Propane Systems
for
Expedition Vehicles

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Version 1.3

Version History
V 1.0……Initial release
V 1.1……Added “Using Foreign Bottles/Tanks” section
V 1.2……Added additional resources and South America country specific information
V 1.3……Added photos of Ecuadorian industrial regulator and Peru quick disconnect, propane plants and delivery trucks, sample cheat sheet, table of contents revision, copy edits

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Introduction

Perhaps no other system on an expedition vehicle is as wrapped in mystery or inspires as much outright fear as the propane system.

With its inherently explosive nature and its bewildering variety of connectors, it is easy to understand why the typical overlander avoids the design and implementation of a propane system if at all possible.

Once the propane system is designed and installed, the challenges do not evaporate. Instead, the overlander who ventures overseas is faced with the daunting task of refilling their propane tank(s) or bottle(s). To refill, they must decipher a highly regulated supply chain and communicate complex concepts and schedules in the local language.

And, if the refilling quest fails, they must do the task on their own, using materials at hand.

All of this adds up to a lot of motivation to avoid a propane system in your expedition vehicle if you can. Unfortunately, the alternatives all present significant challenges and/or downsides of their own, so most of us end up with a propane system in our expedition vehicles, especially if we base our vehicle on a North American factory built camper or Recreational Vehicle (RV).

However, all is not lost. Propane need not be a mystery, propane systems need not be arcane, and refilling overseas need not be daunting.

This document attempts to:

- Explain the basics of Liquid Petroleum Gas (LPG / LP / Gas Propano / GLP), commonly known in the U.S.A. as propane.
- Define the elements of a typical expedition vehicle propane system.
- Document the types of materials and connectors used in a typical expedition vehicle propane system.
- De-mystify the utilization and refilling of a propane system while overseas.

Caveats:

- This document was prepared by a non-professional. I am not a propane engineer or employed in the propane industry. This information has not be reviewed, confirmed or vetted by a propane industry professional. This information may be incorrect in fact or inference.
- You should have your expedition vehicle’s propane system design and installation inspected by a qualified propane professional prior to use.
- Observe all safety warnings and procedures when testing, using and refilling a propane system.
- Any processes or procedures in this document are your responsibility. Use them at your own risk.

Why Propane?

Propane is commonly used in homes, businesses, industry, recreational vehicles (RVs), campers and expedition vehicles to provide energy for:

- Heating water
- Heating living spaces
- Indoor cooking
- Outdoor cooking
- Refrigeration

Common alternative energy sources for these tasks include diesel fuel, 120/220VAC and/or 12/24VDC electricity, and chassis-engine-coolant heat exchangers.

Diesel fuel devices are a very desirable alternative because they eliminate the need to carry and procure another type of fuel. However, some models can be smoky and/or sooty, and often don't work well at moderate to high altitudes.

Utilizing electricity requires being plugged into external power, running a generator, running the chassis engine to utilize an alternator, or placing a very high, unsustainable amp hour load on your house bank (camper) batteries. Using 12/24VDC for heating water or refrigeration is a very efficient approach while the vehicle is in operation, but not always practical, desirable or possible while parked.

Using a chassis motor heat exchanger is a very efficient method for heating water while the vehicle is in operation, but is not always practical, desirable or possible while parked.

Negative attributes of propane include:

- Explosive gas
- Refill and output connectors vary in different countries and regions
- Consumer access to refill systems can be difficult to impossible in some countries and regions
- Bottle/tank sizes vary in different countries and regions
- Weight and size of propane tanks/bottles

Positive attributes of propane include:

- High energy density fuel (74% of gasoline's energy content)
- Portable
- Widely used at the consumer level in most regions of the world
- Generally available at consumer retail in bottle form
- Scent tagged to aid/ensure leak detection
- High auto-ignition point (1,004F/540C vs. 428F/220C gasoline and 437F/225C diesel)
- High peak flame temperature (3,614F/1,990C)
- Appliances, appliance parts and repair widely available at affordable prices
- Hoses/tubing/pipe and connectors widely available at affordable prices
- Affordable fuel cost

Primary challenges of using propane in an expedition vehicle include:

- Requirement for large bottle compartment to allow for varying bottle sizes in different countries/regions
- Weight of propane bottle(s)/tank(s)
- Requirement for adapters/custom connections for each unique local bottle/tank connector type
- Locating and accessing refilling facilities for fixed tanks
- Handling liquid propane for manual jumper refilling

Propane Characteristics

(Portions of this section are excerpted from the Propane Facts page at: http://www.propanecarbs.com/propane.html)

Liquefied Petroleum Gas (LPG) is commonly known as propane or LP in the U.S.A.

Propane is a combustible hydrocarbon based fuel. It is derived from the refining of crude oil and natural gas.

In its native form, propane is colorless and odorless. As distributed to consumers, it is odorized to aid in leak detection.

Propane is heavier than air. It sinks to the lowest level of any contained space, such as the interior of an expedition vehicle's camper box.

At normal air pressure and temperatures above -44F/-42.2C, propane is in gaseous form. At lower temperatures and/or higher pressures, propane is liquid.

Propane is transported and sold in liquid form inside pressurized containers. The propane gas is compressed to turn it into a liquid and then pumped into the pressurized container in liquid form. The propane remains liquid as long as it is under pressure.

If the pressure on the liquid propane is released, it evaporates, changing from liquid to gas. When propane evaporates it expands 270 times its liquid volume.

When used by the consumer, propane is evaporated in its storage bottle by the release of pressure, such as opening the valve on a stovetop burner. Due to this release of pressure, the liquid propane in the bottle evaporates (boils) into gas form, and is piped to the appliance where it is burned to generate heat.

It may be easier to understand how propane changes from a liquid to a gas by comparing its behavior with water. Propane and water share very similar characteristics, with the primary difference being that propane boils (evaporates) at a different temperature than water.

WATER	PROPANE
Water is a clear liquid below 212 deg. F.	Propane is a clear liquid below -44 deg. F.
At sea level water begins to boil at 212 deg. F.	At sea level propane begins to boil at -44 deg. F.
When water boils it becomes water vapor (steam).	When propane boils it becomes propane vapor.
From a liquid to a vapor water expands 700 times its liquid volume.	From a liquid to a vapor propane expands 270 times its liquid volume.
A vehicle cooling system uses pressure to keep the water in its liquid form at temperatures above its normal boiling point.	A propane storage container uses pressure to keep the propane in its liquid form above its normal boiling point.
Below its boiling point water in liquid form expands when heated but does not vaporize.	Below its boiling point propane in liquid form expands when heated but does not vaporize.
Water in liquid form **cannot** be compressed.	Propane in liquid form **cannot** be compressed.
Water in vapor form **can** be compressed.	Propane in vapor form **can** be compressed.
Water in a vehicle cooling system takes on heat from the metal walls of the engine block.	Propane in a fuel storage container takes on heat from the metal walls of the container.

Source: Alternate Fuels Technologies, Inc.

A very important characteristic of propane relates to how it responds to temperature. The internal air pressure of a propane storage bottle/tank is directly related to its temperature.

TABLE #1			
TEMPERATURE		VAPOR PRESSURE	
deg. F	deg. C	PSIG	kPa
130	54	257	1794
110	43	197	1358
100	38	172	1186
90	32	149	1027
80	27	128	883
60	16	92	637
30	-1	51	356
0	-18	24	162
-20	-29	11	74
-44	-42	propane begins to boil @ sea level	
-45	-43	0	0

Pressures based on a propane tank filled to no more than 80% capacity.
Source: Alternate Fuels Technologies, Inc.

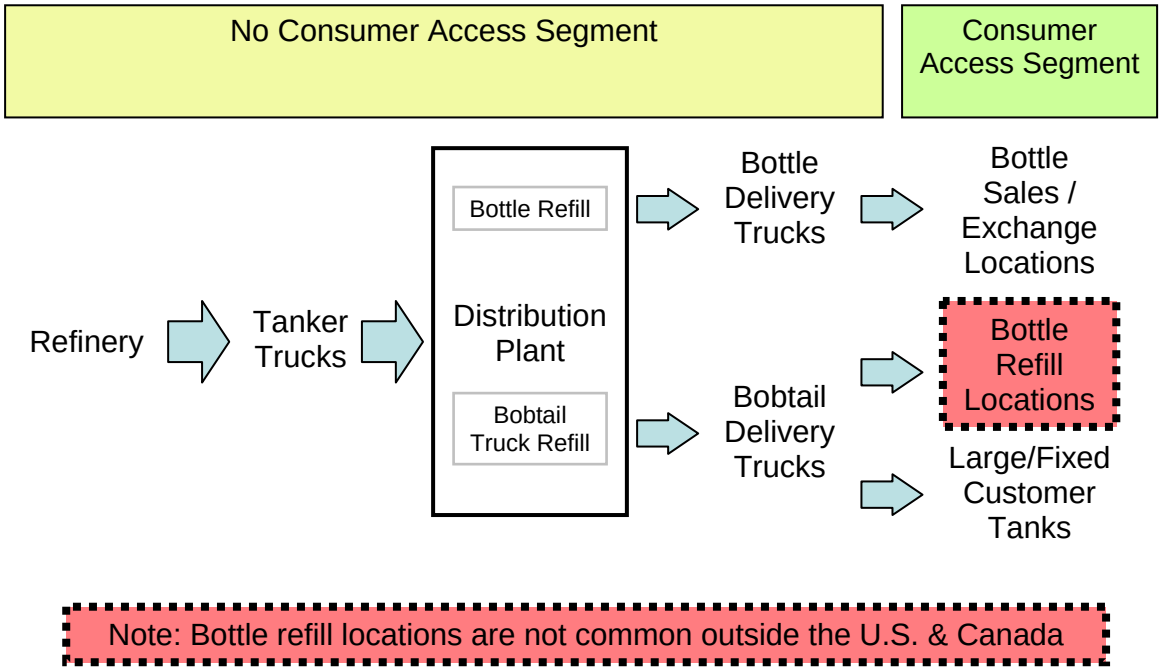
Because the internal pressure of a propane tank rises dramatically with temperature, it is extremely important to always leave 20% of the tank unfilled to allow for expansion due to rising temperatures. If you do not allow for thermal expansion, it is possible for a propane tank to explode if it is filled to 100% capacity in a cool temperature environment and then moved to a hot temperature environment.

For this reason **never fill a propane tank more than 80% full.**

The only safe and reliable way to determine the level of propane in a tank is by weight. You must weigh the tank in order to determine how full it is.

Propane Supply Chain

Propane is a product of the petroleum and natural gas refining process. It is created in a refinery and distributed in the following manner:

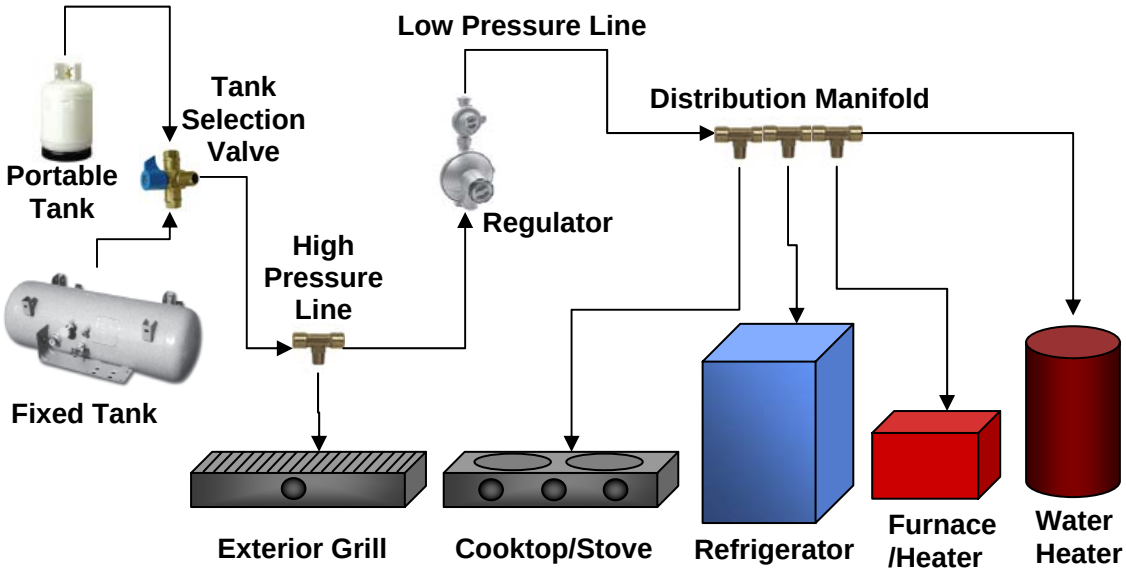


One of the challenges of using propane in an overland expedition vehicle is seeking to refill non-local market bottles. In this scenario the traveler is attempting to insert themselves into the supply chain at a point where there is normally no consumer access – at the point of bottle refill within the distribution plant.

Another challenge arises when attempting to fill fixed tanks permanently mounted on the vehicle. These typically require a connection from a propane pump designed to fuel vehicles or directly from a bobtail delivery truck. Propane pumps for vehicles are not common in many countries, so they can be very difficult to locate. In addition, distances can be vast between pump locations. Coordinating with a bobtail truck to arrange a fixed tank refill, which is usually required at the plant location, can also be a daunting task, especially with limited local language skills.

Propane System Components

Propane systems consist of the components required to store the propane, regulate the system pressure, distribute the propane gas, and burn it to generate heat.



An expedition vehicle's propane system usually consists of the following components:

- Bottle/tank
  - In the U.S.A. the bottle/tank will be a Department of Transportation (DOT) approved container
  - In the U.S.A. the bottle/tank will include a Overfill Protection Device (OPD) to prevent filling to more than 80% capacity
  - Ensure all portable tanks/bottles are firmly secured to the vehicle via ratchet strap, clamp or other means.
  - Do not rigidly mount all four corners of a permanent tank. Use a three point mounting and ensure the tank is isolated from vehicle frame and chassis flex.
- Bottle/tank valve
  - In the U.S.A. DOT portable bottle/tanks will use a QCC Type 1 fill valve connection
  - U.S.A. DOT permanent tanks will use an ACME fill valve, typically 1 ¾" / 44.450mm.
  - Permanent tanks often include a fill valve, level gauge, bleeder/spitter valve, and blow-off/safety valve in one area along the side of the tank. If mounted on the edge of the vehicle, all tank functions can be controlled from that area.
  - If a permanent tank is mounted inboard or between the frame rails, a fill valve panel or manifold needs to be mounted on the exterior of the vehicle, with hose(s) connecting the fill manifold to the tank. Include a bleeder/spitter valve in the fill panel/manifold or a nearby location.
  - Sending units are available for permanent tanks to enable remote level gauges.

- Bottle/tank selection valve
    - Allows selection between multiple portable bottles/tanks or between a portable bottle/tank and a permanent tank. Automatic switchover valves are available. Automatic valves switch from the primary to secondary bottle/tank when the primary bottle/tank empties.
- High pressure line
    - This line is the full output pressure of the propane bottle/tank, which can be as high as 257 PSIG / 1,794 kPa at 130F / 54C degrees ambient temperature.
    - This line is usually only used for high pressure appliances such as exterior grills.
- Regulator
    - This device reduces the full output pressure of the bottle/tank to a level usable by common appliances.
- Low pressure line
    - This line carries the low pressure gas to the system's low pressure appliances.
- Distribution manifold
    - Splits the regulator's output into multiple lines, one for each low pressure appliance.
- Appliances
    - Devices used to convert the propane gas's energy potential to heat by burning the gas. Common examples are furnace/heater, water heater, stove/cooktop and refrigerator.
- Propane detector/alarm
    - An essential component of any propane system. This electronic device should be mounted as low as possible in the living area. It should be tested regularly using the test button on the device. If battery powered, batteries should be changed at least twice a year.

All components except the propane detector/alarm are interconnected with:

- Hose/tube/pipe
    - Expedition vehicles will typically use soft copper tubing for primary distribution and liquid fuel / propane rated rubber hose for tank/bottle and appliance interconnection. Rigid copper or black pipe is not normally used in an expedition vehicle application.
- Connectors
    - Propane systems use a variety of connector types including compression, flare and National Pipe Thread (NPT). For further information see the Propane System Connectors section.

Propane System Connectors

Every propane system has two fundamental elements interconnecting each component:

1) Tube/pipe/hose carrying the propane gas
2) Connections between tube/pipe/hose and the system components

The tube/pipe/hose carrying the propane gas can be:

- Rigid pipe
- Flexible/malleable tubing (copper* or plastic)
- Hose (plastic, rubber* or synthetic rubber*)
- Sheathed hose* (hose covered with braided metal or protective sheathing)

(*) suitable for use on an expedition vehicle

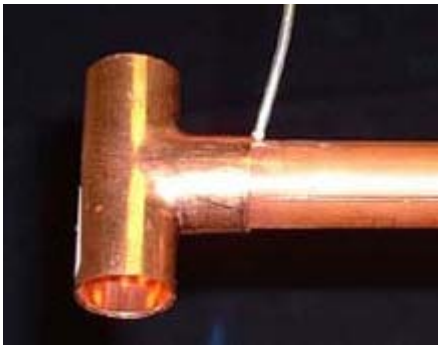
A propane system has two types of interfaces:

a) Between the hose/tube/pipe and its connector
b) Connector to connector

Common propane system tube/pipe/hose to its connector interface types:

- Integral threads—used with rigid brass, black or galvanized pipe. Due to vibration and flexing stresses, rigid pipe is not recommended for expedition vehicle applications.
- Solder—used with rigid copper pipe. Due to vibration and flexing stresses, rigid pipe is not recommended for expedition vehicle applications.
- Hose barb and external ferrule—used with hose. The external ferrule is compressed around the hose and barb using a press and die. This connection is not field repairable.
- Hose barb and hose clamp—used with hose. This connection is not as secure or durable as an external ferrule connection, but is field repairable.
- Compression fitting with an integrated internal ferrule—used with tubing. The ferrule slides over the outer surface of the tube/pipe/hose like a collar and is cinched down by the threaded fitting that tightens over the tube/barb onto the connector the tube/pipe is connecting to. Internal ferrule connections are common on flexible plastic pipe/tubing.
- Flare fitting with a flared tube/pipe—used with malleable copper tubing. The flare is held in place by a threaded collar that slides over the tube/pipe and tightens down onto the connector the tube/pipe is mating up to. Together they form a type of compression fitting. Flare connections require a copper tubing cutoff tool, flare clamp and flaring tool.

Brass pipe with integral NPT thread connector

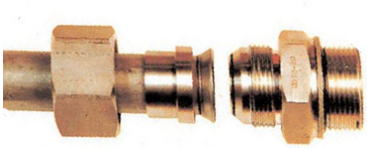


Rigid copper pipe with soldered copper T connector

Hose barb with external ferrule connector

Hose barb with hose clamp connector. Note: a) hose is not installed in this photo, b) when correctly installed hose clamps are positioned over barbed portion of connector.

Malleable copper tubing with internal ferrule and compression connector



Malleable copper tubing with flare connector

A hose/tube/pipe with a connector on each end is used to interconnect propane system components. Each system component has one or more connectors. The connectors may be of different types. Each system component's connector connects with a connector from a hose/tube/pipe.

Common propane system connector types:

- National Pipe Thread (NPT)—used with any type of tube/pipe/hose. Use propane/LP rated thread compound on this type of connection.
- Solder—used with rigid copper pipe. Due to vibration and flexing stresses, rigid pipe is not recommended for expedition vehicle applications.
- Flare—used with malleable soft copper tubing. Do NOT use joint compound on this type of connection.
- Compression—used with any type of tube/pipe/hose, but not common on rigid copper. Do NOT use joint compound on this type on this type of connection.

NPT connector

Solder joint connector

Flare male Flare female

Compression connector

It is very important to make certain that you have matching connectors for each connection in your system. You must use NPT to NPT, flare to flare, compression to compression, etc. Mismatched connector types will leak.

You can see an assortment of compression fittings, internal ferrules, etc. here:
http://www.plumbingsupply.com/compress.html

You can see an assortment of barbed fittings here:
http://www.plumbingsupply.com/barb.html

You can see an assortment of flare fittings here:
http://www.plumbingsupply.com/flarefittings.html

You can see an assortment of NPT fittings here:
http://www.plumbingsupply.com/brass.html

A propane system uses use all brass connectors to eliminate the possibility of sparks and corrosion. **Do not use plastic** connectors for any portion of a propane system.

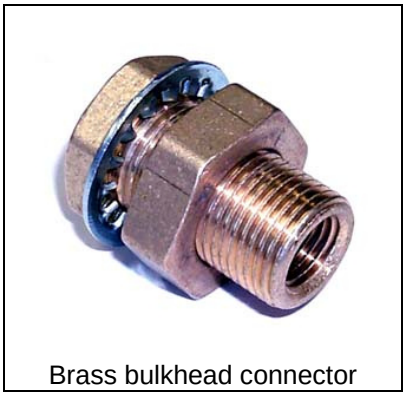
Typically, the fixed components of the system such as the regulator, the tank selection valve, etc., use female NPT connectors. From those points, you insert connectors of your choice, i.e., flare, compression or NPT.

If you use malleable copper tubing for your appliance distribution lines, those connectors are typically flare type.

At the final connection between the feeder line and the appliance, it is common to have a short section of hose to allow for appliance vibration, movement, inspection, removal, etc. The appliance will probably have a female ¼" or 3/8" NPT connection, or already have a compression or flare connector inserted.

When ordering custom propane hoses, carefully specify the type of connector you require on each end of the hose.

To pass through a wall/surface/bulkhead, use a brass bulkhead connector.



Brass bulkhead connector

System Design Considerations

An excellent source for the hose components of your system is a local custom hose shop. They can create hoses to your exact length and connector type specifications, with turnaround as quick as while-you-wait. Be sure to specify LP/propane/liquid gas hose material and be very precise when specifying the connector types. To locate a custom hose shop, look in your local Yellow Pages, search online or call a local Ready Mix / concrete plant and ask them where they get their cement-mixer truck hydraulic hoses repaired or replaced.

Standardizing on one type of connector, i.e., compression, flare or NPT, is important for reducing spare parts inventory and aiding field repair.

Standardizing on one size of hose/tube/pipe, e.g., ¼" or 3/8", and connectors, e.g., ¼" or 3/8", for your entire propane system is also important for reducing spare parts inventory and aiding field repair. For an expedition vehicle system, ¼" or 3/8" tube/hose/pipe should provide adequate flow for typical use of propane appliances.

If you have any system component that has a non-standard-size connector, e.g., a stovetop or water heater, use a brass adapter fitting to convert immediately and directly to your standard size. This allows you to carry one size of repair hose/tubing and an assortment of only one size of replacement/repair fittings.

Propane Bottle/Tank Fill Valves and Connectors

Propane bottles and tanks use a variety of connectors depending on country or region.

U.S.A. / Canada

Common U.S.A. / Canada connectors/fill valves used on Department of Transportation (DOT) approved tanks include:

- POL / Compressed Gas Association (CGA) 510
  The POL is a common fill valve connector in the propane industry with 7/8" / 22.2250mm left hand/counter-clockwise/anti-clockwise threads. In 1994 the POL was replaced for use on U.S.A. consumer propane bottles by the QCC Type 1 connector. The POL name derives from Prest-O-Lite, the first manufacturer to use the connector. POL connectors are common in North, Central and South America.

POL / CGA 510 fill valve

- QCC Type 1
  The QCC type 1 is a propane bottle fill valve connector with male 1 5/16" / 33.3375mm ACME right hand/clockwise threads. Some types include female POL connector threads on the interior of the hose connector. The QCC Type 1 has been the standard connector for consumer propane bottles in the U.S.A. since 1994.

QCC Type 1 connector showing 1 5/16" / 33.3375mm ACME male threads on exterior

QCC Type 1 connector with POL threads on the interior of the hose connection.

- ACME
  The ACME is a propane bottle/tank fill valve connector commonly found on fixed vehicle tanks and large or permanent home/farm/facility tanks. ACME fill valve connectors use male right hand/clockwise threads in four common sizes: 1 ¼" / 31.750mm, 1 ¾" / 44.450mm, 2 ¼" / 57.150mm, and 3 ¼" / 82.550mm. The typical size for fixed tanks on campers, RVs and vehicles is 1 ¾" / 44.450mm.


ACME 1 ¾" / 44.450mm fill valve

Other Regions

Different parts of the world use different fill valve types for bottles and vehicle/large/fixed tanks.

Sample vehicle / tank fill valve connectors and countries/regions:

ACME 1 ¾" / 44.450mm fill valve (photo in prior section)

- Austria
- Belgium
- Germany
- North America
- South America
- South Africa
- The ACME 1 ¾" / 44.450mm fill valve is the new standard for the European Union, although it will take many years for it to become available at all facilities.

Bayonet

- Holland
- Spain
- United Kingdom


Bayonet connector

Dish

- Italy
- France
- Portugal
- Greece
- Denmark
- Poland
- Peru
- China

Dish connector

Source: Connector country and region information provided by Rotarex Group

Country Specific Information

Argentina

- Bottle: Argentina uses POL connectors on all bottles, regardless of size.
- Vehicle fill pump: Argentina has no known vehicle fill pump infrastructure.
- Delivery (bobtail) truck: ACME 1 ¾" / 44.450mm

Chile

- Bottle: Chile uses a proprietary quick disconnect connector on 5, 11 and 15kg size bottles. Chile uses a POL connector on 45kg bottles.

Chilean quick disconnect propane bottle connector.

- Vehicle fill pump: ACME 1 ¾" / 44.450mm. Vehicle fill pumps are available at most LP / Propane / GLP plants.
- Delivery (bobtail) truck: ACME 1 ¾" / 44.450mm

Ecuador

- Bottle: Ecuador uses a quick disconnect fitting for all bottle sizes. This quick disconnect fitting is not the same as Chile's connector.
- Vehicle fill pump: Ecuador has no known vehicle fill pump infrastructure.
- Delivery (bobtail) truck: ACME 1 ¾" / 44.450mm (presumed, not yet confirmed as of 18 October, 2008)

Notes: It is possible to do a jumper fill from an Ecuador bottle if you use a *regulator industrial* (industrial regulator) on the inverted Ecuador bottle. The regulators are available at any large hardware store (ferreteria) or gas/GLP/Gas Propano supply store (see section 11 for details on jumper filling bottles).

Ecuadorian *regulator industrial* (industrial regulator) required for a jumper fill.

Peru

- Bottle: Peru uses a quick disconnect fitting for all bottle sizes. This quick disconnect fitting is not the same as Chile's connector.

Peruvian bottle/tank quick disconnect connector.

- Vehicle fill pump: Italian Dish connector. GLP vehicle fill pumps are available at many fuel stations in most major market towns and cities. Peru has an active program to convert the country's vehicles to run on GLP, a native resource. If you have an adapter from Italian / Peru dish to your bottle or tank connector, you can fill your bottle / tank at any GLP vehicle fill pump.
- Delivery (bobtail) truck: ACME 1 ¾" / 44.450mm

Notes: A supplier to create adapters from Italian / Peru dish connectors to ACME, POL or other connectors is:

Acogas
Avenida Colonial 5443, Callao, Peru
(Av Colonial has been renamed Av Benevides).
Coordinates of the store are S12.03.077, W77.05.204.
(Acogas information from Rick Howe, who had an Italian/Peru dish to ACME 1 ¾" / 44.450mm adapter created at Acogas for ~$50 USD in October 2008.)

This section will be expanded as we explore additional countries.

Additional country specific LP / Propane / GLP information is available here: http://www.xor.org.uk/silkroute/equipment/word/lpglong.doc

International connection adapters, e.g. bayonet to ACME, Italian / Peru dish to ACME, etc., are available from: http://www.mthautogas.co.uk/

Propane Bottle Fill Weight

The only way to measure the level of a propane bottle/tank is by weight.

A foreign bottle refill plant knows the exact weight of its standard, local bottles at 80% of capacity. They will have no idea how much your non-local bottle(s) should weigh at 80% capacity. To ensure you have a safe propane bottle, you must calculate your bottle's 80% full weight prior to re-filling.

Each bottle is stamped with its tare weight (the weight of the empty bottle) and its liquid capacity.

Embossed tare weight (TW) on propane bottle.

Embossed liquid/water capacity (WC) on propane bottle.

Propane weighs 4.2 lbs. per gallon / .51 kilos per liter at 60F / 15.5C.

These values enable you to calculate your bottle(s) weight at 80% of capacity.

Propane Sample Fill Weight			
	Tare	7.5	kilos
	Capacity	21.6	liters
	Propane unit weight	0.51	kilos per liter
100% fill	Propane weight	11.016	kilos
80% fill	Propane weight	8.8128	kilos
80% fill	Propane + tare	16.3128	kilos
	Maximum fill weight	**16.3128**	**kilos**

Calculate this weight and clearly label your bottle with the 80% maximum fill weight in the local language.

Note that current U.S.A. consumer propane bottles/tanks are equipped with an overfill protection device (OPD) built into the fill valve. The OPD shuts off the fill valve at 80% capacity to prevent the bottle from being filled to an unsafe level.

Using Propane in Foreign Countries

Propane is widely available around the world, however getting it into your non-local-market bottle or fixed vehicle tank can be a challenge.

Because of the variety of connector types used for propane and lack of consumer access to refill facilities in other areas of the world, it is best to have multiple ways of refilling your propane tank(s) and bottle(s).

For instance, if you have a large fixed tank, you will be at a significant advantage if you also have the ability to use a small portable bottle/tank in your system. The capability to use small bottles/tanks enables the utilization of local market bottles, or removing your bottle to have it refilled in areas where it is impossible to refill your large tank.

Portable Bottles/Tanks

The easiest way to utilize propane in foreign countries is to use a propane bottle/tank sold or rented in the local market. This method enables the easiest access to full propane bottles since you can swap your empty bottle for a full one at any propane bottle exchange retail location, which are common in market towns and urban areas.

There are two main challenges to this method. First, it requires you to purchase your initial local bottle and build a connection line using the local market bottle's connector type. You can usually buy whatever you need for this connector line, e.g., connector valve/regulator, hose, hose clamps, in a local hardware store in any market town. Make certain that you buy liquid propane rated hose for the connection line. Do not use normal fuel line.

Secondly, your propane bottle storage compartment must be large enough to accommodate a usefully sized local market bottle. When designing and constructing your vehicle, make your propane storage compartment as large as possible to accommodate foreign market bottles, which will probably not be the same size and shape as your U.S.A. market bottle.

If you choose to use your U.S.A. market bottle while traveling overseas, you will need to locate propane distribution plants and have your bottle refilled, assuming they can use your bottle's QCC Type 1 ACME (unlikely) or POL (likely in the Americas) connector to do so. If the plant cannot or will not refill your bottle due to physical (incompatible connectors) or legal/bureaucratic (no local market safety certification, company regulations, etc.) reasons, you must jumper fill your bottle (see the Jumper Filling Propane Bottles section for details on this procedure).

Bottle exchange facility. Chaiten, Argentina.

New, empty bottles for sale at retail. Valdivia, Chile.

Fixed Tanks

If your vehicle has a large, fixed propane tank, you will need to locate and utilize a propane vehicle fill pump, locate and visit a propane distribution plant, or locate and connect to a propane bobtail delivery truck.

Propane vehicle fill pumps can be rare or non-existent depending on the country, and distances between pumps can be measured in hundreds to thousands of miles/kilometers. If they exist in the country, they are usually found in large market towns and major urban areas. The connector used on the pump hose may not be compatible with your tank fill valve connector.

It can be challenging to locate propane distribution plants and equally challenging to coordinate with the plant and/or bobtail delivery truck to obtain a fill. The bobtail delivery truck hose may not use the same connector as you have on your tank.

The best strategy is to either build a fill manifold utilizing a variety of international fill valves, bring along a selection of fill valves you can install on your vehicle, or create adapters from the local market connector to your tank's connector to enable filling in local markets.

<u>If at all possible</u>, arrive in a country with the adapter(s) required to use the local infrastructure to fill your tank(s). If you wait until you arrive, you may need to travel to, and fight your way through the intense traffic of, a very large city in order to find the parts necessary to create an adapter.

Refilling from a bobtail delivery truck. Coihaique, Chile.


Bobtail delivery truck hose and connector

Refilling from a vehicle propane/LPG refill pump. Linares, Chile.


Vehicle propane/LPG refill pump connector

Propane Plants

Propane distribution plants are primarily used by overlanders to refill portable bottles/tanks. If a vehicle fill pump is located at the plant, it may be used to refill fixed tanks if a suitable connector or adapter is available. Propane distribution plants are often the best places to coordinate with and receive a fill from a propane delivery/bobtail truck.

Propane distribution plants are usually located on a main road on the outskirts of major market towns and urban areas. If the city has undergone significant growth, it may have surrounded and absorbed the neighborhood around the plant.

It is very helpful to prepare a document in the local language with your portable bottle/tank information, especially its 80% fill weight, prior to going to the plant. Including photos in the document can help facilitate communication.

Propane distribution plants are often off-limits to consumers, so you may not be able to utilize them to refill your portable bottle/tank. Do not be offended if the plant refuses to fill your portable bottle/tank. Remember that you are attempting to insert yourself into a place in that country's propane supply chain where consumers do not normally participate.

Propane Delivery/Bobtail Trucks

Propane delivery/bobtail trucks are used to refill large fixed tanks at homes, farms and commercial facilities. They often use a connector that can be used to fill fixed tanks on expedition vehicles. They may be the only point in the country's entire propane supply chain that has a suitable connector to fill a fixed tank.

The best place to get a fill from a propane delivery/bobtail truck is at the local propane distribution plant. The best times to receive a fill from a propane delivery/bobtail truck is on late Friday afternoon or first thing (at opening time) on Monday morning. The propane delivery/bobtail trucks are usually at the plants over the weekends, so those two times are your best opportunity to arrange for a fill from them. It is best to stop by the plant and arrange for the fill prior to when you want to accomplish it, e.g., earlier in the day on Friday rather than waiting until 30 minutes before the plant closes.

Many propane companies will require the truck to make the fill at the plant due to company procedures or regulations. In addition, propane delivery/bobtail trucks are not set up for retail sales. In other words, the driver does not have the capability, forms, processes or training to make direct sales to consumers from the truck. By making the fill from the truck to your vehicle's tank at the plant, you can utilize the office staff for payment.

It is very helpful to prepare a document in the local language with your vehicle's fixed tank information, especially its connector type and 80% fill capacity, prior to going to the plant. Including photos in the document can help facilitate communication.

The truck operator will need to physically see your tank's level gauge prior to and during the fill.

If you have a stiff spring in your fill valve's stop seal, you may need to have the truck operator increase his pump pressure to overcome the stop seal's pressure in order to get the propane into your tank.

Do not be offended if the plant refuses to fill your fixed tank. Remember that you are attempting to insert yourself into a place in that country's propane supply chain where consumers do not normally participate.

Useful Gear/Kit

Utilizing propane in foreign countries can be greatly aided by adding some propane components, connectors and adapters to your pack list.

- Propane hose
  - 3 meters / 9.8’ of propane / liquid gas rated hose
  - 3/8” / 9.525mm is a useful size
- POL male to hose barb connectors
  - Ensure the hose barb matches your hose size
- Hose clamps
  - Ensure the hose clamps are 100% stainless steel, use a magnet to check
  - Ensure they match your hose size
- POL connector adapters
  - POL to ¼” or 3/8” NPT is a very useful connector and can be readily adapted to various scenarios
- QCC Type 1 connector adapters
  - QCC Type 1 male to POL male enables use of your standard U.S.A. tank connection hose with POL connector tanks
  - QCC Type 1 male to ¼” or 3/8” NPT is a very useful connector and can be readily adapted to various scenarios
- Brass connectors
  - Bring a variety of male and female brass connectors, bushings, etc. to enable you to adapt to various scenarios and connector types
  - Bring at least four of your main size and connector type for repair purposes
- Propane NPT joint compound
  - Ensure the joint compound is suitable for use with propane
  - Use joint compound ONLY on NPT connections. DO NOT use joint compound on compression, barb or flare connections.
- Jumper hose
  - A POL to POL jumper hose is very useful for jumper filling portable tanks
- Fill valve connectors
  - All connectors required to attach to your fill valve(s), e.g. POL male, ACME female, etc. These connectors will be used to create adapters to local market’s connectors to enable filling your tank from vehicle fill pumps or jumper fills.
- Fill valve adapters
  - Pre-made adapters to convert from planned destination countries’ fill valve type to your bottle/tank’s fill valve type, e.g., Italian/Peru dish to ACME.
- “Cheat Sheet” Documents
  - Documents in local languages depicting and describing your portable bottle/tank’s connector type, tare weight, 80% full weight and liquid capacity and your fixed tank’s connector type and 80% full liquid capacity.

Propane rated hose

POL male to ¼" hose barb

POL male to NPT male adapter

QCC Type 1 male to POL male

QCC Type 1 male to ¼" NPT female adapter

Variety of brass connectors, bushings, etc.

POL to POL jumper hose

Sample “Cheat Sheet” Propane Bottle/Tank Information Document

This document is used to facilitate communication at propane distribution plants or bottle/tank refill facilities. This sample document is partially written in Spanish.

Nombre: First Last
Pasaporte Número: 123456789

Necesito llenar / recargar bottella gas liquido / propano

Bottella Vacío Peso: 7.5 kg
Bottella Liquido Capacidad: 21.6 litros

Propane Fill Weight			
	Tare	7.5	kilos
	capacity	21.6	liters
	Propane unit weight	0.51	kilos per liter
100% fill	Propane weight	11.016	kilos
80% fill	Propane weight	8.8128	kilos
80% fill	Propane + tare	**16.3128**	kilos

Using Foreign Propane Bottles/Tanks

There are two primary means of using portable tanks in foreign markets:

1. Refill your stock U.S.A. / Europe bottle/tank as required
2. Utilize local market bottles/tanks in your vehicle's system

Refilling requires locating and accessing refilling facilities that are not normally part of the consumer market. Refilling also requires that the local refilling plant is equipped with compatible connectors for your U.S.A. / European bottle/tank. Both of these requirements can become insurmountable challenges.

The easiest way to use portable bottle/tanks in foreign destinations is to utilize the tanks sold/exchanged in the local market/region you are visiting.

To do so requires two things:

A. That your vehicle can accommodate local market bottles/tanks. Portable propane bottles/tanks vary in capacity, size and shape in different parts of the world. When designing and building your vehicle, ensure your propane bottle/tank compartment is large enough to accommodate overseas tanks of sufficient capacity to be useful.

B. That you have a hose to connect the local tank to your propane system's regulator.

Before you leave the US, examine your propane system regulator. What you are looking for is the connector that screws into the regulator that is on the end of the hose from your bottle/tank. If the system was made in the U.S.A. or Canada, the connector on the regulator body will probably be a ¼" or 3/8" female NPT. This means the connector on the end of the supply hose from the bottle/tank will probably be a ¼" or 3/8" male NPT.

Your goal is to bring overseas the materials required to build a supply hose to connect any local bottle anywhere in the world to the female connector on the regulator body. The components required for that goal are:

1. Bottle/tank output valve connector
2. Supply hose between the bottle/tank and the regulator
3. Regulator body connector

You probably won't have the ability to obtain the connector for the overseas bottle/tank output valve in the U.S.A. or Europe, but you can buy those connectors in the local hardware stores at your destination country.

What you can buy prior to departure is the hose and the connector that screws into the propane system regulator body. The connectors are available from any well stocked hardware store or online suppliers. The propane rated hose is available from specialty hose suppliers, custom hose shops or online suppliers.

The hose and connectors that connect the bottle to the regulator need to be:

1. Rated for Propane/LP, that means it needs to be rated for Liquid Propane, which can be very, very cold.
2. Capable of handling pressures up to 235 PSI. The pressures downstream of the regulator are only about 5 PSI, but the line between the bottle and the regulator is subject to the full output pressure of the bottle, which is quite high in elevated temperatures. Note that the pressure does not correlate with the liquid volume of the bottle, it correlates with the temperature of the bottle.
3. Brass connectors only. Do not use any other metal or plastic material.
4. Stainless steel hose clamps. Make sure they are appropriately sized. Make sure they are 100% stainless steel. You should probably use two hose clamps per connector, as the pressures can be quite high on this hose.

Build three sets of this connection hose before you leave. I suggest you build one with a POL connector prior to leaving the U.S.A./Europe as the POL connector is used widely around the world.

Leave the other two hoses open with no connectors. You can buy connectors for bottles in the hardware stores when you arrive.

If possible, make up blank (empty on the bottle end) connector hoses with ¼ and 3/8" hose sizes. That will allow you maximum connector size adaptability overseas.

When you arrive at your destination country, examine local propane bottles that will fit in your vehicle to identify their output connector type. Visit a local hardware store and buy at least two of those connectors sized to fit with your blank hose(s).

Attach the local market connector to a suitable size blank hose.

Before your U.S.A. / Europe bottle empties, purchase a local bottle/tank. Depending on the country you may need to buy an empty tank from one store and exchange the empty for a full tank at a propane exchange facility.

Install the local market tank using the following steps

1. Perform this operation outdoors in a well ventilated area.
2. Turn off all valves on your stock bottle/tank.
3. If so equipped, close the main feed valve between the regulator and the vehicle’s appliances. If there is no main feed valve there will be a back feed of propane gas from the system when you disconnect the bottle. This is a normal phenomenon. It will stop once the pressure in the system equalizes.
4. Remove your stock bottle/tank.
5. Remove the original (stock) hose and connector that connects to the regulator.
6. Using propane rated pipe compound or joint tape, attach your local market connector hose to the regulator.
7. Mount the local market bottle/tank. Ensure it is well secured by a ratchet strap or other means.
8. Attach the local market connector hose to the bottle/tank.
9. If so equipped, open the valve on the local market tank.
10. If so equipped, open the main feed valve between the regulator and the vehicle’s appliances.

You are now ready to use local bottles/tanks in your system.

When you change countries or propane bottle/tank service regions you will need to repeat the procedure, starting with examination of the local market tank output valve.

Jumper Filling Propane Bottles

There may be times when you are unable to find a facility willing or able to refill your expedition vehicle's propane bottle(s).

In these circumstances you will need to jumper fill from another propane bottle / tank.

Notes

- This process is dangerous. In the event of an explosion you and those around you may be severely injured or killed.
- Observe all safety precautions.
- Use this procedure at your own risk.
- You are SOLELY responsible for your actions if you use this procedure.

Required procedure components

1. Feeder bottle/tank of propane.
2. Empty target propane bottle(s)
3. Jumper hose with appropriate connectors for the feeder and target bottles
4. Heavy gloves capable of protecting your skin from -44F/-42.2C temperatures
5. Safe, secure, well ventilated location
6. Sufficient time for the jumper fill, which may take several hours or overnight

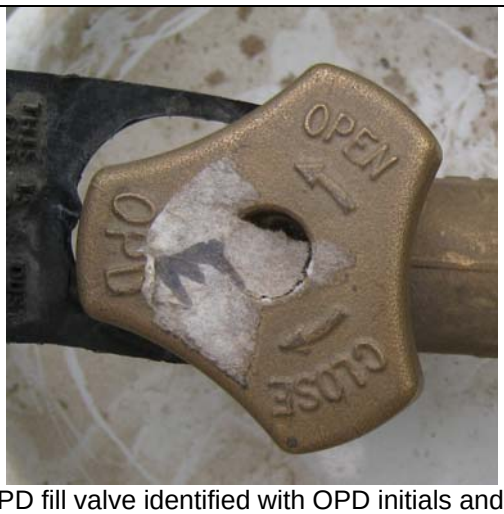
Procedure prerequisites

A) Realize this is a dangerous procedure. You are dealing with explosive materials that can kill you and those around you.
B) Protect your hands. Liquid propane/LPG is very, very cold when it evaporates (changes from a liquid to gas state). It will quickly freeze your skin and tissue, faster than you can react and pull away.
C) Extinguish all flames and eliminate all potential sources of sparks, flames, cinders, hot ash, etc.
D) Turn off all engines, motors, etc. (including all electric motors)
E) Ensure the feeder tank has more than enough liquid propane/LP to fill the target tank.
F) Ensure you have a high output valves (POL) and high capacity hose (3/8") on the feeder tank to target tank jumper connection. Note that you cannot do a jumper fill with a Chilean quick disconnect valve on the feeder tank, it will not pass a sufficient volume of liquid propane.

Process

1. Do the transfer outside, in an area with good ventilation and air flow.
2. Secure all connections and check for leaks.
3. Invert the feeder tank. This puts the liquid (Liquid Petroleum Gas = LPG = LP = propane) at the bottom of the feeder tank.
4. Raise the feeder tank to a level above the target tank.
5. Secure the feeder tank to a solid object using a ratchet strap, tie down strap, etc.
6. Open the target tank valve.
7. Open the feeder tank valve.
8. Open the bleeder valve on the target tank a small amount. When the bleeder valve emits a solid white cloud of propane or continuously spits out liquid propane the target tank is full.
9. If possible, create a temperature difference between the two tanks. Propane sees a lower temperature area as a lower pressure area and seeks to migrate towards it. Creating a temperature delta between the two tanks will help you achieve a higher fill of the target tank. Your goal is to make the target tank cooler than the feeder tank. For instance, locate the target tank in the shade and the feeder tank in the sun. Or, put a damp towel on the target tank. Or, pour warm water on the feeder tank. **Be careful not to overheat the feeder tank.** Keep in mind a propane tank develops an internal pressure of 257 PSIG / 1,794 kPa at 130F / 54C degrees.
10. If you are working with a non-U.S.A. target tank, DO NOT fill it to 100%. Stop your fill at 80% to allow for gas expansion at higher ambient temperatures. Overfilling the target tank can cause it to explode at high ambient temperatures if sufficient gas is not used from the tank prior to high temperature exposure. See the Propane Bottle Fill Weight section for more information. Note that modern U.S.A. consumer propane tanks include an Overfill Protection Device (OPD) which includes automatic fill valve closure at 80% full. OPD equipped fill valves are identified by their three pronged handle and the initials OPD.

Bleeder valve on a QCC Type 1 output valve. The bleeder valve is the flat (slot) head screw.



OPD fill valve identified with OPD initials and 3 pronged handle.

Safety

- Think through the entire jumper fill process before you begin.
- Ensure you have all required components before you begin.
- Be careful and be methodical during the process.
- Monitor the process at all times.
- In case of a leak, immediately close the feeder bottle valve, then the target bottle valve
- DO NOT leave the bottles unattended.

Jumper fill at Gasco bottle exchange retail location in Puerto Natales, Chile. Note inverted feeder tank.

Note frost on the jumper line fitting. Liquid propane is very, very cold and will freeze your skin and tissue on contact.

Jumper test of Chilean 11kg bottle. Note feeder tank securely attached to elevated position with ratchet strap. Note feeder bottle in sun, target tank in shade.

POL to POL hose used for jumper fill. Note this hose is rated for liquid propane.

Resources

National Energy Equipment, Inc.
1.866.574.5100
www.nee.ca

Rego Products
Engineered Controls International, Inc.
1.336.449.6594
www.regoproducts.com
Female ACME connectors on catalog page H5.

Rotarex Group
Ceodux LPG-TEC
352.32.78.32.265
www.rotarex.com

Gaseco, Inc.
1.800.745.2828
www.gaseco.com
Fill adapters on catalog page 16-17.

Rochester Gauges, Inc.
1.972.241.2161
www.rochestergauges.com

Sleegers Engineering, Inc.
1.519.685.7444
http://www.sleegers.on.ca/

International connection adapters, e.g. bayonet to ACME, Italian / Peru dish to ACME, are available from:

MTH GAS SYSTEMS LTD
Castlemain Workshops
Yorkley Road
Parkend
Gloucester
GL15 4HH

Phone: 01594 564385
Phone: 01594 560681
Email: autogas.motorhome@virgin.net
Web: http://www.mthautogas.co.uk/

Document on LP / Propane / GLP resources outside Europe:
http://www.xor.org.uk/silkroute/equipment/word/lpglong.doc