



# Handbook for Handling, Storing, and Dispensing E85



U.S. Department of Energy

## Energy Efficiency and Renewable Energy

Bringing you a prosperous future where energy  
is clean, abundant, reliable, and affordable



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Every effort has been made to ensure that this manual is accurate, complete, and comprehensive at the time of publication. This manual is intended to be used as a guide and resource document. The authors strongly encourage all parties with an interest in establishing E85 fueling systems to engage professional support during installation to ensure fuel integrity and systems compatibility.

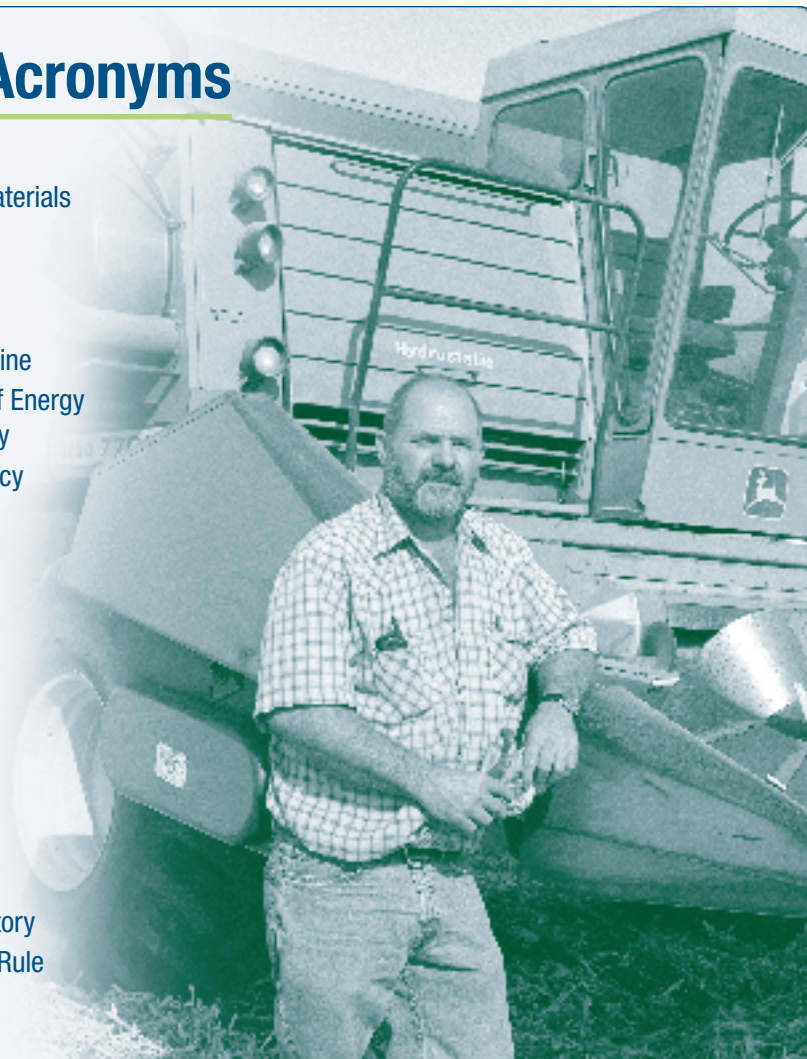
NREL and the NEVC would like to thank the Petroleum Equipment Institute for their support in identifying equipment and materials that are alcohol compatible.

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## Abbreviations and Acronyms

<b>AFV</b>	alternative fuel vehicle
<b>ASTM</b>	American Society of Testing and Materials
<b>CO</b>	carbon monoxide
<b>CO<sub>2</sub></b>	carbon dioxide
<b>DOE</b>	U.S. Department of Energy
<b>E85</b>	blend of up to 85% ethanol in gasoline
<b>EERE</b>	U.S. Department of Energy Office of Energy Efficiency and Renewable Energy
<b>EPA</b>	U.S. Environmental Protection Agency
<b>EPAct</b>	Energy Policy Act of 1992
<b>ETBE</b>	ethyl tertiary butyl ether
<b>FFV</b>	flexible fuel vehicle
<b>HC</b>	hydrocarbon
<b>LDV</b>	light-duty vehicle
<b>MSDS</b>	materials safety data sheet
<b>MTBE</b>	methyl tertiary butyl ether
<b>NEVC</b>	National Ethanol Vehicle Coalition
<b>NFPA</b>	National Fire Protection Agency
<b>NMHC</b>	non-methane hydrocarbon
<b>NREL</b>	National Renewable Energy Laboratory
<b>S&amp;FP</b>	State and Alternative Fuel Provider Rule
<b>UL</b>	Underwriters Laboratory, Inc.



Warren Gretz, NREL/PIX 10489

# Why Use Fuel Ethanol?

As concerns about our nation’s dependence on foreign oil increase, and as Americans become more aware of the environmental impacts of petroleum use, interest in alternative fuels such as ethanol is increasing. In many ways ethanol is an ideal transportation fuel. It’s better for the environment than petroleum, it is domestically produced, and its use supports farmers and rural economies. By switching to ethanol fuels and vehicle technologies, fleet owners are leading the way to both energy security and cleaner air.

Currently, 10% ethanol is added to approximately one third of all the gasoline used in the United States. Ethanol is added to gasoline today to fulfill oxygenate requirements for federal clean air programs, to increase octane, and to extend the petroleum fuel supply.

Another ethanol fuel, E85 (blend of up to 85% ethanol by volume), is gaining popularity. During the past several years, major automobile manufacturers have developed flexible fuel vehicles (FFVs) that can run on gasoline and E85 fuel. As of 2005, the National Ethanol Vehicle Coalition estimated that approximately 6 million FFVs have already been sold in the United States, although many buyers remain unaware that they may fuel with E85.



Warren Gretz, NREL/PIX 00993

**Auto manufacturers that have produced FFVs**

- ▶ General Motors
- ▶ Daimler Chrysler
- ▶ Ford
- ▶ Isuzu
- ▶ Mazda
- ▶ Mercedes
- ▶ Mercury
- ▶ Nissan

To learn more about E85 FFVs, visit the Alternative Fuels Data Center’s E85 Toolkit on the Web at [www.eere.energy.gov/afdc/e85toolkit/eth\\_vehicles.html](http://www.eere.energy.gov/afdc/e85toolkit/eth_vehicles.html).

This guidebook contains information about EPA’s alternative fuels regulations for fleets, FFVs, E85 properties and specifications, and handling and storage guidelines. The information provided in this guidebook is based on proven practices developed by experienced fuel providers, fleet managers, and vehicle manufacturers and describes how to successfully and safely use fuel ethanol, including E85, in vehicles.



Wisconsin Clean Cities

# Energy Policy Act

The Energy Policy Act of 1992 (EPAcT) was passed to reduce our nation's reliance on foreign petroleum and improve air quality. Officially known as Public Law 102-486, EPAcT includes provisions that address all aspects of energy supply and demand. In 2005 it was amended to include new transportation, solar, and other energy efficiency measures.

Several parts of EPAcT were designed to encourage use of alternative fuels. Under EPAcT, the following fuels are defined as alternative:

- ▶ Methanol, ethanol, and other alcohols
- ▶ Blends of 85% or more of alcohol (such as ethanol) with gasoline
- ▶ Natural gas and liquid fuels domestically produced from natural gas
- ▶ Liquefied petroleum gas (propane)
- ▶ Coal-derived liquid fuels
- ▶ Hydrogen
- ▶ Electricity
- ▶ Biodiesel (B100)
- ▶ Fuels (other than alcohol) derived from biological materials
- ▶ P-Series.

EPAcT activities employ both voluntary and regulatory approaches to encourage changes necessary for building a self-sustaining alternative fuel market. EPAcT's voluntary activities are implemented through DOE's Clean Cities initiative, which helps create markets for alternative fuels and vehicles through public/private partnerships in more than 80 U.S. cities.

Congress established several regulatory activities within EPAcT that focus on building an inventory of Alternative Fuel Vehicles (AFVs) in large, centrally fueled fleets in metropolitan areas. For certain fleets, EPAcT requires that a portion of their annual acquisitions of light-duty vehicles be AFVs. DOE's FreedomCAR and Vehicle Technologies Program manages these acquisition requirements through the following initiatives.

**Federal Fleet Requirements** - Federal fleet activities are shaped by the requirements of EPAcT and Executive Order (E.O.) 13149. Under section 303 of EPAcT, 75% of a federal fleet's new Light Duty Vehicle (LDV) acquisitions in a metropolitan area must be AFVs. Issued in April 2000, E.O. 13149 goes a step further by establishing a petroleum reduction goal of

20% compared to their fiscal year 1999 usage. Acquiring AFVs and using alternative fuels are integral parts of achieving this goal.

Agencies are required to annually report compliance with EPAcT and E.O. 13149 require-

ments. Both requirements apply to the major department level agencies within the federal government.

**State & Alternative Fuel Provider Rule** - The State & Alternative Fuel Provider Rule (S&FP) is authorized in Sections 501 and 507 of EPAcT and applies to certain fleets in metropolitan areas. Under the regulation, 75% of a covered state fleet's annual light-duty vehicle acquisitions must be AFVs. For alternative fuel providers, the percentage of required AFVs is 90% of new LDVs. In addition to acquisition requirements, fuel provider fleets are required to use alternative fuels whenever possible. State and fuel provider fleets must also annually report compliance activity to DOE, which uses its authority to enforce the S&FP Rule.

**Alternative Fuel Designation Authority** - EPAcT authorizes DOE to add fuels to the list of EPAcT-authorized alternative fuels through rulemaking. Developers of new fuels can petition DOE with sufficient technical data to have them evaluated for possible inclusion.

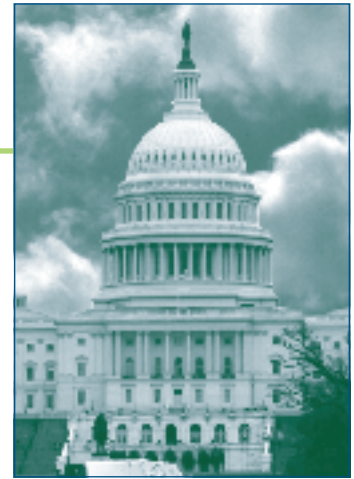
For their request to be considered, petitioners must prove that the fuel:

- ▶ Is substantially nonpetroleum,
- ▶ Yields substantial energy security benefits,
- ▶ Offers substantial environmental benefits.

One type of fuel, P-Series, was approved through this process. Other petitions have also been evaluated by DOE.

The EPAcT regulatory initiatives have collectively put more than 150,000 AFVs on U.S. roadways. Manufacturers are now making more than 25 different models of light-duty AFVs—up from just a handful at the time of EPAcT's passage in 1992. Additionally, there has been tremendous growth in fuel availability, particularly for ethanol and biodiesel.

For more information on EPAcT, visit [www.eere.energy.gov/vehiclesandfuels/epact](http://www.eere.energy.gov/vehiclesandfuels/epact).



National Park Service/PX 05690

## E85-Powered Flexible Fuel Vehicles



To safely and effectively operate a vehicle on E85, the vehicle must be compatible with alcohol use.

Aftermarket conversion of gasoline-powered vehicles to ethanol-fueled vehicles, although possible, is not recommended because of the changes in component materials necessary, the high cost, and the need for extensive engine recalibration. Also, U.S. Environmental Protection Agency regulations restrict aftermarket conversions.

To resolve refueling infrastructure problems, automakers have developed vehicles called flexible-fuel vehicles (FFVs) that can operate on any blend of ethanol and gasoline, from 0% ethanol and 100% gasoline, up to 85% ethanol and 15% gasoline. FFVs are similar to gasoline vehicles; their main differences are the materials used in the fuel management system and modifications to the engine calibration system. There are no switches to flip, no additional fueling tanks or fuel dispensing systems required, and E85 can be handled in the same manner as gasoline.

E85 vehicles are refueled by pumping the fuel from a storage tank through a dispenser and hose, just like gasoline-powered vehicles. Differences in the fueling installations are discussed later in this guidebook. Although the alcohol content of the blend while it is in the storage tank may be specified, the alcohol content of the fuel after it has been dispensed to the vehicle may be different because it may mix with any fuel already in the vehicle's tank. However, the Powertrain Control Module (your vehicle's computer) automatically makes the adjustments your vehicle needs to operate on either gasoline or E85, making E85 use "transparent" to the driver.

Flexible-fuel vehicles manufactured by several major auto companies are available in the marketplace. These vehicles are fully warranted and available at no

**Always follow the manufacturer's recommendations for maintenance, lubricants, and replacement parts for the FFV. Training on ethanol-fueled vehicles is helpful for mechanics, but if the specified parts and lubricants are used, routine maintenance can be performed easily.**

extra cost to the consumer. For a list of FFVs available for purchase, visit EERE's Vehicle Buyer's Guide for consumers ([www.eere.energy.gov/cleancities/vbg/consumers/e85.shtml](http://www.eere.energy.gov/cleancities/vbg/consumers/e85.shtml)) or for fleets ([www.eere.energy.gov/cleancities/vbg/fleets/about\\_ethanol.html](http://www.eere.energy.gov/cleancities/vbg/fleets/about_ethanol.html)).

Additional information can be found on the NEVC flexible fuel Web site ([www.e85fuel.com/e85101/flexfuelvehicles.php](http://www.e85fuel.com/e85101/flexfuelvehicles.php)), through the NEVC hotline, 877-485-8595, or by contacting your automobile dealer.

In order to advance the use of all forms of alternative transportation fuels, the federal government has established some incentives and credits for purchasing FFVs. For a list of state and federal incentives, visit the Alternative Fuels Data Center's State and Federal Incentives and Laws Web page at [www.eere.energy.gov/afdc/laws/incen\\_laws.html](http://www.eere.energy.gov/afdc/laws/incen_laws.html).

# Production, Properties, and Environmental Impacts

**Figure 1. Ethanol Distribution - From A to Z**

**A**



Chris Standlee/PIX 07265

Ethanol Production Facility



Warren Gretz, NREL/PIX 00255

Denatured Ethanol\*  
Transported by Rail,  
Truck, or Barge



Warren Gretz, NREL/PIX 02100

Fuel Supplier



Warren Gretz, NREL/PIX 04061

Fuel Carrier



American Lung Association of Minnesota/PIX 09789

Fuel Marketer

**Z**

## Production

Ethanol is also known as ethyl alcohol or grain alcohol. Like gasoline, ethanol contains hydrogen and carbon, but ethanol also contains oxygen in its chemical structure. The oxygen makes ethanol a cleaner burning fuel than gasoline. It can be produced chemically from ethylene or biologically from grains, agricultural wastes, or any material containing starch or sugar. In the United States, ethanol is produced mainly from corn grown in the Midwest. One bushel of corn (approximately 56 pounds) produces 2.8 gallons of ethanol. During the production of

- 100% ethanol is produced at an ethanol production facility. Prior to transporting, the ethanol must be denatured.\*
- The denatured ethanol is transported to the fuel supplier.
- Denatured ethanol is dispensed into the fuel supplier's ethanol storage tank—in the same manner as gasoline, kerosene, and diesel fuel.
- A fuel carrier orders a tanker full of E85 (85% denatured ethanol and 15% unleaded gasoline).
- The fuel supplier dispenses 8.5 parts denatured ethanol to 1.5 parts unleaded gasoline into the tanker truck.
- The fuel carrier delivers E85 to the retail fuel marketer for sale to the public.

\* Denatured refers to the required "poisoning" of ethanol before it leaves the production plant. Typically, this is done by blending in 5% gasoline to ensure fuel ethanol is not consumed by humans.



ethanol from corn, only the starch is removed. The protein, vitamins, oil, and minerals remain for use by poultry, swine, cattle, or fish as a highly concentrated and valuable feed. Because ethanol can be produced from crops, it is classified as a “renewable fuel.”

While beverage and fuel alcohols are basically produced in a similar manner, ethanol that will be used for fuel is denatured with a small amount (2%–5%) of some product, like gasoline, to make it unfit for human consumption.

### Physical Properties

The properties of E85 are listed in Table 1. Ethanol is a flammable, colorless liquid (E100 is clear like water) with a faint alcohol odor. The color of ethanol fuel blends depends on the color of the gasoline in the blend. Blends may also have a gasoline-like odor.

In the same way a gallon of gasoline contains

approximately 12% less energy than a gallon of #2 diesel fuel; one gallon of E85 contains 27% less energy than gasoline. This results in a proportional reduction in fuel economy. A comparison of the properties of E85 to those of methanol, ethanol, and gasoline is found in Table 2.

### Emissions

According to the U.S. Federal Highway Administration, the average vehicle on the road today emits more than 4,600 pounds of pollution into the air each year. These harmful emissions include carbon monoxide, volatile organic compounds, particulate matter, oxides of nitrogen, and carbon dioxide. These emissions have significant health implications because they contribute to the amount of smog and carbon monoxide in our air. Carbon monoxide emissions have also been implicated in global warming.

**Table 1. Properties of Fuel Ethanol**

Property	Comment
Vapor density	Ethanol vapor, like gasoline vapor, is denser than air and tends to settle in low areas. However, ethanol vapor disperses rapidly.
Solubility in water	Fuel ethanol will mix with water, but at high enough concentrations of water, the ethanol will separate from the water.
Energy content	For identical volumes, ethanol contains less energy than gasoline. On an energy basis, 1.0 gallon of E85 is equivalent to 0.72 gallons of gasoline.
Flame visibility	A fuel ethanol flame is less bright than a gasoline flame but is easily visible in daylight.
Specific gravity	Pure ethanol and ethanol blends are heavier than gasoline.
Conductivity	Ethanol and ethanol blends conduct electricity. Gasoline, by contrast, is an electrical insulator.
Stoichiometric fuel-to-air ratio	E85 needs more fuel per pound of air than gasoline; therefore, E85 cannot be used in a conventional vehicle.
Toxicity	Ethanol is less toxic than gasoline or methanol. Carcinogenic compounds are not present in pure ethanol; however, because gasoline is used in the blend, E85 is considered to be potentially carcinogenic.
Flammability	At low temperatures, the vapor concentration in an E85 tank can fall into the flammable range. The temperature for flammable E85 vapors depends on the E85 volatility. Although less likely than with E85, gasoline tanks can also contain flammable vapors at extremely low temperature.

\* In addition to the ethanol, one bushel of corn in a dry grind ethanol plant produces 18 lb. of Dried Distillers Grains with Solubles (DDGS), and 18 lb. of carbon dioxide (CO<sub>2</sub>).

Table 2. Comparison of Fuel Properties

Property	Methanol	Ethanol	Gasoline (87 Octane)	E85
Chemical formula	CH <sub>3</sub> OH	C <sub>2</sub> H <sub>5</sub> OH	C <sub>4</sub> to C <sub>12</sub> chains	*
Main constituents (% by weight)	38 C, 12 H, 50 O	52 C, 13 H, 35 O	85–88 C, 12–15 H	57 C, 13 H, 30 O
Octane (R+M)/2	100	98-100	86-94	105
Lower heating value (Btu/lb)	8,570	11,500	18,000-19,000	12,500
Gallon equivalent	1.8	1.5	1	1.4
Miles per gallon compared to gasoline	55%	70%	–	72%
Relative tank size to yield (driving range equivalent to gasoline)	Tank is 1.8 times larger	Tank is 1.5 times larger	1	Tank is 1.4 times larger
Reid vapor pressure (psi)	4.6	2.3	8–15	6–12
Ignition point - Fuel in air (%)	7–36	3–19	1–8	*
Temperature (approx.) (°F)	800	850	495	*
Specific gravity (60/65°F)	0.796	0.794	0.72–0.78	0.78
Cold weather starting	Poor	Poor	Good	Good
Vehicle power	4% power increase	5% power increase	standard	3%–5% power increase
Stoichiometric air/fuel ratio (by weight)	6.45	9	14.7	10

\* Depends on percentage and type of the hydrocarbon fraction.

One of the benefits of using E85 vehicles is a reduction in the amount of pollutants emitted into the air we breathe. In general, the type of emissions from vehicles using E85 will be similar to that from gasoline-powered vehicles, but the amount of the emissions will be less. The quantity of pollutants released depends on how well the vehicle’s emissions control system captures and burns emissions and how well the engine is designed and “tuned” for using fuel ethanol. The emissions control systems found on ethanol-powered vehicles manufactured today have been engineered to meet or exceed all federal and state emissions control regulations.

Two types of emissions are released by all vehicles: exhaust and evaporative. Although compliance with federal and state regulations has already resulted in a decrease in exhaust emissions from gasoline-powered vehicles, ethanol-fueled vehicles can further reduce pollutant emissions by a modest, but meaningful, amount. Compared with gasoline-fueled vehicles, most ethanol-fueled vehicles produce lower carbon monoxide (CO) and carbon dioxide (CO<sub>2</sub>) emissions and the same or lower levels of hydrocarbon (HC) and nonmethane hydrocarbon (NMHC) emissions. Nitrogen oxides (NO<sub>x</sub>) emissions are about the same for ethanol and gasoline vehicles.

**Figure 2. E85 is an Environmentally Friendly Fuel**

The plants used to make ethanol take carbon dioxide out of the air in order to grow. This effectively cancels out the carbon dioxide emitted by ethanol-fueled vehicles, resulting in net carbon dioxide gains of zero.

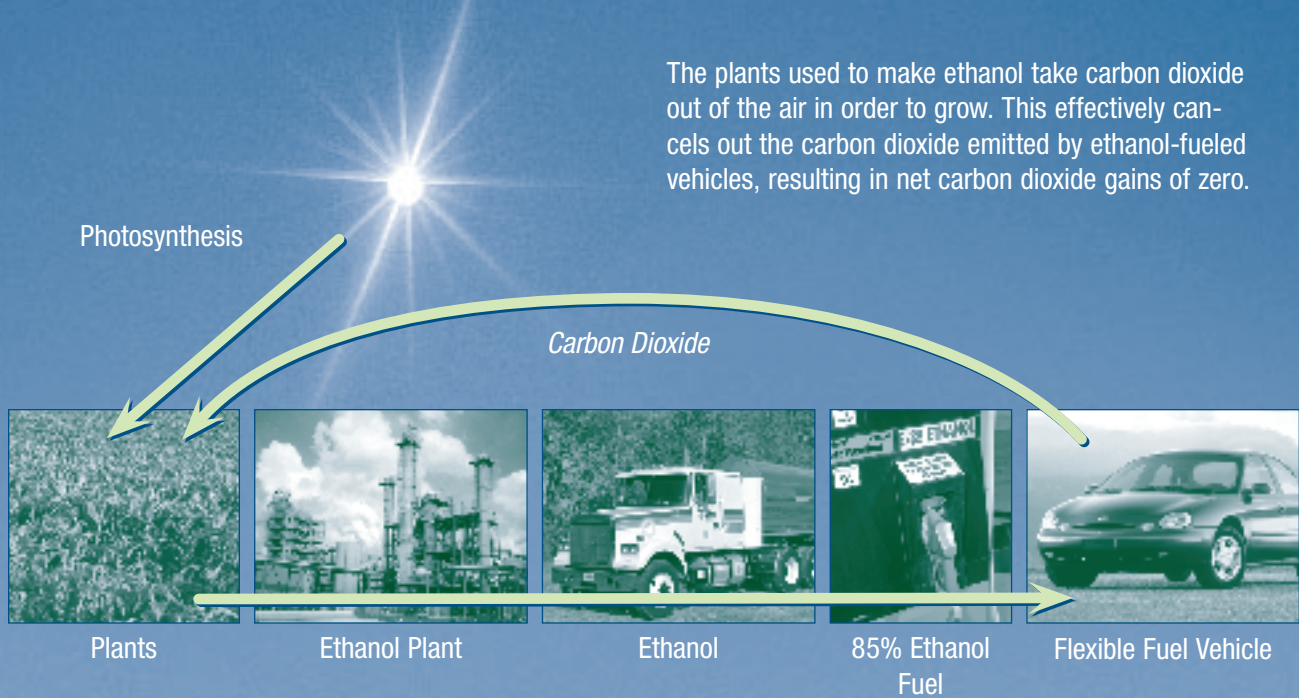
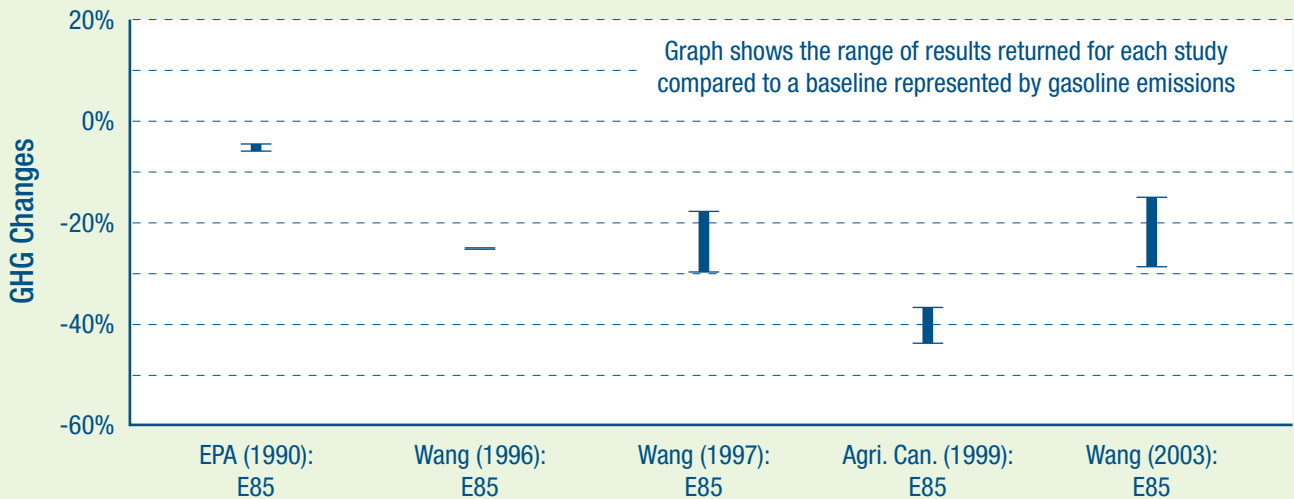


Photo credits, left to right, starting with "Ethanol Plant": Chris Standlee/PIX 07265; Warren Gretz, NREL/PIX 03875 and PIX 07133; Ford Motor Company/PIX 01548

Emissions resulting from fuel evaporation are a potential problem for any vehicle, regardless of the fuel. The build-up of heat in the engine compartment and sometimes even the heat reflected from the pavement onto the fuel tank can cause the most volatile

parts of the fuel to boil off and leak into the air, causing pollution. E85 has a lower vapor pressure than the gasoline used for blending or E10 and so has fewer emissions resulting from evaporation.

**Most Studies on GHG Emissions Show GHG Emission Reduction by Corn EtOH as Compared to Gasoline**



Source: M. Wang, Argonne National Laboratory

## E85 Specifications & Standards

While E85 is a liquid fuel that is handled in a manner similar to that of gasoline, the chemical properties of alcohol are different than those of gasoline and must be recognized when establishing a fuel handling standard.

To reduce the chance for failure or contamination of alcohol equipment and systems, select proper materials and control the fuel composition. Ethanol is not compatible with aluminum, and all aluminum products must be removed from a gasoline dispensing system that will to be used to dispense E85. The American Society for Testing and Materials (ASTM) and the Alliance of Automobile Manufacturers have established standards for E85. While the two standards are similar, only the ASTM standards (Table 3) are discussed in this section.

### ASTM Fuel Standard Specification

The ASTM standard specification for blended ethanol fuel, designated ASTM D5798, covers fuel blends for different seasons and geographical areas. These specifications, shown in Table 3, represent the minimum commercial standards and reflect the consensus of many stakeholders. The ethanol and hydrocarbon denaturant used in making fuel ethanol must meet the requirements of ASTM D 4806. (Specification D4806-01a—Standard Specification for Denatured Fuel Ethanol for Blending with Gasolines for Use as Automotive Spark-Ignition Engine Fuel.)

### Seasonally Adjusted Blends

The amount of alcohol in the fuel ethanol blend depends on the geographical region and the season. (A complete breakdown by volatility class for the geo-



NEVC

graphical fuel regions can be found in Appendix A). In cold weather, more gasoline is added to the blend to ensure proper starting. A minimum of 70% by volume of alcohol is permitted in the winter blend by the ASTM fuel standard. This seasonal blending from 15% to 30% gasoline limits concerns about winter cold starting and are similar to seasonal adjustments of volatility (vapor pressure) used in gasoline blending throughout the United States.

### Hydrocarbons

The most common form of hydrocarbon used in the blending of E85 is unleaded gasoline. The hydrocarbon blended with the ethanol in E85 must comply with the same standards as gasoline. Depending on state regulations, the hydrocarbon may contain ethyl tertiary butyl ether (ETBE), methyl tertiary butyl ether (MTBE), or other aliphatic ethers as blending components. Natural gasoline is also commonly used to denature fuel ethanol.

### Fuel Additives

According to EPA regulations, all commercial grades of gasoline must contain certain additives, detergents, and corrosion inhibitors. In a finished blend of E85, any additives that were previously in the gasoline component are now contained in the E85 (although at reduced levels). While adding detergent additives to the hydrocarbon component of E85 is necessary, it is NOT necessary to add detergent additives based on the alcohol portion of the product. Overuse of additives with E85 may result in poor vehicle operation.

Table 3. ASTM D 5798-99 Standard Specification for Fuel Ethanol for Automotive Spark-Ignition Engines

Property	Value for Class			Test Method
	1	2	3	
ASTM volatility class	1	2	3	N/A
Ethanol, plus higher alcohols (minimum volume %)	79	74	70	ASTM D5501
Hydrocarbons (including denaturant) (volume %)	17-21	17-26	17-30	ASTM D4815
Vapor pressure at 37.8°C - kPa psi	38–59 5.5–8.5	48–65 7.0–9.5	66–83 9.5–12.0	ASTM D4953, D5190, D5191 -
Lead (maximum, mg/L)	2.6	2.6	3.9	ASTM D5059
Phosphorus (maximum, mg/L)	0.3	0.3	0.4	ASTM D3231
Sulfur (maximum, mg/kg)	210	260	300	ASTM D3120, D1266, D2622
Methanol (maximum, volume %)	-	0.5	N/A	-
Higher aliphatic alcohols, C3-C8 (maximum volume %)	-	2	-	N/A
Water (maximum, mass %)	-	1.0	-	ASTM E203
Acidity as acetic acid (maximum, mg/kg)	-	50	-	ASTM D1613
Inorganic chloride (maximum, mg/kg)	-	1	-	ASTM D512, D7988
Total chlorine as chlorides (maximum, mg/kg)	-	2	-	ASTM D4929
Gum, unwashed (maximum, mg/100 mL)	-	20	-	ASTM D381
Gum, solvent-washed (maximum, mg/100 mL)	-	5.0	-	ASTM D381
Copper (maximum, mg/100 mL)	-	0.07	-	ASTM D1688
Appearance	-	Product shall be visibly free of suspended or precipitated contaminants (shall be clear and bright)	-	Appearance determined at ambient temperature or 21°C (70°F), whichever is higher.

N/A = Not Applicable

## Materials Recommendations

As is the case with all liquid fuels, it is vitally important that proper fuel handling techniques be practiced to prevent fuel contamination. Certain materials commonly used with gasoline may be incompatible with high-level alcohol blends. Some materials may degrade and contaminate the fuel, which may result in engine damage and poor performance. Even if engine parts do not fail, operating any vehicle with contaminated fuel can cause deposits that may eventually harm the engine. The materials and parts presented in this guidebook have been shown to perform well with E85.

Some materials degrade over time and in the presence of high-level alcohol blends. Zinc, brass, lead, and aluminum are some of the more sensitive metals. Terne (lead-tin-alloy)-plated steel, which is commonly used for gasoline fuel tanks, and lead-based solder are also incompatible with E85. Avoid using these metals because of the possibility of fuel contamination and potential difficulties with vehicle driveability. Unplated steel, stainless steel, black iron, and bronze have shown acceptable resistance to ethanol corrosion.

Nonmetallic materials that degrade when in contact with fuel ethanol include natural rubber, polyure-



NEVC

thane, cork gasket material, leather, polyvinyl chloride (PVC), polyamides, methyl-methacrylate plastics, and certain thermoplastic and thermoset polymers. Non-metallic materials that have been successfully used for transferring and storing fuel ethanol include thermoset reinforced fiberglass, thermoplastic piping, and thermoset reinforced fiberglass tanks as listed by Underwriters Laboratories, Inc. Buna-N, Neoprene rubber, polypropylene, nitrile, Viton, and Teflon materials may also be used with E85.

## Storing and Dispensing E85

The same technologies used to store and dispense gasoline and diesel fuels are used for alcohol-based fuels because, like gasoline, they are liquid at ambient pressures and temperatures. However, only E85 compatible materials should be used in the storage and dispensing systems.

Most operating problems with ethanol-fueled vehicles have been traced to contaminated fuel. Consequently, choosing the right materials for fuel storage and dispensing systems and following proper fuel-handling procedures are crucial for successfully operating ethanol-fueled vehicles. Although material research and testing is expected to continue, the parts and materials discussed in this guidebook have performed well with E85.

### Using Existing Fueling Systems

In many cases, existing gasoline and diesel fuel systems may also be used to store and dispense E85. Most metal underground storage tanks that meet the U.S. Environmental Protection Agency (EPA) Decem-

**Important!** Before planning any fuel storage system, check your local building and fire codes. While E85 falls under the same handling and storage requirements as gasoline within the provisions of National Fire Protection Agency (NFPA) Standards 30 and 30A, local fire provisions and regulations MUST be considered. See Safety Codes on page 19.



St. Louis Regional Clean Cities

ber 1998 codes, can be used to store E85. Many underground fiberglass tanks that meet the EPA standards may also be used to store E85. However, fiberglass storage tanks manufactured before 1992 should NOT be used with E85. If you are considering the use of an existing fiberglass underground storage tank (UST) that was manufactured before 1992, contact the NEVC for additional information.

If an existing UST will be used to store E85 and if the tank is either metal or fiberglass that is certified for E85, the following steps should be taken.

### Tanks

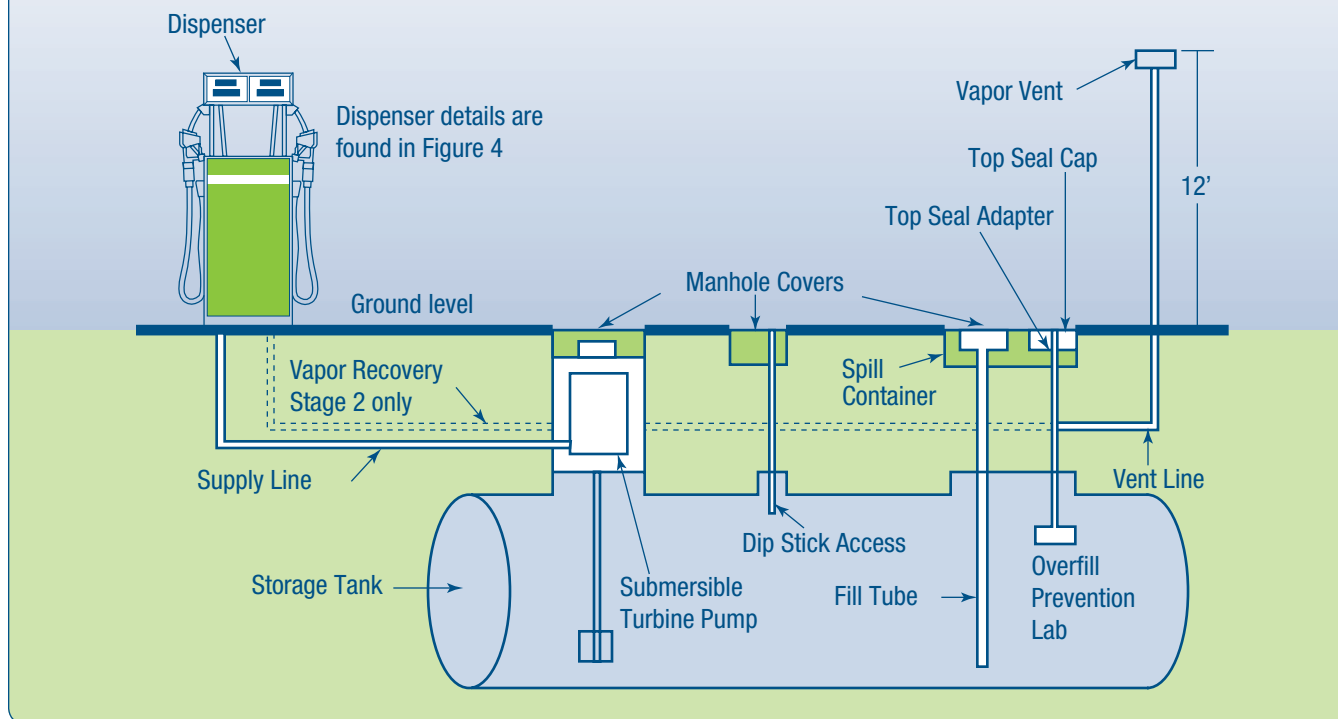
#### Cleaning tanks

If another type of fuel was stored in the tank you are planning to use for E85, the tank must be cleaned. During storage, particles and moisture can build up over time to form sludge or what is called “water bottoms.” Since ethanol is miscible with water, when introducing E85 or another ethanol blend into a dirty storage tank, ethanol’s “cleaning action” will mix with the water bottoms and remove the sludge and result in contaminated fuel. A simple tank cleaning will prevent any problems.

There are several methods for cleaning sludge from storage tanks. Each of the cleaning methods listed below must be completed by a certified and bonded company that is familiar with cleaning petroleum storage tanks.

- ▶ *Optic Sweep.* This patented system uses a fiber optic camera and controllable probe with an extraction device that can visually inspect and clean fuel storage tank bottoms at any fuel level and with no tank downtime. The Optic Sweep

**Figure 3. Typical E85 Underground Storage System**



can locate and remove water, sludge, bacteria, rust particles, and sediment while customers continue to pump.

- ▶ **Steam Cleaning.** This involves physically entering the tank and steam cleaning the tank and removing sludge. Care must be taken to properly dry the tank.
- ▶ **Filter Agitator.** The agitating device is lowered into the tank. The fuel and any debris are agitated and circulated. A filtration system removes the suspended debris.
- ▶ **Chemical Solvents.** Chemical solvents are used to remove scale and debris. Liquid and debris are then pumped from the tank and disposed.

Choosing the appropriate cleaning techniques will depend on your particular situation, the type of fuel that has been stored

in the tank, availability of the service, and state and local environmental regulations.

### Underground Tanks

You can use double-walled, low-carbon, cold-finished steel tanks, but welded tanks are preferable and must be corrosion protected to meet EPA requirements. Do not use plated-metal tanks. Pre-1992 single- and double-wall fiberglass tanks may be used when listed by Underwriters Laboratories, Inc.

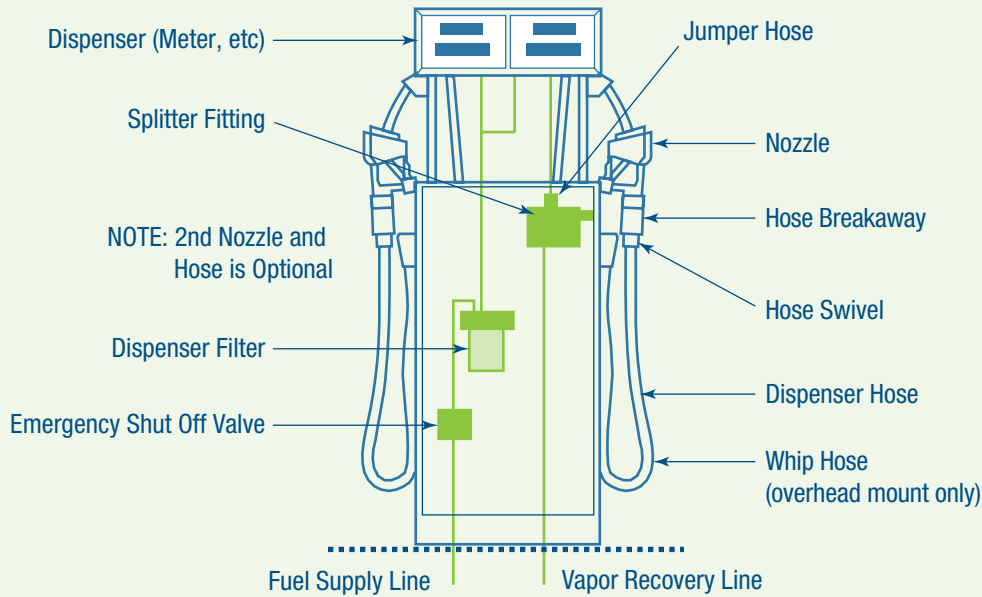
### Aboveground Tanks

Several companies manufacture aboveground storage tanks that may be used for E85. Generally, aboveground storage tanks are smaller than USTs and are typically installed in capacities of 1000 to 2000 gallons. Tanks may be constructed of stainless steel, cold-finished steel, or fiberglass. The use of plated metal tanks is generally not recommended.





**Figure 4. E85 Dispensing Equipment**



### Dispensers

Companies that produce E85 compatible pump dispensers can be found at [www.pei.org/e85/](http://www.pei.org/e85/). The E85 dispenser must use iron, unplated steel, or stainless steel in the fuel path. In the case of vane-type pumps, avoid impellers made from soft metals (zinc, brass, lead, aluminum). Steel or an engineering polymer with a high chemical resistance will give excellent results. Use of non-compatible dispenser materials may lead to premature meter inaccuracies and introduction of contaminants into the fuel.



### General Dispensing Equipment

Dispenser hoses, nozzles, and fitting connectors are the same for aboveground and underground fuel-storage systems. The items common to both systems are discussed in this section. Parts that differ for

aboveground and underground installations are discussed in the sections that follow. Again, your supplier can help you obtain E85-compatible parts and equipment or visit [www.pei.org/e85/](http://www.pei.org/e85/) for an updated list of alcohol compatible equipment.

Avoid any components made from zinc, brass, lead, aluminum, or other soft metals; the ethanol fuel may cause leaching from such soft metals, which may contaminate the vehicle’s fuel system and could potentially result in poor vehicle performance.

### Fill Pipes

Fuel enters the fueling site dispensing system at the point the fuel is “dropped” from the truck through the storage tank fill pipe. Over the last several years, major component manufacturers, such as OPW and Bartush, have converted many of their gaskets, tubes, adapters, piping, and shear valves to be compatible with ethanol blended gasoline and E85. Anodized coatings or components made of cast-iron or stainless steel are available to use with E85.

### Pumps and Leak Detection Equipment

Pressurized and suction fueling systems require different types of leak detection equipment. Suction systems have a pump within the fuel dispenser, while pressurized pumps pump the fuel out of the tank to the dispenser. Typically, pressurized systems will require

both continuous and periodic leak detection as well as other line tightness testing and other precautions. If a suction system has a check valve solely at the dispenser, leak detection testing may not be required, and there may be fewer line testing requirements.

### Piping

The best choice for underground piping is non-metallic, corrosion-proof pipe. New fiberglass pipe should pose no problems when used with E85 systems; however, ask for a product that has been tested for alcohol compatibility (ethanol and methanol) according to UL971. Presently, flex piping is tested to the same Underwriters Laboratory standard; however, methods may change in the near future. Equipment vendors will want to watch for updated information of flex piping certifications. Presently, flex piping companies, such as Environ Products, claim their product may be used with E85. Schedule 40 black iron pipe and galvanized pipe may be used, but will require corrosion protection. Pipe thread sealant, when needed, must be a Teflon tape or Teflon-based pipe-thread compound. If secondary piping is needed, thermoset reinforced fiberglass or thermoplastic double-wall piping should be used.

### Fuel Filters

The dispenser filter is the last line of defense before the fuel reaches a vehicle's tank. Typically, a 30-micron filter is used with diesel fuel and a 10-micron filter is used with gasoline. E85 dispensers should use a 1- or 2-micron filter. The smaller pores will prevent contaminated fuel from causing fuel pump and engine problems. This is especially important with tanks that have been converted to E85.



Always use a 1-micron alcohol dispenser filter with E85.

Always use an E85-compatible hose on E85 dispensers.



### Hoses

Dispenser hosing for E85, as with gasoline, will vary with the type of vapor recovery system that is required in your area. Stage II vapor recovery systems require different fueling hose systems than do areas with stage I-only systems. For E85, always use the hose with the highest resistance to alcohol, as some E85 will always be in contact with the inside of the hose. Goodyear Tire & Rubber Company is one well-known producer of alcohol-resistant hoses. Any hose material deemed to be "100% methanol compatible" will be safe to use with E85, as methanol can be considerably more corrosive.

### Nozzles

Do not use aluminum nozzles with E85 fueling systems. Several companies manufacture stainless steel or nickel-plated nozzles that are compatible with E85. These may be slightly more expensive than the more common aluminum variety.

### Fittings and Connectors

All fittings, connectors, and adapters that will be in contact with the fuel blend should be made of materials like stainless steel (best choice), black iron, or bronze to avoid degradation. If aluminum or brass fittings are used, they must be nickel-plated to avoid any contact between the bare metal and the fuel ethanol.

### Signs

The tanks containing ethanol fuel must be labeled. A bronze pentagon, as shown at right, with "E85" in black must label the fillbox and fillbox cover.



The E85 labels should be placed on the fillboxes and fillbox cover in one of the following ways:

- ▶ Paint the decal on the top of the cover or on the rim of the fillbox
- ▶ Attach a tag to the fillpipe adapter
- ▶ Screw a tag into the fillbox rim
- ▶ Fit a plastic or fiberglass insert into the rim of the fillbox.

Each state, along with the U.S. Department of Transportation, has developed signage to place at refueling stations. You should contact your state Department of Transportation to obtain the correct signage for your area.

The Federal Trade Commission requires a small sticker to be placed on the face of the fuel-dispenser as close as possible to the price per unit of fuel. The sticker should have a black background with orange text. You may receive one of these stickers by contacting the National Ethanol Vehicle Coalition at [nevc@e85fuel.com](mailto:nevc@e85fuel.com) or calling (877) 485-8595.



### E85 Quality Assurance

Once your E85 refueling station has been installed, taking simple operational precautions can assure fuel quality. Periodically checking the fuel properties will avoid costly damage to vehicles operating on E85. Some of these checks may be performed in the field, but others may require the services of a specialized laboratory. A list of some of these laboratories may be obtained by visiting the Alternative Fuels Data Center E85 Fleet Toolkit at [www.eere.energy.gov/afdc/e85toolkit/](http://www.eere.energy.gov/afdc/e85toolkit/).

After the refueling station has reached normal operation, test the fuel periodically. At a minimum, the following items should be checked every 1 to 2 months, depending on how frequently the station is used:

- ▶ Electrical conductivity (see Appendix D).
- ▶ Particulate content
- ▶ Hydrocarbon content (see Appendix D)
- ▶ Reid vapor pressure.

### Shipping Procedures

To ensure the high quality of your fuel, it may be wise to occasionally send a sample of your fuel ethanol to a laboratory for analysis. Your fuel provider may be able to recommend a laboratory in your area that can perform this type of test. To safely ship a sample of the fuel, follow all of your shipper's require-



Warren Greitz, NREL/PIX 09835

ments for hazardous materials. Be sure that the following information appears on the outside of the package:

- ▶ DOT Shipping Name: Alcohol n.o.s. (ethanol, gasoline)
- ▶ Identification Number: UN 1987
- ▶ Diamond Labels: Flammability 3
- ▶ Label: "Flammable Liquid"
- ▶ Arrow Label: "This End Up"

Using a 1-gallon container compatible with ethanol is recommended. The SturdeeSeal UN 4G gasoline combination package is one product on the market that has been successfully used for this purpose. The combination package contains an unmarked 1-gallon metal can with an epoxy phenolic lining, fiberboard, polyethylene bag, and closing tape.

# Safety Procedures

## Health Considerations

Treat fuel ethanol with a high degree of respect, just as you would any fuel. Minimize exposure to the fuel. Like gasoline, fuel ethanol is flammable, poisonous, and may contain additives that are harmful, even in casual contact. Do not confuse fuel ethanol with alcohol intended for human consumption—fuel ethanol can poison and kill you. Never drink fuel ethanol!

Exposure to fuel ethanol can occur by breathing its vapors (inhalation), getting it on the skin or in the eyes (skin adsorption), or accidentally swallowing it (ingestion). The following symptoms of exposure to fuel ethanol may appear immediately:

- ▶ Dullness of memory and concentration
- ▶ Impaired motor coordination
- ▶ Drowsiness, stupor, and finally unconsciousness.

The first-aid treatment needed will depend on the type of exposure:

### *For inhalation,*

- ▶ Move away from the vapors to fresh air
- ▶ Contact medical personnel.

### *For skin adsorption,*

- ▶ Wash the skin with soap and rinse with large quantities of water
- ▶ Remove contaminated clothing
- ▶ Contact medical personnel.

### *For eye adsorption,*

- ▶ Flush the eyes with water for at least 15 minutes
- ▶ Contact medical personnel.



FEMA

**Contact medical personnel  
immediately in cases of exposure**

### *For Ingestion,*

- ▶ Have the person lie down and keep him/her warm
- ▶ Do not induce vomiting
- ▶ Contact medical personnel immediately.

## Fire Safety Considerations

Fuel ethanol fires, like all fires, should be taken seriously. An E85 fire should be handled like a gasoline fire. Use a CO<sub>2</sub>, halon, or dry chemical extinguisher that is marked B, C, BC, or ABC. An alcohol-type or alcohol-resistant (ARF) foam may be used to effectively combat fuel ethanol fires. Never use water to control a fire involving high-concentration fuel ethanol such as E85.

Before constructing any refueling installations, consult your local fire marshall. Regulations governing the safe handling of fuel ethanol may vary from area to area. Consult with local officials about which regulations apply in your area.

## Safety Codes

The 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 fuel 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 E100 and E85) to the same class as gasoline. Contact your local fire marshall or the NFPA for copies of these standards.

A Material Safety Data Sheet (MSDS) for E85 is shown in Appendix C.



NEVC

**Table 4. First Aid Treatments for Exposure to Fuel Ethanol**

### Symptoms of Exposure

- ✓ Dullness of memory and concentration
- ✓ Impaired motor coordination
- ✓ Drowsiness, stupor, and finally coma

Exposure	First Aid Treatment	Treatment Compared to Gasoline Exposure
Inhalation	Move away from the vapors to fresh air and contact medical personnel.	Same
Skin absorption	Wash the skin with soap and rinse with large quantities of water, remove contaminated clothing, and contact medical personnel.	Same
Eye absorption	Flush the eyes with water for at least 15 minutes and contact medical personnel.	Same
Ingestion	Have the person lie down and keep him/her warm; do not induce vomiting; contact medical personnel immediately.	Different



US Postal Service/PIX 13812

*A Northland Minnesota District letter carrier fills up his FFV with E85 at a nearby fueling station.*

## Case Study

### USPS Delivers Alternative Fuel Success

The Northland District of the U.S. Postal Service (USPS) believes in using E85. Considering its home base of Minnesota, this attitude is not surprising. The state has more than 200 ethanol fueling sites—the highest concentration in the country.

The Northland District provides mail service for most of Minnesota and part of Wisconsin and is a valuable partner of the Twin Cities Clean Cities Coalition (TC4). Its AFVs of choice are flexible fuel vehicles (FFVs), which are capable of using gasoline or gasoline-ethanol mixtures up to E85. “We have the opportunity to use E85 because so many stations offer E85 in Minnesota,” says Robert Kunowski, the Northland District’s Manager of Vehicle Maintenance. “We should be leaders because we have the opportunity.”

The USPS Northland District is covered under Executive Order 13149, which requires federal fleets to reduce petroleum consumption by 20%, compared to their FY 1999 consumption levels. The district is also covered under the Energy Policy Act of 1992, which requires federal fleets to acquire AFVs as 75% of their light-duty vehicle acquisitions each year.

Of the district’s 3,594 light-duty vehicles, 525 are FFVs. These include 324 light delivery trucks, 167 minivans, and 34 administrative vehicles. The district

tracks fuel use for the light delivery trucks, which mainly fuel at commercial stations. In 2004, the trucks used 214,000 gallons of E85, up 29% from the year before. Kunowski estimates that the FFV delivery trucks use E85 85% to 90% of the time.

How has the Northland District achieved such high E85 use? “We position our FFVs so they are near stations that offer E85,” says Kunowski. “And if FFV drivers don’t use E85, we take the vehicles away from them and assign them to drivers who will use E85.” This is a big incentive to use E85 because the district’s non-FFV delivery trucks are 10 to 20 years old, and drivers much prefer the model year 2000-2001 FFVs. The district’s 2005 goal is 95% E85 use among its FFV delivery trucks.

Asked to give advice on establishing a successful alternative fuel program, Kunowski emphasizes the importance of an accurate fuel use tracking system. “You have to have good facts and data to make good decisions,” he says. He also stresses educating managers and staff on E85 goals and procedures and designing the program to be cost effective. “You need to balance the cost with the environmental benefits of alternative fuels,” says Kunowski. “And remember, we only get one environment.”

## For More Information

### General

U.S. Department of Energy  
Alternative Fuels Data Center  
E85 Fleet Toolkit  
[www.eere.energy.gov/afdc/e85toolkit/](http://www.eere.energy.gov/afdc/e85toolkit/)

National Ethanol Vehicle Coalition  
33216 Emerald Lane, Suite C  
Jefferson City, MO 65109  
(573) 635-8445/Toll-free (877) 485-8595  
[www.e85fuel.com](http://www.e85fuel.com)

National Renewable Energy Laboratory  
1617 Cole Blvd.  
Golden, CO 80401-3393  
[www.nrel.gov](http://www.nrel.gov)

Governors' Ethanol Coalition  
P.O. Box 95085  
Lincoln, NE 68509  
[www.ethanol-gec.org](http://www.ethanol-gec.org)

National Corn Growers Association  
632 Cepi Drive  
Chesterfield, MO 63005  
636-733-9004  
[www.ncga.com](http://www.ncga.com)

Renewable Fuels Association  
One Massachusetts Avenue, NW - Suite 820 W  
Washington, DC 20001  
202-289-3835  
[www.ethanolrfa.org/](http://www.ethanolrfa.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)

### Ethanol Fuel Codes and Safety

Alternative Fuels Data Center  
E85 Fleet Toolkit  
[www.eere.energy.gov/afdc/e85toolkit/](http://www.eere.energy.gov/afdc/e85toolkit/)

National Fire Protection Association  
1 Batterymarch Park  
Quincy, Massachusetts 02169-7471  
617-770-3000  
[www.nfpa.org](http://www.nfpa.org)

### Standards

ASTM International  
100 Bar Harbor Drive  
West Conshohocken, PA 19428-2959  
Publications and Customer Service  
610-832-9500  
[www.astm.org](http://www.astm.org)

Society of Automotive Engineers  
400 Commonwealth Drive  
Warrendale, PA 15096-0001  
724-776-4841  
[www.sae.org](http://www.sae.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/)

### Flexible-Fuel Vehicles

Alternative Fuels Data Center  
[www.eere.energy.gov/afdc/afv/eth\\_vehicles.html](http://www.eere.energy.gov/afdc/afv/eth_vehicles.html)  
and  
[www.eere.energy.gov/afdc/e85toolkit/eth\\_vehicles.html](http://www.eere.energy.gov/afdc/e85toolkit/eth_vehicles.html)

National Ethanol Vehicle Coalition  
Flexible-Fuel Vehicle Listing  
[www.e85fuel.com/e85101/flexfuelvehicles.php?topic=For%20Fleets](http://www.e85fuel.com/e85101/flexfuelvehicles.php?topic=For%20Fleets)

## Appendix A: Geographical Fuel-Marketing Regions

State and Fuel Marketing Region	Volatility Class by Month											
	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Alabama	2	2	2	2	2/1	1	1	1	1	1/2	2	2
Alaska												
Southern Region	3	3	3	3	3/2	2/1	1	1/2	2/3	3	3	3
South Mainland	3	3	3	3	3/2	2/1	1/2	2	2/3	3	3	3
Arizona												
North of 34° lat & E. of 111° long.	3	3	3	3/2	2	2/1	1	1	1/2	2/3	3	3
Remainder south of 34°	2	2	2	2/1	1	1	1	1	1	1/2	2	2
Arkansas	3	3	3/2	2/1	1	1	1	1	1/2	2	2/3	3
California												
North Coast	2	2	2	2	2	2/1	1	1	1	1/2	2	2
South Coast	2	2	2	2	2/1	1	1	1	1	1/2	2	2
Southeast	3	3/2	2	2	2/1	1	1	1	1/2	2	2/3	3
Interior	2	2	2	2	2	2/1	1	1	1	1/2	2	2
Colorado												
East of 105° longitude	3	3	3	3/2	2	2/1	1	1	1/2	2/3	3	3
West of 105° longitude	3	3	3	3	3/2	2	2/1	1/2	2/3	3	3	3
Connecticut	3	3	3	3/2	2	2/1	1	1	1/2	2	2/3	3
Delaware	3	3	3/2	2	2/1	1	1	1	1/2	2	2/3	3
District of Columbia	3	3	3/2	2	2/1	1	1	1	1/2	2	2/3	3
Florida												
North of 29° latitude	2	2	2	2/1	1	1	1	1	1	1/2	2	2
South of 29° latitude	2	2/1	1	1	1	1	1	1	1	1	1/2	2
Georgia	3	3/2	2	2/1	1	1	1	1	1	1/2	2	2/3
Hawaii	1	1	1	1	1	1	1	1	1	1	1	1
Idaho	3	3	3	3/2	2	2	2/1	1/2	2	2/3	3	3
Illinois												
North of 40° latitude	3	3	3	3/2	2	2/1	1	1	1/2	2/3	3	3
South of 40° latitude	3	3	3	3/2	2/1	1	1	1	1/2	2/3	3	3
Indiana	3	3	3	3/2	2/1	1	1	1	1/2	2/3	3	3
Iowa	3	3	3	3/2	2	2/1	1	1	1/2	2/3	3	3
Kansas	3	3	3	3/2	2	2/1	1	1	1/2	2/3	3	3
Kentucky	3	3	3/2	2	2/1	1	1	1	1.2	2	2/3	3
Louisiana	2	2	2	2/1	1	1	1	1	1	1/2	2	2
Maine	3	3	3	3/2	2	2/1	1	1/2	2	2/3	3	3
Maryland	3	3	3/2	2	2/1	1	1	1	1/2	2	2/3	3
Massachusetts	3	3	3	3/2	2	2/1	1	1	1/2	2	2/3	3
Michigan												
Lower Peninsula	3	3	3	3/2	2	2/1	1	1/2	2	2/3	3	3
Upper Peninsula	3	3	3	3	3/2	2/1	1	1/2	2	2/3	3	3
Minnesota	3	3	3	3	3/2	2/1	1	1/2	2	2/3	3	3



Appendix A: Geographical Fuel-Marketing Regions - *continued*

State and Fuel Marketing Region	Volatility Class by Month											
	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Mississippi	2	2	2	2/1	1	1	1	1	1	1/2	2	2
Missouri	3	3	3	3/2	2/1	1	1	1	1/2	2/3	3	3
Montana	3	3	3	3	3/2	2	2/1	1/2	2/3	3	3	3
Nebraska	3	3	3	3/2	2	2/1	1	1/2	2	2/3	3	3
<b>Nevada</b>												
North of 38° latitude	3	3	3	3/2	2	2	2/1	1/2	2	2/3	3	3
South of 38° latitude	3	3	3/2	2	2/1	1	1	1	1/2	2	2/3	3
New Hampshire	3	3	3	3/2	2	2/1	1	1/2	2	2/3	3	3
New Jersey	3	3	3/2	2	2/1	1	1	1	1/2	2	2/3	3
<b>New Mexico</b>												
North of 34° latitude	3	3	3	3/2	2	2/1	1	1	1/2	2/3	3	3
South of 34° latitude	3	3	3/2	2/1	1	1	1	1	1/2	2/3	3	3
<b>New York</b>												
North of 42° latitude	3	3	3	3/2	2	2/1	1	1/2	2	2/3	3	3
South of 42° latitude	3	3	3	3/2	2/1	1	1	1	1/2	2	2/3	3
North Carolina	3	3	3/2	2	2/1	1	1	1	1/2	2/3	3	3
North Dakota	3	3	3	3	3/2	2/1	1	1/2	2	2/3	3	3
Ohio	3	3	3	3/2	2/1	1	1	1	1/2	2/3	3	3
Oklahoma	3	3	3	3/2	2/1	1	1	1	1/2	2	2/3	3
<b>Oregon</b>												
East of 122° longitude	3	3	3	3/2	2	2	2/1	1/2	2	2/3	3	3
West of 122° longitude	3	3/2	2	2	2	2/1	1	1	1/2	2	2	2/3
<b>Pennsylvania</b>												
North of 41° latitude	3	3	3	3/2	2	2/1	1	1/2	2	2/3	3	3
South of 41° latitude	3	3	3	3/2	2	2/1	1	1	1/2	2	2/3	3
Rhode Island	3	3	3	3/2	2/1	1	1	1	1/2	2	2/3	3
South Carolina	2	2	2	2/1	1	1	1	1	1	1/2	2	2
South Dakota	3	3	3	3/2	2	2/1	1	1/2	2	2/3	3	3
Tennessee	3	3	3/2	2	2/1	1	1	1	1/2	2	2/3	3
<b>Texas</b>												
North of 31° latitude	3	3	3/2	2	2/1	1	1	1	1/2	2	2/3	3
South of 31° latitude	2	2	2	2/1	1	1	1	1	1	1/2	2	2
Utah	3	3	3	3/2	2	2/1	1	1	1/2	2/3	3	3
Vermont	3	3	3	3/2	2	2/1	1	1/2	2	2/3	3	3
Virginia	3	3	3/2	2	2/1	1	1	1	1/2	2	2/3	3
<b>Washington</b>												
East of 122° longitude	3	3	3/2	2	2	2/1	1	1	1/2	2/3	3	3
West of 122° longitude	3	3/2	2	2	2	2/1	1	1	1/2	2	2	2/3
West Virginia	3	3	3	3/2	2	2/1	1	1/2	2	2/3	3	3
Wisconsin	3	3	3	3/2	2	2/1	1	1/2	2	2/3	3	3
Wyoming	3	3	3	3	3/2	2	2/1	1.2	2	2/3	3	3

Source: National Ethanol Vehicle Coalition



This worksheet has been prepared to illustrate the use of the federal tax incentives that are available which assist to promote the use of E85 as a form of alternative transportation fuel by providing federal income tax credits. These credits assist in reducing the price of E85 to a level that is often very competitive with the price of regular unleaded gasoline. This example is based on information and experience that has been accumulated by the NEVC while working with tax advisors, the IRS, ethanol producers and fuel marketers.

## Explanation of E85 Pricing for *Winter Blend* (70% ethanol and 30% hydrocarbon)

### Assumptions:

#### Computation for one gallon of fuel

Terminal price of unleaded/gallon	\$ 2.0000	Enter local costs in shaded area.
Terminal price of ethanol/gallon	\$ 2.0000	Enter local costs in shaded area.
Federal excise tax on unleaded/gallon	\$ 0.1840	
State excise tax on unleaded/gallon	\$ 0.2400	Enter state tax rate in shaded area.
State excise tax on E85/gallon	\$ 0.2400	Enter state tax rate in shaded area.

### Cost of E85

Net price from Distributor/Blender	
Cost of unleaded (30% of terminal price)	\$ 0.6000
Cost of ethanol (70% of terminal price)	\$ 1.4000
Federal excise tax on E85	\$ 0.1840
State excise tax on E85	\$ 0.2400
Cost of E85 before fuel tax credit	\$ 2.4240
Fuel tax credit	\$ (0.3570)
<b>Net cost of E85</b>	<b>\$ 2.0670</b>

### Cost of Unleaded

Net price from Distributor/Blender	
Cost of unleaded (100% of terminal price)	\$ 2.0000
Federal excise tax on unleaded	\$ 0.1840
State excise tax on unleaded	\$ 0.2400
<b>Net cost of unleaded</b>	<b>\$ 2.4240</b>

**SAVINGS PER GALLON OF E85 OVER UNLEADED \$ 0.3570**

### Federal Excise Tax Refund (FORM 8849)

Pure gallons of ethanol used in the gallon of E85	0.7000
Volumetric Ethanol	
Excise Tax Credit per gallon	\$0.5100
<b>Per gallon fuel tax credit</b>	<b>\$0.3570</b>

### Explanatory notes:

- Federal excise taxes are paid at fuel terminal. Tax is added to supplier's invoice at the time fuel is loaded to the distributor. Gasoline federal excise tax including ethanol = \$0.184  
Forms that apply: IRS Forms 8849 and 720.  
Publications that apply: IRS 378 and 510.
- Form 8849 is the federal excise tax refund form. This form is used to claim a refund for the blender's federal excise tax credit on ethanol. This form is filed separately from a company's income tax return.
- Form 720 is the federal excise tax return form and is filed with the quarterly income tax return.

### Federal Infrastructure Tax Credit

The Energy Policy Act of 2005 (H.R. 6) created a new credit that permits taxpayers to claim a 30% credit, up to \$30,000, for the cost of installing clean-fuel vehicle refueling property. The portion of the credit attributable to property of a character subject to an allowance for depreciation is treated as a portion of the general business credit; the remainder of the credit is allowable to the extent of the excess of the regular tax (reduced by certain other credits) over the alternative minimum tax for the taxable year. With regard to property used by a tax-exempt entity, the credit applies to those who sold the infrastructure property to the tax-exempt entity. The credit applies to property placed in service between December 31, 2005 and December 31, 2009. The law repeals code section 179A (the current deduction) after December 31, 2005.

The use of federal income tax credits becomes complicated by the unique characteristics of each individual, company, or corporation seeking to utilize these incentives. For example, in order to take advantage of a federal income tax credit, the organization seeking to use the credit must have a federal income tax liability. Many corporations are assessed tax rates pursuant to the federal Alternative Minimum Tax. Companies being taxed pursuant to AMT would have difficulty in taking advantage of the tax incentives described above. Additionally, there is a maximum tax credit that any single company may take in any one tax year.

The NEVC strongly encourages each company to consult its tax advisors.

For copies of any of these forms or publications, please contact the National Ethanol Vehicle Coalition.



# NEVC Pricing Worksheet: Summer Blend

Appendix B

## National Ethanol Vehicle Coalition

3216 Emerald Lane, Suite C • Jefferson City, MO 65109 • 573-635-8445  
 email: info@E85fuel.com web: www.e85fuel.com

This worksheet has been prepared to illustrate the use of the federal tax incentives that are available which assist to promote the use of E85 as a form of alternative transportation fuel by providing federal income tax credits. These credits assist in reducing the price of E85 to a level that is often very competitive with the price of regular unleaded gasoline. This example is based on information and experience that has been accumulated by the NEVC while working with tax advisors, the IRS, ethanol producers and fuel marketers.

### Explanation of E85 Pricing for *Summer Blend* (85% ethanol and 15% hydrocarbon)

#### Assumptions:

*Computation for one gallon of fuel*

Terminal price of unleaded/gallon	\$ 2.0000	Enter local costs in shaded area.
Terminal price of ethanol/gallon	\$ 2.0000	Enter local costs in shaded area.
Federal excise tax on unleaded/gallon	\$ 0.1840	
State excise tax on unleaded/gallon	\$ 0.2400	Enter state tax rate in shaded area.
State excise tax on E85/gallon	\$ 0.2400	Enter state tax rate in shaded area.

#### Cost of E85

Net price from Distributor/Blender	
Cost of unleaded (15% of terminal price)	\$ 0.3000
Cost of ethanol (85% of terminal price)	\$ 1.7000
Federal excise tax on E85	\$ 0.1840
State excise tax on E85	\$ 0.2400
Cost of E85 before fuel tax credit	\$ 2.4240
Fuel tax credit	\$ (0.4335)
<b>Net cost of E85</b>	<b>\$ 1.9905</b>

#### Cost of Unleaded

Net price from Distributor/Blender	
Cost of unleaded (100% of terminal price)	\$ 2.0000
Federal excise tax on unleaded	\$ 0.1840
State excise tax on unleaded	\$ 0.2400
<b>Net cost of unleaded</b>	<b>\$ 2.4240</b>

**SAVINGS PER GALLON OF E85 OVER UNLEADED \$ 0.4335**

Federal Excise Tax Refund (FORM 8849)	
Pure gallons of ethanol used in the gallon of E85	0.8500
Volumetric Ethanol	
Excise Tax Credit per gallon	\$0.5100
<b>Per gallon fuel tax credit</b>	<b>\$0.4335</b>

#### Explanatory notes:

- Federal excise taxes are paid at fuel terminal. Tax is added to supplier's invoice at the time fuel is loaded to the distributor. Gasoline federal excise tax including ethanol = \$0.184  
Forms that apply: IRS Forms 8849 and 720.  
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The NEVC strongly encourages each company to consult its tax advisors.

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## Appendix C: Material Safety Data Sheet for E85

**Material Safety Data Sheet**

May be used to comply with OSHA's Hazard Communication Standard, 29 CFR 1910.1200. Standard must be consulted for specific requirements.

**U.S. Department of Labor**

Occupational Safety and Health Administration  
(Non-Mandatory Form)  
Form Approved  
OMB No. 1218-0072

**IDENTITY** (As Used on Label and List)  
Fuel Ethanol E85

Note: Blank spaces not permitted. If any item is not applicable, or no information is available, the space must be marked to indicate that.

**Section I**

Manufacturer's Name: Archer Daniels Midland Company	Emergency Telephone Number: 800/424-9300 or 217/424-5200
Address: (Number, Street, City, State, and ZIP Code)  4666 Fairies Parkway Decatur, Illinois 62526	Telephone Number for Information: 217/362-3980
	Date Prepared: 7/5/95
	Signature of Preparer (optional)

**Section II — Hazardous Ingredients/Identity Information**

Hazardous Components (Specific Chemical Identity: Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% (optional)
Ethyl Alcohol (200 proof) CAS 0064-17-5	80%	-	-	80%
Gasoline CAS 008-006-619	20%	-	-	20%
Benzene CAS-0071-43-2*	1ppm	10ppm	-	< 1100ppm

\*"A chemical known to the State of California to cause cancer"

**Section III — Physical/Chemical Characteristics**

Boiling Point: 96°-170°F	Specific Gravity (H <sub>2</sub> O = 1): 0.76-0.78
Vapor Pressure (mm Hg.): 340-560	Melting Point: N/A
Vapor Density (AIR - 1): 2.0-4.0	Evaporation Rate (Butyl Acetate = 1): Not Estimated
Solubility in Water: 60-70 gm/100ml	Appearance and Odor: Clear, colorless volatile liquid with ethereal odor.

**Section IV — Fire and Explosion Hazard Data**

Flash Point (Method Used): -20°F to -4°F TCC	Flammable Limits: Not Estimated	LEL 1.4	UEL 19.0
Extinguishing Media: Carbon dioxide dry chemical, water for small fires. Polar solvent foam for large fires.			
Special Fire Fighting Procedures: Use necessary protective equipment and breathing apparatus as would normally be used when fighting fires where there may be danger of breathing hazardous products of combustion.			
Unusual Fire and Explosion Hazards: Flammable liquid			

(Reproduce locally)

OSHA 174, Sept, 1985

Appendix C: Material Safety Data Sheet for E85 - *continued*

Section V — Reactivity Data			
Stability	Unstable	Stable <b>X</b>	
Conditions to Avoid: None in normal use.			
Incompatibility (Materials to Avoid): May react vigorously with oxidizing materials.			
Hazardous Decomposition or Byproducts: Combustion may produce CO <sub>2</sub> , NO <sub>x</sub> and reactive hydrocarbons.			
Hazardous Polymerization	May Occur	Will Not Occur <b>X</b>	
Conditions to Avoid: None in normal use.			
Section VI — Health Hazard Data			
Route(s) of Entry:	Inhalation?	Skin?	Ingestion?
	(A)	(B)	(C)
Health Hazards (Acute and Chronic): (A) May cause mucous membrane irritation, unconsciousness, coma, respiratory failure and death. (B) May cause skin irritation as a result of defatting. (C) Moderately toxic (LD50 0.5 to 5 G/Kg), gastrointestinal irritation, vomiting, CNX depression, coma.			
Carcinogenicity:	NTP?	IARC Monographs	OSHA Regulated?
	Not determined	Not determined	Yes
Signs and Symptoms of Exposure: May cause dizziness, loss of balance and coordination.			
Medical Conditions Generally Aggravated by Exposure: Not determined			
Emergency and First Aid Procedures: If swallowed, do not induce vomiting. If inhaled, remove person to fresh air. Give artificial respiration if breathing has stopped. Call a physician. If splashed in eyes or on skin, flush immediately with copious amounts of water.			
Section VII — Precautions for Safe Handling and Use			
Steps to be Taken in Case Material is Released or Spilled: Eliminate all sources of ignition. Small spills should be flushed with large quantities of water. Large spills should be collected for waste disposal.			
Waste Disposal Method: Do not allow to enter sewers where vapors may be ignited. Incinerate in furnace where permitted under appropriate federal, state & local regulations or dispose of in a site stipulated for hazardous materials.			
Precautions to Be Taken in Handling and Storage: Keep away from heat, sparks, and open flames. Keep container closed. Use with adequate ventilation.			
Other Precautions: Use explosion proof electrical equipment and non-sparking tools. Ground electrical equipment.			
Section VIII — Control Measures			
Respiratory Protection (Specify Type): Air supplied mask for high concentrations			
Ventilation	Local Exhaust: Preferred	Special: None	
	Mechanical (general): Acceptable	Other: None	
Protective Gloves: Rubber			
Eye Protection: Goggles			
Outer Protective Clothing or Equipment: Eye bath and safety shower			
Work/Hygienic Practices: N/A			
Page 2		*U.S.G.P.O.: 1986-491-529/45775	

## Appendix D: Procedures for Determining Selected Properties of Ethanol Fuel Samples

E85 is a form of alternative transportation fuel that can be produced from a wide range of renewable feedstocks. As is the case with all forms of fuels, it is critical that the integrity of the fuel be maintained and that seasonal volatility adjustments be made. The following summary describes a “field test” procedure to determine the levels of hydrocarbon and alcohol in E85.

The following equipment is available from VWR Scientific, 800-932-5000. Reference numbers are those used by VWR. Other equipment suppliers are available.

- 50 mL pipettes  
Cat. #52966-217
- Safety bulb  
Cat. #53497-202
- 100 mL cylinders,  
Cat. #24762-117

### Procedure for Determining Hydrocarbon Percent of Ethanol Fuel Samples

**Safety Note:** Hydrocarbon- and alcohol-resistant gloves are recommended when collecting samples and conducting tests. Additionally, eye protection should be utilized. Testing personnel should also carry water in plastic containers.

1. Using the suction bulb, pipette exactly 50 mL of fuel sample into the graduated cylinder.
2. Add about 48 mL of water to make the total liquid volume just under 100 mL.
3. Place the stopper in the cylinder and shake vigorously for about 15 seconds.
4. Carefully loosen the stopper to release any accumulated pressure; do not remove the stopper.
5. Close the stopper again and place the cylinder upright on a level surface. Allow the mixture to sit for about 15 minutes.
6. Record the total volume of liquid by reading the lowest part of the upper meniscus (the curved interface between the liquid and air).
7. Record the total volume of the alcohol/water layer by reading the lowest part of the lower meniscus (the curved interface between the two liquid layers).

### Calculation

- The hydrocarbon percent is calculated by:  
$$2.1 + 1.94 * (\text{total volume} - \text{alcohol/water volume})$$
- Assuming the sample was an ethanol/hydrocarbon mixture, the ethanol percent is 100 minus the hydrocarbon percent.

### Procedure for Determining Conductivity of Ethanol Fuel Samples

#### Sampling

Note: Fuel dispensing equipment and sample containers can contaminate the sample, giving a falsely high conductivity for the bulk sample. Dispensing systems should be purged (at least 2 gallons for an aboveground tank and at least 5 gallons for an underground tank) immediately prior to sample collection.

#### Equipment for conductivity testing

- VWR Scientific 800-932-5000
- Conductivity meter and gold-plated dip cell
- Dip cell
- 250 mL disposable polypropylene beaker.

#### Calibration and Setup

Regularly calibrate the instrument according to manufacturer's specifications and enable temperature compensation option.

#### Procedure

Note: Fuel samples and the conductivity probe are easily contaminated. Take care not to contaminate the sample or conductivity probe by dirt or even fingerprints. The probe should be kept clean and not placed on a lab or work bench.

1. Add about 200 mL of fuel to beaker.
2. Insert the conductivity probe into the sample; move the probe up and down to flush out the electrodes. Discard the sample and add a second 200 mL sample into the beaker.
3. Repeat step 2.
4. Wait for about 30 seconds for the reading to stabilize, then record conductivity in uS/cm. Multiply number by 100 to calculate uS/m.



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