Propane Mower

Dealer Demonstration Program Training Manual
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The Propane Mower Dealer Demonstration Training Manual is designed to help commercial mower dealers feel comfortable selling propane mowers to lawn and landscape customers as a part of the Propane Mower Dealer Demonstration Program.

IN THIS MANUAL, DEALERS WILL GAIN A BETTER UNDERSTANDING OF:

- The Propane Mower Dealer Demonstration Program and the goals it is designed to achieve.
- How propane mowers differ from gasoline mowers.
- How the propane mower fuel system works.
- The properties of propane as an engine fuel.
- Propane refueling options, delivery infrastructure, and how to refuel a propane mower.
- The benefits of propane mowers.
- Basic service and maintenance techniques for propane mowers.
- How to sell propane mowers effectively.

INTERACTIVE FEATURES

The interactive element of this manual allows dealers to easily reference a topic of interest by clicking on a specific section title in the Table of Contents. Once dealers click on a section title, the manual will skip to that topic of choice, and provide access to information at the click of a button. Also, dealers will find that they can click on links throughout the manual and will be directed to the referenced section. This interactive feature also allows dealers to search topics or sections by using key words in the search box.
SECTION TWO

Overview of the Propane Mower Dealer Demonstration Program

IN THIS SECTION:

• Learn the main goals and purpose of this program.
• Find out what support Propane Education & Research Council and the original equipment manufacturers will provide to participants in this program.
• Understand what is expected of dealers who participate in this program.

PROGRAM GOALS

The purpose of the Propane Mower Dealer Demonstration Program is to help commercial mower dealers provide demonstration propane mowers to their customers on a trial basis. Although there has been a small increase in propane’s market share during the past few years, sales of dedicated propane-fueled commercial mowers built by original equipment manufacturers (OEMs) remain low in comparison to the overall market share held by gasoline and diesel. The Propane Education & Research Council’s (PERC) goal is to change that and help create new business opportunities in the commercial mower industry.

Based on communications with OEMs and customer research, PERC has found that lawn and landscape customers and mower dealers have three primary requests before they feel comfortable purchasing or selling propane mowers. This program has been developed to address these requests:

• **Hands-On Experience with a Propane Mower.** Lawn and landscape customers want hands-on experience with propane mowers before they commit to buying them.

• **Education about Propane Mowers.** Dealers who are unfamiliar with propane technology are less likely to actively sell propane mowers. Because their unfamiliarity with the product, dealers would like support and training on propane mowers and refueling to feel more comfortable selling them.

• **Help Understanding Refueling Options.** As with any alternative fuel, refueling propane mowers is different from traditional gasoline mowers. Dealers and customers alike feel uncomfortable with how to handle refueling. They need to know that propane fuel is easy to get, easy to store, and easy to use before they are willing to buy propane mowers.

DID YOU KNOW

PERC developed this program to give lawn and landscape professionals hands-on experience with propane mowers before they commit to buying them and to help dealers sell propane mowers more effectively by providing basic propane training and refueling support.
Overview of the Propane Mower Dealer Demonstration Program

To address these issues, increase sales of propane mowers, and encourage the lawn-care industry to look more closely at propane products, PERC has launched the Propane Mower Dealer Demonstration Program. This unique program gives dealers the opportunity to have a propane mower in their dealership to display and lend to potential customers allowing them to gain firsthand experience with the product. The program also includes basic training on operating, maintaining, refueling, and selling propane mowers to give dealers the knowledge they need to sell propane mowers. Through this program, dealers will also have an opportunity to build relationships with propane providers in their area to gain their support with refueling and other technical fuel issues.

THE PROPANE EDUCATION & RESEARCH COUNCIL’S ROLE

Through this program, PERC plans to place 300 propane-fueled demonstration mowers at dealerships throughout the United States. Dealers will be chosen in partnership with original equipment manufacturers. PERC will also provide the following to ensure a successful program:

- **Financial Incentive.** As motivation for participating in the program, PERC will offer $2,000 per mower\(^1\) to reward dealers for meeting the requirements of the program and to help them justify their investment in the demonstration unit and cover the loss dealers will face when selling the used demonstration mower at the end of the demonstration period.

- **Online Training.** PERC will provide an online training session and this dealer training manual in a downloadable PDF format. The purpose of the training is to help dealers understand the basics of propane mower operation and service, refueling options and partners, the primary benefits of propane mowers, and key strategies for marketing propane mowers.

- **Building Relationships with Local Propane Providers.** PERC will help dealers build relationships with local propane providers who can help dealers with refueling and other fuel issues.

- **Communications Support.** PERC will provide communications support to promote the program and drive customers to the dealerships by distributing press releases to trade publications in the lawn and landscape industry and to local media outlets in each dealer’s area.

- **Surveys and Feedback.** PERC will collect monthly data from dealers on demonstration mower usage and customer feedback. This information is critical to PERC’s mission to understand and advance the market for propane mowers. The data will be collected through a simple online form, which will be sent via email to dealers once a month. If the survey has not been completed through the online form, PERC representatives will call dealers and collect this data.

\(^1\) Note that some OEMs have opted to change this amount for their mowers/dealers to include more dealers in the program.
Overview of the Propane Mower Dealer Demonstration Program

- **Ongoing Support and Assistance.** PERC support staff will be available to answer additional questions throughout the program. Every dealer will be given the direct email and phone number of a PERC support team member. You can also reach us through an email helpline at propanemowerdemos@propane.com.

- **Propane Mower End-User Incentive Program.** In an effort to help dealers sell more propane-fueled commercial mowers, PERC has established the Propane Mower End-User Incentive Program. This program rewards propane mower customers with an incentive up to $1,000 for purchasing a new, dedicated propane mower from their local dealer and for providing data on mower usage and performance to PERC throughout the mowing season.

The goal of the program is to sell 600 propane-fueled mowers by providing assistance with the incremental cost of a propane mower over a gasoline mower. Incentives will be allocated on a first come, first served basis. Once all 600 incentives have been allocated, the program will end. Customers interested in the incentive will sign a grant agreement with PERC, provide proof of purchase, contact information, and sign a commitment to provide data about mower usage throughout the mowing season. This data will include information about approximate fuel usage, mower performance, what worked well about the mower, and what could be improved. For more information, visit http://www.autogasusa.org/mower-incentive.

**NOTE:**

The Propane Mower End-User Incentive Program is open to all dealers, including those participating in the Propane Mower Dealer Demonstration Program.

**THE ORIGINAL EQUIPMENT MANUFACTURER’S ROLE**

Six original equipment manufacturers (OEMs) have contracted with PERC to participate in the Propane Mower Dealer Demonstration Program. The OEM's role is to get dealers involved and help them stay engaged, work with PERC to select the appropriate dealers to join the program, provide propane mowers to dealers, and channel financial incentives from PERC to the dealers selling their propane mowers.

Each OEM will provide the demonstration mowers through traditional floor plan programs, including agreements with dealers on ownership, operation, maintenance, and insurance. Throughout the program, OEM representatives will be available to support dealers on technical issues for their specific brand of propane mower. For a list of OEM contacts, see Section 13, Resources.
THE DEALER’S ROLE

PERC is asking dealers to meet several requirements to receive the $2,000 incentive, including participating in propane mower online training, meeting a minimum number of demonstration hours, providing monthly feedback through an online survey, and including the propane mower in promotional activities.

DID YOU KNOW

In order to receive incentive funding, the dealer must make a strong effort to complete the following:

- Watch a PERC online training session and download the Training Manual available in PDF format.
- Loan the demonstration unit out for at least 90 hours of use before selling it.
- Loan the mower out to multiple customers throughout the demonstration period.
- Provide online feedback to PERC each month on approximately how many people have tested the demonstration mower, how many hours of demonstration use the mower has gotten, and what feedback customers are providing on the performance and their experience with the propane mower. PERC will assist in this process by emailing monthly reminders with a link to an online form. If the form has not been completed each month, the dealer will receive a follow-up email and/or phone call reminder.
- Build relationships with local propane providers who can provide technical support on refueling and propane fuel issues. Local propane providers can be a great resource for helping to answer customer questions and assisting customers with refueling their propane mowers during the demonstration period and after they purchase a propane mower. Propane providers can also be partners in developing sales leads.
- Sell the mower to a customer by the end of the demonstration period.

Note that some OEMs have opted to change this amount for their mowers/dealers to include more dealers in the program.
How Propane Mowers Differ from Gasoline Mowers

The first question many potential customers will ask about propane mowers is: How are they different from gasoline mowers? Overall, the differences between these two types of mowers are relatively minor. The most visible difference is that propane mowers have exposed fuel tanks — the silver cylinders mounted to the mower frame. There are a few other differences that are worth knowing.

**Fuel System.** The fuel systems in propane mowers work differently than those in gasoline mowers because propane has different fuel characteristics than gasoline. OEMs have developed systems for their mowers to accommodate for propane’s natural properties. For a detailed overview of the propane mower fuel system, see Section 7, The Propane Mower Fuel System. For more information about the fuel properties of propane, see Section 4, Propane Fuel Properties.

**Environmental Benefits.** As an alternative fuel, propane is environmentally friendly and will lessen the carbon footprint of both your company and your customers. Propane mowers reduce greenhouse gas emissions by nearly 50 percent and carbon monoxide emissions by more than 80 percent compared to gasoline-powered mowers. For more information on the environmental benefits of propane mowers compared to gasoline mowers, see Section 6, Benefits of a Propane Mower.

**Choke.** A propane mower does not need a choke. Gasoline mowers use a choke to reduce the airflow entering the carburetor to provide the right air to fuel mixture entering the engine. Because propane is in a gaseous state when it enters the engine, propane mowers do not need this part. For more information, turn to Section 8, How to Operate and Store a Propane Mower.

**Storage.** It is much easier to store a propane mower than a gasoline mower. To store at the end of the day, simply turn the vapor withdrawal valve on the cylinder to the off position. That’s it. Propane fuel has no risk of moisture or degradation, and no fuel stabilizers are needed. To store a propane mower for a longer term, like over the winter, simply turn off the cylinder and run the mower until the propane fuel is out of the fuel lines. Propane fuel lasts

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**KEY SIMILARITIES OF PROPANE AND GAS MOWERS**

Many of your customers may want to know that there are actually more similarities between propane- and gasoline-powered mowers than there are differences. For example:

- Starting, running, mowing, and stopping are basically the same.
- Very few parts are changed to make a mower run on propane.
- Basic maintenance and service of propane-fueled mowers is virtually the same as gasoline mowers. We recommend always following the manufacturer’s suggested maintenance schedules.

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**DID YOU KNOW**

Commercial propane-fueled mowers offered by major mower manufacturers meet or exceed all current Environmental Protection Agency standards and, if sold in California, the more stringent California Air Resources Board standards.

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Section 3: How Propane Mowers Differ from Gasoline Mowers
for years, with no need for fuel stabilizers and no risk of contamination from water, simplifying long-term storage. For more information on propane mower storage, see Section 8, How to Operate and Store a Propane Mower.

**Cylinder Mounting.** Propane cylinders are mounted externally within the outline of the vehicle to ensure that the cylinder will not hit any surrounding objects. However, propane cylinders are 20 times more puncture resistant than a standard gasoline or diesel fuel tank and can be safely mounted outside of the mower body. For more information on refueling propane mowers, see Section 10, How to Refuel Propane Mowers.

One difference between propane- and gasoline-fueled mowers is that the propane fuel cylinders are mounted on the outside of the mower body.
Propane Fuel Properties

This section covers some basic characteristics of propane fuel. Because propane's chemical composition and fuel properties impact how propane-fueled equipment performs, it is worth understanding the basics about the fuel.

IN THIS SECTION:

- Understand propane as an engine fuel.
- Recognize how propane fuel affects the operation of mower engines.
- Learn how to get the best performance from propane-fueled mowers.

WHAT IS PROPANE?

Understanding the composition of propane will give dealers a better understanding of how it works as a clean-burning fuel.

Propane contains fewer carbon atoms than gasoline. The chemical composition of propane is C₃H₈ (or three carbon atoms and eight hydrogen atoms) while gasoline is C₈H₁₈ (or eight carbon atoms and 18 hydrogen atoms). Propane is referred to as a hydrocarbon because it is made up of hydrogen and carbon.

Propane is a lower-carbon fuel than gasoline. This has many positive impacts on how propane-fueled mowers operate.

Propane has only three carbon (C) atoms (right) compared to eight carbon (c) atoms in gasoline (left).
**Propane Fuel Properties**

**Ignition.** The carbon content of the fuel influences how well a mower starts and runs. Higher carbon fuels have greater electrical conductivity and ignite more easily. Propane is a lower carbon fuel than gasoline so it ignites less easily, but OEMs have accommodated for this difference in their mowers.

**Emissions.** Propane’s lower carbon to hydrogen ratio results in lower carbon dioxide (CO2) emissions, lower carbon monoxide (CO), and less smog reactive hydrocarbons in exhaust emissions. The propane hydrocarbon is less reactive causing less damage to the ozone layer than gasoline.

**Odorants.** Because propane is odorless and colorless in its natural state, an odorant must be added so that propane users can detect leaks.

An effective odorant assists in detecting leaks before gas concentrations in the air reach a flammable level. Odorants also reduce gas loss through early detection and repair of leaking pipes, fittings, and storage container fixtures. The most common odorant is ethyl mercaptan, which has a very pungent odor. Ethyl mercaptan matches the vapor pressure of propane and is also resistant to decomposition. Propane manufacturers add an odorants to the fuel when it is withdrawn from the pipeline using injection equipment.

**Octane.** The octane rating of a fuel indicates how much the fuel can be compressed before it spontaneously ignites. When gas ignites by compression rather than because of the spark from the spark plug, it causes knocking in the engine. Propane can stand higher compression pressures and more advanced ignition timing than gasoline because it has a higher octane rating. As a result, the same engine running on propane can be tuned to get more horsepower than when it runs on gasoline.

- Propane’s octane rating is ~106 octane; gasoline’s rating is 82 to 93 octane.

**Fuel Economy.** Propane delivers slightly lower fuel mileage than gasoline because it has a slightly lower energy density than gasoline. Most end-users see a decrease in fuel economy of 10 percent or less. However, this difference in fuel economy is usually more than made up for by propane’s lower costs compared to gasoline.
Propane Fuel Properties

**Vapor Versus Liquid State.** Propane is a gas in its natural state and will stay in this form under normal pressure and temperatures above -44° F. Propane turns into a liquid when stored under moderate pressure making it easier to transport and store. Propane’s pressure varies with temperature. For example, at 35° F, cylinder pressure is 58 PSIG; at 95° F, cylinder pressure is 160 PSIG. Gasoline, on the other hand, is a liquid at normal air pressure in both its natural and stored states.

**Ignition Temperature.** Propane has a much higher ignition temperature starting at a minimum of 920° F. The minimum ignition temperature of gasoline is 500° F. This makes propane a very safe fuel. Propane won’t ignite when combined with air unless the source of ignition reaches at least 920° Fahrenheit, while gasoline will ignite when the source of ignition reaches only 500° Fahrenheit.

**Air/Fuel Mixtures.** Understanding how the air/fuel mixture is important because it impacts the ignition of fuel and therefore how a mower starts, how the propane fuel burns, and, the performance and emissions of the mower.

Propane operates at a leaner air/fuel ratio than gasoline. Gasoline operates at 14.7:1. Propane operates 15.5:1. It is critical to get the right air/fuel mixture for a propane mower to operate correctly. When fuel is introduced into the air flowing to an engine’s combustion chamber, the mixture becomes a conductor. The engine can only start and run properly if the engine’s electrical circuit is completed, which in turn requires that the air/fuel mixture is correct. Lean air/fuel mixtures are difficult to ignite — so mowers may not start well or run well if the ratio isn’t right. Rich air/fuel mixtures can result in lower fuel economy and increased emissions.

**Specific Gravity (Vapor).** Specific gravity is an important safety feature that dealers and their mower technicians need to be aware of when performing maintenance.

Propane is heavier than air. When propane vapor leaks, it sinks accumulating in low-lying areas. Natural gas, on the other hand, rises. If liquid propane leaks, it doesn’t puddle but, instead, vaporizes and dissipates into the air.

**Weight of Fuel.** Gasoline weighs 6 pounds per gallon compared to propane which weighs only 4.2 pounds per gallon. However, when using an aluminum cylinder with propane, propane and gasoline have no weight differential.

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**DID YOU KNOW**

Propane eliminates ethanol issues. Ethanol issues are a top concern for many landscape professionals, who are running into problems because there is ethanol in regular gasoline sold at many gas stations today. Propane fuel eliminates the issues associated with ethanol because ethanol is not mixed in propane.
Section 4: Propane Fuel Properties

Flammability Limits. Flammability limits play a role in two areas:

- How lean or rich an air/fuel mixture can be before a fire could occur.
- Safety. Fuels that can ignite across a broader range of temperatures require greater safety precautions to avoid unintended ignition.

Propane has a narrow range of flammability, making propane safer than gasoline. That means it will not ignite except within a narrow range of temperatures. The lower limit is the percentage of gas in the leanest (least gas) mixture that will support combustion. For propane, the lower limit is 2.15 percent. The upper limit is the percentage of gas in the richest (most gas) mixture that will support combustion. For propane, the higher limit is 9.6 percent.
Customers often have questions about where propane comes from, if the supply is adequate, and if it can be easily delivered to their locations.

**IN THIS SECTION:**
- Understand fuel availability and delivery methods.
- Learn how propane is transported to propane suppliers and end-users.

**Where Does Propane Come From?** Propane is a by-product of natural gas and petroleum refining. The majority of propane used in the U.S. comes from natural gas, and the remainder comes from petroleum refining. Propane is a **domestically produced fuel**. Nearly 97 percent of propane consumed in the United States is produced in North America.

Up to 56,000 miles of pipeline, more than 6,000 retail dealer locations, and more than 3,500 providers make propane readily available throughout the United States.

**How is Propane Delivered?** Propane is shipped from its point of production to bulk distribution terminals, primarily through pipelines. When propane is needed, it is shipped by pipeline, ground transportation, and rail to secondary aboveground storage facilities. Then, propane is transported to other areas of the country via ground transportation for customer use.

- **Propane is easy to transport** and used beyond gas main pipelines because it can be transported by truck and stored in portable cylinders.

- **Propane is easy to deliver to an end-user’s location.** Propane providers can install low-cost private refueling infrastructure for larger users or can deliver full propane cylinders and remove empty ones from end-user’s location.

- **Propane is available at public refueling stations.** Propane is the only alternative fuel with fueling stations located in every state; and the United States has the world’s largest propane storage capacity.

For more information about refueling with propane, refer to **Section 10, How to Refuel Propane Mowers**.
The vast majority of propane used in the U.S. is domestic. There is a well established distribution system and the fuel is widely available everywhere in the nation.
As a dealer, it is valuable to familiarize yourself with the numerous benefits of propane mowers. The purpose of the Propane Mower Dealer Demonstration Program is to help inform lawn and landscape professionals of these benefits so that they can make knowledgeable decisions when it comes to purchasing propane-fueled commercial mowers. Dealers play a very important role in communicating these benefits to their customers.

**IN THIS SECTION:**
- Lower operating costs.
- Simple and convenient refueling options.
- Increased productivity.
- Equal performance to their gasoline counterparts.
- Easy maintenance and storage.
- Environmental benefits.
- Safety.

**LOWER OPERATING COSTS**
Propane fuel is competitively priced. Research shows that propane-fueled mowers cost less to operate than gasoline-fueled mowers. Propane is usually available at a significantly lower cost per gallon than gasoline. Also, with propane there is little to no fuel loss due to theft or spillage.

**EASE OF REFUELING**
Refueling propane equipment is easy. There are two primary options available from your propane provider for refueling:

- **Cylinder Exchange.** This refueling method is already used successfully by hundreds of thousands of forklift operators across the country. Using this method, simply remove the empty cylinder from the mower and replace it with a full one provided by the propane supplier.

- **Refilling Cylinders From a Propane Refueling Station.** This method likely makes the most sense for customers who use larger quantities of propane fuel, as it usually requires installing a propane refueling station on-site. Using this method, empty cylinders are refilled from a propane pump at an on-site propane refueling station. Propane refueling is discussed in more detail in Section 10, How to Refuel Propane Mowers.

**DID YOU KNOW**
Refueling landscape equipment with regular gasoline results in 17 million gallons of spilled gasoline in the U.S. each year — more than one and a half times the volume of oil spilled by the Exxon Valdez into Prince William Sound in 1989. Using propane-fueled equipment reduces this spillage.

In the cylinder exchange refueling method, propane providers deliver full propane cylinders to customers’ sites and remove empty ones.
Benefits of a Propane Mower

INCREASED PRODUCTIVITY

Propane-fueled mowers can help increase your overall productivity in several ways.

- **Continue to Operate During Air Pollution Advisories.** Due to their low emissions, propane-fueled mowers can continue to operate even when air pollution advisories, such as ozone action days, are in effect. Be sure to check local regulations for details.

- **Save Time and Money by Not Going to the Gas Station.** Propane can also help customers operate more productively. Because propane fuel is delivered right to their business, customers will save time going to the gas station to refuel equipment. This might sound like a small source of savings, but it can add up. For example, a company could save almost $5,000 per year by not going to the gas station (based on a team of four employees and a 30 minute gas station trip).

<table>
<thead>
<tr>
<th>Extra Gasoline Fill Up Time Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 Minutes</td>
</tr>
<tr>
<td>30 Minutes</td>
</tr>
<tr>
<td>4 employees per team</td>
</tr>
<tr>
<td>Lost Time Per Day</td>
</tr>
<tr>
<td>6 hours</td>
</tr>
<tr>
<td>times 6 Days/Week</td>
</tr>
<tr>
<td>times $10/Hour</td>
</tr>
<tr>
<td>$2,400</td>
</tr>
</tbody>
</table>

In addition, employees can’t “borrow” propane for their personal trucks.

Save Time and Money with On-Site Propane Fuel Delivery

On-site propane refueling stations can use fuel pumps very similar to those found at your local gas station.
Benefits of a Propane Mower

EQUIVALENT PERFORMANCE

Properly tuned to the manufacturer’s guidelines, propane mowers offer the same power and work capability as gasoline-fueled commercial mowers. Propane mowers offer approximately the same length of mowing time per fuel cylinder and even better performance on steep slopes because vapor fuel will reach the engine even when the mower is at a steep tilt.

EASY MAINTENANCE AND WINTER STORAGE

Another added benefit of the natural properties of propane: It doesn’t go bad. This makes for ease of storage during the winter months. For more information about storage, see Section 8, How to Operate and Store a Propane Mower.

ENVIRONMENTAL BENEFITS

For those customers who are interested in the more eco-friendly aspects of a propane mower, there are many environmental benefits of switching to propane-fueled mowers.

• **Cleaner-Burning than Gasoline.** Propane-fueled equipment runs cleaner than gasoline or diesel, releasing fewer pollutant emissions and greenhouse gases.

• **Lower Greenhouse Gas Emissions.** Propane-fueled mowers reduce greenhouse gas emissions by nearly 50 percent.

• **Reduce Air Pollution and Emissions that are Harmful to Human Health.** Propane mowers reduce carbon monoxide emissions by more than 80 percent and emit significantly fewer ground-level ozone precursors and particulate matter than gasoline-powered mowers. These emissions cause ground-level air pollution, commonly referred to as smog. They also worsen health conditions like asthma.

• **Eliminate Ground and Water Pollution from Spilled Gasoline.** The pressurized storage of propane reduces any fuel spillage. The EPA estimates that more than 17 million gallons of gasoline are spilled during the refueling of lawn equipment each year. Gasoline typically contains more than 150 chemicals, including small amounts of benzene, toluene, xylene, and sometimes, lead, that are released into the environment.
Benefits of a Propane Mower

PROPANE IS VERY SAFE

Safety is a top concern for many dealers and lawn and landscape professionals who are just learning about propane. Here are some points to use to help customers understand that propane is very safe.

- **Low Ignition Range.** This means propane is less likely to light on fire than many other fuels.

- **Highly Reinforced Fuel Cylinders.** This means it is highly unlikely a cylinder will be punctured and leak propane.

- **Low “Explosion” Potential, Given Proper Handling.** Following simple guidelines for safe refueling and fuel handling, propane is very safe.

- **Already in Use.** Most customers already use it on their own back deck. If people are comfortable having a propane cylinder right next to their house to cook hamburgers, they should feel comfortable using it to fuel their mower.

**Remember:** All of the equipment in this demonstration program is sold by major manufacturers who test their equipment to meet rigorous safety standards.
The propane fuel system is a dedicated part of the demonstration mower when delivered to the dealer. The fuel system is installed by the original equipment manufacturer and is not an aftermarket conversion kit.

### HOW THE PROPANE MOWER FUEL SYSTEM WORKS

The fuel system in a propane-fueled mower works much the same as a gasoline model.

The main difference is that propane is a gaseous fuel that is a vapor at normal air pressure and temperature. Propane fuel is stored as a liquid under pressure in the fuel cylinder, but turns to a vapor when it leaves the pressurized fuel cylinder and enters the fuel lines before entering the engine. This is different from a gasoline mower where the fuel remains in a liquid state until it hits the carburetor.

**Gaseous Fuel System Operation.** A gaseous fuel system performs the same functions as a gasoline fuel system. However, there are important differences between the two.

- The major components of a gaseous system are separated throughout the engine compartment, rather than in a one-piece casting, such as in a gasoline carburetor. For example, a gas/air mixer performs the same function as a carburetor venturi and discharge nozzle.
- The primary side of the gas regulator performs the initial pressure reduction. This also helps with vaporization. The secondary side provides the final pressure trim or dampening similar to a float chamber and inlet needle and seat in a traditional carburetor.

### HOW PROPANE TRAVELS TO THE ENGINE

- The propane leaves the cylinder through a pressurized fuel line (160 PSIG or less).
- The pressurized fuel line is connected to the fuel lockoff.
- If the lockoff is open, which it will be if the fuel cylinder is turned on, the fuel passes through the lockoff and into the regulator.
- Low pressure lines feed into the carburetor, which is mounted on the engine.

### DID YOU KNOW

In a propane fuel system, a fuel pump is not needed because the vapor is naturally pushed from the cylinder to the regulator/carburetor due to the change from pressurized liquid to unpressurized vapor when the fuel leaves the cylinder and enters the fuel lines.
The Propane Mower Fuel System

CARBURETION

The majority of gasoline fuel systems currently in use for outdoor power equipment still use carburetors. Carburetors all perform the same basic functions. The fundamental purpose of any fuel system is to measure the incoming air mass and mix the appropriate amount of fuel, under all engine-operating conditions. This applies equally to gasoline or gaseous fuel systems. The basic engine operating conditions have not changed much over the years. What has changed is government and consumer outlooks concerning lower exhaust gas emissions, improved fuel economy, and efficient energy usage and conservation.

HOW THE FUEL GETS FROM THE CYLINDER TO THE ENGINE

Vapor withdrawal and liquid withdrawal are two methods used to supply propane to an engine. Check with the mower manufacturer to determine which type of cylinder is used on their mowers.

Vapor withdrawal is common on small, air-cooled engines.

- Fuel is drawn from the vapor space in the cylinder and forced forward by the pressure in the cylinder directly to the regulator.
- The size of the cylinder and the ambient temperature affect how much propane gas is available to the engine from the vapor space in the cylinder.

In liquid withdrawal, the pressure in the cylinder forces liquid fuel forward.

- The liquid is turned into a gas at the vaporizer/regulator (converter).
- This method ensures that an adequate supply of fuel is available for the engine demand regardless of the cylinder size or temperature.

DID YOU KNOW

Propane becomes a vapor as soon as it leaves the cylinder, where it is under pressure, and enters the fuel lines. Then, it runs through the fuel lines as a vapor and enters the engine as a vapor.
The Propane Mower Fuel System

KEY COMPONENTS OF THE PROPANE FUEL SYSTEM

The propane fuel system has several components that are different from a gasoline fuel system. This section explains the key components of a propane fuel system.

**Automatic Shutoff Valve/ Fuel Lockoff.** An approved automatic shutoff valve, more commonly known as a lockoff or fuel lock, must be provided in the fuel system and installed as close as practical to the gas regulator. This valve prevents fuel flowing to the regulator and mixer when the engine is not running, even if the ignition switch is in the “on” position. Since propane is stored under pressure in the cylinder, no fuel pump is required. For safety reasons, a method of automatically shutting off fuel to the engine when the engine stops for any reason is therefore provided by the fuel lockoff. In addition to the lockoff function, most fuel lockoff valves also incorporate a filter to prevent contaminants from entering the fuel system.

**Types of Fuel Lockoffs.** There are two types of fuel locks that are used in a gaseous fuel system: electrical lockoffs and vacuum fuel locks.

**Electrical Lockoff.** The electrical lockoff uses a magnetic coil which, when energized, lifts the piston off its seat, allowing gas to flow. When the current stops, a small spring forces the piston back down, covering the seat and stopping the flow of fuel. In order to meet the requirements for propane fuel system lockoffs, which states that the fuel lock must close when the engine is not running, a safety switch must be added.

There are various types of safety switches used:

- A vacuum safety switch.
- An oil pressure safety switch.
- An electronic device that senses secondary ignition pulse.

These switches stop the flow of current to the lockoff when the engine is not running, even if the key is on. Some fuel lockoffs incorporate a filter to remove impurities as part of the lockoff. Most applications use a small electric lockoff and a separate filter, which is incorporated as part of the fuel system. The internal portion of the filter may look like a gasoline filter because the fuel is in a liquid state similar to gasoline. Some filters also contain a magnet to capture any rust flakes and metal scale that flakes off from a steel fuel cylinder. If these particles go through the system, they could get under the regulator valve seats.

**Vacuum Fuel Lock.** The vacuum fuel lock operates due to the venturi vacuum created when the engine is running. During engine cranking or running, a small venturi vacuum signal from the air valve acts on a diaphragm assembly and, with atmospheric pressure, moves the diaphragm inward against a valve-operating lever. The lever, in turn, moves a valve-operating pin that lifts the fuel valve off its seat and allows propane to flow through the filter and lockoff.
to the regulator. If the pin or lip seal around it becomes worn or damaged, gas will pass into the vacuum chamber on back through the vacuum hose to the air valve as unmetered fuel. This results in a rich air/fuel mixture and high CO emissions.

**Vacuum Safety Switch.** The vacuum safety switch can be a two- or three-pole switch. A vacuum switch is a canister with two contact posts: an internal diaphragm and contacts, and a vacuum port. When a vacuum is applied to the canister, electrical currents pass through when the diaphragm is pulled against the contacts. When the engine is not running, contact is broken because there is no vacuum present. In three-pole vacuum switches, the third pole used is for a starter bypass so that electrical current can energize the lockoff during engine cranking.

**Oil Pressure Safety Switch.** The oil pressure safety switch operates similarly to the three-pole vacuum switch, except it is activated by engine-oil pressure. It takes 4 pounds of oil pressure to close the terminals. The oil pressure switch has one advantage over the vacuum switch — this unit shuts off the fuel when the oil pressure drops below 4 pounds. This, in turn, stops the engine, possibly preventing serious engine damage.

For more information on propane cylinders, see [Section 10, How to Refuel Propane Mowers](#).
Operating and storing a propane-fueled mower is simple. There are very few differences between gasoline mowers and propane mowers. In many cases, the differences are actually significant benefits for the propane mower.

IN THIS SECTION:

- Identify the basic operational differences between propane-and gasoline-fueled mowers.
- Discover why propane mowers are so easy to operate.
- Learn how to start, run, and store a propane mower.

STARTING A PROPANE MOWER

With a propane-fueled mower, operators will experience easy daily operation. Follow these simple steps to operate your mower.

To start the mower:

- Turn on vapor withdrawal tube/valve, also commonly referred to as the service valve, to release the propane. On forklift cylinders, which are used by some mower brands, this valve is called the liquid withdrawal valve.
- Turn key to start. (No choke is needed.)
- Operate mower.

NOTE:

The only differences in operating a propane mower from operating a gasoline mower are that you turn the fuel cylinder on before starting the mower and you do not need to use a choke.

At end of operation:

- Turn key off.
- Turn off vapor withdrawal tube/valve, also commonly referred to as the service valve, to seal off the propane.
- Store for the evening.

NOTE:

The only difference in shutting down a propane mower from shutting down a gasoline mower is that you turn the fuel cylinder off when you are done running the mower.
How to Operate and Store a Propane Mower

OPERATING A PROPANE MOWER

Operating a propane mower is the same as running a gasoline mower. Once the mower is on, start the cutting blades and get to work.

The following information is included to help you understand the parts of a propane mower, which make it run efficiently.

**The Venturi Principle.** The venturi principle explains how fuel is sucked into the carburetor. As air is drawn into the engine by the piston, it must pass through a venturi, which creates a low pressure (a vacuum) proportional to the amount of air being drawn through the venturi. In a gasoline mower, which has a liquid fuel system, the vacuum created by the venturi acts on the discharge nozzle, main jet, and, in turn, the float and needle valve to draw in fuel. In a propane mower, which has a gaseous fuel system, the low pressure generated in a gaseous fuel mixer acts upon a diaphragm in a fuel regulator (zero governor, final stage regulator). As the diaphragm is drawn toward the source of the low pressure, an attached lever opens a valve and allows the gaseous fuel to flow through to the carburetor. The proper air/fuel mixture is then obtained by a mixture adjustment in the fuel line between the fuel regulator and the venturi.

**Idle Adjustment.** There are several different methods used to control idle air/fuel mixtures. The most popular methods are described here. With the throttle plate nearly closed, the air and fuel metering valves are almost at rest in their seats. (This may not be the exact position necessary for all engines.)

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**Turning on a Propane Cylinder**

*Before starting a propane mower, turn the vapor withdrawal tube/valve, also known as the service valve, to the on position. Turn this valve off again at the end of mower operation. On forklift cylinders, which some mower brands use, this valve is called the liquid withdrawal valve.*
How to Operate and Store a Propane Mower

Air is allowed to bypass the air valve via an idle air passage. An adjustment screw limits the amount of air that is able to bypass the air valve thus causing the air and fuel metering valves to rise or fall to the correct position for each application.

Part Throttle Mixtures. Part throttle mixtures are controlled by the fuel-metering valve. The shape of this valve plays a very important role as to the exhaust emission levels the engine produces at part throttle. The valve is only partly out of the orifice during part throttle operation and the power mixture adjustment has very little effect at this throttle position.

Full Power Mixtures. When the demand for full power is upon the engine, and the air/fuel valve is fully lifted, the fuel-metering valve gives up its authority to control the fuel mixture and the authority is given to the power mixture control. The same mixer and engine may have a variety of applications so this necessitates that the full power mixtures be field adjustable. Note: This should be set at maximum rpm with manifold vacuum 3 inch h.g. or lower.

Storing Propane Mowers
Propane-fueled mowers can be stored anywhere gasoline-fueled vehicles are stored. There is no need to build additional facilities to accommodate propane mowers. Any additional propane cylinders you are storing, not attached to a mower, should be secured in a storage cage or other protected storage area away from ignition sources that include such things as open flames or spark producing equipment. Cylinders should be stored horizontally.

Storing a propane mower at the end of the day is simple: Park the mower and turn off the propane cylinder.

FUEL CYLINDER STORAGE

When storing tanks inside a building, there can be no more than 300 pounds of propane at one spot (NFPA 58, 2011 edition). Additional cylinders must be stored 300 feet away. An empty cylinder is considered the same as a full one for this purpose. For more information about the Liquefied Petroleum Gas Code NFPA 58, visit www.nfpa.org.
How to Operate and Store a Propane Mower

**Short-Term Storage.** Storing a propane mower at the end of the day is easy. Simply park the mower where desired and turn off the propane cylinder. The sealed cylinder means that there is no risk of water or other contaminants entering the fuel. Also, there is no need for fuel stabilizers. There is also no need to use ethanol, which can attract moisture into gasoline fuel and cause engine problems. This is a significant benefit of propane mowers.

**Long-Term Storage.** When propane mowers are being stored for a long period, shut off the cylinder supply valve and run the mower until the fuel trapped downstream of the valve is depleted. The National Fire Protection Association's NFPA 58 Manual covers the procedures for storage and garaging for repair purposes on propane-fueled equipment. Unlike gasoline mowers, there is no need to drain the cylinder because propane fuel does not go bad like gasoline often does during the winter months.
As a dealer, knowing the basics of how to service and maintain propane mowers provides the background to knowledgeably sell this product to potential customers.

**IN THIS SECTION:**
- Understand basic maintenance.
- Troubleshoot possible performance issues.

**BASIC MAINTENANCE**
Maintaining a propane mower is very similar to maintaining a gasoline one. For all maintenance issues, please follow the original equipment manufacturer (OEM) mower manual included with the propane demonstration mower. If the manual does not answer your questions, please contact your OEM representative. See Section 13, Resources, for a list of OEM contacts.

**BASIC SERVICE AND TROUBLESHOOTING**
The remainder of this section provides an overview of possible performance issues when servicing propane mowers, and guidance on how to figure out exactly what the problem is to resolve performance issues.

**Verifying Engine Condition.** A rough running engine may indicate vacuum hoses have fallen off. To find out, perform these tests:
- Spray a compound around the carburetor base plate and intake manifold area to check for vacuum leaks.
- Perform a dry and wet compression test or a cylinder air pressure test.

Once assured that the other engine components are in good operating condition, the fuel system may be checked. When using proper methods, the complete fuel system can be tested in about 15 to 20 minutes.

**Ignition System.** Propane requires greater electrical energy for proper ignition as compared to gasoline. What may be an acceptable ignition system for gasoline may not be acceptable for propane. If a no-start or poor running condition exists, a spark may jump that gap, but may not have sufficient energy to fire when compression and an air/fuel mixture are present in a combustion chamber. However, if the spark jumps the gap of the test plug, the ignition system is generally fine.
Fuel Ignition. Starting and running a mower requires igniting the fuel. So it is useful to understand how propane ignition differs from gasoline ignition. As discussed in Section 4, Propane Fuel Properties, propane is a lower carbon fuel than gasoline, and, as a result, does not ignite as easily. One simple remedy for this, which should be undertaken by the manufacturer, is to reduce the spark plug gap.

Because propane has different ignition properties than gasoline, it is useful to review the process of combustion within the combustion chamber and how a simple ignition system functions.

A typical spark plug design consists of an insulated electrode and a ground. To cause a spark to cross from the electrode to the ground requires a certain amount of electrical energy.

- The energy comes from the ignition coil to the ignition wires. The energy from the collapsing magnetic coil field induces a high voltage in the secondary windings. The voltage is then transferred through a single high-tension carbon wire to the spark plug.
- A metal connector joins the plug wire to the spark plug, allowing the electrical energy to flow down the insulated electrode. If there were only atmospheric air in the combustion chamber, the spark would easily jump across to ground; but because the rising piston on the compression stroke compresses the air, the spark will not jump because the resistance is too great. This is where fuel composition becomes important.
- In order for the electrical energy to reach ground, a conductor is needed. If some form of carbon is placed between the electrode and the ground, the energy can then freely dissipate. A source of carbon is found in the carbon content of fuel.

Each molecule of fuel (propane, for example) contains hydrogen and carbon. Carbon is a good conductor of electricity. The carbon in the fuel becomes a bridge for the electrical energy to jump the spark plug gap. The energy will cross the gap as long as there is sufficient carbon (fuel) in the air mixture.

Spark plug gaps should be checked and should be within the manufacturer’s specifications.

DIAGNOSING PERFORMANCE ISSUES

No-Start. Possible fuel system causes:

- No Fuel. Obviously if there is no fuel, the mower won’t run. The first thing to check is whether or not there is fuel in the cylinder. Check the fuel level by observing the fuel gauge or cylinder pressure gauge. If there is no gauge in a propane cylinder, the safest method is to remove the cylinder and check its weight or open the liquid-level valve and monitor any discharge.
• **Cylinder On/Off Switch.** Unlike gasoline mowers, operators have to manually turn on the cylinder before starting the mower and turn it off again when done running the mower. If the mower won’t start, make sure the fuel cylinder is switched to the “on” or “open” position.

• **Faulty Lockoff.** If the lockoff does not open when the engine is running, fuel will not be released from the cylinder. If it is vacuum operated, remove the vacuum hose and apply a vacuum using a vacuum hand pump. Confirm that the fuel lockoff will hold a vacuum. If so, is fuel flowing to the regulator?

• **Vacuum or Oil Safety Switch Faulty.** Once it is confirmed that fuel is at the fuel lockoff, check the lockoff function. Confirm that the electrical current is at the lockoff during cranking. If not, check the vacuum or oil pressure safety switch operation.

• **Incorrect System Wiring.** Refer to the manufacturer’s wiring schematic.

• **Faulty Regulator.** Most regulators have a port for testing the pressure at the primary section of the vaporizer/regulator. Some regulators have 1/8 inch pipe threaded plugs that require a 7/16 wrench to remove. Connect a 0-20 psi gauge to the port and crank the engine. Primary pressure should be within the manufacturer’s specifications.

• **Fuel Mixture.** Air/fuel mixtures that are too lean or too rich will prevent an engine from starting. Check for a residue buildup in the vaporizer/regulator and gas mixer. This residue sets up and has a wax-like appearance when cold. This can prevent the proper functioning of these components, causing incorrect fuel mixtures.

If all of the above has been ruled out, confirm that fuel is available to the gas mixer, that the hose supplying fuel to the mixer is disconnected, and that the regulator primer is activated to check fuel delivery.

**Proper Regulator Function.** The heart of a venturi-type gaseous carburetion system is the vaporizer/regulator.

The key to satisfactory performance in the venturi system is the sensitivity of the fuel regulator throughout its operating range. When dealing with this type of system, consider the following:

• A properly set regulator using a rubber seat and spring tension against an orifice will shut off the flow of fuel when the engine is not running.

• The slightest amount of vacuum should cause the seat to move and allow gas to flow.

• If the spring force is too great and requires a greater vacuum to open the device, a flat spot or sluggish progression off idle will develop with the possibility of lean mixtures and power losses at full load.

If the fuel regulator allows fuel to leak through at shutdown, a flood condition will occur similar to that in a liquid fuel carburetor, resulting in hard-starting and the danger of fire.
Hard-Starting

- Ignition system, system condition, and ignition timing.
- Engine mechanical system.
- Fuel system:
  - Faulty lockoff.
  - Faulty vacuum or oil safety switch.
  - Incorrect system wiring.
  - Faulty regulator.
  - Lean fuel mixtures/rich fuel mixtures.
  - Throttle in incorrect position during cranking.

The procedure for diagnosing a hard-start condition is similar to the no-start condition; but there are some differences. First, follow the no-start procedures. If these procedures do not indicate any failures, then check idle fuel mixtures. It is best to use a four-gas exhaust gas analyzer for this procedure.

Cold-Starting. Gaseous fuels like propane pose slightly different problems for fast cold-starts than a conventional gasoline fuel system. An explanation of what happens when a vehicle shuts off will help understand what steps to take to correct a poor cold-start.

- A major difference with a gaseous fuel system like propane is that the major components are separated in the engine compartment.
- The vaporizer/regulator, acting as a carburetor float system, is separated from the gas mixer.
- When the engine shuts off, gas is trapped in the gas delivery hose connecting the mixer to the regulator.
- As the engine cools down, the gas in the hose contracts and air from the engine is drawn into the gas hose.
- When the engine is cranking to restart, the air has to be purged from the system before the engine will start.
- A similar situation occurs when attempting to light a propane barbecue grill after replacing the cylinder.
**Simulating Cold-Starting.** Most cold-starting problems are caused by incorrect installation or inadequate ignition systems. In many cases, after the engine is started and warmed up, it will restart satisfactorily during the day even if the weather is quite cold. Therefore, a first morning start-up problem can be hard to troubleshoot. In a properly functioning gaseous fuel system, the starting time required is approximately one second for every 1 foot length of gas hose between the fuel regulator and the mixer.

**NOTE:**

*Mounting the regulator as close as possible to the mixer can alleviate this condition. To simulate first morning start up when servicing a mower for customer complaints about cold-starting issues:*

- Disable the gas lockoff.
- Loosen the hose clamp on the fuel regulator end of the gas hose.
- Remove the gas hose at the fuel regulator.
- Crank the engine.

The rotation of the engine will pull all of the gas from the mixer and the hose and replace it with air. To ensure that there is no fuel left in the engine or mixer, reconnect the hose and crank the engine with the throttle partly open to verify that the system is completely purged.

**Vaporizer/Regulator Freeze-Up.** Regulator freezing will occur if the engine coolant fails to circulate the heat exchanger portion of the vaporizer/regulator. Confirm correct circulation. Aftermarket temperature control systems are also available. They are designed to keep the regulator/vaporizer temperatures below a point where ‘heavy end’ hydrocarbons begin to drop out of propane and cause problems.

**Blocked Fuel Filter.** A fuel filter can get plugged with cylinder slag — a gray metal-like substance that comes from the inside of steel propane cylinders. The key indicator that this is occurring is freezing at the fuel filter when the engine is at full load.

**Low-Regulator Pressures.** Check the outlet pressure at the inlet to the low-pressure regulator. This check should be carried out at both idle and at full power. If there is a large pressure drop between these two readings, the high-pressure regulator may need servicing or readjusting.

**Regulator Atmospheric Vents Restricted or Plugged.** A regulator must have a vent to the atmosphere in order to set up a differential pressure on the secondary diaphragm. Many machines have this vent connected to the air cleaner side of the mixer to correct improper fuel mixture calibration caused by airflow restrictions in the air cleaner. If the regulator vent is restricted or
blocked, the incorrect difference in pressure in the secondary side of the regulator will cause the regulator not to deliver sufficient fuel to meet engine demands.

**Mixer Air-Flow Capacity Mismatched to Engine Capacity.** The gas/air mixer must have sufficient capacity to meet engine airflow requirements. Many conversions are aftermarket conversions, and the possibility of an incorrect mixer application can arise.

**System Byproducts.** When inspecting a propane vaporizer/regulator mixer or carburetor, a certain amount of heavy ends or fuel byproducts will be found in the system.

HD5 grade propane — the highest grade of propane fuel available to consumers — is recommended for use in propane mowers. The vast majority of propane fuel available in the U.S. meets this specification. However, even HD5 propane will carry a certain amount of heavy ends. Propane is a byproduct of crude oil and natural gas. In the extraction process various hydrocarbons are separated; products, such as gasoline, kerosene, oil, propane, butane, and diesel fuel, are separated. None of these products are perfectly pure. Each of these carries a certain amount of byproduct residue called heavy ends. Under normal circumstances, these residues remain in suspension in liquid and pass through the system undetected.

Why do these propane fuel byproducts occur? Engine coolant flows through the vaporizer/regulator assisting in the propane vaporization process. As the coolant temperature rises, the vaporizer/regulator temperature also rises. The gas becomes hot and expands to the point where it cannot carry the heavier hydrocarbons and drops them into the vaporizer/regulator.

When they cool, they become a wax-like sludge. Some manufacturers provide an opening in the regulator to drain out this product. A fuel filter cannot remove this, as it is not dirt, but a part of liquid propane.

In order to solve this problem, the technician can do one of two things.

- The vaporizer/regulator can be remounted as high and as close to the carburetor as possible. In this position, the substance will pass through the mixer for combustion.
- An in-line thermostat can be installed in the regulator coolant line. This will keep the coolant temperature at approximately 110° F at the vaporizer/regulator and minimize most of the sludge buildup.
How to Refuel Propane Mowers

Think back to when you were 16-years-old and how nervous you were to pump gas into your dad’s car for the first time. Now, there's no hesitation at the pump. Just like filling up your car’s gas tank, refueling a propane mower will become second nature after some practice.

Refueling propane mowers is often a primary concern for potential customers. This section is intended to help you be prepared to explain how refueling options work so you can help customers feel comfortable with refueling options.

IN THIS SECTION:

- Learn about the refueling options available for propane mowers.
- Understand how to refuel a mower using cylinder exchange or cylinder refill.
- Learn safety tips when handling a propane cylinder.
- Find out how to install a propane cylinder onto the mower.
- Understand the key parts of a propane cylinder.

EASY REFUELING OPTIONS

There are two main options available for refueling a propane mower: fuel cylinder exchange and on-site propane refueling tanks. For both of these options, your propane supplier is available to install and maintain the refueling infrastructure and to train your employees about proper refueling and handling. A third, less-common option is cylinder pick-up. For this option, the customer picks up full cylinders at the propane supplier’s location.

Fuel Cylinder Exchange. The fuel cylinder exchange option has been established through use in the forklift industry, and, therefore, has a proven cylinder and fuel distribution system that most propane companies can support. The fuel cylinder exchange process is simple and straightforward.

- Your propane supplier will provide a metal storage cage for keeping the propane cylinders.
- The propane fuel supplier delivers full cylinders to your site.
- When a full fuel cylinder is needed, simply remove one from the storage cage and mount it on the mower. Then place the empty cylinder back into the cage.
• Your fuel provider will pick up the empty cylinders and fill the storage cage with full ones.

Check with your propane provider because many suppliers will provide the protective storage cage for little to no cost. Any additional propane cylinders you are storing, not attached to a mower, should be secured in a storage cage or other protected storage area away from ignition sources that include such things as open flames or spark producing equipment. Cylinders should be stored horizontally.

**STEPS TO REFUELING BY FUEL CYLINDER EXCHANGE**

1. Park the mower.
2. Turn mower off.
3. Set the parking brake.
4. Make sure any sources of ignition are at least 25 feet away, including anyone smoking.
5. Touch a grounded object to control static electricity.
6. Put on protective clothing. (See Wear Protective Gear.)
7. Close service valve on empty cylinder.
8. Unscrew service line fitting.
   a. If a left-hand thread, loosen to the right, tighten to the left. This is referred to as an outdoor power equipment or mower cylinder, which usually has a green painted collar on the service end of the cylinder.
   b. If a right-hand thread, loosen to the left, tighten to the right. This is commonly referred to as a forklift or liquid delivery cylinder.
10. Remove empty cylinder.
11. Select a full cylinder.
12. Inspect cylinder and valves for leaks, wear, and damage.
13. Place full cylinder on mower.
   a. Make sure locating pin on mower is lined up with locating hole on cylinder and relief valve is in 12 o’clock position.
14. Latch hold-down straps.
15. Inspect hose and fitting on service line.
16. Check connection gasket is in place.
17. The service hose and service valve each have a check valve.
   a. If not connected, no propane will flow when coupled together. Check that valves are open and the propane can flow.
18. Make sure the service valve is closed.
19. Attach service line to the cylinder.
20. Make sure service lines threads match service value fitting.
22. Check for leaks in connection or hose.
23. Start mower.
On-site Propane Tank to Refill Cylinders. Another option is to install a propane refueling tank and propane fuel pump on-site. The installation costs are similar or often lower than gasoline storage tanks and the tanks are available in a wide range of sizes. Skid mounted systems are easy to install and portable. A typical skid mounted system installed costs about $30,000. Many propane providers will cover a portion of the cost for installing a propane refueling tank for their larger customers.

**STEPS TO REFUELING BY ON-SITE REFUELING TANK**

1. Park the mower.
2. Turn mower off.
3. Set parking brake.
4. Remain in attendance during entire refueling.
5. Make sure any sources of ignition are at least 25 feet away, including anyone smoking.
6. Put on protective clothing. (See Wear Protective Gear.)
7. Remove cylinder from the mower and set on the ground upright on the foot ring.
8. Inspect cylinder and valves for leaks, wear, and damage.
9. Inspect filler nozzle.
10. Make sure the relief valve is in the 12 o'clock position.
11. Remove plastic dust cap on filler valve.
12. Connect dispensing hose by rotating the filler nozzle clockwise until it is firmly attached to the filler valve.
13. Make sure filler valve vent valve is closed.
14. Open fixed maximum liquid level gauge.
   a. If a steady white mist appears, stop immediately.
   b. If no mist or only a small stream of white mist appears, continue filling operation.
15. Start the pump and slowly open filler nozzle.
16. When a white mist begins to escape from the fixed maximum liquid level gauge, immediately close the hose end valve.
17. Close the vent valve on the fixed maximum liquid level gauge. Failure to shut off the propane promptly will result in an overfilled cylinder. An overfilled cylinder may discharge propane if the temperature rises, posing a risk of fire or personal injury to anyone nearby.
18. Shut off the pump if no other cylinders will be filled at this time.
19. Loosen the connection and wait for any trapped liquid to bleed off. Stow hose assembly.
20. Reconnect plastic dust cap on filler valve.
21. Reconnect the fuel line and check the cylinder and its valves for leaks with a non-corrosive leak detector solution, inspecting the gaskets and O-rings in the filler valve, and service valve connector for defects or leaks.
22. After the cylinder is filled, or at any time the dispensing station is unattended, shut off the pump, close valves at the storage tank and disconnect and store the hose to secure the dispenser against tampering.
23. Start mower.
REFUELING SAFETY

The key to refueling is to follow the procedures and not take shortcuts. Here are some tips to refueling safety:

- **Check for Leaks.** Keep this phrase in mind when inspecting a cylinder: smell, look, and listen. Use your nose to smell for the odorant that has been added to the propane. It is very distinctive and smells like rotten eggs. Look around the fittings and hoses for leaks. Listen for a hissing sound. Or conduct a simple “bubble” test by applying a leak detector solution or thick soapy water to the connections. Slowly open the cylinder valve and watch for bubbles. If bubbles appear, close the cylinder valve, tighten the connection, and repeat the process. If bubbles still appear, set the cylinder aside and call your propane provider.

- **Wear Protective Gear.** When released into the atmosphere, liquid propane has a refrigerating effect that makes everything it touches extremely cold. This means if it comes in contact with your skin, it can cause third-degree or deep-freeze burns. For this reason, you should wear gloves or other personal protective equipment (PPE) resistant to propane when filling containers. To protect your skin and eyes from any potential freeze burns from propane vapor, wear protective coated gloves, protective goggles, and ideally a long-sleeved jacket or shirt.

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**CALCULATING CYLINDER FILL LEVEL BY WEIGHT**

If you or your customers are using the cylinder exchange refueling option, you won’t have to refill cylinders. But if you or your customers are refilling cylinders from an on-site refueling station, you should know how to fill a cylinder by weight. Follow these steps:

- **Step 1:** Check the water capacity (w.c.) and tare weight (t.w.) stamped on the cylinder or its protective collar.

- **Step 2:** Determine the propane capacity from the conversions table. Remember, if you don’t have a conversion table handy, you can determine propane capacity by using the following formula:
  
  \[ \text{w.c. (lb)} \times 0.42 = \text{propane capacity (lb)} \]

- **Step 3:** Add the tare weight and propane capacity together to determine the total filled weight of the cylinder.
Propane cylinders are different from the gas tanks on gasoline-fueled mowers. It is useful to know a little bit about propane cylinders when working with propane mowers and answering customer questions.

IN THIS SECTION:
• Understand the basics of propane fuel cylinders.
• See the key parts of a cylinder.
• Learn to detect cylinder wear and damage.
• Find out how to mount a cylinder on a mower.

PROPANE FUEL CYLINDER BASICS

Cylinder Construction. Cylinders are made from either aluminum or a type of alloyed steel and are most commonly a two-piece or three-piece design.

In the USA, cylinders must be designed, fabricated, tested, marked, and certified to meet the codes and standards of the DOT or the ASME. Under no circumstances should any container be filled with propane that does not conform to these codes and standards.

Propane cylinders are designed to be filled to a maximum of 80 percent of capacity. This leaves 20 percent of the capacity available for vaporized propane gas to expand if there is an increase in temperature. If the cylinder is overfilled and not enough room is left for expansion, the pressure will increase to the point where the pressure relief valve will open, exhausting liquid propane.

NOTE:
Any time the pressure relief valve opens on a propane cylinder, the cylinder must be taken outdoors and away from buildings and the propane provider notified.

DID YOU KNOW
Propane cylinders should only be filled to 80 percent capacity. This allows the fuel room to expand when temperatures rise.

CYLINDER WEIGHT AND VOLUME

Most zero-turn radius, ride-on mowers use a cylinder that can:
• Hold approximately 33.5 pounds of propane.
• Have a total filled weight of 57 pounds.
• Provide approximately six to eight hours of run time per cylinder, depending on load and duty cycle.
KEY PARTS OF A PROPANE CYLINDER

Labels. DOT and OSHA require specific labeling for all cylinders. Cylinders used to transport propane must be clearly and durably marked with the proper shipping name (Liquefied Petroleum Gas) and its hazard class (1075). If the original manufacturer’s label is not present or clearly legible, apply a new warning label to the cylinder.

Valves. The following valves and apparatus are the same for both ASME and DOT applications:

- Manual shutoff liquid (or vapor) withdraw valve (also known as the service valve).
- Pressure relief valve.
- Fill valve.
- Fixed maximum liquid level gauge (also known as 80 percent liquid level valve).
- Fuel gauge.

We discuss each of these valves in more detail on the next pages.
**Propane Cylinders**

**Liquid or Vapor Withdrawal Valve (or Service Valve).** Depending on the service, the cylinder may be equipped with a valve to withdraw liquid or vapor. As earlier discussed, vapor withdrawal is common on small air-cooled engines, outdoor power equipment, platform lifts, and barbecue grills. Where higher BTU is required, liquid withdrawal, employing the use of a vaporizer, will be used.

**NOTE:**
- Either valve is designed to provide positive closure.
- They are manual shut.
- They are equipped with an internal excess flow check valve designed to close automatically at the rated flow of vapor or liquid specified by the valve manufacturers.

The vapor or liquid service valve has an internal check valve, or excess flow valve, that is designed to prevent fuel from discharging from the cylinder if the valve is sheared off in an accident or if the liquid line has ruptured.

_Forklift cylinder valves and mounting configuration_
Propane Cylinders

DID YOU KNOW

Cylinders are completely sealed, that means no moisture or other contaminants can get into the fuel. Plus, propane lasts for years without any fuel stabilizers.

**Pressure Relief Valve.** Every propane container is equipped with at least one pressure relief valve. This is necessary because of the change in liquid volume, as well as high storage pressures. If the pressure inside the container becomes too high, then the relief valve discharges vapor and reduces the pressure to a safe level. This ensures that the vapor pressure never reaches the maximum pressure the container is designed to handle, which could cause it to rupture. Relief valves are covered more in depth elsewhere in this course. It should be kept clean and unrestricted and positioned in the 12 o’clock position when the cylinder is mounted horizontally, whether on a mower or in a storage rack. In some designs, a deflector (pipe-away adaptor) is screwed into the pressure relief valve that directs the fuel away from the driver upward at a 45° angle. The valve must have a dust cap to prevent dirt and debris from clogging it.

**Fill Valve.** This is the valve through which the cylinders are refueled. This valve has an internal check valve necessary to prevent fuel loss in the event of an accident. If the top portion of the fill valve is sheared off, the fuel will remain locked inside the cylinder. This valve should be covered with a plastic cap. When remote filling is used, a double backflow check valve must be installed in the container’s fill valve opening. Some fill valves may contain an Overfilling Prevention Device (OPD) attached to the bottom of the valve.

Mower cylinder valves and mounting configuration
Propane Cylinders

• **Fixed Maximum Liquid Level Gauge.** This gauge is also called a “spit valve,” “10 percent,” “80 percent liquid level valve,” or “bleeder valve.” It indicates when the maximum permitted filling level has been reached in a container. This gauge has a tube connected to the container at a point where the opening of the tube is at the container’s maximum fill level. When the level of liquid propane reaches the tube opening, propane emits out the partially opened vent valve, signaling the operator to stop filling. Propane cylinders must not be filled beyond this level in order to allow sufficient room for thermal expansion.

• **Fuel Gauge.** ASME and DOT cylinders that have fuel gauges use a magnetic liquid level float dial inside of the cylinder. A site gauge or a sending unit may be placed on the external portion of the gauge to indicate the amount of fuel in the cylinder. If a sending unit is used, it is matched with the receiving unit. (These are not legal devices for filling cylinders; instead most propane suppliers fill cylinders by weight.) Some DOT cylinders do not have fuel gauges.

**Why are These Valves Important?** The line carrying the fuel to the propane fuel system flows through this valve. If, for any reason, the line would become severed, the flow of fuel would increase to the point that the excess flow valve would close, locking the fuel inside of the cylinder. It is mandatory that when the propane cylinder container is in use, the valve is completely open. If the valve is only partly open, the vehicle may not be getting enough fuel to operate efficiently. Always open the manual shutoff valve slowly to prevent the possibility of activating the check valve.

**When Using More than One Cylinder on a Mower.** When more than one container is installed on a piece of equipment, the operator must close the manual shutoff valve on the container not in use. Once a container is empty, close the container shutoff valve prior to opening the valve on the full container. If this is not done, the container can attempt to transfill.

**NOTE:**

*Check valves are not required to completely close when activated and even though the check valve has activated, a small quantity of propane may still flow through the valve.*

**Quick Disconnect Couplings.** There are multiple quick disconnect couplings that are permitted for use on containers. For the purpose of this manual, outdoor power equipment will normally use an ACME connection.

• For liquid withdrawal from the container, a CGA-790 right-handed ACME connection is the most common connection.

• For vapor withdrawal from the container, a CGA-790 right-handed ACME connection or CGA-789 left-handed ACME connection is utilized.

**DID YOU KNOW**

Most OEMs design their propane mowers to use mower-specific cylinders. These cylinders use a left-hand thread and have a colored, usually green, mower-specific collar. A few OEMs design their propane mowers to use forklift cylinders, which have a right-hand thread. Check with your mower manufacturer to find out which type of cylinder should be used on their mowers.

Also, mower-specific cylinders have an inside tube that allows for the cylinder to supply propane as a vapor, even on hilly terrain. Forklift cylinders also provide vapor, but since they operate on flat surfaces, there is no need for a drawtube.
Most OEMs of outdoor power equipment utilizing vaporous propane will utilize the CGA-789 left-handed ACME connection to prevent possible attachment of a liquid withdrawal cylinder to vapor withdrawal equipment.

Both halves of the coupling are equipped with 100 percent shutoffs and as they are coupled together, they open and allow gas to flow.

- The female portion is adapted to the hose going to the carburetion mixer system.
- The male portion of the coupling acts as an added check valve.

If the withdraw valve is turned on while the cylinder is in transit or if a passerby turns the wheel of the valve, no gas can escape.

The coupler has two seals: The o-ring prevents leakage from the shaft on the other coupling and the flat washer bottoms out and seals when the coupler is fully connected. Both the washer and the o-ring must be replaced periodically to prevent the leakage of fuel.

**Propane Hose and Fittings.** High-pressure, flexible hose, and matching fittings are commonly used. The hose and connectors used for conveying propane under pressure are made from materials resistant to the action of propane, both liquid and vapor. They incorporate a wire braid reinforced construction.

**CYLINDER WEAR**

If there is noticeable wear on a cylinder or the cylinder has been involved in a fire, err on the side of caution, discontinue use, and contact your propane provider.

- Containers showing serious denting, bulging, gouging, or excessive corrosion must be removed from service.
- Steel containers that have been involved in a fire must be removed from service. In a case where the container shows no distortion, it may be sent back to the manufacturer and re-qualified, or sent to an approved repair facility. The cylinder must be retested using the hydrostatic test procedures applicable at the time of the original fabrication and all valves must be replaced.
- Aluminum cylinders involved in a fire must be permanently removed from service.

**DID YOU KNOW**

Propane cylinders are environmentally friendly, are low maintenance, and can last up to 40 years. Plus, a propane cylinder is 20 times as puncture resistant as a typical gasoline tank.
Examples of cylinder wear and damage that would require discontinuing use.
INSTALLING PROPANE CYLINDERS ONTO MOWERS

When installing a cylinder on a propane mower, the cylinder must be within and cannot exceed the outline of the vehicle. This will ensure that the cylinder will not hit objects when maneuvering in tight places, preventing damage to the cylinder or its valves. The cylinder may be installed in a vertical or a horizontal position, depending on the design of the equipment and fuel delivery system. Observe any markings or labels on the cylinder for the proper orientation of the cylinder.

- **A horizontal** cylinder must be installed on the saddle that contains an alignment pin, which matches a hole in the collar of the cylinder. A common problem is that the alignment pin can break off, allowing the cylinder to be mounted in any position. If the alignment pin does break off, it should be replaced immediately because it will cause a serious safety problem. When the alignment pin is properly inserted in the hole, the pressure relief device is in the vapor phase of the cylinder.

- **When mounted in a vertical position**, liquid will travel up the liquid withdrawal tube from the bottom of the cylinder regardless of cylinder orientation in the cylinder cradle.

The cylinder must be securely mounted in its brackets. The brackets of the American Society of Mechanical Engineers (ASME) tank and mounting fixtures for Department of Transportation (DOT) cylinders must be able to support and secure four times the combined weight of the cylinder and the fuel.

Horizontal Cylinder Mounting Position

*When mounting a propane cylinder on a mower horizontally, always make sure the mower’s alignment pin is correctly positioned on the cylinder collar.*
Communicating with Customers about Propane Mowers

To sell propane mowers effectively, dealers need to identify receptive potential customers and know what kinds of information will increase potential customers’ interest and confidence in making a purchase. Not every customer is going to be interested in a propane mower when they first walk through your doors, even with the benefits it provides. But some customers are more likely than others to be interested in what propane mowers have to offer. Targeting the right potential customers and sharing the right information can move those customers from interest to trial to purchase.

IN THIS SECTION:
- Get tips on good target markets for propane mowers.
- Get ideas on how to help customers feel comfortable with a new technology.
- Get recommendations for effectively communicating with customers about propane mowers.

FIND YOUR TARGET MARKET

A critical step to selling propane mowers successfully is finding the right target market. In order to do this, we recommend targeting the following:

- Public organizations.
- Major corporations.
- Lawn-care industry.

Public Organizations. The main reason to focus on public organizations is that they often face pressure to look for environmentally friendly products and services, including external public pressure and internal mandates. Consider contacting municipal grounds maintenance departments or other governmental entities, like highway maintenance and parks and recreation departments. This could also include universities, which have extensive grounds to maintain. Whether public or private, many university maintenance departments are being asked to green their operations. Propane mowers can help these customers meet their environmental goals. Furthermore, a propane mower’s lower operating costs should be appealing to all public organizations that are being asked to provide the same level of service with less funding.

Major Corporations. The environmental benefits of propane mowers may also be appealing for many major corporations that have made internal
commitments to implementing more sustainable operations in response to public pressure or the desire to be good corporate citizens. Corporate grounds management departments and lawn-care professionals who service major corporations are a great potential market for propane mowers.

Lawn-Care Industry. Lawn-care business operators are likely a central part of your business. Many of them may be prime customers for propane mowers. Virtually every landscape professional is interested in cutting costs; propane mowers provide a great way for them to do so. Look for customers who are always interested in what’s new in lawn and landscape equipment or want to be innovators in their industry. Propane mowers are a cutting-edge technology. Recommend them to your customers who want to be first to try new technology. Also, focus on lawn and landscape professionals who have a personal interest in being green. Customers with environmental concerns are good potential targets for a propane mower.

HELP CUSTOMERS FEEL COMFORTABLE WITH PROPANE TECHNOLOGY

Even the most innovative landscape contractor needs some help feeling comfortable with new technology like propane mowers, and, for more conservative customers, this “comfort raising” is essential. The Propane Education & Research Council has conducted extensive customer research to understand what customers need to know to feel comfortable with propane mowers.

Here are potential customers’ top concerns.

Firsthand Experience. First, people want to try them out. Not surprisingly, customers want a chance to not just kick the tires, but also use a propane mower in their daily operations before they are willing to buy one. That is the goal of this Propane Mower Dealer Demonstration Program.

Fuel Availability. In addition, people want to understand that propane fuel is widely available and easy to get. Explain that the supply of propane in the U.S. is abundant; the supply is so great that the U.S. is actually a net exporter of propane. Propane is already available virtually everywhere because it is widely used in residential heating and cooling, everywhere forklifts are used, and to fuel most backyard grills. In addition, propane is easy to transport and easy to get directly to end-users' site.

Service and Repair. Next, let potential customers know that the mowers are easy to service and repair. There is not much difference in the mower parts. And, the fuel is cleaner burning. Basic maintenance and service of propane mowers can potentially be even easier than for gasoline mowers.

Performance Features. Explain that overall performance is very similar to gasoline mowers. Propane mowers have many benefits over gasoline mowers. But, they also have a lot of similarities. Running, mowing with, and maintaining propane mowers is basically the same as gasoline mowers.
Communicating with Customers about Propane Mowers

**Operator Training.** Potential customers will want to know that there is not a lot of special training needed for employees to be able to use propane mowers. Employees will need to learn a few basic differences in operation, like turning the fuel cylinder on and off. Also, they will need to learn how to change out fuel cylinders. Otherwise, operation is basically the same as the gasoline-fueled mowers they already use.

**Refueling Concerns.** Perhaps most importantly, customers are going to want to know how to refuel propane mowers. Be sure to explain the options (cylinder pick-up, cylinder exchange and on-site fuel storage tanks) clearly. Be sure to explain how easy these options are and offer to introduce them to some local propane providers who can help them understand and set up refueling options.

COMMUNICATE WITH CUSTOMERS ABOUT PROPANE MOWERS EFFECTIVELY

PERC’s customer research suggests that there are more and less effective ways to communicate with customers about propane mowers. We recommend focusing on the following points in order of importance in your initial discussions with potential customers. Of course, follow their lead in terms of what they ask about and seem most interested in. But, use this overall approach to get started.

Most Important Topics to Discuss with Potential Customers

**Focus on Cost Savings.** Virtually all of your customers have to answer to the bottom line, whether they are business owners or government entities. We recommend starting a discussion about the ways propane mowers will save customers money. For more details, see [Section 6, Benefits of a Propane Mower](#).

Be sure to mention:

- Lower fuel costs.
- Productivity and labor savings.
- Approved operation on ozone action days.
- Fuel delivery directly to end-users.
- No fuel lost due to theft or spillage.
Communicating with Customers about Propane Mowers

**Follow with Environmental Benefits.** Many customers may want to be more environmentally friendly. This is often less important than saving money. So we recommend bringing up environmental benefits second. The combination of costs savings and environmental benefits is enough to sway many customers to consider a propane mower. For more details, see Section 6, Benefits of a Propane Mower.

Be sure to mention that propane mowers:

- Reduce greenhouse gas emissions by 50 percent.
- Reduce smog-forming emissions.
- Reduce emissions harmful to human health.

**Second Most Important Topics to Discuss with Potential Customers**

**Spend Time Explaining the Easy Refueling Options.** Refueling is one of the biggest concerns about propane mowers for many potential customers. Be prepared to know how refueling options work and spend plenty of time explaining it to customers. Refueling is discussed in detail in Section 10, How to Refuel Propane Mowers.

Here are refueling topics to include in discussions with customers:

- The propane provider delivers fuel to your site.
- The cylinders are easy to swap out.
- Forklift operators already use cylinder exchange.
- Refueling does not require extensive training or purchase of special equipment.

**Focus on the Ways Propane Mowers are the Same as Gasoline Mowers.** Customers will feel more comfortable with propane mowers once they know they are really not that different from what they are already using — in most cases that will be a traditional gasoline-powered mower. Major elements of operations like starting, running, and mowing, are all basically the same with propane mowers. Be prepared to discuss these points with potential customers.

- Starting, running, mowing, and stopping are basically the same. (See Section 8, How to Operate and Store a Propane Mower.)
- Very few parts are changed to make a mower run on propane. (See Section 7, The Propane Mower Fuel System.)
- Basic maintenance and service is virtually the same as gasoline mowers. (See Section 9, Maintenance and Service Basics.)
Communicating with Customers about Propane Mowers

Other Important Topics to Discuss with Potential Customers

**Mention that Propane Eliminates Ethanol Issues.** Ethanol issues are top of mind for many landscape professionals, who are running into trouble because there is ethanol in regular gasoline sold at the gas station. Propane fuel eliminates the issues associated with ethanol. Customers can’t control if there is ethanol in their gasoline; but they will know there isn’t any in their propane.

**Explain that Propane Is Very Safe.** Safety is a top concern for many customers who are just learning about propane. Propane is very safe. It is stored at a low pressure — 160 PSIG or less, about the equivalent of brake-line pressure in a vehicle. It has a narrow ignition or flammability range. And, it is stored in extremely durable, puncture resistant tanks. For more details on why propane is a safe fuel, see Section 6, Benefits of a Propane Mower.

**Discuss Energy Security Benefits.** Energy independence is often not as important to potential customers as cost or environmental benefits; however, it is something a lot of people want to support if they can.

Some key points to mention include:

- Over 90 percent of U.S. propane supplies are produced in the United States.
- Propane reduces dependence on foreign fuel sources because it is domestically produced.
# Resources

**IN THIS SECTION:**

Find out key contacts that can help you with your propane mowers including:

- PERC’s Dealer Demonstration Program resources for dealers.
- Propane mower Original Equipment Manufacturer contacts.
- State Propane Gas Association contacts.
- Other helpful websites.

**PERC EMAIL HELP LINE**
[propanemowerdemos@propane.com](mailto:propanemowerdemos@propane.com)

**PERC PROPANE MOWER DEALER DEMONSTRATION PROGRAM WEBSITE**
[www.autogasusa.org/mower-demonstration-program](http://www.autogasusa.org/mower-demonstration-program)

**PROGRAM ORIGINAL EQUIPMENT MANUFACTURERS (OEM) CONTACTS**

<table>
<thead>
<tr>
<th>Company</th>
<th>Website</th>
<th>Contact Details</th>
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</table>
| ARIENS / GRAVELY         | [www.ariens.com](http://www.ariens.com) 920-756-4716 | Brian Anundsen  
BAAnundsen@ariens.com  
Gravely Brand          |
| EXMARK                   | [www.exmark.com](http://www.exmark.com) 402-223-6308 | John Cloutier  
John.Cloutier@exmark.com                                |
| HUSQVARNA                | [www.husqvarna.com](http://www.husqvarna.com) 704-921-7080 | Gent Simmons  
Gent.Simmons@husqvarna.com                              |
| KUBOTA                   | [www.kubota.com](http://www.kubota.com) 310-370-3370 ext.1807 | Christine Chapman  
CCChapman@kubota.com                                |
| SCHILLER GROUND CARE     | [www.bobcat.com](http://www.bobcat.com) 920-699-5806 | Jeff Hallgren  
JHallgren@schillergc.com  
Bobcat Brand          |
| ZIPPER                   | [www.zippermowers.com](http://www.zippermowers.com) 321-863-0913 | Deven Hurst  
Deven@zippersales.com                                |
Resources

PROPANE PROVIDERS

PERC’S FIND A PROPANE RETAILER
www.propanecouncil.org

STATE PROPANE GAS ASSOCIATIONS

ALABAMA
800-242-2742
www.alabamapropane.com

ALASKA
866-881-6309
www.pacificpropane.org

ARIZONA
866-881-6309
www.nwpga.org

ARKANSAS
479-824-4299
www.arkansaspropane.com

CALIFORNIA
916-447-9742
www.westernpga.org

COLORADO
866-881-6309
www.copropane.com

CONNECTICUT
888-445-1075
www.pgane.org

DELAWARE
804-643-4433
www.mapga.org

FLORIDA
850-681-0496
www.floridapropane.org

GEORGIA
770-645-8677
www.georgiapropane.org

HAWAII
866-881-6309
www.pacificpropane.org

IDAHO
866-881-6309
www.rmpropane.org

ILLINOIS
800-727-6207
www.ilpga.org

INDIANA
317-655-4444
www.indianapropane.com

IOWA
515-564-1260
www.iapropane.org

KANSAS
785-354-1749
www.pmak.org
www.propaneinkansas.org

KENTUCKY
502-875-2686
www.kypropane.org

LOUISIANA
225-763-8922
www.louisianapropane.com

MAINE
888-445-1075
www.pgane.org

MARYLAND
804-643-4433
www.mapga.org

MASSACHUSETTS
888-445-1075
www.pgane.org

MICHIGAN
517-487-2021
www.mi.gov/lp

MID-ATLANTIC PROPANE GAS ASSOCIATION (DELAWARE AND MARYLAND)
434-977-3716
www.mapga.org

MINNESOTA
763-633-4271
www.mnpropane.org

MISSISSIPPI
601-354-4077
www.mspropane.com

MISSOURI
573-893-7655
www.missouripropane.com

MONTANA
866-881-6309
www.rmpropane.org

NEBRASKA
402-475-3996
www.nebraskapropane.com

NEVADA
775-853-8464
www.nvpropane.net

NEW JERSEY
609-890-6094
www.njpga.org

NEW HAMPSHIRE
888-445-1075
www.pgane.org

NEW MEXICO
866-881-6309
www.nmproga.com

NEW YORK
518-383-3823
www.nypropane.com

NORTH CAROLINA
919-787-8485
www.ncpga.org

NORTH DAKOTA
701-223-3370
www.ndpropane.org

OHIO
614-221-1900
www.ohiopropanegas.org

OKLAHOMA
405-424-1775
www.oklpgas.org

OREGON
866-881-6309
www.pacificpropane.org
Resources

PACIFIC PROPANE GAS ASSOCIATION (OREGON, WASHINGTON, HAWAII, AND ALASKA)  
866-881-6309  
www.pacificpropane.org

 PENNSYLVANIA  
717-441-6040  
www.papropane.com

PROPANE GAS ASSOCIATION OF NEW ENGLAND (MAINE, MASSACHUSETTS, VERMONT, NEW HAMPSHIRE, CONNECTICUT, AND RHODE ISLAND)  
888-445-1075  
www.pgane.org

PROPANE MARKETERS ASSOCIATION OF KANSAS, INC.  
785-354-1749;  
www.pmak.org  
www.propaneinkansas.org

RHODE ISLAND  
888-445-1075  
www.pgane.org

ROCKY MOUNTAIN PROPANE ASSOCIATION (IDAHO, MONTANA, WYOMING, AND UTAH)  
866-881-6309  
www.rmpropane.org

SOUTH CAROLINA  
803-865-2284  
www.scpropane.com

SOUTH DAKOTA  
605-224-8606  
www.sdpmpropane.com

TENNESSEE  
888-240-8742  
www.thinkpropane.com

TEXAS  
800-325-7427  
www.txpropane.com

UTAH  
866-881-6309  
www.rmpropane.org

VERMONT  
888-445-1075  
www.pgane.org

VIRGINIA  
434-977-3716  
www.propaneva.com

WASHINGTON  
866-881-6309  
www.pacificpropane.org

WEST VIRGINIA  
703-530-9772  
www.wvpropanegas.org

WESTERN PROPANE GAS ASSOCIATION (CALIFORNIA)  
916-447-9742  
www.westernpga.org

WISCONSIN  
608-251-0927  
www.wipga.org

WYOMING  
866-881-6309  
www.rmpropane.org

OTHER HELPFUL WEBSITES

PERC  
www.autogasusa.org/propane-vehicles-and-equipment/ground-maintenance-equipment

METRO LAWN  
www.gogreenmetrolawn.com

ONYX ENVIRONMENTAL SOLUTIONS  
www.onyxenvironmentalsolutions.com/lawn-care.php

ALL PROPANE MOWERS  
www.allpropanemowers.com
What is PERC?

The mission of the Propane Education & Research Council (PERC) is to promote the safe and efficient use of odorized propane gas. It accomplishes this through wide-ranging programs that support safety, training, research, and the development and commercialization of promising propane technologies.

PERC was authorized by the U.S. Congress with passage of the Propane Education and Research Act (PERA), Public Law 104-284, signed into law on October 11, 1996. In a referendum soon afterward, propane producers and providers overwhelmingly approved its formation.

The Council is a 21 member board appointed by the National Propane Gas Association and the Gas Processors Association, both of which appoint nine council members and cooperate in the appointment of three public members.

PERC is authorized to carry out programs, projects, and activities in three key areas:

Safety
Nothing is more important to PERC and the propane industry than the safety of everyone who works with, sells, buys, or depends on propane. Through training, communications, and outreach to consumer safety organizations, trade groups, emergency responders, and the public, PERC increases awareness of safe practices in the handling and use of propane and propane-fueled appliances and equipment.
Training
A well-trained propane workforce is essential to protecting the health and wellbeing of propane consumers and the general public. PERC leads development in updating the propane industry’s most relied upon employee training and certification programs and courses.

Research and Development
By supporting research, development, and demonstration of innovative propane-fueled products and applications, PERC promotes the commercialization of technologies that expand the utility, efficiency, environmental performance, and safety of propane for users in residential, commercial, engine fuel, and agricultural markets.

PERC’s operations and activities are funded by an assessment levied on each gallon of propane gas at the point it is odorized. The assessment, authorized under PERA, varies and is currently set at four-tenths of a cent per gallon.