



The Use of Ethanol Blended Fuels in Non-Road Engines

March 2011

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America's drive to become more reliant on domestic sources of energy has led to a rapid expansion of ethanol-blended fuel. Today, ethanol can be found in nearly all of the nation's gasoline and is being utilized in all engine types, including marine engines. However, there have been exceptions made to allow for gasoline only fuel for marine and other special applications. More information on the fuels available in your area may be obtained from the regional fuel regulating agency.

During the 1980's gasoline/ethanol blends comprised only a small percent of the gasoline marketplace and were viewed as somewhat of a novelty. Small engine/ equipment manufacturers were slow to conduct tests on a fuel with limited market share and an uncertain future. Little technical data about the use of gasoline ethanol blends was available and, of course, there was little field experience upon which to base decisions regarding its use in such applications. These factors led to the majority of manufacturers recommending that gasoline/ ethanol blends not be used in the products during that time frame.

By the mid 1990's manufacturers began to indicate that gasoline/ethanol blends containing up to 10 volume percent ethanol could be used in their products provided certain storage precautions were followed. The degree of approval often varied with some simply stating ethanol blends could be used while others stated such use was permitted but not recommended.

National interest in protecting the environment and improving domestic energy security requiring the increased use of ethanol has led to changes in the nation's fuel. Small engine manufacturers have made modifications to the engine fuel systems to be compatible with ethanol blended fuels. This can be seen through the collection of varying recommendations from equipment owner's manuals from over the years. These changing recommendations have led to some confusion about the selection of fuels to use in various non-automotive applications. With the increase in ethanol blended fuels availability throughout the country, several power and recreational equipment manufacturers and small engine service/repair personnel often receive questions about the proper fuel for their equipment.

Non-Road Engines

It should be noted that all gasoline is designed for its primary intended use, the automobile. In fact, the standard industry specification for gasoline is titled *Standard Specification for Automotive Spark Ignition Engine Fuel*. Little consideration is given to the needs of the small engine manufacturer and they find themselves designing around whatever fuels are made for automotive use. Recently, fuel blenders have extended the availability of fuels containing up to 10 volume percent ethanol (E10) to nearly every area of the U.S. Many areas across the country successfully utilize only ethanol blended fuels year round and across all octane grades, proving that ethanol blended fuels can be used successfully in all applications. E10 is interchangeable

with gasoline and virtually every gallon of gasoline sold in the U.S. today contains a percentage of ethanol up to 10%. As ethanol has entered these new markets, some equipment owners and operators have raised questions about ethanol's use in their particular equipment. This bulletin is meant to provide information about successful operation of non-automotive equipment on E10.

Manufacturers of gasoline powered non-automotive equipment fall into one of two major categories:

- Recreational equipment such as snowmobiles, ATV's and watercraft
- Lawn/ Garden power equipment.

Manufacturers in these categories have various fuel related issues when designing their products or when developing recommendations for their use. For instance, many products in these categories are usually subject to seasonal use and extended storage periods. Gasoline can deteriorate in storage, which tends to contribute to more engine deposits and gumming of carburetors and fuel injectors. Therefore, most manufacturers recommend either draining all gasoline, or treating it with a fuel stabilizer when equipment is to be stored for long periods. Additionally, compared to an automobile, much of this type of equipment is relatively inexpensive. Consequently consumers often do not exercise the same degree of care that they would with the family car.

Snowmobiles and equipment used in extreme cold often specify rich air/fuel ratio settings and the engines in such equipment may be sensitive to enleanment. Lawn and garden equipment is often designed to be light weight for ease of handling. Consequently, the fuel systems of such equipment may be fitted with different metals, plastics, and elastomers than those utilized in an automobile's fuel system. The lawn and garden equipment category is also subject to the greatest degree of consumer neglect, since it is usually relatively inexpensive.



Engine manufacturers are currently confronted with a growing amount of environmental regulations designed to lower emissions from their products. These regulations are in addition to an extensive array of laws pertaining to noise levels and safety. Consequently, these manufacturers are confronted with the need for extremely low production costs, specialized considerations, and limited research and development budgets. Yet they must produce equipment that is safe, reasonably quiet, durable, consumer friendly, capable of operating on today's fuels, and with increasingly lower exhaust emissions.

The information listed here has been accumulated from non-automotive, non-road equipment manufacturers and from many years of ethanol experience. There is no better information reference for these engines and equipment than the original manufacturer's published references. Two critical points:

- **Refer to the owner's manual for each specific piece of equipment for all engine and fuel information.**

- **If you do not have access to the owner’s manual for your equipment, contact the engine manufacturer or authorized dealer. Remember that a wealth of information on your equipment is available to you on the internet.**

Ethanol Blended Fuels

It should be noted that the traditional ethanol blend in the marketplace has contained 10 volume percent ethanol and is referred to as E10. In 2010, the U.S. EPA approved the use of 15 volume percent ethanol (E15) in 2001 and newer automobiles. However, this approval to use E15 does not apply to non-automotive engines. Consequently, the information in this document pertains strictly to E10.

Past concerns expressed by equipment manufacturers fall into four categories. These include materials compatibility (i.e. metals, plastics, & elastomers), lubricity, enleanment, and storage considerations (phase separation, fuel stability). Some manufacturers have also expressed concerns about over-blending of ethanol (i.e. blends containing more than legally permitted levels of ethanol). The following provides more detail on each topic.

Materials Compatibility: Ethanol has been extensively tested for its affect on various metals, plastics, and elastomers. Such tests have included both controlled laboratory testing as well as field demonstration projects. Some equipment manufacturers have also conducted tests on their specific equipment. In the early to mid 1980’s, some manufacturers found it necessary to upgrade some of the materials used in their fuel systems. Whether or not this was necessitated



by the use of ethanol is sometimes uncertain because the aromatic content of gasoline was also increased during the same time frame. Since aromatics also affect elastomer durability, this may have contributed to isolated problems. In any event, manufacturers now use upgraded materials that are largely unaffected by properly formulated ethanol blends. This is evidenced by their fuel recommendation comments, which now permit the use of such fuels in their equipment marketed in the U.S. Further, responsible aftermarket suppliers provide only

replacement parts that are designed for use with oxygenated fuels. As an example, Walbro Engine Management Corp., a major supplier of carburetor rebuild kits and other parts, long ago indicated that Walbro parts are resistant to alcohol-related decomposition as long as the volume of alcohol is within legal limits.

Lubricity: In the past, some manufacturers, especially of two stroke engines/equipment, have expressed concern that gasoline ethanol blends may not provide adequate lubricity. There is no technical data to support such a position. In fact, the data available indicates that properly formulated gasoline ethanol blends may provide slightly better lubricity¹.

¹ Downstream Alternatives, Inc., *Lubricity of Reformulated & Oxygenated Gasolines*. March, 1997

Enleanment: Ethanol chemically enleans the air/fuel (A/F) mixture. As an example, in engines set at an A/F ratio of 14.7:1 on all hydrocarbon fuel, the introduction of 3.5% oxygen in the fuel would enlean the A/F ratio to about 15.2:1. Computerized engines can compensate for this shift by sending a command to increase fuel flow. Most non-automotive equipment is not sophisticated enough to accomplish this. However, this small change in air/fuel ratio is not of concern in most equipment and usually no modifications are required. Some manufacturers have expressed concern that the enleanment resulting from fuel bound oxygen could create problems in certain severe applications. In particular, there is concern about continuous operation at wide open throttle (WOT). Also of concern is equipment that typically operates rich at specified settings. An example here would be snowmobiles. The two primary concerns are octane quality and excessive heat. Increasing volumes of ethanol in gasoline should not present problems in the area of octane quality because ethanol is actually an octane enhancer. Ethanol is routinely used to improve the octane quality of gasoline. The more predominant concern is the potential for higher operating temperatures. The maximum combustion temperature (and resulting engine temperature) occurs at an air/fuel ratio of 14.7:1. Going rich or lean from this point will result in lower temperatures. Therefore, equipment with richer initial A/F ratio settings such as 13 or 14 to 1 may experience increased operating temperatures when switched to oxygenated fuels. This increase is not significant and most manufacturers do not require any modifications, but some do. For instance, Polaris recommends that their older carbureted sleds “jet up” one size when operating on ethanol blends. Further, some of their fuel injected 2 cylinder models require a “shim kit” to lower the compression ratio. Polaris fuel injected 3 cylinder models are computerized and the E-Prom is already calibrated to compensate for changes in oxygen content. Artic Cat recommends “jetting up” the carburetor jets one size. Only a handful of manufacturers offer such recommendations but consumers should be advised to consult their owner’s manual or servicing dealer to determine if any modifications are recommended.



Storage Considerations: If excessive moisture is absorbed, the ethanol and water can phase separate (fall out of suspension) from the gasoline blend. This would result in a mixture of ethanol and water in the bottom of the fuel tank. Aside from the fact that the engine would not operate on this ethanol/water blend, it can also cause corrosion of various metals with which it comes in contact. However, the potential for phase separation must be put in perspective. It would take almost four teaspoons of water per gallon to phase separate a gasoline ethanol blend. This would be an incredibly large amount of water to be accidentally introduced into the system. To absorb this much moisture from the atmosphere (at a relative humidity of 70%) would take hundreds of days even if the gasoline cap were left off. These concerns can be addressed simply by exercising caution that no water is introduced into the system.

- Precautions include a gasoline tank cap that seals properly and filling the tank before extended periods (note that some manufacturers recommend draining of the fuel tank and system before storage).

- During in-season use, it is best not to buy more than a 30 to 60 day supply of any type of gasoline.
- Proper storage preparation is essential for keeping equipment trouble free and looking good. Fuel deterioration and oxidation can begin to occur in a short period of time and may cause damage to the fuel system.

During the offseason, or when equipment is to be stored for extended periods of time, additional steps are recommended. Most manufacturers recommend one of two storage methods:

Dry Storage Method: Drain all the fuel from the fuel tank and operate the equipment until it stops due to lack of fuel.

Wet Storage Method: Treat the fuel with a fuel stabilizer, which extends the fuel's storage life. Many equipment manufacturers sell such products under their own brand name. Some engine manufacturers recommend storing the fuel tank full (90-95% to allow room for expansion) and/ or recommend the use of a fuel stabilizing additive if the equipment will be idle. All fuels are susceptible to degradation and weathering.

Once treated, fill the equipment fuel tank to 90-95% full. This will minimize in-tank water condensation and accumulation, while allowing room for temperature expansion. After adding a fuel stabilizer, run the engine to be sure that the treated fuel has replaced the untreated fuel throughout the fuel system.

A partially full tank is not recommended because the air space above the fuel allows air movement that can introduce water through condensation with changes in outside ambient temperature. Water introduced through this condensation action can build to a level that can cause phase separation of the fuel. Additional fuel storage recommendations specifically for your geographic location may be available from the local authorized servicing dealer.

Gasoline and E10 fuel blends can oxidize and deteriorate in storage leading to gummy deposits in the fuel system. Old gasoline can cause hard starting due to "weathering of the fuel," meaning a loss of the easier vaporizing components of the fuel due to evaporation. Very warm storage temperatures accelerate this type of fuel deterioration. If the gasoline in your fuel tank and carburetor deteriorates during storage, you may need to have the carburetor and other fuel system components serviced or replaced. Because power equipment and recreational products are stored for extended periods, often six months or longer, manufacturers often make recommendations about storage.

Over-Blending: Manufacturers of gasoline ethanol blends are very cautious not to over-blend and most now use very sophisticated equipment to achieve precise blend levels at or below maximum permitted levels.

Beyond E10 and Small Non-Road Applications

Passage of the 2007 Energy Independence and Security Act (EISA) will help usher in the use of ethanol beyond the traditional 10 percent blend for conventional vehicles. Expanded ethanol use

together with expectations for improved fuel economy can dramatically reduce demand for gasoline and increasingly displace our need for oil and gasoline imports.

Currently, the U.S. Environmental Protection Agency (EPA) recognizes gasoline blended with 10 percent ethanol as an acceptable fuel for use in today's non-road gasoline engines. Likewise, nearly all automakers warranty the use of E10, with some recommending its use. Continuing investigations of the use of higher ethanol content in gasoline for conventionally fueled vehicles will help us reach our goals of energy independence. Many authoritative entities, such as the

Renewable Fuels Association (RFA), State of Minnesota, U.S. Department of Energy and Coordinating Research Council, are focused on investigating the effect of higher levels of ethanol content in gasoline and their suitable use by conventional engine platforms.



Fuels such as E85 (85% ethanol and 15% gasoline) are available in many markets. E85 is for use in specially prepared flex-fuel vehicles (FFVs) and should not be used in non-road engines.

The RFA has recognized some of the concerns voiced by the small engine community. As such, in its comments to the EPA, the RFA outlined possibilities to allow for the use of E15 for on-road applications, like passenger vehicles, while keeping 10% blends available at other fuel outlets. Specifically, the RFA wrote, "Thus, to the extent EPA believes there is insufficient evidence to determine whether E15 emissions will cause or contribute to non-road vehicles and non-road engines failing to meet emission standards required for certification, EPA should still grant a waiver for E15, but limit such waiver to motor vehicles and motor vehicle engines."

Future Opportunities for Expanded Ethanol Use in Small Engines

Kohler's FFV Lawn Tractor

In October 2008, Kohler Engines raised the bar for all non-road engine manufacturers by announcing their new fuel efficient, cleaner burning engines will soon be the standard – not an option – on all KOHLER Command PRO® and Aegis® twin-cylinder engines. Starting with its Command PRO 30 gasoline, twin-cylinder model in March 2009, Kohler introduced the first flex-fuel, electronic fuel injection (EFI) engine. Over the coming years, Kohler will convert its entire Command PRO air-cooled and Aegis liquid-cooled engines with this technology, at a competitive price with traditional carbureted engines. Kohler partnered with Delphi – a leading global supplier of mobile electronics and transportation systems – to design this new flex-fuel EFI system with patent-pending technology that will offer significant fuel savings, improved performance and reduced emissions.

KOHLER flex-fuel EFI models will be available on 26 twin-cylinder models ranging from 19-41 hp, and will operate efficiently and without excessive wear on the engine when E85 is used. An

additional benefit of the new Kohler flex-fuel EFI engines is instant load response. The Kohler exclusive EFI system allows the engine to respond with peak Kohler performance even in changing altitudes and load requirements, which in turn, operates at top efficiency. For more information please see <http://www.kohlerengines.com/home.htm>.

Ethanol Blended Fuels for Use in Marine Equipment

All but the latest watercraft models have fuel systems vented to the atmosphere, which may require extra precaution. Marine equipment operate, and are often stored in, a wet environment. Owners/operators must preclude any water or moisture introduction to the fuel system. Marine fuel systems are robust in nature; however the fuel system may not be conducive to a visual inspection or identification of any environmental influences that may have resulted in a poor fuel quality condition.



Because of the above unique considerations, the RFA has prepared two documents, “Update for Boat Owners: Ethanol Blended Fuels for Use in Marine Equipment” and “E10 and Winterization”. These documents are available on the RFA website at www.EthanolRFA.org.

Manufacturers’ Positions

While one can debate test data versus myths on the use of gasoline ethanol blends in non road engines, consumers should focus primarily on what the equipment manufacturers recommend. They are, after all, most familiar with the quality of their products and whether or not they will operate satisfactorily on specific fuels.



Not all manufacturers mention gasoline ethanol blends either as approved or not approved. Most of these manufacturers rely on the engine manufacturer’s recommendation. However, the Outdoor Power Equipment Institute has indicated that all the existing equipment manufactured by their members is compatible with up to 10% ethanol. If there are any doubts about a manufacturer’s position, it is recommended that the manufacturer or an authorized dealer be consulted. Among the listed manufacturers that specifically mention ethanol, all permit these fuels to be used, although many offer special instructions.

A few manufacturers indicate they recommend non-ethanol blended fuels be used, but that gasoline ethanol blends are acceptable. Of course, today gasoline ethanol blends are the only fuel available in most markets. Many manufacturers, especially of power equipment, offer special instructions for extended storage periods. A few manufacturers in the recreational category indicate that modifications may be necessary on older models for proper operation on

ethanol blends.

The following provides information on the position some of the larger non-automotive engine and equipment manufacturers take on ethanol. The information excerpts have been collected from manufacturer websites and equipment owner's manuals. Please note unlike vehicle owner's manuals, equipment owner's manuals cannot be identified by the model year.

Briggs & Stratton (Website – 2011)

All 4 stroke cycle spark ignition engines

Fuel must meet these requirements:

- Clean, fresh unleaded gasoline.
- A minimum of 87 octane/87 AKI (91 RON). High Altitude use, see below.
- Gasoline with up to 10% ethanol (gasohol) or up to 15% MTBE (methyl tertiary butyl ether) is acceptable.

CAUTION: Do not mix oil in gasoline or modify engine to run on alternative fuels. This will damage the engine components and void the engine warranty.

To protect the fuel system from gum formation, mix in a fuel stabilizer when adding fuel. See storage section below.

All fuel is not the same. If starting or performance problems occur, change fuel providers or change brands. This engine is certified to operate on gasoline. The emissions control system for this engine is EM (Engine Modifications).

High Altitude

At altitudes over 5,000 feet (1524 meters), a minimum 85 octane/85 AKI (89 RON) gasoline is acceptable. To remain emissions compliant, high altitude adjustment is required. Operation without this adjustment will cause decreased performance, increased fuel consumption, and increased emissions. See an Authorized Briggs & Stratton Dealer for high altitude adjustment information.

Operation of the engine at altitudes below 2,500 feet (762 meters) with the high altitude kit is not recommended.

All 2 stroke cycle spark ignition engines

Mixing fuel and oil: Always mix a high quality, 2-cycle oil, such as Briggs & Stratton 2-cycle oil, at 50:1 gasoline to oil ratio.

Fuel must meet these requirements:

- Clean, fresh unleaded gasoline.
- A minimum of 87 octane/87 AKI (91 RON). High Altitude use, see below.
- Gasoline with up to 10% ethanol (gasohol) or up to 15% MTBE (methyl tertiary butyl ether) is acceptable.

CAUTION: Do not use unapproved gasoline such as E85*. Do not modify engine to run on alternative fuels. This will damage the engine components and void the engine warranty.

To protect the fuel system from gum formation, mix in a fuel stabilizer when adding fuel. See Storage section below.

Not all fuel is the same. If starting or performance problems occur, change fuel providers or change brands. This engine is certified to operate on gasoline. The emissions control system for this engine is EM (Engine Modifications).

*NOTE: Briggs & Stratton engines are not designed to run on E85 fuel. E85 is a blend of 85% ethanol (alcohol) and 15% gasoline, which is not compatible with most engines intended to run on regular gasoline. While alcohol is an excellent octane booster, it delivers less power, having an energy content value of only about 77,000 Btu per gallon versus 114,000 Btu for regular gasoline. E85 also demands a different fuel-to-air ratio to burn efficiently, requiring specially calibrated carburetors. Further, specially designed fuel system components are required to withstand the high alcohol concentration found in E85.

High Altitude

At altitudes over 5,000 feet (1524 meters), a minimum 85 octane/85 AKI (89 RON) gasoline is acceptable. To remain emissions compliant, high altitude adjustment is required. Operation without this adjustment will cause decreased performance, increased fuel consumption, and increased emissions. See an Authorized Briggs & Stratton Dealer for high altitude adjustment information.

Operation of the engine at altitudes below 2,500 feet (762 meters) with the high altitude kit is not recommended.

Storage

Fuel will become stale when stored over 30 days when recommended storage guidelines are not followed. Stale fuel causes acid and gum deposits to form in the fuel system or on essential carburetor parts. To keep fuel fresh, use Briggs & Stratton FRESH START™ fuel stabilizer, available as a fuel stabilizer or a drip concentrate cartridge.

There is no need to drain gasoline from the engine if a fuel stabilizer has been added according to instruction. Run the engine for 2 minutes to circulate the stabilizer throughout the fuel system. The engine and fuel can then be stored up to 24 months.

If gasoline in the engine has not been treated with a fuel stabilizer, it must be drained into an approved container. Run the engine until it stops from lack of fuel. The use of a fuel stabilizer in the storage container is recommended to maintain freshness. It is also recommended that fuel is purchased in quantities that can be used within 30 days. This will assure fuel freshness and volatility tailored to the season.

TecumsehPower (Website – 2011)
(4-stroke cycle engines)

Fuel

Use unleaded regular, unleaded premium or reformulated automotive fuel only. You may use gasoline containing the components identified in Table 3.

<u>Fuel Component</u>	<u>Percentage</u>
Ethanol	10%
Grain Alcohol (Gasohol)	10%
MTBE (Methyl Tertiary Butyl Ether)	15%
ETBE (Ethyl Tertiary Butyl Ether)	15%

- DO NOT use leaded fuel.
- Fuel must be fresh and clean. NEVER use fuel left over from last season or stored for long periods.
- NEVER mix oil with fuel.
- DO NOT use fuel containing methanol (wood alcohol).

CAUTION: The use of alternative fuels, such as E85 or E20 are NOT recommended for use in TecumsehPower engines. Alternative fuels with high alcohol content can cause hard starting, poor engine performance, and may cause internal engine damage.

NOTE: Damage and/or performance problems that occur from use of fuels other than those listed in the Operator's Manuals will not be considered under warranty.

Kohler (Website – 2011)

General Recommendations:

- Purchase gasoline in small quantities and store in clean, approved containers. A container with a capacity of 2 gallons or less with a pouring spout is recommended. Such a container is easier to handle and helps eliminate spillage during refueling.

- Do not use gasoline left over from the previous season to minimize gum deposits in your fuel system and to ensure easy starting.
- Do not add oil to the gasoline.
- Do not overfill the fuel tank. Leave room for the fuel to expand.

Fuel Type

For best results use only clean, fresh, unleaded gasoline with the pump sticker octane rating of 87 or higher. In countries using the Research method, it should be 90 octane minimum.

Unleaded gasoline is recommended as it leaves less combustion chamber deposits and reduces harmful exhaust emissions. Leaded gasoline is not recommended and must not be used on EFI engines, or on other models where exhaust emissions are regulated.

Gasoline/Alcohol Blends

Gasohol (up to 10% ethyl alcohol, 90% unleaded gasoline by volume) is approved as a fuel for Kohler engines. Other gasoline/alcohol blends are not approved.

Gasoline/Ether Blends

Methyl Tertiary Butyl Ether (MTBE) and unleaded gasoline blends (up to a maximum of 15% MTBE by volume) are approved as a fuel for Kohler engines. Other gasoline/ether blends are not approved.

Honda Engines (Website – 2011) (4-stroke cycle engines)

ADDITIONAL INFORMATION

Oxygenated Fuels: Some conventional gasolines are being blended with alcohol or an ether compound. These gasolines are collectively referred to as oxygenated fuels. To meet clean air standards, some areas of the United States and Canada use oxygenated fuels to help reduce emissions. If you use an oxygenated fuel, be sure it is unleaded and meets the minimum octane rating requirements. Before using an oxygenated fuel, try to confirm the fuel's contents. Some states/provinces require this information to be posted on the pump.

The following are the EPA approved percentages of oxygenates:

- Ethanol – (ethyl or grain alcohol) 10% by volume.
You may use gasoline containing up to 10% ethanol by volume. Gasoline containing ethanol may be marketed under the name Gasohol.
- MTBE – (Methyl Tertiary Butyl Ether) 15% by volume.
You may use gasoline containing up to 15% MTBE by volume.

- Methanol – (Methyl or wood alcohol) 5% by volume.
You may use gasoline containing up to 5% methanol by volume, as long as it also contains co-solvents and corrosion inhibitors to protect the fuel system. Gasoline containing more than 5% methanol by volume may cause starting and/or performance problems. It may also damage metal, rubber, and plastic parts of your fuel system.

If you notice any undesirable operating symptoms, try another service station or switch to another brand of gasoline.

Fuel system damage or performance problems resulting from the use of oxygenated fuel containing more than the percentages of oxygenate mentioned above are not covered under warranty.

Please note that the above are excerpts from fuel recommendations or applicable service bulletins and are meant simply to provide an overview. The entire fuel recommendation section of the owner's manual or applicable bulletins should be reviewed and followed in their entirety.

If information is unclear or insufficient, an authorized dealer for the applicable brand of equipment should be consulted.

Consumers should be advised that if they are purchasing new equipment, they should ensure that the manufacturer permits the use of gasoline ethanol blends. Due to existing federal regulations, nearly all gasoline sold in the U.S. contains ethanol. No one wants to purchase a product that will not operate satisfactorily on the available fuel supply.

The facts demonstrate that gasoline ethanol blends, containing up to 10 volume percent, can be used in these applications provided the manufacturer's instructions are followed. Numerous tests and field demonstrations have proven the performance of oxygenated fuels in these applications.

Appendix

Useful Websites

Information Resources

Renewable Fuels Association
www.EthanolRFA.org/

National Renewable Energy Laboratory
www.nrel.gov

ASTM International
www.astm.org

Outdoor Power Equipment Institute
<http://www.opei.org/>

U.S. Environmental Protection Agency Non Road Engines, Equipment and Vehicles
<http://www.epa.gov/nonroad/>

Other Important RFA Documents

RFA Update for Boat Owners: Ethanol Blended Fuels for Use in Marine Equipment

E10 and Winterization

Ethanol and Marine Use: Frequently Asked Questions

Changes in Gasoline Manual: Fourth Edition

All these documents can be found at www.EthanolRFA.org.