

TRUGRADE™

SUCCESS IN FUEL DELIVERY SYSTEMS



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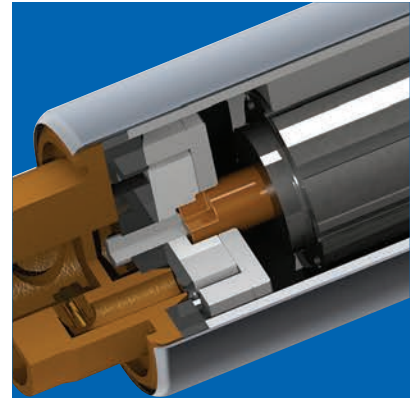
FOREWORD

The purpose of this booklet is to provide a basic overview of automotive fuel systems. This includes information on how to avoid common causes for fuel system failures as well as best practices for fuel pump replacement. Information in this booklet can also assist in determining the possible causes and validity of a warranty claim on an automotive fuel pump.

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Fuel Pumps

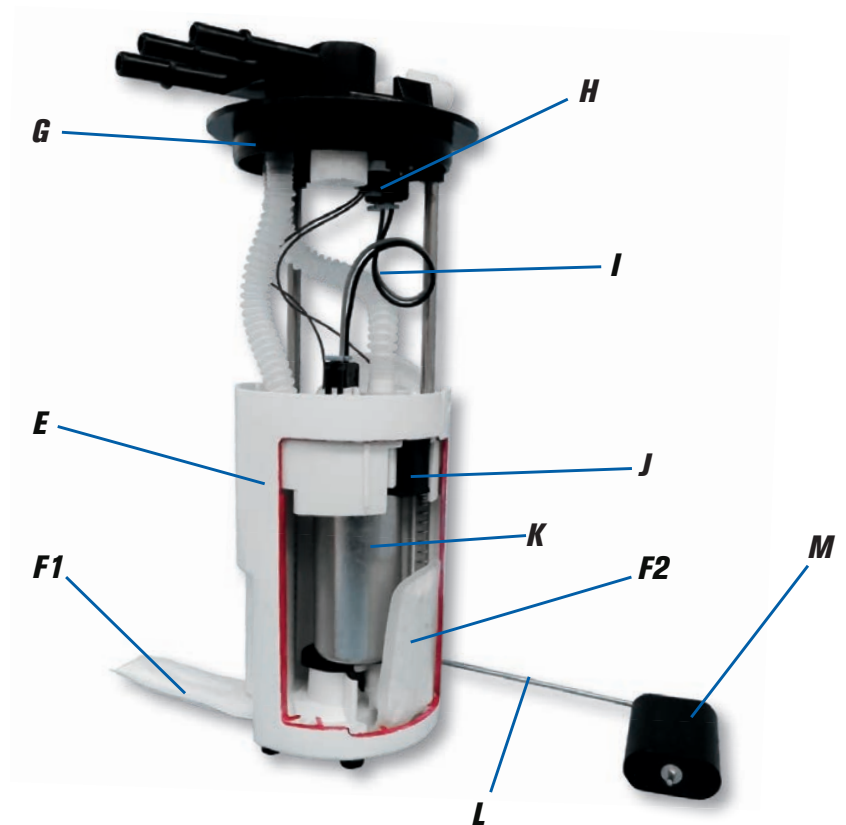
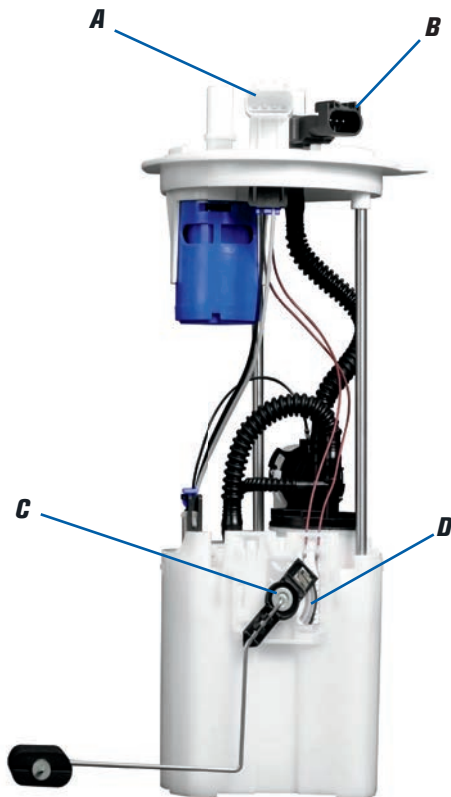
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OE REPLACEMENT FUEL PUMP ASSEMBLIES

TruGrade™ Fuel pump modules are manufactured with NEW high quality components. All modules include a fuel pump inside a housing that has the fuel float sensor attached. General items found in a standard fuel pump assembly are shown in the diagrams.

- A.** Upgraded “Flat-4” connectors on all GM modules for increased reliability and longevity. Mating pigtail harness included with all upgraded connectors
- B.** Hybrid circuit pressure sensor for increased reliability in harsh conditions
- C.** Bifurcated (split) contacts used on fuel level sensor wiper for low friction and increased lifespan
- D.** Palladium silver alloy used on fuel level sensors for increased reliability in ethanol and ethanol blend fuels
- E.** Rubber vibration dampers to decrease noise
- F1 - F2.** Dual strainers for superior filtration. Internal and externally mounted
- G.** POM plastic used for strength and durability
- H.** Increased thickness connector pins used for increased reliability
- I.** Teflon insulated wires for superior chemical resistance
- J.** Nitrile or Viton used for all rubber components for long life and fuel resistance
- K.** Robust 2 stage turbine or roller vane internal pump (depending on application)
- L.** Stainless steel used for all metal components
- M.** Foam fuel float for increased reliability over molded type

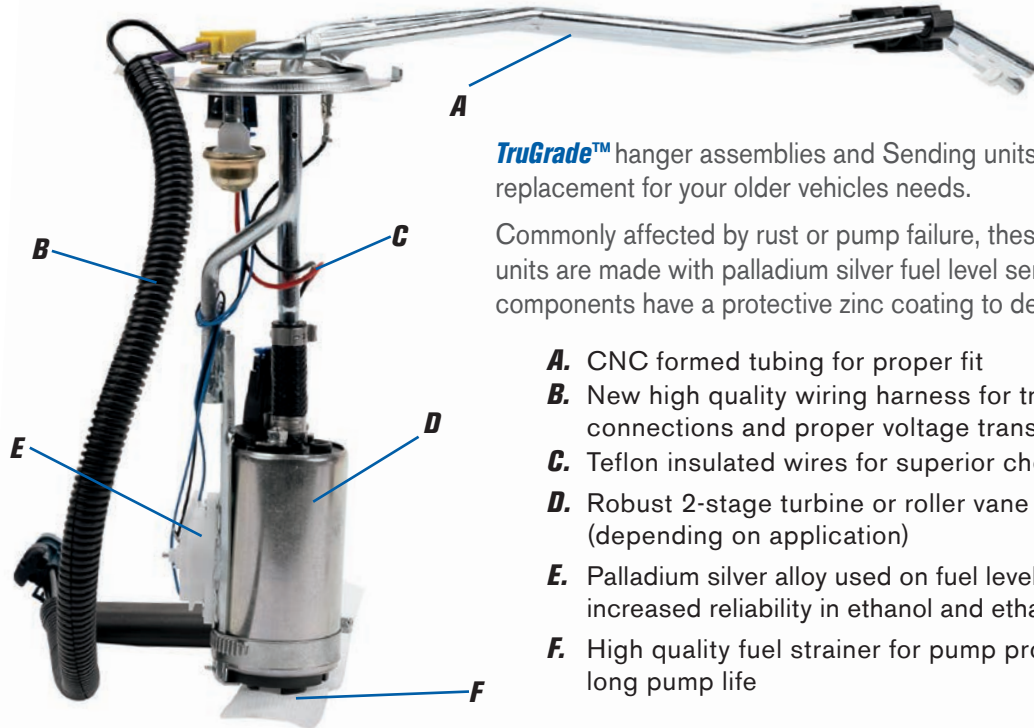
TRUGRADE™ fuel pump kits and modules include a strainer, and all modular units with an integrated primary filter include a new filter assembly.



OE Style Internal Fuel Pumps

TruGrade™ uses OE style fuel pumps rather than less expensive turbine units (where applicable). This ensures quality and performance that meets or exceeds OE standards.

HANGER FUEL ASSEMBLIES

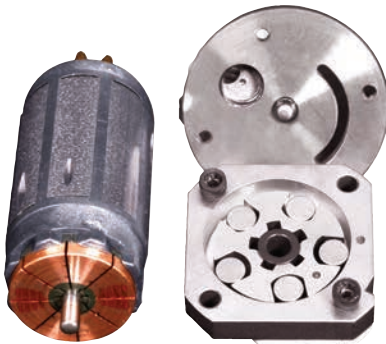


TruGrade™ hanger assemblies and Sending units are an OE style replacement for your older vehicles needs.

Commonly affected by rust or pump failure, these new **TruGrade™** units are made with palladium silver fuel level sending units and all steel components have a protective zinc coating to defend against rust.

- A.** CNC formed tubing for proper fit
- B.** New high quality wiring harness for trouble free connections and proper voltage transfer
- C.** Teflon insulated wires for superior chemical resistance
- D.** Robust 2-stage turbine or roller vane internal pump (depending on application)
- E.** Palladium silver alloy used on fuel level sensors for increased reliability in ethanol and ethanol blend fuels
- F.** High quality fuel strainer for pump protection ensuring long pump life

INTERNAL PUMP TYPES



Roller Vane

This pump uses a steel rotating disk with sliding rollers that move outward and suck fluid through the pump. Roller vane pumps can tolerate fuel contamination much better than other pumps but create more noise.



Gerotor

This pump has a steel gear type pumping mechanism. Gerotor is quieter than roller vane but cannot tolerate fuel contamination.

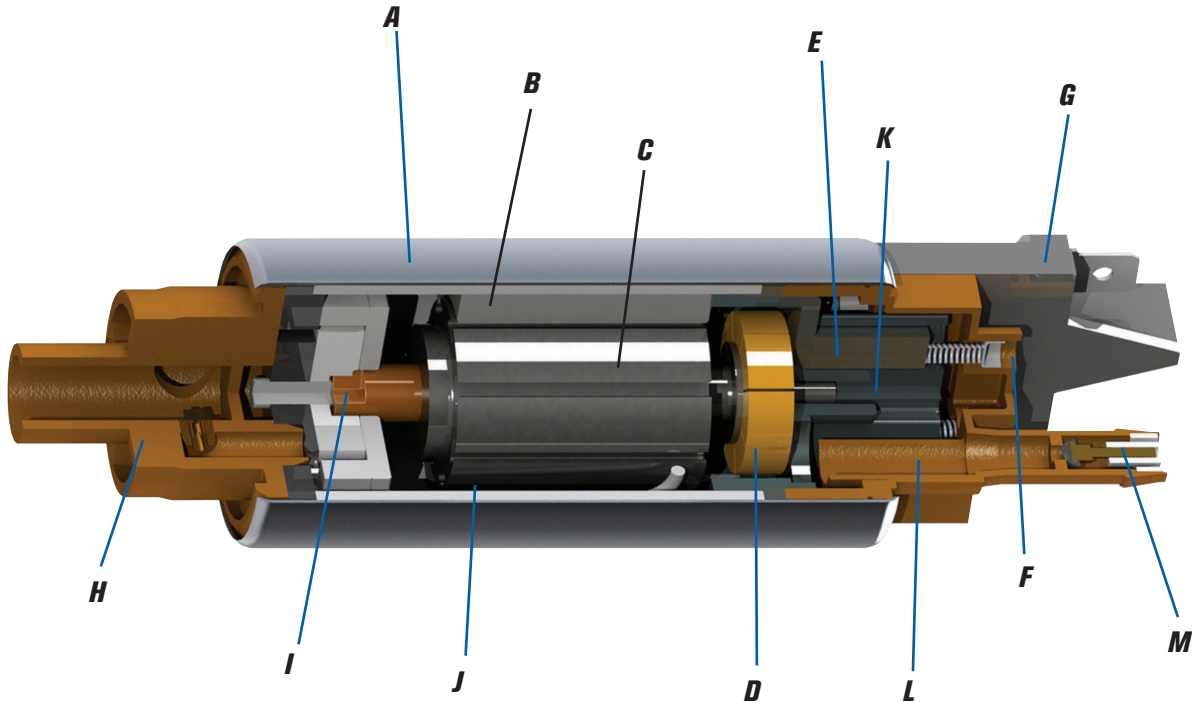


Turbine (single and double stage)

The spinning of the turbine causes fluid to flow through the fins moving the fuel through this pump. The turbine turns at a higher speed than the other pump types and requires tighter tolerances to operate. Because of the tight tolerances required on turbine pumps, they are very susceptible to debris and fuel contamination.

FUEL PUMPS

A fuel pump consists of up to 200 individual components that have to work correctly in order for proper function. This diagram shows the critical components inside a fuel pump.



A. Can

High quality conversion coating for superior resistance to corrosion

B. Permanent Magnet

Alnico, neodymium, or tombarthite permanent magnets for the best performance & resistance to temperature

C. Armature

Pure copper windings and soldered connections for the best performance

D. Commutator

Pure copper commutator for gasoline applications and carbon commutator for ethanol applications

E. Brushes

High quality carbon brushes for long life and optimum performance

F. Brush Springs

High silicon steel coil springs specifically wound to prevent binding

G. RF Suppressor

OE style RF suppression prevents radio noise and sensor interference

H. Inlet Housing

Durable precision molded plastic with brass jet port

I. Pump Mechanism

Powerful OE style for maximum performance and life. Roller vane gerotor, turbine, and peripheral styles available

J. Flux Ring

Internal steel flux ring concentrates the magnetic field from permanent magnets

K. Brush Holder

Made from high temperature plastic for perfect brush alignment.

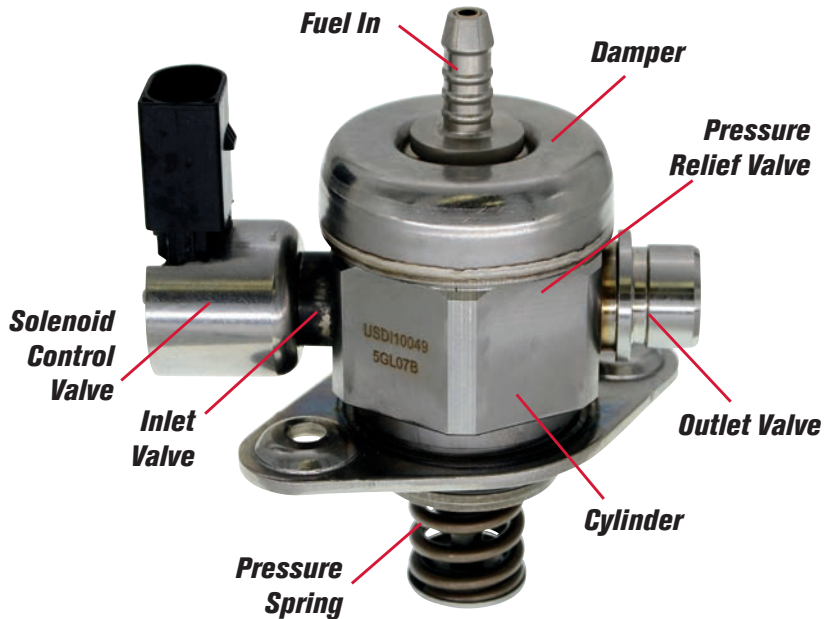
L. Outlet Manifold

Precision molded with polarity markings for proper wiring identification

M. Check Valve

Prevents fuel system back draining

GDI - (HIGH-PRESSURE GASOLINE DIRECT INJECTION)



TruGrade™ offers a wide range of Gasoline Direct Injection (GDI) fuel pumps for import and domestic applications

- High Precision Castings
- Reinforced Diaphragms
- Built to Meet or Exceed OE Quality and Function

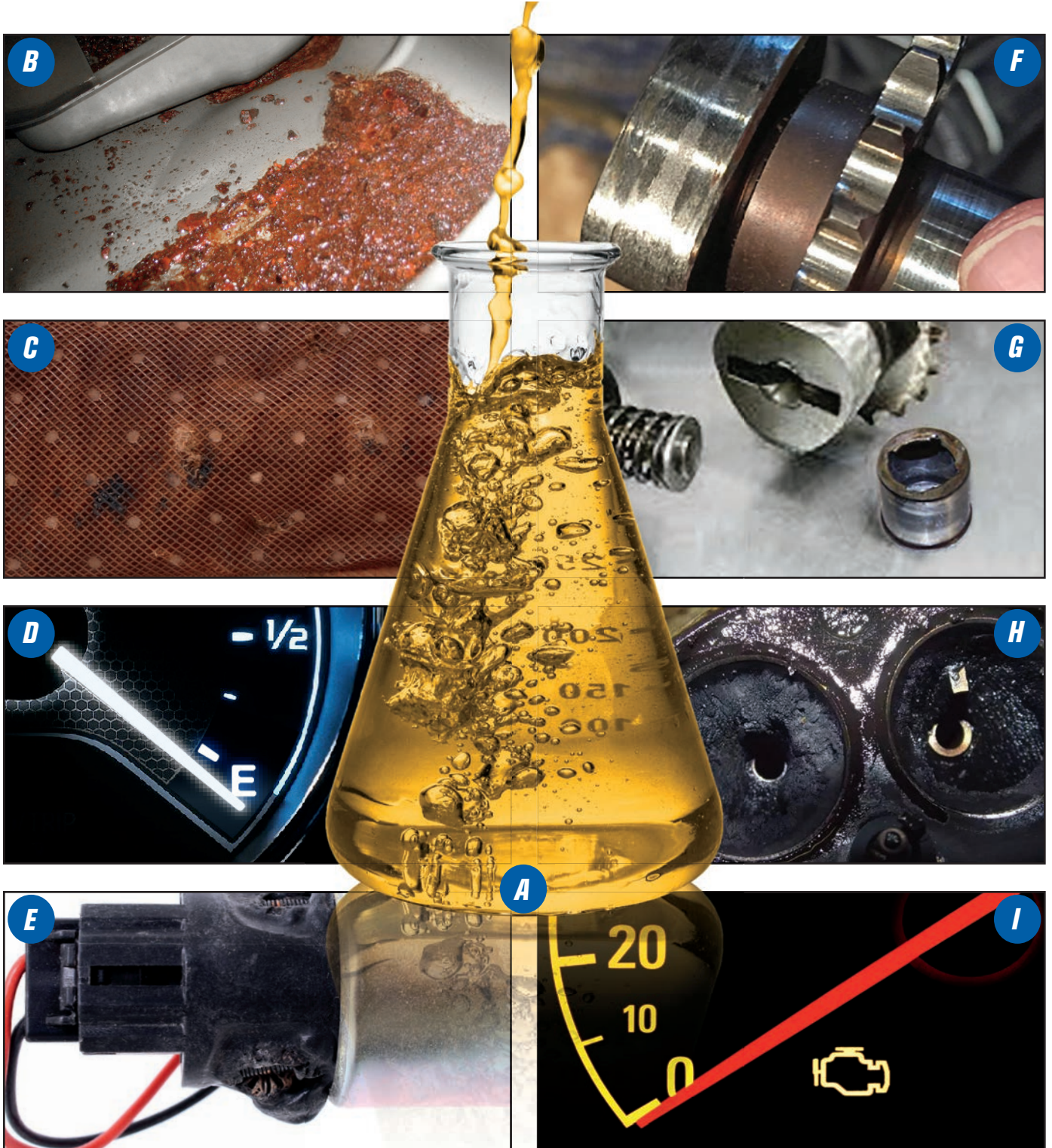
MECHANICAL FUEL PUMPS



TruGrade™ offers a wide range of mechanical fuel pumps for import and domestic applications

- High Precision Castings
- Reinforced Diaphragms
- Compatible with New Fuel Blends
- All Gaskets and Hardware Included for Proper Installation

COMMON REASONS FOR FAILURE



A *LOW QUALITY FUEL*

Fuel quality is important for proper function and longevity of your fuel pump. High quality fuels from top tier supplies include additive packages that help lubricate and cool the internal components of the fuel pump and fuel system.

B FUEL SYSTEM CONTAMINATION

Fuel system contamination is commonly a problem with older vehicles and vehicles used in rough terrain.

Contaminants can enter the automotive fuel system when filling the tank or from the breakdown of fuel system components such as fuel lines and fuel tank liners.

Did You Know?

If you do not clean your fuel system when replacing your fuel pump that there is a 90% chance that the fuel pump will fail in under 30 days. Drain and clean your fuel tank every time you replace a fuel pump!!

C CLOGGED FILTER OR STRAINER

A fuel pump must pull fuel through a strainer attached to its inlet and push it through an external fuel filter. If either of these are clogged and cannot support the flow-rate required by the engine, there will be bogging and vehicle hesitation as well as increased strain on the fuel pump causing it to eventually fail.

Low quality fuels do not lubricate the fuel pump properly. If excessive moisture is present, it will cause premature failure of many fuel system components such as the fuel pump, fuel level sensor, fuel pressure regulator, fuel injectors, etc.

Low quality fuel can also be contaminated with small particles that will quickly clog and damage an in-tank fuel pump.

Did You Know?

A clogged strainer and filter will decrease flow-rate requiring a fuel pump to work harder to make the proper pressure and flow. These conditions overheat the fuel pump causing it to fail. Always install a new strainer and fuel filter when replacing a fuel pump.

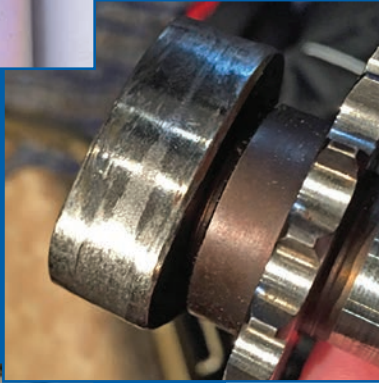
D LOW FUEL LEVELS

Running your vehicles on low levels of fuel for extended periods is extremely bad for the fuel system. The pump being submerged in fuel allows heat to be dissipated. Fuel is used to cool and lubricate the internals of the fuel pump and if the tank is allowed to frequently run low, the cooling ability is compromised.

Did You Know?

Frequently running on low fuel levels allows a large amount of air to remain in the fuel tank causing potential for condensation. This will cause the internal tank liners to break down at an accelerated rate.





E OVER HEATING

Overheating of fuel pumps occurs when the pump is subjected to severe loads with minimal cooling. This can occur when the pump flow is restricted or if foreign debris gets jammed in the pump mechanisms. Overheating can cause damage to fuel pump connectors and associated wiring and electrical components. In severe cases, the fuel pump armatures can get so hot that the plastic armature material can melt.

Did You Know?

To prevent connector overheating, it is always recommended to replace the wiring connector when replacing a fuel pump. This is especially important for vehicles over 10 years old.

TruGrade™ assemblies include improved harnesses and pigtail connectors to replace the OE harness when required.

F LACK OF MAINTENANCE

The main culprit of **GDI** pumps is a lack of oil changes. When there is wear between the pump follower and the camshaft lobes, the pump is prevented from producing enough piston movement. When there is less pump movement, there is less pressure. If the pressure is not correct the fuel mixture could become too lean. Always check the lobes on the camshaft before the installation of a new fuel pump. An issue with lack of power may be improved, however it will never be entirely corrected.

Did You Know?

Proper oil change intervals with quality oil and filters are extremely important in GDI performance.

G WRONG OIL

To avoid premature wear on the camshaft and high-pressure fuel pump follower, your engine oil must meet OE specifications. Ask your engine oil supplier to confirm if an engine oil matches the OEM's specifications. Volkswagen, GM and many other OEMs have oil standards that address wear issues on the camshaft and pump follower.

Did You Know?

A worn out Fuel Pump Follower (worn through or anti wear coating is gone) can lead to extreme damage and expensive repairs. Check Follower every 20,000 miles to prevent GDI and engine damage.

H LEAKS

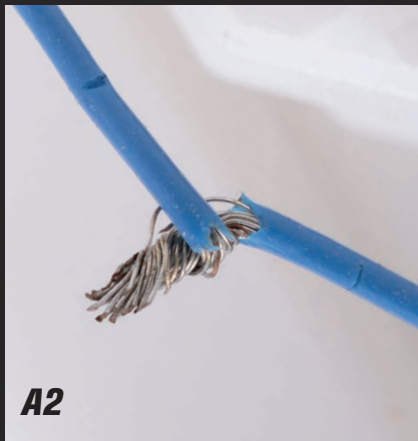
Because of the high pressure, a direct injector can experience leaks. When leaks happen while the engine is resting it will lead to severe carbon buildup and a rich fuel reading. Possible wear and a longer cranking cycle can also happen because of leaks. Most systems have a specified resting pressure which is made to maintain a specific amount of pressure in the system while the engine is turned off. There is a scan tool that can monitor the values. There are tests for injector balance and leakdown usually included in an enhanced or factory scan tool. You can use these tests to detect a leaking pump.

I IGNORING THE SIGNS

There are always some who aren't afraid to drive with their check engine light on. They assume it will go out if they put better fuel in the tank, but we all know that this is not true. A direct-injection engine that has a high-pressure pump issue will go into a limp or low-pressure mode. In this mode, the in-tank pump will take over and the injector open time will increase. In a low-pressure mode, it is less precise. The car will start and run, but the performance will be reduced and the catalytic converter could be harmed. Engine wear can also occur.

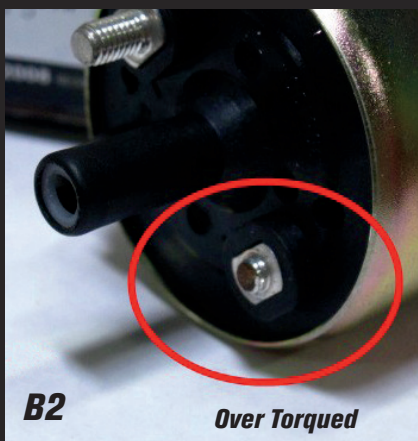
WARRANTY EXCLUSIONS

- A.** Modified parts
- B.** Broken parts
- C.** Dark, clogged, or contaminated strainers
- D.** Units with corrosion, rust, or discoloration from contamination
- E.** Units with burned wiring or connector
- F.** Units showing severe damage from lack of lubrication or maintenance

**A1****A2**

TRUGRADE™

TruGrade™ a brand of AutoZone® warrants products to be free from defects in material and manufacturing, under normal use and service. The following images are indications of damage caused by improperly maintained systems and modifications.

**B2**

Over Torqued

**B1**



C1



D1



D2

TRUGRADE™

TruGrade™ a brand of AutoZone® warrants products to be free from defects in material and manufacturing, under normal use and service. The following images are indications of damage caused by improperly maintained systems and modifications.



F1



E1



E2



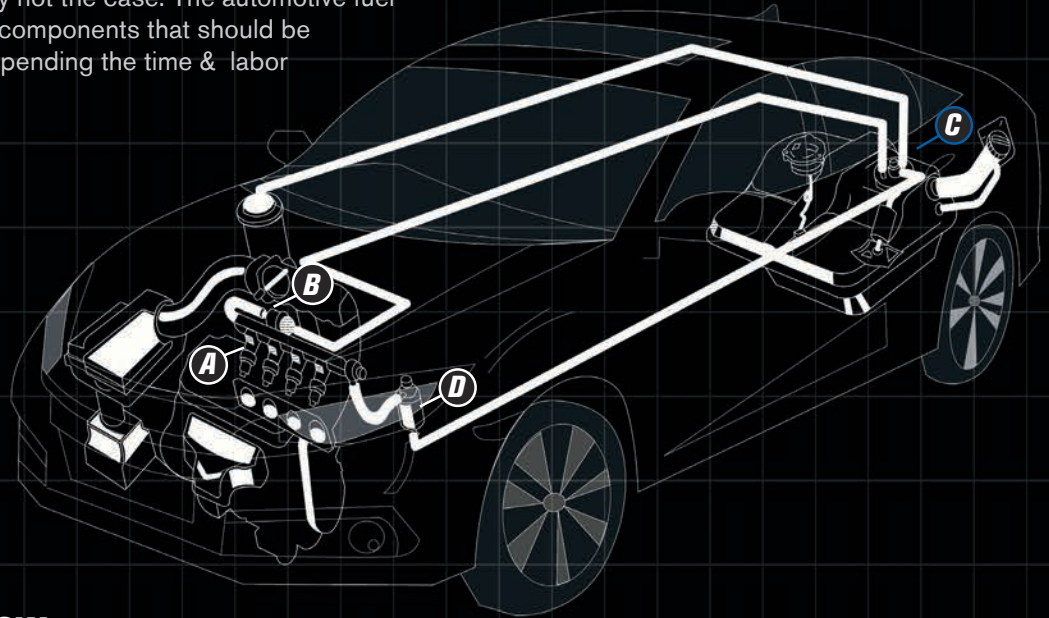
F2

BEST PRACTICES

TROUBLESHOOTING YOUR FUEL SYSTEM & REPLACING YOUR FUEL PUMP

Low fuel pressure and low fuel flow-rate at the engine are the most common characteristics that are found in a faulty fuel system. It is a common misconception that these are caused by a faulty fuel pump or fuel pump module, which is usually not the case. The automotive fuel system is made up of several components that should be checked and tested before expending the time & labor to replace the fuel pump.

- A.** Fuel injectors
- B.** Fuel pressure regulator
- C.** Fuel pump
- D.** Fuel filter



Fuel System Overview

The fuel system begins with power being sent to the ECU from the battery.

With a low or dead battery, lack of proper voltage to the system may cause the vehicles electric fuel pump to appear as if it has stopped working.

This power distribution is normally switched on by a relay or controlled directly by the ECU.

The wires from the relay or ECU carry the power to the fuel pump. These wires may have several connections before actually reaching the fuel pump.

The fuel pump is the heart of the fuel system! Its job is to deliver fuel from the tank to the engine.

The fuel pump sends fuel out of the fuel tank at the proper flow rate and correct pressure for the engine to run at all RPMs and throttles positions.

Depending on the type of fuel system that the vehicle has, (return vs. non-return) there will be differences in configuration at this point.

For return type fuel systems, the fuel will be pumped through fuel lines and an external fuel filter before reaching the engine.

For non-return type systems, the fuel will be pumped through a built in pressure regulator contained in the module, and then through the fuel lines and external fuel filter before reaching the engine.

Once at the engine the fuel is fed into the fuel rails or throttle body before being supplied to the fuel injectors.

At this point we will also see additional differences between a return and non-return type fuel system.

For a return type fuel system, the fuel pressure regulator will be found after the fuel rail.

An additional fuel line will "return" bypassed fuel from the pressure regulator back to the fuel tank.

On a non-return fuel system, there will only be a feed line to the fuel rail.

There is no additional return line back to the tank since the fuel pressure has already been regulated at the fuel pump module before reaching the engine.

SAFETY FIRST!

- A.** Work on a level surface
- B.** Use safety stands for support, not a jack
- C.** Keep an ABC fire extinguisher close by
- D.** Wear approved safety glasses
- E.** Work in a well-ventilated area
- F.** Do not smoke or allow open flames near vehicle
- G.** Disable fuel pump before servicing by removing fuse or battery cables
- H.** Relieve fuel system pressure before servicing pump

WARNING!

Gasoline is extremely flammable, so take extra precautions when you work on any part of the fuel system. Don't smoke or allow open flames or bare light bulbs near the work area, and don't work in a garage where a natural gas appliance is located. Gasoline is also carcinogenic, take the proper precautions and wear latex gloves when spills are possible. If fuel does come into contact with your skin, rinse it off immediately with soap and water. Mop up all fuel spills and do not store any fuel-soaked rags where they could ignite.

FUEL

This is the first thing you should check if you are having problems with your fuel delivery system. Make sure that your fuel tank is at least 1/2 full of fuel when diagnosing any fuel delivery problems.

VOLTAGE

This is the second thing to check when you are having issues with fuel delivery. Without the proper voltage reaching the fuel pump you will immediately have a low or no flow and/or pressure situation. It is important to check the voltage drop directly at the fuel pump connector. There should be less than .5 volt voltage drop from the battery to the positive fuel pump terminal.

Things to check if you find no or low voltage at the pump connector:

- A.** Check that battery and alternator are in proper working condition
- B.** Verify that ECU is properly functioning
- C.** Check fuel pump fuse
- D.** Check fuel pump and/or ASD relay for proper function
- E.** Check wiring harness for loose or broken connections
- F.** Check fuel pump ground location for good contact

FLOW

Next thing to check is to see that the fuel pump is actually sending fuel out of the tank. You can verify this by removing the test port cover from the fuel rail or disconnecting the fuel line from the in-line filter. Switch the ignition to the "ON" position and the fuel pump should operate for a few seconds. At this time you can look at the disconnected fuel line or open test port to verify if there is any flow from the fuel pump.

Some common causes of low or no flow other than a faulty fuel pump are:

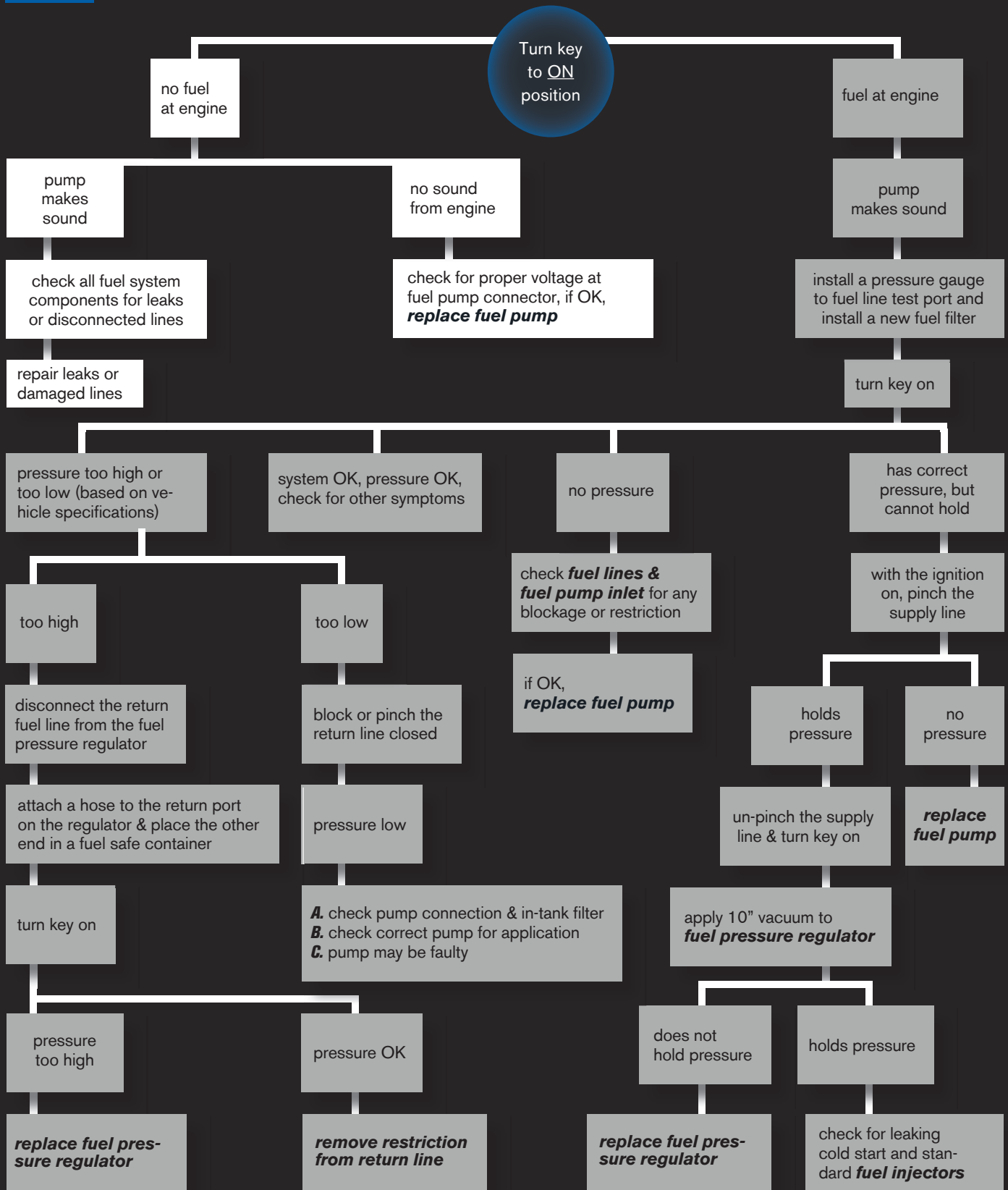
- A.** Leak in the fuel line
- B.** Clogged fuel line
- C.** Clogged in-line filter
- D.** Crimped or smashed metal fuel lines

PRESSURE

After you have confirmed that you have flow in the fuel system then you can move on to checking if there is proper pressure in the system. The best way to check fuel pump output pressure is to connect a pressure gauge to the fuel pump output line before the in-line fuel filter. This will allow you to test the direct output pressure of the fuel pump without additional components in the system such as a fuel pressure regulator.

Some common reasons for low pressure other than a faulty fuel pump are:

- A.** Low voltage at the pump
- B.** Bad fuel pressure regulator
- C.** Clogged in-line fuel filter
- D.** Leaking injectors
- E.** Leaking fuel line connectors
- F.** Clogged or damaged fuel lines



Keep your work area clean!

The number 1 cause of fuel pump failures is from fuel pump contaminants such as dirt, rust, & moisture. If the fuel system is not cleaned, then these contaminants will cause the replacement fuel pump to fail prematurely. Make sure to clean your fuel tank & keep your work area clean to prevent this type of contamination.

FUEL PRODUCTS

The **TruGrade™** line can handle all of your fuel system needs with pumps containing high quality, economically minded fuel system components. All products are built to OE Standards for fit, form and function.

Our engineering team has reviewed failure points of many OE units, and has made improvements for a long life of trouble-free performance in your fuel system.

Our direct-fit replacement pumps, modules and hanger assemblies are built using modern materials that are compatible with today's fuel blends.

UNIVERSAL FUEL PUMPS

Our universal fuel pumps are compatible with a range of modern fuels, for carbureted and fuel injection applications.

FUEL PUMP KITS

TRUGRADE™ uses OE style fuel pumps rather than less expensive turbine units (where applicable). This ensures quality and performance that meets or exceeds OE standards.

- A.** New wiring
- B.** New strainer
- C.** New fuel lines

FUEL PUMP MODULES

- A.** Drop-in replacement
- B.** OE style internal fuel pumps
- C.** Palladium silver fuel level sensor
- D.** Made with modern materials that are compatible with today's fuel blends



MECHANICAL FUEL PUMPS

All mechanical fuel pump kits include gaskets and hardware necessary for installation.

GDI HIGH PRESSURE FUEL PUMPS

All GDI replacement pumps include O-ring or gasket where applicable.

Regular oil changes using quality oil and filters, will ensure a long life of trouble free operation.

STRAINERS

Quality made strainers help protect your fuel pump from contamination, this helps ensure longer lasting fuel pump performance.



TRUGRADE™

