

Propane 6.8L Starting & Filling Procedure

LPA System Overview

The introduction of the Propane powered Blue Bird Vision marks a new generation in alternative fuel powered school buses. The bus is powered by a Ford Triton 6.8L V10 engine equipped with a Liquid Propane Autogas (LPA) fuel system. Unlike the traditional propane powered vehicle that supplies propane to the engine in a vapor phase the LPA system delivers, meters and injects propane in a liquid phase into the engine.

Similar to a modern gasoline engine, the LPA system stores liquid propane in the fuel tank. Dual in-tank electric fuel pumps circulate the propane through fuel rails which supply fuel to the fuel injectors. The injectors meter and inject liquid propane into each of the original ten (10) inlet ports on the Triton engine. Fuel that is not used by the injectors will return to the fuel tank through a flow control solenoid.

The ROUSH CleanTech LPA system is fully integrated using Ford's One Touch Integrated Start (OTIS) system. When the ignition key is turned to **Start** and released to the **ON** position, the LPA system runs a purge process, then the starter engages and the vehicle starts with no further action required from the operator.

Fueling a propane powered bus is noticeably different than on a conventional fueled vehicle. A propane fuel system is completely sealed and the major difference is the screw-on type fill connector used for propane. When fueling, turn connector clockwise to tighten ensuring a good seal at the fill valve. The tank is equipped with an automatic stop fill device, which only allows to tank to be filled to 80% of the overall tank volume leaving room for the fuel to expand and contract. At the 80% fill level the dash fuel gauge will read full. The fill time is only slightly longer than refueling a diesel powered bus.

Propane is commonly referred to as LPG or LP gas. Like most liquids, liquid propane expands as its temperature increases. This is why propane tanks are only filled to 80% of its liquid capacity. Even with an 80% fill capacity, due to liquid propane's expansion ratio of 1:270 (liquid propane to a gas by volume) and its high BTU rating a large volume of energy can be stored in a relative small tank under relative low pressure

Fill Stations

Propane is readily available anywhere in the United States. To locate the nearest station, check with <http://www.afdc.energy.gov/afdc/locator/stations/>.

ROUSH CleanTech recommends facilities designed for automotive refueling. Other locations may have low output pumps, resulting in slow or no fill, or low quality fuel which can result in premature component failure.

[WARNING] CleanTech nor *Blue Bird* approve of any additions to or modifications of this fuel systems. This fuel system is designed and installed to meet federal standards and engine manufacturer's guidelines. The maintenance provider or modifier assumes all responsibility for the vehicle engine and fuel system if the fuel system is changed or modified. Some states require a special license to perform maintenance or work on propane powered vehicles. Check with local authorities or your state LP Gas Association for details. All fuel system components must be a minimum of 18 inches from any exhaust system component unless properly shielded. All service, maintenance and repairs performed on LP Gas systems must be done by an authorized LP Gas service technician.

Start Sequence

When the engine is not running, the fuel in the rail boils and turns to vapor. For proper engine operation the vapor must be flushed from the rail prior to starting the engine. This is a fully automated process that is controlled by the PCM. This process takes 2 - 45 seconds, depending on ambient conditions, engine off time, and engine temperature at shutdown. The cycle will begin when the operator turns the key to

the crank position and released to the ON position. Upon receiving the crank request, the PCM initiates the start sequence. During this time, the PCM performs diagnostics on several of the solenoids, as well as flushing the rail of vapor. This is accomplished by monitoring the Injection Pressure & Temperature Sensor (IPTS) while opening the various solenoids in the tank & FRPCM in stages, then engaging the fuel pump.

There are seven distinct stages of the start cycle:

Stage	Name	Description
1	CAN Bus Initialization	For the sequence to work the PCM and SRM need to be communicating. There is a short delay after key-up to ensure communication has been established
2	Bleed Diagnostic Pressure Read	The PCM measures the fuel pressure in the rail after a bleed cycle. All solenoids are still closed at this time. If the pressure is too high, the system did not bleed and a fault will set.
3	Open Tank Solenoid	The tank solenoid is energized. The pressure in the rail is measured (again). This pressure will be used later to determine if the FRPCM supply solenoid has properly opened.
4	Open supply solenoid	The FRPCM Supply Solenoid is energized
5	Flush	The FCS is energized and the fuel pump is turned on high speed. The IPTS monitors pressure and temperature in the rail to determine when the vapor has been cleared from the rail.
6	Pressure Build	The FCS is de-energized and the pressure is allowed to rise. The IPTS is still monitoring the pressure and temperature in the rail to ensure there is liquid in the rail.
7	Crank	Once the pressure has built in the rail and the IPTS verifies there is liquid in the rail, the starter is engaged.

General Propane Tank Filling Procedure

The most important aspect of filling a propane tank is safety. Understanding the properties and characteristics and safe handling practices of the fuel is required before conducting any propane tank filling efforts.

A propane powered vehicle is equipped with a propane tank built and certified to the regulations of the American Society of Mechanical Engineers (ASME). These tanks have a data plate with pertinent information including the ASME stamp. This plate must be securely attached and legible or the tank should be taken out of service and replaced. There are no requirements for re-certifying ASME tanks, however, inspection is required and maintenance is recommended if there are signs of corrosion.

Propane tanks are filled to 80% capacity to allow for the liquid fuel to expand and contract depending on ambient temperatures. All tanks built for use on motor vehicles are equipped with an overfilling prevention device (OPD). The National Fire Protection Association (NFPA) requires motor vehicle propane tanks be equipped with an overfill prevention device to automatically prevent filling the tank beyond the maximum recommended capacity of 80%. This automatic stop fill system prevents overfilling of the fuel tanks. This requirement has been in effect since January 1, 1984.

Vehicle Filling Procedure

This filling procedure is included for reference only. All personnel conducting fills should receive safety training on proper fill procedures.

[WARNING] *For passenger safety, Blue Bird recommends all occupants disembark to a safety zone before fuel filling procedures take place.*

1. Entering the propane fueling station.
 - a) Park the vehicle in close proximity to the motor fuel dispensing station.

▲ [WARNING] *NO SMOKING ALLOWED.*

2. Turn off and remove the vehicle ignition key.

▲ [WARNING] *Technicians working with or around, fuel systems should be properly trained to utilize extreme care and caution at all times. Failure to exercise extreme caution and care may lead to serious accidents which can result in property damage, personal injury and/or death.*

3. Exit the vehicle and ask all passengers to step outside the vehicle.
 - a) Some stations may ask all passengers to stand outside the area where the fill process is taking place.
 - b) Some stations could be self-service and the driver would perform the filling process; however in this case the driver has to be trained and certified to obtain an authorized filling station dispenser access card.
4. The attendant may need to inspect the propane tank for corrosion, dents and verify the data plate displays the ASME stamp and other pertinent information is correct. An attendant can refuse to fill your propane tank if it does not pass this inspection. Regular inspection and maintenance of your tank will prevent refusal to fill the tank.
5. Unlock and open the fuel door.
6. Verify the dispenser meter is set to zero.
 - a) If the dispenser is an electronic dispenser it will set to zero automatically once the transaction has been initiated.
7. Connect the fuel nozzle to the vehicle fueling receptacle.
 - a) The propane fueling nozzle has to be screwed on securely (clockwise)
 - i. Wear protective gloves while fueling a propane tank.
▲ Warning: Liquid propane is cold. The temperature of propane in its liquid state is -44°F (-42°C).
 - ii. Remove the protective cap from the vehicle fueling receptacle.

- iii. Mate the nozzle coupling to the fueling receptacle.
- iv. Turn the nozzle coupling in a clockwise direction; two or three turns until secure. A soft rubber washer or o-ring seals the connection so over tightening is not required.
- v. Most nozzles for motor vehicle fueling are much like a gasoline type nozzle. The nozzles are also minimum bleed type for safety and to meet hydrocarbon release requirements in certain jurisdictions.

NOTE: Do not open the remote bleeder valve while filling as this will allow gaseous propane to be released.

- 8. Turn on the propane dispenser/pump and begin the filling process.
 - a) Open the nozzle to begin filling.
 - b) Do not fill the tank based on a mechanical float gauge reading or the fuel level gauge on the dashboard.
 - c) Pay attention and never walk away from the filling process.
 - d) When the tank is full the overfill prevention device automatically stops the filling process at the 80% liquid level capacity of the tank.
 - 9. Release or close the fueling nozzle.
 - a) Turn off the fuel dispenser/pump.
 - b) Carefully and slowly unscrew the fueling nozzle (counterclockwise).
 - i. A minimum bleed nozzle on the station's nozzle should have released any pressure left in the space between the nozzle and the receptacle when closed and should not bleed any pressure when unscrewing the connection.
- NOTE:** *Some nozzles will have more pressure trapped between the nozzle and the receptacle, so it is necessary to slowly unscrew the connection to allow pressure to bleed off before removing the nozzle completely*
- 10. Replace the nozzle and fuel transfer hose on the dispenser.
 - 11. Verify there are no leaks at the tank filling receptacle and replace the protective cap.
 - 12. The fueling process is complete.

[WARNING] *During a propane vehicle fueling process fuel may be emitted to the immediate area. There could be a combustible fuel mixture around this immediate area. The person performing the re-fueling process has total responsibility for safety in the immediate area.*

NOTES:

- It is unlawful to fill a non-compliant tank or a tank that possesses a safety violation.
- Any person performing the re-fueling process must be trained and certified in the procedures of filling propane tanks and in the procedures of safe handling.