



Renewable Fuels Association

# **E 85 FUEL ETHANOL**

## **INDUSTRY GUIDELINES, SPECIFICATIONS AND PROCEDURES**

**Renewable Fuels Association**  
**One Massachusetts Ave. NW Suite 820**  
**Washington DC 20001**  
**Phone: (202) 289- 3835**  
**Fax: (202) 289-7519**  
**Email: [info@ethanolrfa.org](mailto:info@ethanolrfa.org)**  
**Website: [www.ethanolrfa.org](http://www.ethanolrfa.org)**

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## Introduction

The Renewable Fuels Association (RFA) is the national trade association for the U.S. fuel ethanol industry. Membership is comprised of numerous ethanol producers, both large and small, as well as suppliers to the industry and other interested parties. Founded in 1981, the RFA's primary objective is to promote public policy initiatives that increase the market for fuel grade ethanol produced from a variety of feedstocks including grains, agricultural wastes, and various biomass feedstock sources.

As the ethanol industry has grown, so too has the Renewable Fuels Association's areas of responsibility to its membership. Today the RFA not only focuses on legislative/regulatory and public policy type issues but also maintains several committees and task groups to address industry needs. These committees include a technical committee to address various technical issues and to assist with technical industry publications (such as this one). In addition, there are plant and employee safety, environmental, and cellulosic committees monitoring efforts in each of these respective areas. The technical committee also has an E85 task force to deal specifically with E85 issues. Other committees utilize standing and ad hoc task forces and work groups as well. These committees and task forces are comprised of representatives of our member companies, staff, and, when necessary, technical consultants and other interested stakeholders. The RFA provides support for educational outreach programs through its research and education arm, the Renewable Fuels Foundation.

The RFA promotes the use of fuel grade ethanol in all its legal applications. Fuel ethanol is blended in over 70% of the nation's gasoline. This includes not only conventional E10 (90% gasoline/10% ethanol), and reformulated gasoline (RFG), but also developing markets such as E85 for use in flexible fuel vehicles (FFVs) and mid level ethanol fuel blends. This document focuses on the product quality and integrity of E85, which is of the utmost importance to the Renewable Fuels Association and its members because, unlike ethanol as a blend component, in this application it is the finished fuel. To promote the highest quality fuel possible, the Renewable Fuels Association has put together this information offering a discussion of specifications, properties and their importance as well as other important topics related to E85. The purpose of this document is to serve as a condensed technical reference for manufacturers and retailers of E85 and other interested parties who need such information. All RFA Technical Publications and other RFA Reference materials are available on the RFA website at: [www.ethanolrfa.org](http://www.ethanolrfa.org).

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## E85 and Flex Fuel Vehicles

While fuel grade ethanol is most widely recognized for its use in E10 gasoline/ethanol blends there is growing awareness and use of what is commonly called E85. E85 can actually range from 70% ethanol/30% hydrocarbons to 79% ethanol/21% hydrocarbons (discussed in more detail later in this publication). E85 is currently restricted to use in FFVs.

**Flex Fuel Vehicles:** Several manufacturers currently offer vehicles that are capable of operating on 100% gasoline or E85, or any mixture of the two. These vehicles are called flex fuel vehicles (FFV) or variable fuel vehicles (VFV). Ford, General Motors, and the Chrysler Corporation, as well as some foreign based manufacturers, all offer certain models as FFVs that operate on E85.

It is estimated that there are over 7 million FFVs on the roads today. Through the commitment of the U.S. automakers, nearly 50% of their vehicles sold by 2012 will be FFVs. FFVs are growing in demand as consumers want a choice in fuels and desire to support domestically grown transportation fuels. Fuel infrastructure is growing at a steady pace as well. There are currently over 2,000 retail stations offering E85.

A full list of FFV models for the past and current model years is available from the Department of Energy's website: [http://www.afdc.energy.gov/afdc/vehicles/flexible\\_fuel\\_availability.html](http://www.afdc.energy.gov/afdc/vehicles/flexible_fuel_availability.html) This website also has an E85 station locator feature to find a fueling station near you, [http://www.afdc.energy.gov/afdc/ethanol/ethanol\\_locations.html](http://www.afdc.energy.gov/afdc/ethanol/ethanol_locations.html). **E85 should not be dispensed into non FFVs as it could damage the vehicle. It could also result in significant fines for the fuel retailer.**

### Initiating a Successful E85 Retail Marketing Program

There are six distinct areas of importance to initiating a successful E85 marketing program:

- Product Quality
- System Conversion and/or New Installations
- Transportation Considerations
- Safety Issues
- Retail Marketing Considerations
- Legal Compliance

### Product Quality

There are several issues regarding E85 quality, including the quality of the ethanol, the quality of the hydrocarbon portion of the blend, and the quality of the finished blend. In addition, adequate treatment with certain additives and proper care during transport and delivery, as well as proper procedures for conversion and housekeeping, are also necessary.

### E85 Quality

At retail E85 should meet the property limits set forth in ASTM D 5798 Standard Specification for Fuel Ethanol (Ed75-Ed-85) for Automotive Spark- Ignition Engines. The lower case "d" in "Ed" stands for "denatured" ethanol meaning for instance Ed75 is 75 volume %

denatured ethanol. Table 2 lists the property limits as well as designated test methods for E85. The full ASTM specification has very detailed information regarding the importance of each property. As such, testing frequency is not defined here. Each E85 manufacturer should evaluate their own operation and process to set a testing frequency to ensure adherence to the ASTM standards. The RFA has developed a quality assurance/quality control (QA/QC) guide entitled, "Guidelines for Establishing Ethanol Plant Quality Assurance and Quality Control Programs," RFA Publication #040301, which may prove useful in setting up a fuel quality and oversight program. This document is available on the RFA website: [www.ethanolrfa.org](http://www.ethanolrfa.org).

**Table 1 ASTM D 5798 Standard Specification for Fuel Ethanol (Ed75-Ed85) for Automotive Spark Ignition Engines**

Properties				ASTM
	Class1	Class 2	Class 3	test method
Ethanol + higher alcohols, min, volume %	79	74	70	
Hydrocarbon/aliphatic ether, volume %	17-21	17-26	17-30	
Vapor pressure, kPa (psi)	38-59 (5.5-8.5)	48-65 (7.0-9.5)	66-83 (9.5-12.0)	D4953 / D5190
Sulfur, max, mg/kg	80	80	80	D2622 / D5453
All Classes				
Methanol, volume %, max		0.5		
Higher alcohols (C <sub>3</sub> -C <sub>8</sub> ), max, volume %		2.		
Acidity, (as acetic acid CH <sub>3</sub> COOH), mass % (mg/L), max		0.005 (40)		D1613
Solvent-washed gum content, max, mg/100mL		5.		D381
pH <sub>e</sub>		6.5 to 9.0		D6423
Unwashed gum content, max, mg/100 mL		20.		D381
Inorganic chloride, max, mg/kg		1.		D7319 / D7328
Copper, max, mg/L		0.07		
Water, max, mass %		1.0		D1688
Appearance	This product shall be visibly free of suspended or precipitated contaminants (clear and bright). This shall be determined at ambient temperature or 21°C (70°F), whichever is higher.			

\*\* Note that certain states ban the use of MTBE/or other aliphatic ethers.

As some of the methods listed in this specification were not originally developed to evaluate high ethanol content fuels, the ASTM D02.08 Analytical Methods subcommittee has formed a Biofuel Method Applicability work group to address concerns with the above listed method applicability to fuel with an ethanol content greater than 10% volume.

The following pages discuss the importance of these property limits.

**Ethanol & Higher Alcohols, Hydrocarbons/Aliphatic Ethers, and Vapor Pressure:** The limit of the ethanol/higher alcohols and hydrocarbon portion of E85 varies by class. For instance,

Class 3 requires less ethanol and allows a lower ethanol minimum. This is done to increase fuel volatility (vapor pressure) to provide better cold start and warm up performance. Class 3 is typically the winter grade, Class 1 the summer grade and Class 2 is typically inter-seasonal (fall/spring). The minimum ethanol and higher alcohols in the specification takes into consideration that the ethanol in the blend is denatured. Thus Class 1 E85, which would typically contain 85% denatured ethanol, is required to meet a 79% minimum ethanol content.

**Vapor Pressure:** As discussed above, vapor pressure is altered based on historical climate conditions and altitude. Table 2 of ASTM D 5798 lists the appropriate class by state, by month. Class 1 (summer grade) requires a vapor pressure of 5.5-8.5 psi. Class 2 (spring/fall) requires a vapor pressure of 7.0 – 9.5 psi and Class 3 (winter) 9.5 – 12.0 psi. Testing is currently underway to determine if these ranges (established on older vehicle technology) are still appropriate or require revision.

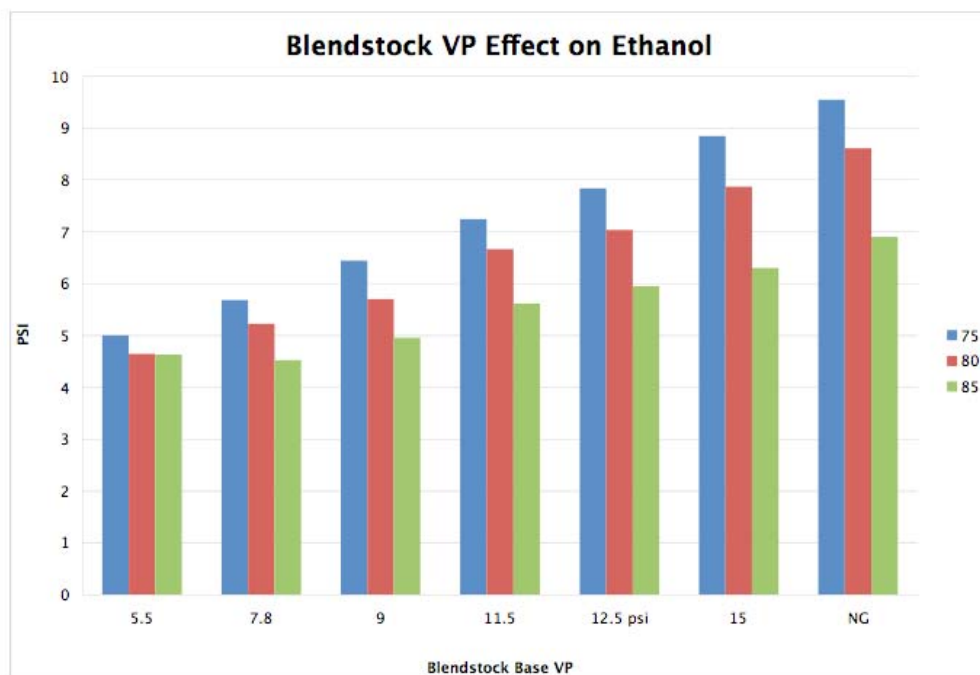
**Note: Some states such as California have, or are developing, their own E85 standards.**

It is often difficult to meet the minimum vapor pressure requirements with today’s lower volatility gasolines. General Motors and the RFA conducted a study of various volatility hydrocarbon blend stocks at varying levels. This included gasolines with vapor pressures of 5.5, 7.8, 9, 11.5, 12.5, and 15 psi as well as natural gasoline. The following table lists the “as tested” (ASTM D 4953), ASTM Dry Vapor Pressure Equivalent (DVPE) of the fuels, as received.

<b>Table 2 Hydrocarbon / Vapor Pressure Results</b>	
	<b>ASTM DVPE</b>
Description	psi
5.5 CARB	5.63
7.8 CBOB	7.09
9.0 psi	8.67
11.5 psi	10.51
12.5 psi	12.26
15.0 psi	14.65
Natural Gasoline	13.4

The following figure shows the vapor pressure results (ASTM D 4953) for blending each hydrocarbon at 15%, 20%, and 25% (i.e. E85, E80 and E75 respectively).

Figure 1



As can be seen, for E85 (typically the summer grade), some blendstocks do not meet the 5.5 psi minimum. For E80, some do not meet the 7.0 psi minimum and for E75 very few meet the 9.5 psi minimum. Selection of a sufficiently volatile (high vapor pressure) hydrocarbon allows the final blend to meet minimum ASTM vapor pressure requirements when added at the correct levels.

**Seasonal Inventory Control:** Retailers should exercise caution at seasonal changeover time. For instance, a high inventory of summer grade, if not run down before cold weather, would be below the specified vapor pressure and may adversely affect cold start and warm up performance.

**Sulfur:** Sulfur limits must be controlled because sulfur can damage the catalytic converter. Care should be used in selecting denaturants because these hydrocarbons are the source of most sulfur in denatured ethanol.

**Methanol and Higher Alcohols:** Methanol is held to low limits due to its corrosive properties, while higher alcohols are controlled to ensure ethanol purity.

**Acidity, pHe and Inorganic Chloride:** These are limited to reduce corrosive properties.

**Solvent Washed Gum/Unwashed Gum:** Solvent washed gum can contribute to fuel system deposits. The unwashed gum content is set to limit high boiling point components such as diesel fuel. The difference between unwashed and solvent washed gum can be used to determine the

presence of non-volatile materials. More analytical testing would be necessary to identify the exact material, which could be additive or additive carrier oils.

**Copper:** Copper is undesirable in fuels because it can decrease fuel stability thereby contributing to increased gum formation.

**Water:** Water levels are controlled because excessive water levels may increase fuel system corrosion.

**Appearance:** Product should be visibly free of suspended or precipitated contaminants.

**Workmanship Clause:** Section 5 of ASTM D 5798 also contains a workmanship clause which states:

“Fuel Ethanol (Ed75-Ed85) shall be visually free of sediment and suspended matter. It shall be clear and bright at the ambient temperature or 21°C (70°F), whichever is higher. The specification defines only a basic purity for fuel ethanol (Ed75-Ed85). The product shall be free of any adulterant or contaminant that can render the material unacceptable or its commonly used applications.”

**Octane:** A minimum octane for E85 is not specified. FFVs can tolerate the lower octane of gasoline, i.e. 87 (R+M)/2. The RFA recommends that the octane not be posted because of variations and testing expense. There is no requirement to post octane on an E85 dispenser. If a retailer chooses to post octane, they should be aware that the often cited 105 octane is incorrect. This number was derived by using ethanol’s blending octane value in gasoline. This is not the proper way to calculate the octane of E85. Ethanol’s true octane value should be used to calculate E85’s octane value. This results in an octane range of 94-96 (R+M)/2. These calculations have been confirmed by actual octane engine tests.

**Product Additization:** ASTM D 5798 does not contain guidelines for additives such as corrosion inhibitors or detergents/deposit control additives. Work in this area is ongoing. As such, the RFA has not yet prepared a formal recommendation for additives to be used in E85. The following discussion provides information on developing issues.

**Corrosion Inhibitors:** Nearly all ethanol producers add a corrosion inhibitor at a level sufficient to treat the entire finished gallon of E10. This level would actually over-treat a gallon of E85. However, since E85 is typically made from ethanol in common storage and E10 is the primary blend, this is unavoidable at the present time.

**Detergents/Deposit Control Additives:** Recent studies have shown that E85 may, in some cases, lead to development of fuel injector and/or intake valve deposits. Preliminary work indicates that this may be a result of no detergents in the ethanol portion of the blend in combination with high levels of corrosion inhibitor. This can be addressed through the addition of detergents/deposit control additives. If an additive is used, the blender must rely on information from the additive manufacturer. In addition to effectiveness, it should be confirmed that any additive selected will remain soluble in varying blend levels of gasoline and ethanol, and that the additive meets the “no harm” criteria, meaning it will not interact with other gasoline additives present in a manner that would cause problems or reduce the effectiveness of other additives. Common gasoline additives may not be compatible with E85. The recommended treat rate of any additive should not be exceeded.



**Quality Assurance and Quality Control (QA/QC) Program:** The product quality of E85 is very important. The extent of any QA/QC program will depend on if the fuel is purchased pre-blended and if it is splash blended or produced by automated blending. It may also depend on the use of an in-house laboratory versus an independent laboratory, volumes sold, and individual company operating producers. As noted earlier, the RFA has a QA/QC guidance document available on its website.

Quality Assurance (QA) is a set of operating principles that, when strictly followed, a product will be produced meeting the expectations of the customer. The program should provide assurance of compliance to any applicable quality expectations as well as any regulatory requirements.

Quality Control (QC) is a measure within a sample analysis methodology to assure that the process is in control. Quality Control Programs ensure that the process is running as designed and through various process checks, such as sampling methods, produce representative samples, confirm that laboratory analyses are reliable, and verify that the reported results are suitable to support decisions, and measure and document any uncertainty in analytical data.

Because of all the variables that determine the necessity and frequency of tests, QA/QC procedure needs will vary by company.

## **E85 Blending**

E85 may be blended at an ethanol plant or a petroleum distribution terminal. Some retailers have retail dispenser systems that can blend E85 at the pump. The level of QA/QC and product documentation may vary depending upon the location and method of blending.

**Purchased Pre-Blended (Automated Blending):** In this instance, you can usually rely on the seller's certificate of analysis or specification sheets. Certificates of Analysis (COA) can be considered a legal document ensuring compliance to the agreed upon fuel quality standard. A Certificate of Analysis should contain each of the following: Manufacturing/Blending, location, Lot or Batch Identification, product name, date of analysis, test methods and results as performed, and a signature of the person responsible for ensuring product quality or person performing the analysis. In many instances, testing frequency should be indicated next to the test parameter and if any typical properties are listed it must be indicated as such. Clear instructions on how to correctly complete a COA will provide for the utmost accurate and truthful communication to the customer. A COA may be duplicated and issued on a time based approach (daily, shift wise, etc.) or process conditional approach (batch, shipment, etc.). Since E85 is usually manufactured at the terminal as the truck is being loaded, a COA is more likely to show percent of blend and properties of blend components and then typical properties on the blend. Even when a COA is provided, it is a good practice to periodically spot check a few samples.

**Purchased Pre-Blended (Splash Blends):** Here the retailer can also rely on a COA, but again it is good practice to periodically spot check samples. In this instance, where there is a greater potential for mis-blends, more frequent sampling is advised.

**Blender of Record:** If your company is the blender of record, i.e. the entity actually blending the two components, more stringent QA/QC is required. Automated blending equipment should be checked periodically to verify blending accuracy. While automated blending is preferred, it is often not available because of current low sales volumes of E85 in many areas. If your company

is splash blending, you should meet with your transport drivers (or common carrier dispatchers and drivers) to cover proper procedures. Pre-calculated blend cards should also be developed for each tanker/compartiment size. An example is provided in the table below.

<b>Table 3</b>		<b>E85 Blend Calculation Card</b>		
<b>Compartment Size (gallons)</b>		<b>E85</b>	<b>E80</b>	<b>E75</b>
1600	Gasoline	240	320	400
	Ethanol	1360	1280	1200
2000	Gasoline	300	400	500
	Ethanol	1700	1600	1500
2400	Gasoline	360	480	600
	Ethanol	2040	1920	1800

As noted in the transportation section, the gasoline should be added to the compartment first. This reduces the potential for build-up of static charge and improves blending (by introducing a larger quantity into a smaller one).

Note that the components of E85 are blended on a volume basis of the components, corrected to identical temperatures (usually 60°F). There are currently no volume correction tables for E85 blends.

### **Other Product Quality Considerations**

Blenders of E85 should also monitor the properties of the blendstocks they use to manufacture E85.

**Base Ethanol Quality:** The ethanol most often used at terminals to make the various blend levels of E85 is the same ethanol that is used to make E10 blends. Consequently, much of the ethanol used to make E85 meets ASTM D 4806 “Standard Specification for Denatured Fuel Ethanol for Blending with Gasolines for Use as Automotive Spark-Ignition Engine Fuel.” A table listing the key properties defined by ASTM D 4806 is included in Appendix A.

For a more detailed discussion of the importance of these properties, refer to a copy of the applicable specification. Copies of ASTM D 4806, ASTM D 5798, and other ASTM specifications and standards may be obtained from:

ASTM  
100 Bar Harbor Drive  
W. Conshohocken, PA 19428-2959  
Publication orders: Phone: (610) 823-9585 Fax: (610) 832-9555  
Website: <http://www.astm.org>

**Corrosion Inhibitors:** The RFA also recommends that its ethanol producers add corrosion inhibitors to the ethanol they produce. These additive recommendations can be found in RFA Publication # 960501, “Fuel Ethanol Industry Guidelines, Specifications and Procedures,” which is available on the RFA website. These additive recommendations are currently under review and may be revised in the near future.

**Hydrocarbon Quality:** The hydrocarbon portion of E85 is usually comprised of regular unleaded gasoline meeting ASTM D 4814, “Standard Specification for Automotive Spark-Ignition Engine Fuel” or Natural Gasoline. Some ethanol producers use Natural Gasoline to produce E85 because it is commonly stocked at the plant for denaturing ethanol. The quality and characteristics of hydrocarbon materials can vary significantly. Whatever hydrocarbon blendstock is used, the blender should be sure that its properties will allow E85 to meet the requirements of ASTM D 5798, “Standard Specification for Fuel Ethanol (Ed75-Ed85) for Automotive Spark-Ignition Engines.” (See page 5) Key properties of concern in selecting the hydrocarbon blend component include:

**Vapor Pressure:** The vapor pressure of the hydrocarbon must be sufficient to raise the vapor pressure of the finished blend to the minimum requirement at the blend levels specified.

**Sulfur:** The sulfur level of the hydrocarbon must be low enough that the finished blend complies with ASTM specifications as well as any state or federal requirement.

**Other Important Properties:** Other important hydrocarbon blendstock properties include an end point 437°F (225°C), gum content, oxidative stability, and appearance, all which could impact the quality of the finished E85 blend.

### Installations and Conversions

Whether installing a new E85 system or converting an existing system to E85 there are certain preparatory steps that must be taken. Additionally certain housekeeping procedures must be adhered to. A useful information guide for retail E85 dispensing is the “Handbook for Handling, Storing, and Dispensing E85,” (DOE/GO-102008-2450) April 2008, available on the internet at: [www.atdc.energy.gov/afdc/pdfs/41853.pdf](http://www.atdc.energy.gov/afdc/pdfs/41853.pdf). This and more information is available from the Department of Energy website. [www.afdc.energy.gov/afdc/ethanol](http://www.afdc.energy.gov/afdc/ethanol). This website contains excellent information on E85 installations and conversions as well as other information on E85. Another useful website is the Petroleum Equipment Institute, [www.pei.org/e85](http://www.pei.org/e85), which has a list of suppliers with E85 compatible equipment. These guides and documents also provide information on materials compatibility with E85. As a general guideline Table 4 lists compatible and non-compatible metals while Table 5 lists Elastomers & Plastics.

<b>Table 4 Metal Compatibility with E85</b>	
<b><u>Compatible</u></b>	<b><u>Non Compatible</u></b>
Unplated Steel	Zinc
Stainless Steel	Brass
Black Iron	Lead (& lead alloys)
Bronze	Aluminum and certain Aluminum Alloys*
Nickel Plate	Terne Plate
	Copper

\*Intermittent contact with Aluminum Alloys, example given transport trucks, has not shown any compatibility problems.

**Table 5 Elastomer/Plastics Compatibility with E85**

<u>Compatible</u>	<u>Non Compatible</u>
Teflon	Natural Rubber
Nitrile	Cork
Viton	Leather
Polypropylene	Polyurethane
Buna-N	PVG
Neoprene Rubber	Some Plastics/
Thermo Plastic Pipe	Thermo Set Plastics
Thermoset Reinforced Fiberglass	

In addition to following industry guidelines for fuel performance and federal regulations, there are usually state and local regulatory guidelines that must also be adhered to. These requirements may differ for terminal and retail fuel locations. These requirements may include state and local fire codes as well as Department of Transportation (DOT) and OSHA Hazardous Materials Regulations. As such, you should consult with state and local officials before beginning your installation or conversion.

**Authorities Having Jurisdiction (AHJ):** In most cases local authorities having jurisdiction (AHJ) have control over certain aspects of the installation. For example, they may require UL listed equipment or manufacturer certified equipment. They may also waive such requirements but require more frequent inspections.

### **Transportation**

Because E85 is produced at a petroleum distribution terminal or an ethanol production facility, it is almost always delivered by transport truck (typically 7800-8200 gallon compartmentalized capacity). While equipment suitable for transportation of gasoline is acceptable for handling E85, a few extra precautionary steps should be taken. Truck compartment(s) should be clean and dry before loading. Avoid contamination from water, leaded fuels such as racing gasoline/AV gas, or diesel, etc. Always ground the truck during loading and unloading operations. Hoses must be purged. It is best to have pumped ethanol or unleaded gasoline prior to pumping E85 to avoid contamination. Before the first delivery to the E85 storage system, make certain that the lines and pump are clean. E85 is a DOT Class 3 flammable liquid. Handle with the same safety precautions as gasoline. Avoid sparks and flames. It is advisable to wear safety goggles when handling E85. If E85 contacts the body or face, flush with water. Use good ventilation. Avoid breathing vapors, because they can cause headaches, dizziness, and nausea. If delivering to an outlet not within your own control, you should contact the manager to verify their unloading hours and procedures. All transport drivers should be issued a Material Safety Data Sheet (MSDS) on E85. A sample MSDS is included in the appendices. Transport drivers should also be advised of all safety and firefighting guidelines.

If product is blended in the truck compartments the gasoline should be loaded first to reduce buildup of static charge. This also results in a more homogenous blend. Also the blends should

be blended by compartment to ensure proper mixing. The truck should always be grounded during loading and unloading.

**Placarding:** Transport trucks hauling E85 should be placarded as UN 3475 (ethanol and gasoline mixture). On January 28, 2008, the United States Department of Transportation, Pipeline and Hazardous Materials Safety Administration (PHMSA) issued a final rule creating a new proper shipping name and placard for E85. The RFA Safety Committee recommends that fuels containing greater than 10% volume fuel alcohol and less than 95% use the UN 3475 identification. Mandatory compliance with the new placarding regulation began October 1, 2008. This mandatory placarding will direct “First Responders” to Guide 127 of the Emergency Response Guidebook (most recent publication 2008).

**Prior Commodities Hauled:** Prior commodities hauled that are acceptable in trucks include E85, ethanol, fuel grade denatured ethanol, unleaded gasoline, unleaded racing gasoline, unleaded RBOB, unleaded CaRBOB, and natural gasoline. Equipment used to haul other commodities should not be used unless the equipment has been properly cleaned. Residual amounts of other products may contaminate the E85. For an expanded discussion of prior commodities hauled, as well as various equipment cleaning procedures, refer to RFA Publication # 960501.

### Handling and Receipt of E85

The same handling and product receipt safety and administrative procedures for gasoline are appropriate for E85. It is important to note two additional safety factors. E85 electrical conductivity is different than gasoline and is more prone to build a static charge. Additionally, E85 vapors are more easily ignitable than gasoline vapors. Mixtures of air and vapors will only burn or explode within a certain range of concentrations. The lean limit (or lower explosive limit) is where the mixture has just enough vapor to burn and the rich limit (or upper explosive limit) is where it is almost too rich to burn. E85 vapors often fall between the lean and rich limits meaning that it is a combustible mixture.

### Safety and Firefighting

**Health Considerations:** E85 should be handled in the same manner as gasoline. Personal exposure should be minimized. Like gasoline, E85 is flammable, poisonous, and may contain additives that can be harmful even with casual contact. E85 is poisonous and should not be consumed. Exposure to E85 can occur by inhalation (breathing in its vapors), absorption (getting it on the skin or in the eyes), or ingestion (swallowing it). The various symptoms of exposure to E85 and fuel ethanol are shown in Table 6.

Table 6. First Aid Treatment for Exposure to Fuel Ethanol		
Symptoms of Exposure:	Dullness of memory and concentration Impaired motor coordination Drowsiness, stupor, and coma	
<b>Exposure:</b>	<b>Fuel Ethanol First Aid Treatment</b>	<b>Treatment Compared to Gasoline Exposure</b>
Inhalation	Move away from the vapors to fresh air, contact medical personnel immediately	Same
Skin Absorption	Immediately wash skin with soap, and flush skin with plenty of water for at least 15 minutes. Remove	Same

	contaminated clothing and contact medical personnel immediately	
Eye Absorption	Immediately flush eyes with plenty of water for at least 15 minutes, contact medical personnel	Same
Ingestion	Lie down, keep warm, do not induce vomiting, and contact medical personnel immediately	Different

**Fire-fighting:** Fuel ethanol and E85 fires require specific equipment, materials, and training. Recent testing of fire-fighting agents sponsored by the Ethanol Emergency Response Coalition using the Underwriters Laboratories, Inc. (UL) 162 test methodology revealed that conventional gasoline fire-fighting methods and chemicals are not likely to be effective on high ethanol content fuel fires. Ethanol blended fuels with greater than 10% ethanol require the use of a Polar Solvent or Alcohol Resistant (AR) type of Foam commonly known as an AR-AFFF. Traditional AFFF foams have limited to no ability to extinguish fire emergencies when the ethanol content is above 10% by volume. AR type foams work on all alcohol variations of ethanol and gasoline blended fuels and would be the best use of fire response equipment. It should be mentioned that Dry Chemical fire extinguishing agents may also work on ethanol blended fuels, however, the dry chemical manufacturer must be consulted for appropriateness.



The RFA has been an instrumental member of the Ethanol Emergency Response Coalition (EERC), which collectively produced a video entitled “Responding to Ethanol Incidents.” This video is available for free download at the RFA website, [www.ethanolrfa.org](http://www.ethanolrfa.org). This video provides the necessary guidance for foam selection to address ethanol blended fuel fires. Another reference point for ethanol specific safety information is the EERC’s website, [www.ethanolresponse.com](http://www.ethanolresponse.com). The EERC website holds a library of emergency and environmental information to help with both education and preparedness in the first response community when responding to ethanol related emergencies. There are contacts, MSDS, and technical bulletins available on this website.

Safety training for distribution, retail, and emergency response personnel should be included specifically for ethanol blended fuels. Ethanol specific training provides the communication link between all parties to ensure an effective response to any emergency that may arise.

**Safety Codes:** Safety standards for handling and storing E85 are the same as those for gasoline. The National Fire Protection Agency (NFPA) has two standards that apply to ethanol blends: NFPA 30, “Flammable and Combustible Liquids Code,” and NFPA 30A, “Automotive and Marine Service Station Code.” These codes contain information on refueling facilities, storage, and handling requirements for all flammable and combustible liquids. NFPA assigns ethanol fuels (including E95 and E85) to the same flammability class as gasoline. Copies of these standards can be obtained through the Office of the State Fire Marshal or the NFPA website. A sample material safety data sheet for E85 is shown in Appendix B.

## Retail Issues

**Marketing:** E85 requires a special marketing effort. Prior to installation, the retailer should determine if the local FFV population is sufficient to recoup any investment and return a reasonable profit. FFVs can be identified by a unique character in the Vehicle Identification Number (VIN), vehicle emblem or by the owner's manual. The retailer should contact the RFA's Market Development Team for assistance in site assessment. Together, they can work with the auto manufacturers and/or bureau of motor vehicles to identify the consumer FFV population by zip code, provide information on fleet FFV population by zip code, local traffic counts, partnerships with auto dealerships and more. If at all possible, some type of incentive should be offered to entice the FFV owner to try E85. Examples of successful offers include "cents off," giveaways, celebrities, etc. There may be funds available to help with such promotions. Check with RFA's Market Development Team to see what is available. This team works directly with other organizations that promote E85, such as state corn grower associations, the automakers, American Lung Association, Clean Cities Coalitions, ethanol producers and, in some cases, state and federal government. The bottom line is that any marketing program must advise consumers of the fuel's availability and advantages to get them to try it. For more information, the National Renewable Energy Laboratory (NREL) has produced a business case for E85: <http://www.afdc.energy.gov/afdc/pdfs/41590.pdf>

**Gasoline Gallon Equivalence (GGE):** E85 blends contain less energy than gasoline, which results in fewer miles per gallon. Fuel cost, on a miles driven basis, must be considered. This is sometimes called gasoline gallon equivalence (GGE). E85 is really E75 in the winter, E80 in spring and fall, and E85 in summer. Ethanol does not contain as much energy as gasoline (lower btu/gallon). In fact, E85 (E75, E80) contains about 73% to 76% the btu content of gasoline. The actual impact on fuel economy can vary depending on the model of vehicle, vehicle driving patterns, driving conditions, driver input, state of tune of the vehicle and other factors. Some drivers and fleets have experienced fuel economy penalties below 10%, but most drivers will experience a larger miles per gallon drop, typically in the 20% range.

It is important to promote the benefits of ethanol, and the value associated with those benefits. It does not take the consumer long to figure out that they cannot go as far on a tankful of E85 as on one of gasoline, but the value of the benefits may help. To offer comparable value the consumer typically will want to drive the same distance on a dollar's worth of E85 as a dollar's worth of gasoline. As a trade association, the RFA cannot offer recommendations on, or suggest how to price E85. The price of E85 must be set by the retailer. However, to provide the retailer with information on how a consumer might compare E85 on a cost per mile or GGE basis a hypothetical example is provided in Table 7. The table uses gasoline meeting ASTM D 4814. This is only one example and is on a btu basis only, and presents a worst case scenario. Some drivers experience better fuel economy than the btu content would predict. Unlike gasoline, which typically has a lower energy content in the winter (as much as 10%), E85 has a higher energy content in the winter. Many FFVs take advantage of ethanol's greater thermal efficiency, which achieves more miles per btu than gasoline, although not enough to offset the total energy content difference.

<b>Table 7 E85 Gasoline Gallon Equivalence</b>			
	<b>Gasoline</b>	<b>E75</b>	<b>E85</b>
Gasoline Portion	218.4	54.6	32.76
Ethanol Portion	0	111.75	126.65
Total	218.4	166.35	159.41
% of Gasoline Price	100%	76.20%	73%

Ethanol price 200 cpg less 51 cpg credit = \$1.49. Unleaded regular 218.4 cpg

In the hypothetical example in the table the consumer pays less per gallon or tankful for E85 but since fewer miles per gallon are achieved, the driving cost to the consumer is approximately the same. If a consumer gets 20 mpg on gasoline and 15 mpg on E85, that equates to 400 miles on 20 gallons of gasoline and 300 miles on 20 gallons of E85. Most will not be willing to use E85 unless it is correspondingly less expensive than gasoline.

**Retail Dispenser Labeling:** There are certain specific labeling requirements for alternative fuels, including E85. At a minimum, the pump must be labeled with the Federal Trade Commission (FTC) required label as described in the Code of Federal Regulations (CFR) Title 16 Part 306. This label must identify the fuel as E85 and state the minimum volume percentage of ethanol present. By stating 70% this covers all blend scenarios down to E75 and allows for the denaturant. An example of a compliant FTC label is provided in Figure 2.

Figure 2





It is also recommended (and in some areas required) that the dispenser or nozzle have a consumer advisory label that states this fuel is for use in FFVs only. Please contact RFA's Market Development Team for additional voluntary dispenser labels and suggestions.

### Other Necessary Identifications

Retail storage tanks containing E85 should be labeled in accordance with the API Color Coding System with a bronze pentagon with E85 in black. See example figure 3.

Figure 3



The pentagon should be painted on fill line manhole covers. It is also recommended that similar identification be placed on the tank fill line. Many states and local authorities may also require specific labeling or signage so the retailer should check with state and local authorities.

### Tax Incentives and Funding

There are various tax incentives available to encourage the expansion of E85 marketing. These include incentives for fuel blending as well as for the cost of new installations or conversions.

**VEETC:** The Volumetric Ethanol Excise Tax Credit (VEETC) allows the blender of E85 to take a credit of 45¢ per gallon of denatured ethanol used in the production of E85. The credit is permitted on ethanol and up to 2% on the denaturant in the ethanol. There is specific guidance for how to file for the VEETC on the RFA website. Ethanol producers who are blenders of record can take the VEETC for the ethanol portion of E85.

**Refueling Stations Credit:** In 2009, the American Recovery and Reinvestment Act increased the government incentive for new or newly converted refueling infrastructure. This credit now allows a credit of 50% (capped at \$50,000) per facility for alternative refueling installations such as E85.

**State Level Incentives:** Many states also offer assistance for new or newly converted alternative fuel installations. These change from time to time so the individual state should be consulted. To explore incentives by state, click here: [http://www.afdc.energy.gov/afdc/incentives\\_laws.html](http://www.afdc.energy.gov/afdc/incentives_laws.html)

**Renewable Identification Numbers (RINs):** The blender of record that produces E85 can generate RINs which can be sold to companies who fail to meet their minimum renewable fuel use requirement. The value of RINs is determined by marketplace conditions.

**Other Sources:** Other organizations have also been instrumental in either providing a portion of necessary funding or helping to identify additional funding sources. The RFA and the Department of Energy has assisted with, or provided guidance for, numerous E85 installations.

### **Legal Considerations**

As with all transportation fuels sold at retail there are various legal considerations. While many of these regulations for E85 are identical, or similar, to gasoline some are unique to E85. Some of the most important are discussed below.

**Misfueling Prevention:** Under the Clean Air Act and EPA guidance it is illegal for the retailer to allow E85 to be dispensed into a non-FFV. Fines can be levied on the retailer or customer and can be as high as \$10,000 per offense. Even though the facility may be “self-serve,” the retailer is considered responsible and can be fined for misfueling events. Dispensers and nozzles should be clearly identified as “for use in FFVs only” and “check your owner’s manual.”

**Labeling Requirements:** As noted in the Retail Issues section, certain FTC labeling requirements are required. State or local authorities may have additional labeling or product identification requirements.

**Equipment Requirements:** As noted in the Installation and Conversion section, some states and local jurisdictions may have specific regulations or guidelines on what equipment is approved for E85 use.

**Fuel Quality:** Many states have fuel quality programs. These programs are usually (but not always) part of a state’s Department of Weights and Measures. Many states have recently adopted, or are currently considering adopting, fuel quality regulations that apply to E85.

## Appendix A

### Key Properties

#### ASTM D 4806\*

#### Appendix A ASTM D 4806 “Standard Specification for Denatured Fuel Ethanol for Blending with Gasolines for Use as Automotive Spark-Ignition Engine Fuel” – Key Properties

Property	Specification	ASTM Test Method
Ethanol Volume % min	92.1	D 5501
Methanol, volume %, max	0.5	
Solvent-washed gum, mg/100 ml max	5.0	D 381
Water content, volume %, max	1.0	E203
Denaturant content, volume % min	1.96	
volume % max	5.0	
Inorganic Chloride content, mass ppm (mg/L) max	10 (8) +	D 7319/D 7328
Copper content, mg/kg, max	0.1	D 1688
Acidity (as acetic acid CH <sub>3</sub> COOH), mass percent (mg/L), max	0.007 (56)	D 1613
pHe	6.5-9.0	D 6423
Sulfur mass ppm, max	30.	D 2622/D 5453
Sulfate mass ppm, max .	4	D 7318/D 7319
Appearance	visibly free of suspended or precipitated contaminants (clear & bright)	

+ In order to meet the Chloride Specification for E85 the base ethanol used must have a maximum chloride level of 1.17 ppm.

\*Refer to the ASTM website, [www.astm.org](http://www.astm.org) for the most current version of the ASTM D 4806 specification.

## Appendix B

### E85 Material Safety Data Sheet (MSDS)

Material Safety  
Data Sheet

Revision Date:  
November 1, 2008

**COMPANY X**  
**100 Main Street City, State, zip code**  
**(area code) 555-1234 (8am-5pm M-F)**  
**800.424.9300 (Chemtrec)**

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#### Section 1: PRODUCT IDENTIFICATION

Product Name: **Ethyl Alcohol, Anhydrous, Denatured**  
Common Names: E-85

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#### Section 2: HAZARDOUS COMPONENTS

<u>INGREDIENT</u>	<u>CAS #</u>	<u>% (BY VOL)</u>	<u>OSHA PEL</u>	<u>ACGIH TLV</u>
Ethyl Alcohol	64-17-5	70 - 85	1000 ppm	1000 ppm
Natural Gasoline	8006-61-9	15 - 30	300 ppm	300 ppm

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#### Section 3: PHYSICAL PROPERTIES

Physical State: Liquid  
Boiling Point: 96 - 170 °F (35 -77 °C) @ 760.00 mm Hg  
Vapor Pressure: 340 - 560 mm Hg @ 68.0 °F (20.0 °C)  
Specific Vapor Density: HEAVIER THAN AIR  
Specific Gravity: 0.76 - 0.78 @ 60.00 °F (15.55 °C)  
Appearance and Odor: Clear, colorless, volatile liquid with characteristic alcohol odor.

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#### Section 4: FIRE AND EXPLOSION INFORMATION

FLASH POINT: (Tag closed cup) -20.0 - -4.0 °F  
EXPLOSIVE LIMIT: LOWER 1.4% UPPER 19.0%  
EXTINGUISHING MEDIA: Alcohol foam (AR-AFFF)  
HAZARDOUS DECOMPOSITION PRODUCTS: May form toxic materials, carbon dioxide and carbon monoxide, etc.  
FIREFIGHTING PROCEDURES: Use alcohol compatible foam (AR-AFFF). Water may be ineffective on flames but may be used to cool fire exposed containers. Wear self-contained breathing apparatus with a full facepiece operated in the positive pressure demand mode when fighting fires.  
SPECIAL FIRE & EXPLOSION HAZARDS: Vapors are heavier than air and may travel along the ground or may be moved by ventilation and ignited by pilot lights. Other flames, sparks, heaters, smoking, electric motors, static discharge, or other ignition sources at locations distant from material handling point.  
Never use welding or cutting torch on or near drum (even empty) because product (even just residue) can ignite explosively.

**NFPA 704 CODES: HEALTH - 1 FLAMMABILITY - 3 REACTIVITY - 0**

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#### Section 5: FIRST AID

IF ON SKIN: Thoroughly wash exposed area with soap and water. Remove contaminated clothing. Launder contaminated clothing before re-use.

IF IN EYES: Flush with large amounts of water for at least 15 minutes, lifting upper and lower lids occasionally. Check for and remove contact lens. Get medical attention if irritation persists after flushing.

IF SWALLOWED: Immediately drink two glasses of water and induce vomiting by either giving IPECAC syrup or by placing finger at back of throat. Never give anything by mouth to an unconscious person, get medical attention immediately.

IF BREATHED: If affected, remove individual to fresh air. If breathing is difficult, administer oxygen. If breathing has stopped, give artificial respiration. Keep person warm, quiet and get medical attention.

---

## Section 6: ACCIDENTAL RELEASE

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED:

SMALL SPILL: Absorb liquid on paper, vermiculite, floor absorbent, or other absorbent material and transfer to hood.

LARGE SPILL: Eliminate all ignition sources (flares, flames including pilot lights, electrical sparks). Persons not wearing protective equipment should be excluded from area of spill until clean up has been completed. Stop spill at source, dike area or spill to prevent spreading. Pump liquid to salvage tank. Remaining liquid may be taken up on sand, clay, earth, floor absorbent, or other absorbent material and shoveled into containers. Prevent run-off to sewers, streams or other bodies of water. If run-off occurs notify proper authorities as required that a spill has occurred.

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## Section 7: STABILITY AND REACTIVITY

STABILITY	Stable
CONDITIONS TO AVOID	High heat, sparks, hot metal surfaces
HAZARDOUS POLYMERIZATION	Cannot occur
INCOMPATIBILITY	Avoid contact with strong oxidizing agents and strong inorganic acids

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## Section 8: HANDLING AND STORAGE

Store this material away from heat, sparks and flames. Containers of this material may be hazardous when empty since emptied containers retain product residues (vapor or liquid). It is good practice to triple rinse with water empty drums. Above ground storage must meet applicable codes. Ground and cross bond all containers when pouring or transferring. All hazard precautions given in this datasheet must be observed.

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## Section 9: EXPOSURE CONTROL, PERSONAL PROTECTIVE EQUIPMENT

PRIMARY ROUTE(S) OF ENTRY: INHALATION, SKIN CONTACT

PERMISSIBLE EXPOSURE LEVEL: See Section 2.

EFFECTS OF ACUTE OVEREXPOSURE:

EYES: Can cause moderate irritation, redness, tearing.

SKIN: Can cause slight irritation.

BREATHING: Excessive inhalation of vapors can cause nasal and respiratory irritation. When inhaled or absorbed in harmful quantities may produce central nervous system depression characterized by irritation, headaches, nausea, dizziness, lack of concentration, fatigue, and stupor.

SWALLOWING: Can cause gastrointestinal irritation, nausea, vomiting, and diarrhea. Introduction of solvents, as in aspiration of vomit fluid, may produce chemical pneumonia.

EFFECTS OF CHRONIC OVEREXPOSURE: Overexposure to this material has been suggested as a cause of the following effects in humans: liver abnormalities and eye damage. Material can cause dermatitis of the skin on prolonged or repeated exposure. Single large doses taken into the body through ingestion may lead to alcohol poisoning.

SIGNS AND SYMPTOMS OF OVEREXPOSURE: Central nervous system reactions including nausea, dizziness, headaches and stupor of speech associated with difficulty in walking.

MEDICAL CONDITIONS USUALLY AGGRAVATED BY EXPOSURE: Existing respiratory disorders and skin diseases may be aggravated by exposure.

CARCINOGENITY: NTP – No IARC Monographs – No OSHA Regulated – No

RESPIRATORY PROTECTION: If workplace exposure limit(s) of product or any component is exceeded, (section II) a NIOSH/MSHA approved air supplied respirator is advised in absence of proper environmental control. OSHA

regulations also permit other NIOSH/MSHA respirators (negative pressure type) under specified conditions (see your safety equipment supplier). Engineering or administrative controls should be implemented to reduce exposure.

VENTILATION: Provide sufficient mechanical or general ventilation to maintain exposure below TLV(s).

PROTECTIVE GLOVES: Wear resistant gloves such as neoprene.

EYE PROTECTION: Chemical splash goggles in compliance with OSHA regulations are advised; however, OSHA regulations also permit other type safety glasses (consult your safety equipment supplier).

OTHER PROTECTIVE EQUIPMENT: To prevent repeated or prolonged skin contact, wear impervious clothing boots. Eye wash baths and safety showers are recommended. Also check atmosphere for explosiveness and oxygen deficiency when necessary.

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## Section 10: WASTE DISPOSAL CONSIDERATIONS

SMALL SPILL: Allow volatile portion to evaporate in hood. Allow sufficient time for vapors to completely clear hood duct work. Dispose of remaining material in accordance with applicable regulations.

LARGE SPILL: Destroy by liquid incineration.

Contaminated absorbent may be deposited in a landfill in accordance with local, state and federal regulations.

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## Section 11: ECOLOGICAL INFORMATION

Not Available

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## Section 12: TOXICOLOGICAL INFORMATION

Ethyl Alcohol LD50 Acute Oral	7060 mg/kg (Rat)
Ethyl Alcohol LD50 Acute Oral	3450 mg/kg (Mouse)
Ethyl Alcohol LD50 Acute Dermal	20000 mg/kg (Rabbit)

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## Section 13: TRANSPORTATION INFORMATION

DOT Classification: FLAMMABLE LIQUID, Hazardous Class 3, Packing Group II (173.115)

Placard Identification: UN3475 Ethanol and gasoline mixture

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## Section 14: REGULATORY

SARA Section 302 (Extremely Hazardous Substance): Not Applicable

SARA Section 313 (Toxic Chemicals): Not Applicable

CERCLA: Not Applicable

CAA 112 (r): Not Applicable

RCRA: Not Applicable

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## Section 15: OTHER

THIS MSDS COMPLIES WITH 29 CFR 1910.1200 (THE HAZARD COMMUNICATION STANDARD)

The information accumulated herein is believed to be accurate, but is not warranted to be whether originating with the company or not. Recipients are advised to confirm in advance of need that the information is current, applicable, and suitable to their circumstances.

## Appendix C

### Acronyms, Abbreviations, and Commonly Used Terms

<b>AFDC</b>	<b>Alternative Fuels and Advanced Vehicles Data Center</b>
<b>AHJ</b>	<b>Authorities having jurisdiction</b>
<b>ASTM</b>	<b>ASTM International</b>
<b>BTU</b>	<b>British thermal unit</b>
<b>CARBOB</b>	<b>California Reformulated Blend Stock for Oxygenate Blending</b>
<b>CBOB</b>	<b>Conventional Blendstock for Oxygenate Blending</b>
<b>C of A</b>	<b>Certificate of Analysis</b>
<b>CO<sub>2</sub></b>	<b>Carbon dioxide</b>
<b>DOE</b>	<b>U.S. Department of Energy</b>
<b>DOT</b>	<b>U.S. Department of Transportation</b>
<b>DVPE</b>	<b>Dry Vapor Pressure Equivalent</b>
<b>E10</b>	<b>10% ethanol, 90% gasoline</b>
<b>E85</b>	<b>85% ethanol, 15% hydrocarbons</b>
<b>EPA</b>	<b>U.S. Environmental Protection Agency</b>
<b>FFV</b>	<b>Flexible fuel vehicle</b>
<b>gge</b>	<b>Gasoline Gallon Equivalence</b>
<b>mg</b>	<b>Milligram</b>
<b>mg/kg</b>	<b>Milligram Per Kilogram</b>
<b>mg/L</b>	<b>Milligram Per Liter</b>
<b>ml</b>	<b>Milliliter</b>
<b>MSDS</b>	<b>Material Safety Data Sheet</b>
<b>NEVC</b>	<b>National Ethanol Vehicle Coalition</b>
<b>°C</b>	<b>Degrees Centigrade</b>
<b>°F</b>	<b>Degrees Fahrenheit</b>
<b>pHe</b>	<b>Measure of Ethanol Acidity</b>
<b>ppm</b>	<b>Parts Per Million</b>
<b>QA/QC</b>	<b>Quality Assurance/Quality Control</b>
<b>RFA</b>	<b>Renewable Fuels Association</b>
<b>(R+M)/2</b>	<b>The Average of Research Octane and Motor Octane</b>
<b>RBOB</b>	<b>Reformulated Blendstock for Oxygenate Blending</b>
<b>UL</b>	<b>Underwriters Laboratories, Inc.</b>
<b>VP</b>	<b>Vapor Pressure</b>

## Appendix D

### Useful Websites

#### **Information Resources**

##### **General**

Alternative Fuels and Advanced Vehicles  
Data Center E85 Information  
<http://www.afdc.energy.gov/afdc/ethanol/e85.html>

National Renewable Energy Laboratory  
[www.nrel.gov](http://www.nrel.gov)

U.S. Environmental Protection Agency  
Office of Transportation and Air Quality  
[www.epa.gov/otaq/consumer/fuels/altfuels/altfuels.htm](http://www.epa.gov/otaq/consumer/fuels/altfuels/altfuels.htm)

California Air Resources Board  
Fuels Programs  
[www.arb.ca.gov/fuels/fuels.htm](http://www.arb.ca.gov/fuels/fuels.htm)

National Ethanol Vehicle Coalition  
[www.e85fuel.com](http://www.e85fuel.com)

Renewable Fuels Association  
[www.ethanolrfa.org/](http://www.ethanolrfa.org/)

Governor's Ethanol Coalition  
[www.ethanol-gec.org](http://www.ethanol-gec.org)

National Corn Growers Association  
[www.ncga.com](http://www.ncga.com)

##### **Ethanol Fuel Codes and Safety**

Alternative Fuels and Advanced Vehicles Data Center E85  
<http://www.afdc.energy.gov/afdc/ethanol/e85.html>

National Fire Protection Association  
[www.nfpa.org](http://www.nfpa.org)

International Association of Fire Chiefs  
[www.iafc.org](http://www.iafc.org)

Underwriters Laboratories  
[www.ul.com](http://www.ul.com)



## **Standards**

ASTM International  
[www.astm.org](http://www.astm.org)

Underwriters Laboratories, Inc.  
[www.ul.com](http://www.ul.com)

U.S. Department of Transportation  
Pipeline and Hazardous Material Safety Administration  
[www.phmsa.dot.gov](http://www.phmsa.dot.gov)

Society of Automotive Engineers  
[www.sae.org](http://www.sae.org)

U.S. Environmental Protection Agency  
Office of Transportation and Air Quality  
[www.epa.gov/otaq/consumer/fuels/altfuels/altfuels.htm](http://www.epa.gov/otaq/consumer/fuels/altfuels/altfuels.htm)

California Air Resources Board  
Fuels Programs  
[www.arb.ca.gov/fuels/fuels.htm](http://www.arb.ca.gov/fuels/fuels.htm)

Alliance of Automobile Manufacturers  
[www.autoalliance.org](http://www.autoalliance.org)

## **Equipment**

Petroleum Equipment Institute  
Ethanol Compatible Equipment Guide  
[www.pei.org/e85/](http://www.pei.org/e85/)

Fiberglass Tank and Pipe Institute  
11150 South Wilcrest Dr., Suite 101  
Houston TX 77099-4343  
[www.fiberglasstankandpipe.com/](http://www.fiberglasstankandpipe.com/)

## **Appendix E**

### **List of Other RFA Technical Documents and Other Publications**

Fuel Ethanol Industry Guidelines, Specifications, and Procedures  
RFA Publication # 960501, Revised October 2005

Changes in Gasoline IV, The Auto Technician's Gasoline Quality Guide  
Revision 2009 (expected release May)

Guidelines for Establishing Ethanol Plant Quality Assurance and Quality Control Programs  
RFA Publication # 040301  
Revised December 2007

Guidelines and Best Practices for Blending Mid Level Ethanol Blends  
RFA Publication # 090401  
April 2009