



Preface

This training guide for small engine conversions addresses mainly the commercial lawn equipment and has been published to help educate installation service personnel in LP-gas (propane) carburetion.

This guide is not intended to be an exhaustive treatment and should not be interpreted as precluding the use of other procedures which would enhance safe LP-gas operations, nor is it intended to preclude compliance with more extensive federal, state, and local codes and/or regulations.

Issuance of this bulletin is not intended to nor should it be construed as an undertaking to perform services on behalf of any party either for their protection or for the protection of third parties. Propane Power Systems LLC assume no liability for reliance on the comments of this guide. It is offered as a guide only to assist expert and experienced teachers and managers in training service personnel in their operations.

TRAINING MANUAL OVERVIEW FOR SMALL ENGINE CONVERSIONS

- Propane in the fuel tanks is at a pressure of approximately 200 PSI. The fuel system is a VAPOR system and the fuel tanks are designed for this application. Fork lift tanks or other liquid tank designs will not work
- The propane fuel will be delivered to the engine as a gaseous fuel. Unlike gasoline that is delivered to the carburetor as a liquid and then must be atomized to be injected into the engine by the carburetor or injection system
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- The prescribed method for starting a propane engines is to have the throttle in the closed position. It is possible to flood a propane powered engines. However since propane evaporates quickly, by letting it set a short time it is easily over come as compared to gasoline.
- The fundamentals are the same for the propane engine as the gasoline engine. If you have fuel flow to the carburetor, air, and ignition spark. It will fire and run.
- Propane ready engines will normally have hardened exhaust valve and heads since propane octane rating is approximately 104 octanes as compared to 87 - 89 octane that is used in most small engines.
- With power being equal in performance, other advantages are longer engine life and less maintenance. Propane has 70% less carbon which produces less wear and carbon in engine oil. You also do not have the shellac build up in carburetors clogging fuel jets etc with propane.
- Propane is the third most widely fuel used in the United States behind gasoline and diesel. The availability is easily accessible through numerous operations.
- As with any equipment a low battery can cause starting problems.
- When equipment is being operated in extremely hot temperatures, it is recommended that the propane tanks be shut off while the mower is running at high RPM to remove fuel from the regulator and low pressure fuel line. This is important because the propane fuel will expand once the flow has stopped. As the propane in the regulator and lines expand under hot ambient temperatures it may flood the engines when attempting to restart. Stopping the engine by shutting off the fuel tanks is recommended as normal procedure by most propane companies anyway. **DON'T FORGET TO TURN OFF KEY AFTER ENGINE HAS SHUTDOWN.**

FUEL SYSTEMS COMPONENTS

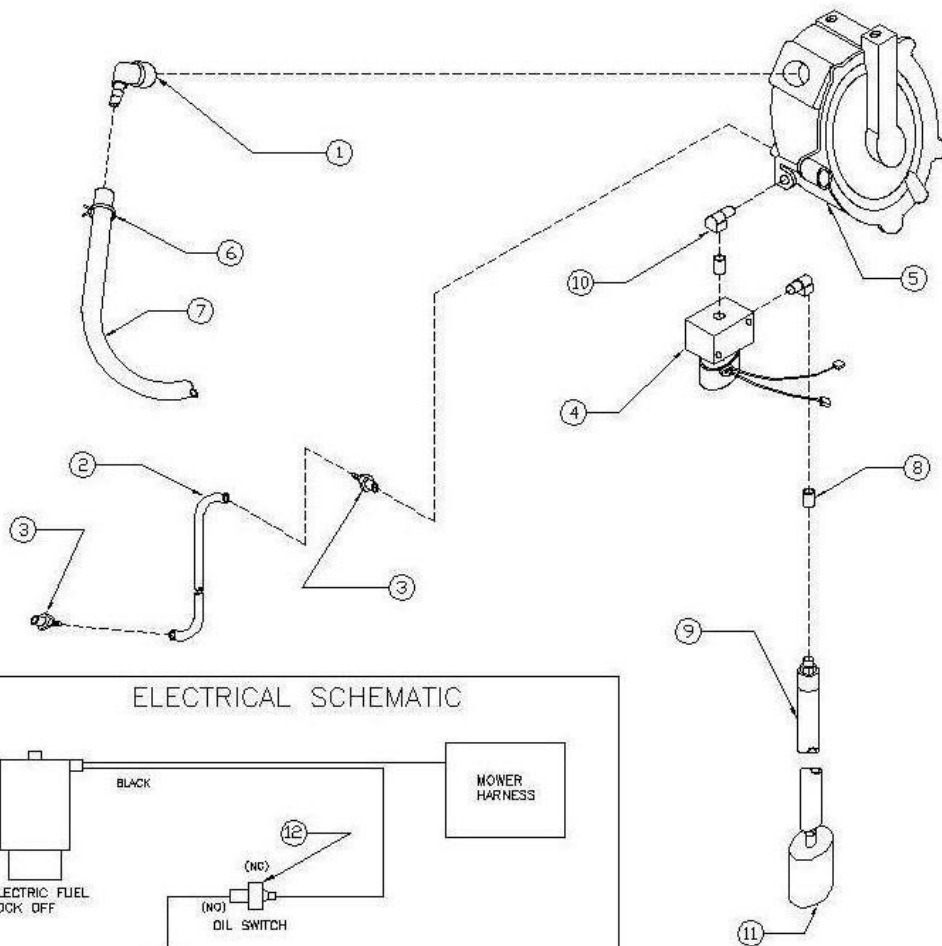
The following items make up the fuel system which was designed specifically for the small engine industry.

- **PROPANE REGULATOR.** Pre set at factory to operate between 4 and 5 pounds depending on engine size
- **LOCK-OFF SAFETY.** Plumed to inlet side of regulator. Opens to let fuel into regulator when ignition key is turned on or oil pressure has reached approximately 4 pounds during start if mower was set up with oil switch as part of the system.
- **OIL SWITCH.** This is a normally open switch and in some cases is wired to the lock-off and the hot wire from the engine or ignition. When oil pressure is sufficient the switch will close completing the circuit and open the lock-off. This will allow fuel to flow to the regulator. At the same time should the engine stop running for any reason, the loss of oil pressure to the switch will also close the lock-off shutting off the fuel to regulator and engine. Option used on some engines.
- **VACUUM HOSE.** This 1/4" or 5/16" hose runs from the regulator to the fuel pump on the engine. The fuel pump creates a vacuum for the regulator that allows the regulator to open and let fuel through it to the supply hose to the carburetor. This is also a second safety. Loss of vacuum through the engine stopping will also close the regulator stopping fuel flow.
- **LOW PRESSURE FUEL HOSE.** This hose supplies fuel from the regulator to the carburetor
- **PROPANE CARBURETOR.** The carburetor is specifically designed for the engine application and is part of the overall fuel system. Modifications or changes are not recommended for best performance.
- **PROPANE FUEL CYLINDER. (FUEL TANKS).** Some of the larger mowers have a twin tank design. Smaller mowers have the single tank design in both smaller Z mowers and walk behind units. Fuel tanks on Z mowers are 33 # or approximately 7.5 Gal. Walk behinds will be 20 # or approximately 4.5 gal.
- **HIGH PRESSURE FUEL HOSES.** These hoses have a special fitting on one end called a Rego Valve which is designed to connect to the propane tank. It is also a safety device. These hoses will run from the tanks to the regulator
- **TANK BRACKETS.** The brackets are made to properly hold the propane tanks on the mower and should be securely mounted on such unit.

ENVIROGARD PROPANE SINGLE TANK OPTION

REF#	PART#	DESCRIPTION	QTY
1	W2662	ELBOW (3/8"x1/2" 90°)	1
	*F69946	ELBOW (3/8"x3/8" 90°)	1
2	W2658	VACUUM HOSE (36")	1
3	F69917	MALE HOSE BARB BRASS FITTING (1/8")	2
4	W2609	ELECTRIC FUEL LOCK-OFF	1
5	W2606	REGULATOR	1
6	W2661	13/16" HOG RING HOSE CLAMP	2
	*F00144	5/8" HOG RING HOSE CLAMP	2
7	W2660	1/2" LP 350 psi HOSE (36")	1
	*W2652	36" 125 psi FUEL HOSE	1
8	F69862	CLOSE NIPPLE (1/4")	2
9	W2649x	HOSE LHS	1
10	F69881	STREET ELBOW 1/4 F-M	2
11	W2650	REGO COUPLING	1
12	W4304	OIL SWITCH	1

* 3/8" FUEL SYSTEM PARTS

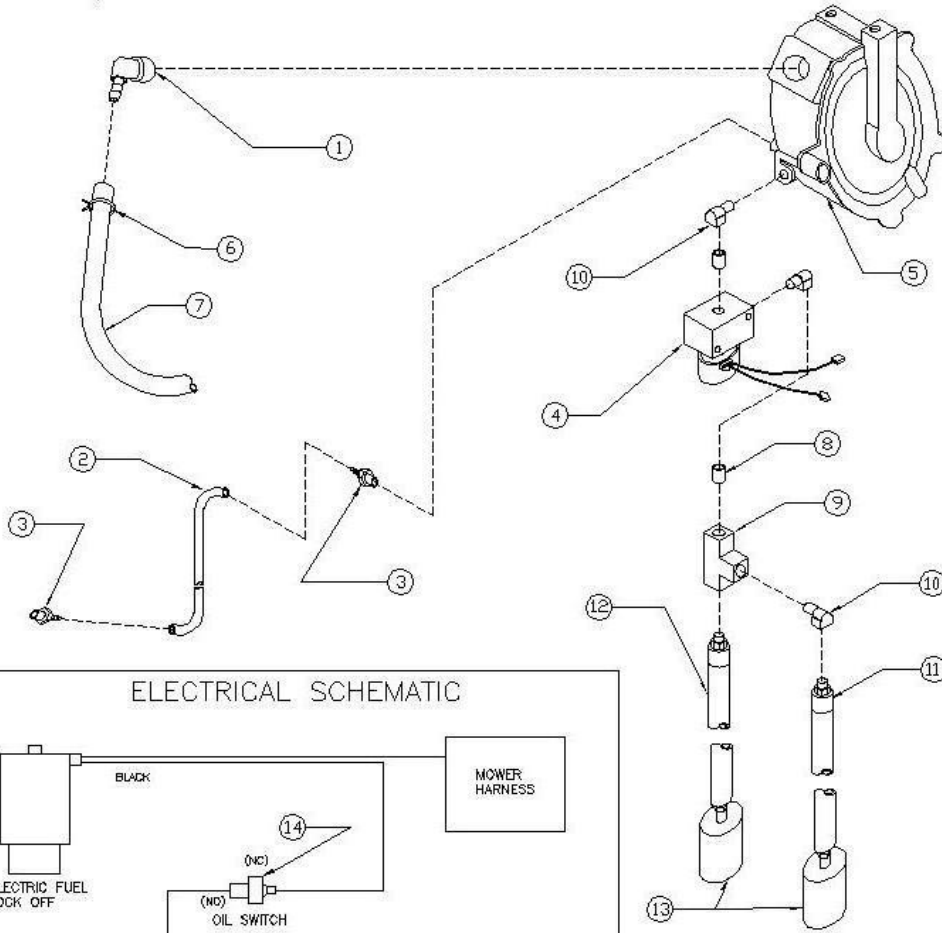


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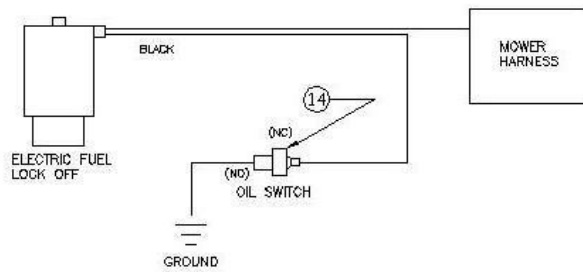
ENVIROGARD PROPANE TWIN TANK OPTION

REF#	PART#	DESCRIPTION	QTY
1	W2662	ELBOW (3/8"x1/2" 90°)	1
	*F69946	ELBOW (3/8"x3/8" 90°)	1
2	W2658	VACUUM HOSE (36")	1
3	F69917	MALE HOSE BARB BRASS FITTING (1/8")	2
4	W2609	ELECTRIC FUEL LOCK-OFF	1
5	W2606	REGULATOR	1
6	W2661	13/16" HOG RING HOSE CLAMP	2
	*F00144	5/8" HOG RING HOSE CLAMP	2
7	W2660	1/2" LP 350 PSI HOSE (36")	1
	*W2652	36" 125 PSI FUEL HOSE	1
8	F69862	CLOSE NIPPLE (1/4")	2
9	F69826	BRASS "T"	1
10	F69881	STREET ELBOW 1/4 F-M	3
11	W2649x	HOSE RHS	1
12	W2649x	HOSE LHS	1
13	W2650	REGO COUPLING	2
14	W4304	OIL SWITCH	1

* 3/8" FUEL SYSTEM PARTS



ELECTRICAL SCHEMATIC



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INSTALLATION INSTRUCTIONS

WALK BEHIND MOWERS

1. Disconnect the positive (RED) lead from the battery.
2. Remove air filter assembly from engine and carefully retain all the parts.
3. Remove gasoline carburetor from engine and place to one side. Carefully retain all hardware and gaskets. Remove the choke rod from the engine control panel and discard.
4. Remove the fuel lines from the gasoline fuel pump and discard. Leave the gasoline fuel pump assembly in place.
5. Install the supplied LP carburetor in reverse order to #3. Be sure to hook up the throttle rod before you slide the LP carburetor in place on the mounting studs. Make sure adjusting screw on load block is facing out away from the engine.
6. Removal of the gasoline tank and gasoline fuel lines may be necessary.
7. Loosely assemble the LP Regulator and 12 volt Lockoff using the supplied brass fittings so that the assembly will install easily under the large bracket that the gasoline fuel tank rested on. Take into consideration that once the assembly is installed you will need to have access to the idle screw and primary pressure setting bolt.
8. Disassemble the brass and remove the fittings from both the Regulator and the Lockoff. Seal the threads on each part, reassemble and tighten each fitting to the same position it was when unsealed. This includes sealing the ¼" NPT ends of the tapered fittings and then tighten one onto the "Rego" connector and tighten the other end into the inlet on the Lockoff. Do not seal the tapered fittings that are on either end of the 350 PSI fuel hose. Simply connect the fuel hose to the "REGO" and the Lockoff via the tapered fittings.

9. The Lockoff mounts into the “INLET” of the regulator and the 3/8” X 1/2” 90 degree barb mounts into the “OUTLET” of the Regulator. The 1/8” X 1/8” 90 degree barb mounts unsealed into the “VAC” hole in the side of the Regulator. After drilling two 1/4” holes one inch apart, position and mount the assembly in place using the bolts supplied in the Regulator.
10. Wire one of the wires exiting the 12 volt Lockoff into the mowers’ keyed power. Route the other wire to ground.
11. Route the 3/8” LP fuel line from the 90 degree barb outlet in the Regulator to the 3/8” fuel barb on the side of the LP carb. Be sure to use the supplied ring clamps to secure the 1/2” fuel hose to the barb fitting at each end. Route the vacuum line from the 1/8” straight barb to the fuel pumps’ intake nipple. The fuel pump will now function as a vacuum pump. Secure the fuel line to the engine etc., for support and attach the vacuum line to the fuel line to support it. If no fuel pump is on the engine connect the vacuum line to the black hose barb on top of the LP carburetor.
12. First, mount the LP cylinder into the carrier and position this assembly on the bracket which previously held the gasoline fuel tank. Check for adequate clearance between the LP cylinder and the engine. Then position the carrier only on the bracket. Drill two 5/16” holes through the bracket and then bolt the carrier in place. Mount the LP cylinder into the carrier and fully tighten the “Rego” connector onto the fuel valve. Open the valve.
13. **LEAK TESTING**
Leak testing is a very important and essential part of this process. Leak test soap can be purchased at most hardware stores.
14. Reconnect the positive cable to the battery. There is a black allen set screw on the end of the load block to adjust fuel flow. Another smaller set screw on the side of the load block to lock it in place once set.
15. On the first attempt to start the engine a very minor amount of starter fluid may be required until the low idle screw is adjusted.
16. On the first attempt to start the engine a very minor amount of starter fluid may be required to start until the fuel adjustment screw is set properly. To start move throttle 1/8” to 1/4” open.

Turn on key and start. Engine. Once engine starts advance throttle to full open and run for 15 to 20 seconds. Now bring throttle back to idle slowly. If engine attempts to die when idled down increase fuel flow with allen wrench by turning allen screw on load block counter clock wise. Turning it clock wise will decrease fuel flow.

17. **An exhaust gas analyzer is recommended for this procedure.**

Next reduce the throttle to idle. Within the $\frac{3}{4}$ " X $\frac{3}{4}$ " square "tower" on the Regulator is a small screw that accepts a small standard screw driver. Turn this screw counterclockwise until the engine peaks and begins to roughen. **DO NOT** turn the screw out beyond the base of the depression in the hole where the screw is mounted. **DAMAGE** to the Regulator may result. Now turn the screw clockwise until the engine smooths out and then another full turn beyond that. Tap the seal plug into place to prevent tampering. Set the idle with the idle screw. Turn the key to "OFF".

18. After removing the temporary nuts and washers from the studs on the LP carburetor. Remount the air filter assembly onto the front of the LP carb/engine.

INSTALLATION INSTRUCTIONS

Z-RIDER MOWERS SINGLE TANK AND DUAL TANK DESIGN

1. Disconnect the + positive (RED) lead from the battery.
2. Remove air filter or intake hose assembly from engine and carefully retain all the parts.
3. Remove gasoline carburetor from engine and place to one side. Carefully retain all hardware, gaskets, and the plastic spacer which fits between the carburetor and the intake manifold.
NOTE: The plastic spacer has an engine side and an intake side. Remove the choke rod from the engine control panel and discard.
4. Remove the fuel lines from the gasoline fuel pump and discard. Leave the gasoline fuel pump assembly in place.
5. Install the supplied LP carburetor in reverse order to #3, after first carefully making sure that the plastic spacer is in its correct position along with the gasket. Be sure to hook up the throttle rod before you slide the LP carburetor in place on the mounting studs.
6. Removal of the gasoline tank or side tanks may be required if propane tanks are to be mounted in the same location. Remove gasoline fuel lines and discard.
7. Loosely assemble the LP Regulator and 12 volt Lockoff using the supplied brass fittings so that the assembly will install easily in the locations you have selected to mount it. Take into consideration that once the assembly is installed you will need to have access to the idle screw and primary pressure setting bolt.
8. Disassemble the brass and remove the fittings from both the Regulator and the Lockoff. Seal the threads on each part, reassemble and tighten each fitting to the same position it was when unsealed. This includes sealing the ¼" NPT ends of the tapered fittings and then tighten one onto the "Rego" connector and tighten the other end into the inlet on the Lockoff. Do not

use pipe dope on tapered fittings that are on either end of the 350 PSI fuel hose. Simply connect the fuel hose to the “REGO” and the Lockoff via the tapered fittings.

9. The Lockoff mounts into the “INLET” of the regulator and the 3/8” X 1/2” 90 degree barb mounts into the “OUTLET” of the Regulator. The 1/8” X 1/8” 90 degree barb mounts unsealed into the “VAC” hole in the side of the Regulator. After drilling two 1/4” holes one inch apart, position and mount the assembly in place using the bolts supplied in the Regulator. On dual tank design a tee will be used on the inlet side of the lock off. Two 350 pound high pressure fuel lines are supplied. One will be longer than the other. This is to give flexibility for mounting the regulator assembly on either side of the mower.
10. Wire one of the wires exiting the 12 volt Lockoff into the mowers’ keyed power. Route the other wire to ground.
11. Route the 1/2” LP fuel line from the 90 degree barb outlet in the Regulator to the 1/2” fuel barb on the side of the LP carb. Be sure to use the supplied ring clamps to secure the 1/2” fuel hose to the barb fitting at each end. Route the vacuum line from the 1/8” straight barb to the fuel pumps’ intake nipple. The fuel pump will now function as a vacuum pump. Leave the discharge side of the fuel pump open. Secure the fuel line to the engine etc., for support and attach the vacuum line to the fuel line to support it.
12. Since mower manufacturers vary in designs. The mounting straps for the tanks are supplied. (Two per tank). You will need to fabricate finders or a structure to mount these straps to. They must be strong enough to support the weight of the tank with fuel. On single tank design mounting the propane tank over the engine and behind the seat is common. Be mindful how ever of air flow for engine cooling for this method. You should have at least two inches of clearance above the engine cooling fan. Dual Tank designs generally mount the tanks over the rear wheels. The tanks may face forward or to the rear of the mower. That is your choice. Keep in mind though if you mount the tanks with the valves facing the rear of the mower, and you use, bracket, struts, or frame work instead of fenders, your valves and hose connection will be covered in mud and grass in wet conditions. When routing all hoses and fuel lines make sure they are not rubbing on tires, control rods, hydraulic lines, or any other moving part of the mower. If fenders are used again they must be strong enough to support the tank and fuel.

LEAK TESTING

Leak testing is a very important part of this process and essential. Test high pressure fitting and connection between the Propane tank and the pressure regulator. Most hardware stores sell a can of solution for leak detection with an applicator.

13. Reconnect the +positive Battery cable to the battery.
14. There is nothing to adjust on the LP carburetor. Leave the throttle closed and turn the key ON and attempt to start the engine. On the first attempt to start the engine a very minor amount of starter fluid may be required until the low idle screw is adjusted on the regulator.

15. **An Exhaust Gas Analyzer is recommended for this procedure.**

When the engine starts advance the throttle to FULL and see how the engine reacts. Next reduce the throttle to idle. Within the $\frac{3}{4}$ " X $\frac{3}{4}$ " square "tower" on the Regulator is a small screw that accepts a small standard screw driver. Turn this screw counterclockwise until the engine peaks and begins to roughen. **DO NOT** turn the screw out beyond the base of the depression in the hole where the screw is mounted. **DAMAGE** may result to the regulator. Now turn the screw clockwise until the engine smoothes out and then another full turn beyond that. Idle engine all the way down and turn off. After waiting 30 seconds restart leaving throttle closed, or at idle. If engine has starting issues refer to trouble shooting guide.

TROUBLE SHOOTING TIPS

** TURN IGNITIONS KEY NOTHING HAPPENS

- Both steering handles all the way open to engage safety switch.
- PTO for blades OFF
- Parking brake set
- Setting in seat properly
- Battery charged
- Battery connected, no corrosion on terminals
-

** ENGINE TURNS OVER, BUT WON'T START

- Both steering handles all the way open to engage safety switch.
- Fuel tank has fuel and valve is open.
- Parking brake is set.
- Make sure oil level is ok. Oil pressure must be obtained in order for oil switch to send power to lock-off and open it for fuel flow. If your mower uses an oil switch as part of the fuel system.
- It takes fuel; air and ignition spark to make an engine run at this point you need to check for engine spark. If you have spark check fuel supply. Start by bypassing the lock-off electrically. One wire hot and the grounded will open the lock off. If it starts under that condition. The lock-off is either not getting proper ground or power or it is bad or you will need to replace it.
- If lock off is working check the regulator. Small vacuum hose must have vacuum in order to open the safety in the regulator. Determine if the pump on the engine is providing adequate vacuum. One way to determine if lack of fuel is the problem is to use a hand held propane torch bottle. Remove the hose from the intake manifold. Have someone turn the engine over while propane is being released from the bottle into the intake. If the engine starts then it is a fuel issue. If it does not start then it is an ignition problem.
- If engine runs using a propane torch or starting fluid and lock-off is working and you have vacuum to regulator, but still do not get fuel to carburetor, then you have a regulator problem and may have to replace it.
- All mowers will have safety switches designed to protect the operator. These safety switches are often wired together and can be complicated to track down if you have one that is keeping the mower from starting. Bypassing safety switches one at a time may be necessary to determine where the problem is.

** BACK FIRE ON START UP OR UNDER POWERED UNDER A LOAD

- One of the causes for back fire on start up can be one cylinder not getting Ignition Spark. That will allow raw fuel to go through that cylinder and back fire when ignition spark finally starts or produce a blue flame coming out of the exhaust. If the cylinder never gets spark two things will happen. (1) It will be under powered when a load is put on it. (2) You will very likely see a blue flame coming out of the muffler as the propane will ignite in the muffler. You will need to determine if you have a plug problem, plug wire problem or a magneto/stator problem.