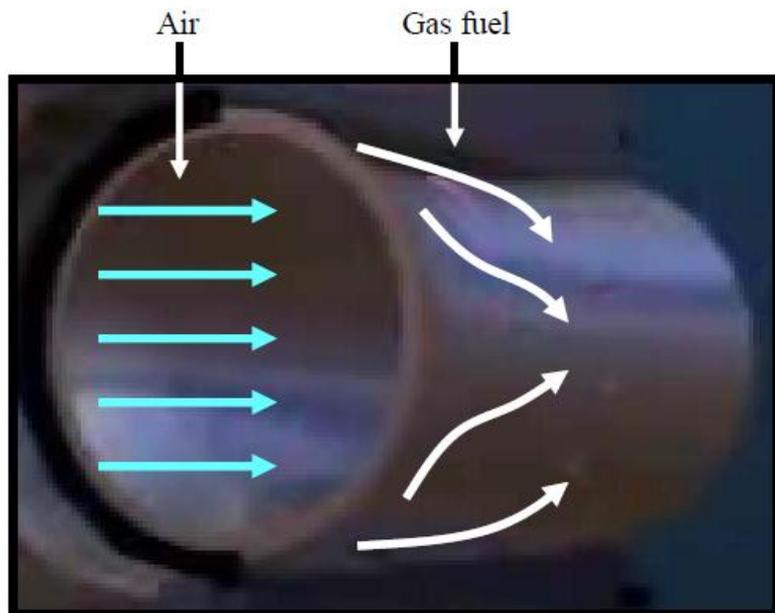
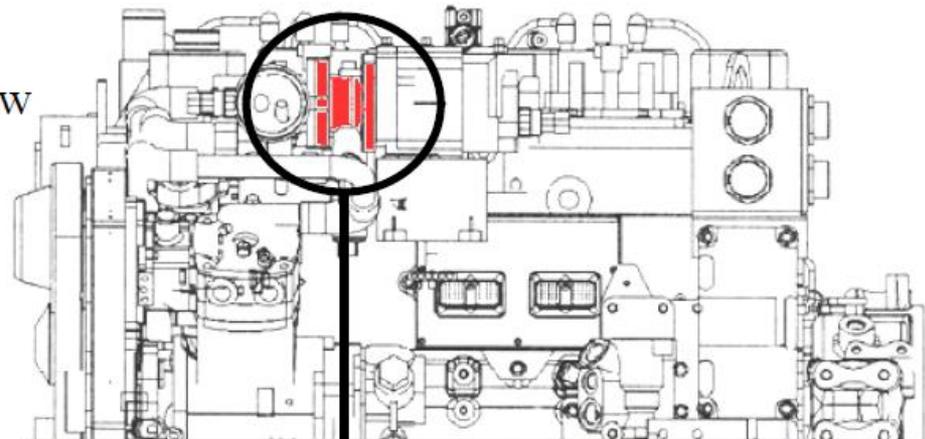
Fuel Control Valve [FCV]

- Mounted:- Intake elbow prior to mixer
- ECM sends a duty cycle command to the FCV to open a set percentage thus dictating the amount of fuel available to the engine- Normally closed
- Duty cycle based upon inputs from GMF sensor and EGO sensor
- Duty cycle is proportional to the current input



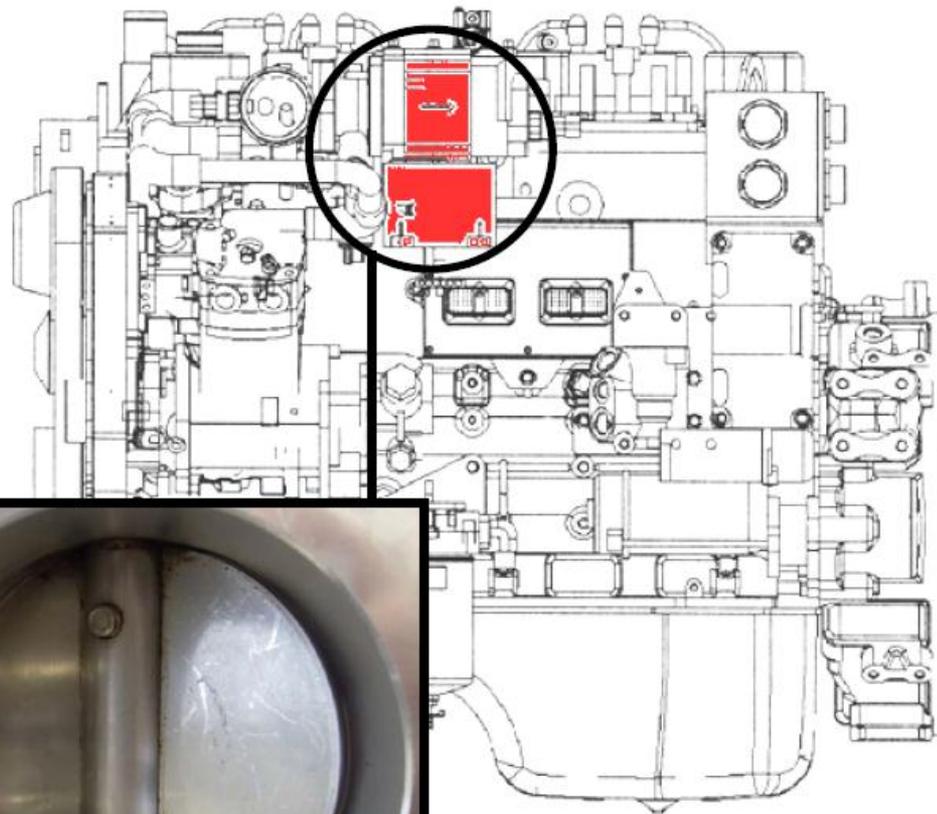
Fuel Flow Mixer

- Mounted:- Intake side prior to throttle
- Venturi style mixer design encourages gas flow to mix with air flow
- Air flow through the mixer creates a vacuum that pulls the fuel into the flow + the fuel is entering under a greater pressure than the air



Fuel Flow Throttle

- Mounted:- Intake side
- Control air/fuel flow to cylinders
- Air/fuel ratio based upon sensor and accelerator inputs
- Normally closed - PWM signal operation
- Throttle Plate design allows for duty cycle demand to equate to corresponding % open



Ignition Components

➤ Engine Position Sensor



➤ TMAP Sensor



➤ Engine Control Module



➤ Spark Plug



➤ Ignition Control Module



➤ B Gas [2 x Coil Pack]



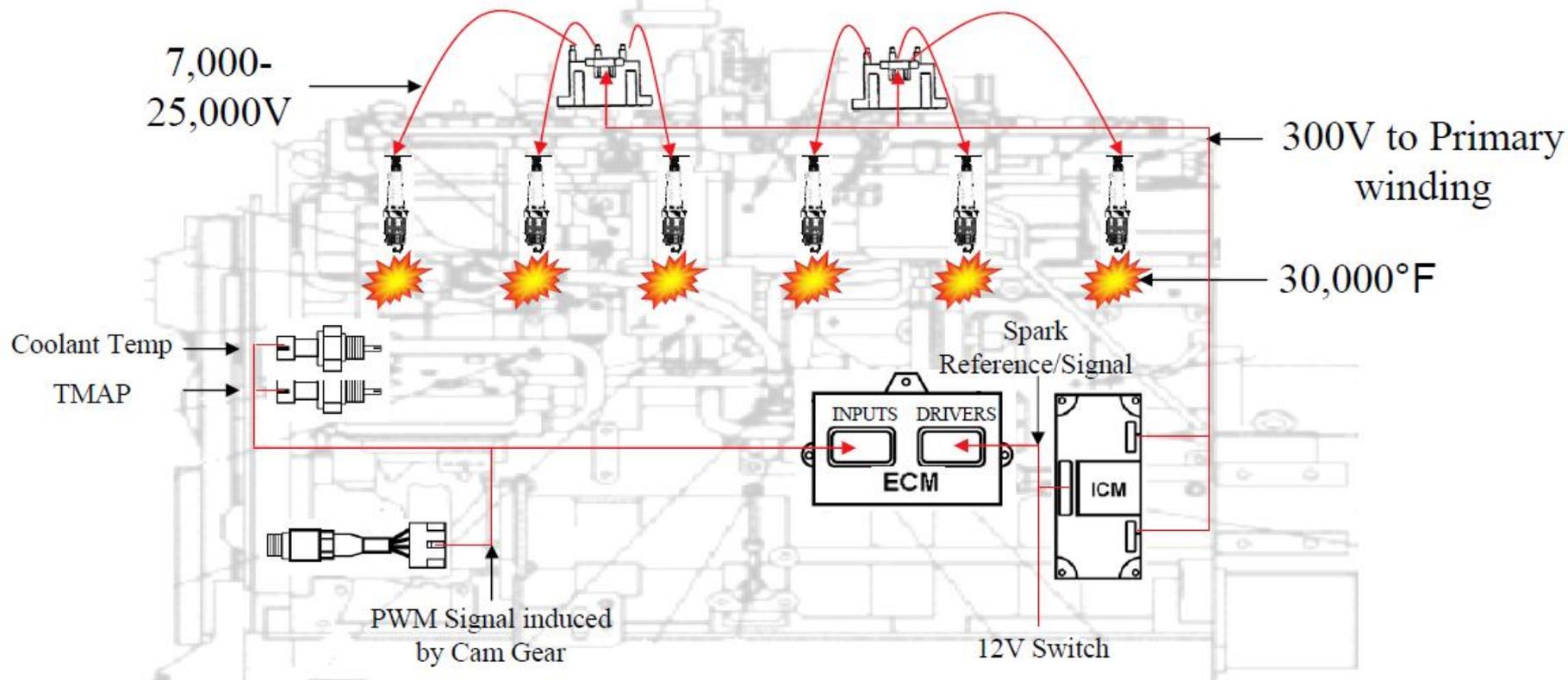
➤ C Gas [COP]



➤ Coolant Temp Sensor

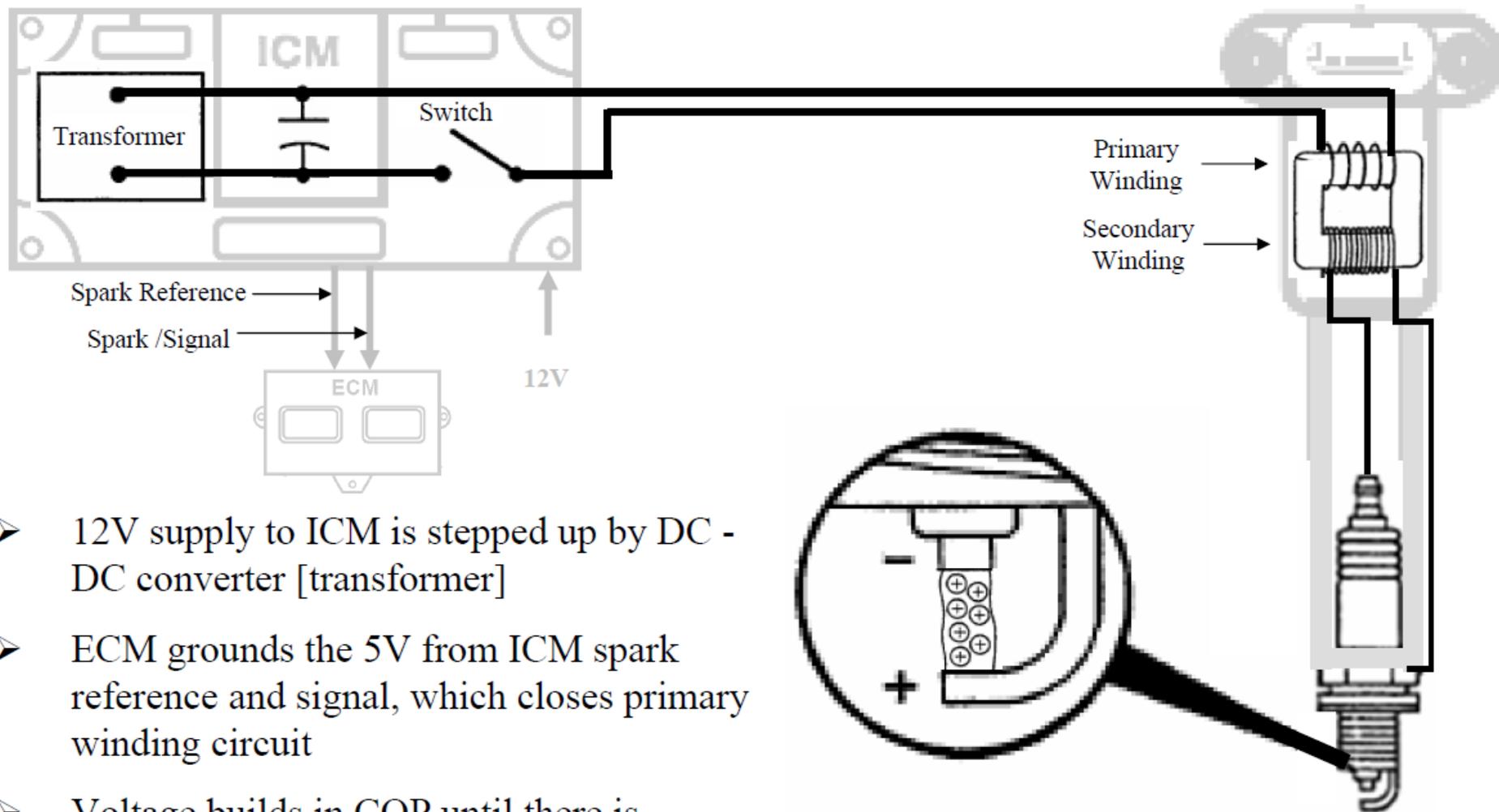


B 5.9 Gas Plus & B 5.9 LPG Plus Ignition Sequence



➤ Special note: In diagram above please substitute Coil Packs with COP for C engine

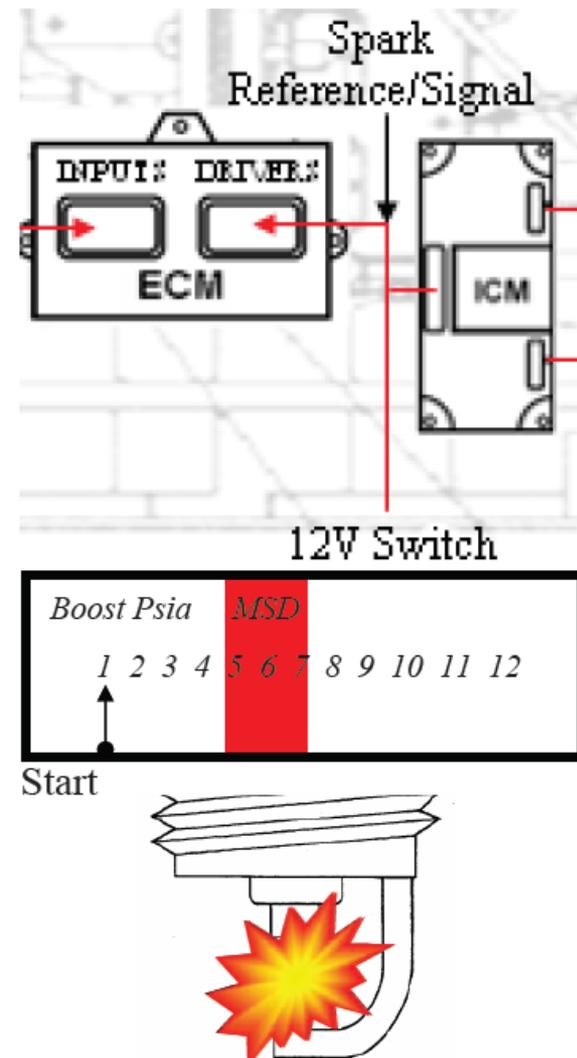
C8.3 Gas Plus Ignition Voltage System



- 12V supply to ICM is stepped up by DC - DC converter [transformer]
- ECM grounds the 5V from ICM spark reference and signal, which closes primary winding circuit
- Voltage builds in COP until there is sufficient voltage to bridge the plug gap

C8.3 Gas Plus Ignition MSD

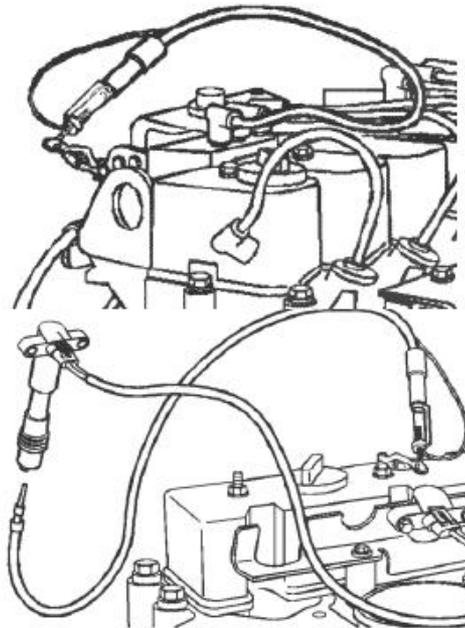
- When the Manifold pressure drops to 5psia the ECM commands the ICM into Multiple Spark Discharge MSD
 - Manifold pressure above 7psia turns off the MSD
 - ECM removes [grounds] the spark reference signal approximately 4 times longer to initiate MSD mode
-
- At low boost it is possible for the spark to be quenched by the lean air/fuel mixture due to
 - Too few air/fuel molecules
 - Plug temperature too low
 - MSD prepares the cylinder to optimise the firing conditions for the compression stroke



Checking Ignition Voltage

- Checking coil lead and COP voltage can eliminate many upstream components from troubleshooting
- Use Cummins ignition coil test kit [P/n 3164486] to verify spark
- If circuit continuity is lost at cylinders 3 or 4 [C Plus] / 1 or 6 [B Plus] there will be no spark at any of the plugs and the engine will not start
- Note - If spark is good then plug may be defective

➤ With plug leads



➤ With COP



Spark Plug Care



- The importance of clean care surrounding spark plug inspection and renewal cannot be overstressed
- Improper handling of plugs will dramatically reduce the plug life and cause OEM service headaches as a result
- The high voltages involved in the ignition will travel the path of least resistance to ground so any residual oils left on the plug ceramic will elevate the probability of reduced plug life
- Certain ratings can at present have the plug gap set. However this policy is subject too continual change so frequent checks on service topics will keep you up to date [extract below from service parts topic 013-016]



Boot Flashover

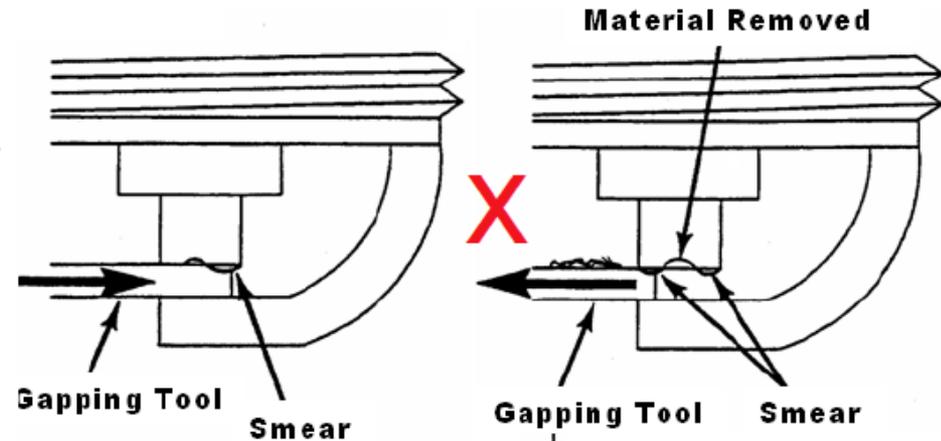


Only gap B5.9G-230 hp, B Gas International-230 hp, B Gas Plus-200 hp, B Gas Plus-230 hp, C8.3G or C Gas Plus Extended Life, L10G Manual Transmission and CNGE Prime Power applications or loss of spark plug life will occur.

Spark Plug Care



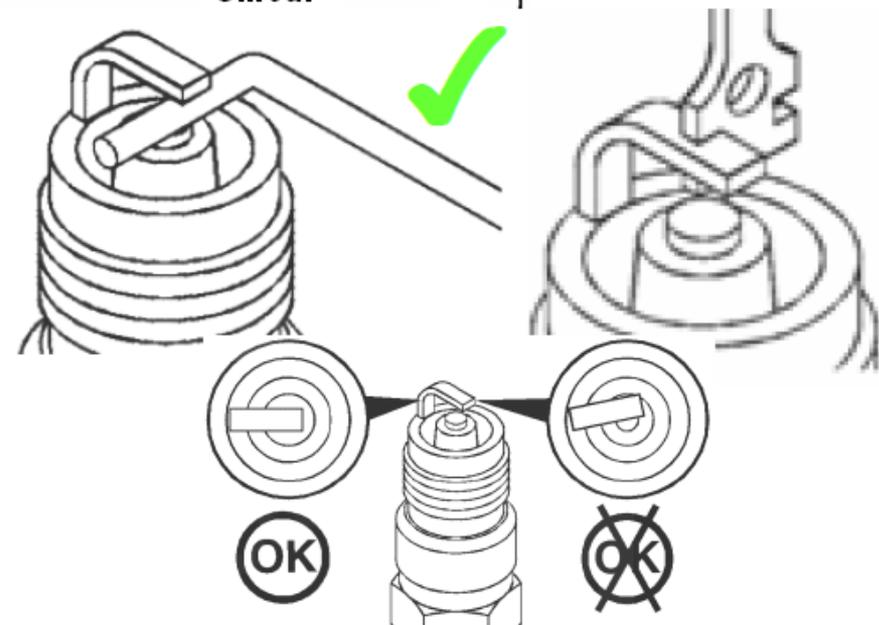
➤ Since the platinum core of the of the electrode is soft it will easily distort and smear if gapped incorrectly



➤ In both the examples of gapping shown NEVER does the gap tool come between the electrode and ground strap

➤ When adjusting the plug gap only visual the gauge to the gap rather than insert between electrode and strap

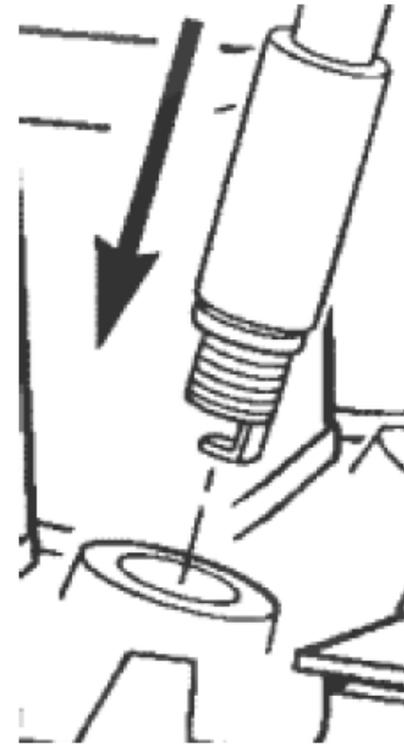
➤ Ensure that the ground strap is aligned correctly with the electrode



Spark Plug Care



- When installing the spark plugs first clean the porcelain with an rubbing alcohol based solution wiped on with a lint free cloth
- Clean the magnetic plug socket with contact cleaner
- Install the plug into the head using the magnetic socket taking care to not foul the ground strap against the head as it is inserted - and torque to specification. Applying the correct torque ensures:-
 - Combustion gas will not escape
 - Reduced likelihood of plug seizing in head
 - Correct dissipation of heat away from the plug



- Clean boot with alcohol based solution wiped on with a lint free cloth
- Apply proportional amount of dielectric grease to the boot - Some replacement boots come pre-greased
- Do not clean or grease C Plus boots as they come pre-greased

C Gas Plus Maintenance Schedule

Daily or Refueling

- Operator's Report - Check
- Engine Oil - Check, add if required
- Engine Coolant - Check, add if required
- Cooling Fan - Check
- Radiator Hose - Check
- Air Intake Piping - Check
- Crankcase Ventilation Filter - Check
- Fuel Filter - Drain
- Throttle Response – Check

Every 12,000 Kilometers [7,500 Miles], 500 Hours, or 6 Months – Whichever Comes First

- Catalyst Housing - Check Exterior
- Air Cleaner - Check
- Charge Air Cooler - Check
- Charge Air Piping - Check
- Lubricating Oil and Filter - Change
- Supplemental Coolant Additives (SCA) and Antifreeze - Check
- Coolant Filter - Change
- Crankcase Ventilation Filter - Change

Every 24,000 Kilometers [15,000 Miles], 1000 Hours, or 1 Year - Whichever Comes First

- Drive Belt - Check
- Automatic Belt Tensioner - Check
- Fan Hub, Belt Driven - Check
- Water Pump - Check
- Catalytic Converter - Check
- Ignition Coils - Check
- Spark Plugs and Boots - Replace
- Engine Fuel Filter – Replace
- Overhead Valve Lash – Adjust

Every 48,000 Kilometers [30,000 Miles], 2000 Hours, or 2 Years – Whichever Comes First

- Vibration Damper - Check
- Turbocharger - Check
- Engine Coolant - Flush and Replace
- Air Compressor - Check
- Overhead Valve Lash - Adjust
- Extended Life Spark Plugs and Boots

Keys to Success

- Follow Cummins maintenance intervals and procedures outlined in C Gas Plus Operation and Maintenance manual (Bulletin 3666183)
- Set oil drain/service interval based on published guidelines

Oil Drain/Service Intervals				
Average Vehicle Speed	Kilometers	Miles	Hours	Months
Below 20 mph (32 kph)	12,000	7,500	500	6
20 mph (32 kph) and higher	12,000	7,500	250	6

- Use only natural gas engine oil
- Check air intake frequently and use only Cummins approved air filters

Use 15W-40 Natural Gas Engine Oil

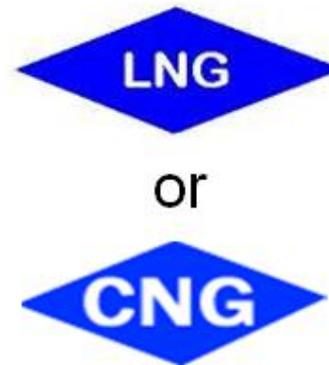


- Cummins Westport natural gas engines require special engine oil that is available from major oil suppliers.
- Careful attention must be paid to engine oil specifications because natural gas engine oil has different properties than diesel engine oil. A sulfated ash limit of 0.6 percent has been placed on all engine lubricating oil recommended for use in Cummins Westport engines.
- Higher ash oils can cause valve and/or piston damage and lead to excessive oil consumption and degradation of the catalyst.

Do not use diesel engine oil in a natural gas engine. If diesel engine oil is used, valve torching, piston scuffing, and reduction in spark plug life will occur.

Fuel

- Natural gas fuel must meet C Gas Plus fuel specs per AEB 79.02
- Minimum Methane Number (MN) is 65
- Natural Gas fuel for the C Gas Plus can be stored on the vehicle in either liquid (LNG) or compressed (CNG) form.
- C Gas Plus requires fuel to be regulated to max 150 psi, min 70 psi
- Cummins Westport approves the use of up to 100% biomethane that meets Cummins published natural gas fuel specifications





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