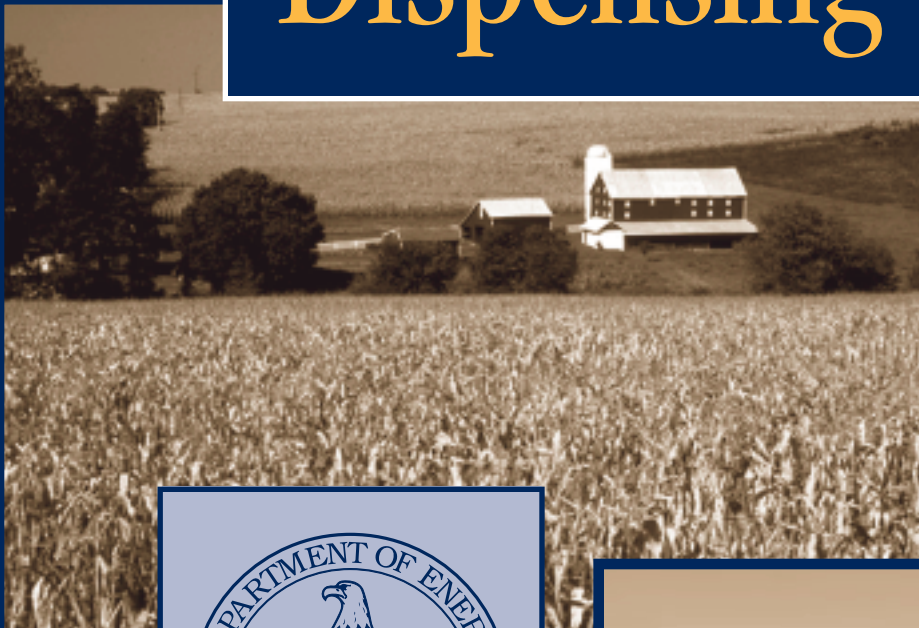


# Handbook for Handling, Storing, and Dispensing E85



**E85**  
85% Ethanol

## Foreword

This publication was jointly prepared by the National Renewable Energy Laboratory (NREL), a Department of Energy (DOE) national laboratory, and the National Ethanol Vehicle Coalition (NEVC). The NEVC is a nonprofit advocacy organization that was established to promote the use of 85% ethanol as a renewable form of alternative transportation fuel while enhancing agricultural profitability, advancing environmental stewardship, and promoting national energy independence.

Members of the NEVC include:

- Governors' Ethanol Coalition
- Ford Motor Company
- General Motors
- DaimlerChrysler
- Colorado Corn Growers Association
- Missouri Corn Growers Association
- United Energy Distributors
- Kansas Corn Growers Association
- Maryland Grain Producers Council
- PMC Marketing, Inc.
- Osage, Inc.
- Nebraska Ethanol Board
- National Corn Growers Association

Every effort has been made to ensure that this manual is accurate, complete, and comprehensive. 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 its support in identifying equipment and materials that are alcohol compatible.

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## Disclaimer

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# 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 like 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 advanced vehicle technologies, fleet owners are leading the way to both energy security and cleaner air.

Currently, a small amount of ethanol (10% by volume; E10\*) is added to much of the gasoline we put in our vehicles in order to fulfill federal oxygenate requirements, add octane, and greatly extend the petroleum fuel supply. E10 is a widely available vehicle fuel and is used for oxygenated fuel



programs such as those in operation during the winter in Denver and Las Vegas, and in reformulated gasoline programs.

Another ethanol fuel, E85 (85% ethanol by volume), is gaining popularity. During the past few years, several major automobile manufacturers have developed flexible fuel vehicles (FFVs) that can run on either gasoline or E85 fuel.

This guidebook contains information about EPA's alternative fuels regulations for fleets, FFVs, E85 properties and specifications, and E85 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.

\* Alcohol fuel blends are designated by E for ethanol or M for methanol, followed by a number representing the percentage of alcohol (by volume) in the blend. The ethanol used in fuel blends is denatured ("poisoned" to prevent human consumption) and can contain up to 5% hydrocarbons (gasoline or gasoline-like additives) before blending. Additional gasoline is added to the ethanol to make up the desired percentage in the blend. The fuel E10 is made of 10% denatured ethanol blended with 90% gasoline; E85, commonly called fuel ethanol, is made of 85% denatured ethanol blended with 15% gasoline; and E100 is 100% denatured ethanol.

# Energy Policy Act of 1992



The Energy Policy Act of 1992 (EPAct) was established with the goals of enhancing our nation's energy security and improving environmental quality. The legislation's provisions address all aspects of energy supply and demand, including energy efficiency, alternative fuels, and renewable energy. It also addresses more traditional forms of energy such as coal, oil, and nuclear power. Several parts, or titles, of EPAct were designed to encourage use of alternative fuels (not substantially derived from petroleum) that could help reduce our dependence on imported oil. EPAct defines alternative fuels to include:

- ◆ 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

Implementing EPAct is the responsibility of the U.S. Department of Energy's (DOE) Office of Transportation Technologies. EPAct also gave DOE the authority to add additional fuels to the list of alternatives based on their potential benefits to the nation's energy security and the environment.

EPAct activities employ both voluntary and regulatory approaches to encouraging the fundamental changes necessary for building a self-sustaining alternative fuel market. EPAct's voluntary activities are being implemented through DOE's Clean Cities Program, which helps create markets for alternative fuels and alternative fuel vehicles (AFVs) through public/private partnerships in more than 80 U.S. cities. The Clean Cities Program helps empower local leaders to bring together purchasers of

fleet and private vehicles, fuel suppliers, and vehicle manufacturers to advance alternative fuel choices. For more information on the Clean Cities Program, visit <http://www.ccities.doe.gov/>.

Regulatory-based EPAct activities consist of four programs:

**The State & Alternative Fuel Provider Program** requires state government and alternative fuel provider fleets to purchase AFVs such as FFV's as a percentage of their annual light-duty vehicle acquisitions. In addition to acquiring AFVs, fuel provider fleets are required to fuel their vehicles with alternative fuels whenever possible.

**The Federal Fleet Program** requires 75% of federal fleets' new light-duty vehicle purchases to be AFVs. Issued in April 2001, Executive Order 13149 goes a step beyond EPAct by establishing a petroleum reduction goal of 20% by 2005 for federal fleets compared to their 1999 petroleum consumption. Acquiring AFVs and using alternative fuels are integral to achieving this goal.

**The Alternative Fuel Petitions Program** outlines a formal rulemaking process through which DOE can add additional fuels to the list of EPAct-authorized alternative fuels. Under this program, the developer of a new fuel can petition DOE to add a new fuel to the list of EPAct-designated alternative motor fuels.

**The Private & Local Government Fleet Program** gives DOE the authority to impose AFV acquisition requirements on private and local government fleets. The implementation of this section of EPAct is still under consideration.

For more information, visit the EPAct Web site at <http://www.ott.doe.gov/epact>.

## Alcohol-Fueled 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.

To resolve refueling infrastructure problems, automakers have developed vehicles called flexible fuel vehicles that can operate on any blend of ethanol and gasoline, from 0% ethanol and 100% gasoline, up to 85% ethanol and 15% gasoline. Ethanol 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. In specific cases, some E85 vehicles require special lubricating oils.

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

(see Fuel Storage and Dispensing on pages 12-16). 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 (the vehicle's computer) automatically makes the adjustments the vehicle needs to operate on either gasoline or E85, making E85 use "transparent" to the driver.

FFVs manufactured by several major auto companies are available in the marketplace. These vehicles are fully warranted and available at no extra cost to the consumer. For a list of FFVs available for purchase, visit <http://www.afdc.doe.gov/afvehicles.html>, [http://www.e85fuel.com/information/ff\\_vehicles.htm](http://www.e85fuel.com/information/ff_vehicles.htm), or contact your automobile dealer, the E85 Hotline (877-485-8595), or the National Alternative Fuels Hotline (800-423-1363).

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 incentives, visit <http://www.fleets.doe.gov> and click on "Incentives and Laws."

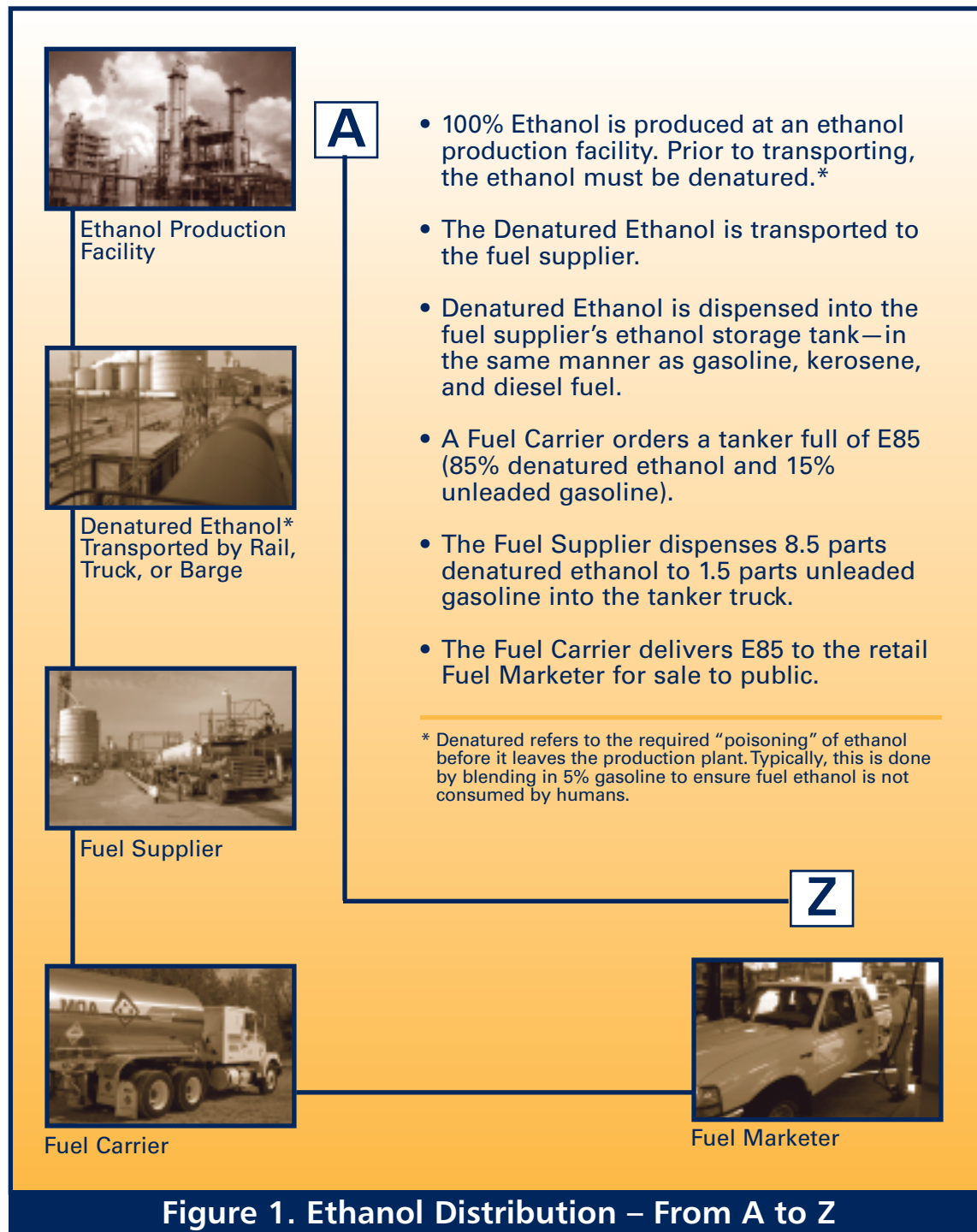
**Always follow the manufacturer's recommendations for maintenance, lubricants, and replacement parts for an FFV. Training on ethanol-fueled vehicles is helpful for mechanics, but if the specified parts and lubricants are used, routine maintenance can be performed easily.**

# Production, Properties, and Environmental Impacts

## 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 2.7 gallons of ethanol\*. Ethanol can also be produced from cheese whey, spilled beer, and dated soda. Because ethanol can be produced from crops, it is classified as a renewable fuel.

Although beverage and fuel alcohols are produced in a similar manner, fuel alcohol is denatured or poisoned to prevent ingestion. Denaturing can be accomplished by adding a “bitterent” or a form of hydro-carbon such as gasoline.

### 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 does a gallon of #2 diesel fuel, one gallon of E85 contains 27% less energy than one gallon of gasoline. However, while the science shows that a gallon of E85 contains 27% less energy, experience has shown that a motor vehicle will experience only a 5% to 12% decline in fuel mileage. A comparison of the properties of E85 to those of methanol, ethanol, and gasoline are found in **Table 2**.

### Emissions

According to the U.S. Federal Highway Administration, the average vehicle on the road today emits more than 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

**Table 1. Properties of Fuel Ethanol**

Property	Comment
<b>Vapor density</b>	Ethanol vapor, like gasoline vapor, is denser than air and tends to settle in low areas. However, ethanol vapor disperses rapidly.
<b>Solubility in water</b>	Fuel ethanol will mix with water, but at high enough concentrations of water, the ethanol will separate from the water.
<b>Energy content</b>	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.
<b>Flame visibility</b>	A fuel ethanol flame is less bright than a gasoline flame but is easily visible in daylight.
<b>Specific gravity</b>	Pure ethanol and ethanol blends are heavier than gasoline.
<b>Conductivity</b>	Ethanol and ethanol blends conduct electricity. Gasoline, by contrast, is an electrical insulator.
<b>Stoichiometric fuel-to-air ratio</b>	E85 needs more fuel per pound of air than gasoline; therefore, E85 cannot be used in a conventional vehicle.
<b>Toxicity</b>	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.
<b>Flammability</b>	At low temperature (32°F), E85 vapor is more flammable than gasoline vapor. However at normal temperatures, E85 vapor is less flammable than gasoline, because of the higher autoignition temperature of E85.

\*In addition to the ethanol, one bushel of corn produces 12.4 lb of 21% protein feed, 3 lb of 60% gluten meal, 1.5 lb of corn oil, and 17.0 lb of carbon dioxide.



**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	96
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.

in our air. Carbon monoxide emissions have also been implicated in global warming.

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 those from gasoline-powered vehicles, but the **amount** of 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 E85 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 pollution from emissions by a modest, but meaningful, amount. Compared with gasoline-fueled vehicles, most ethanol-fueled vehicles produce lower carbon monoxide and carbon dioxide emissions and the same or lower levels of hydrocarbon and nonmethane hydrocarbon emissions. Nitrogen oxide emissions are about the same for ethanol and gasoline vehicles.

Emissions resulting from fuel evaporation are a potential problem for any vehicle,

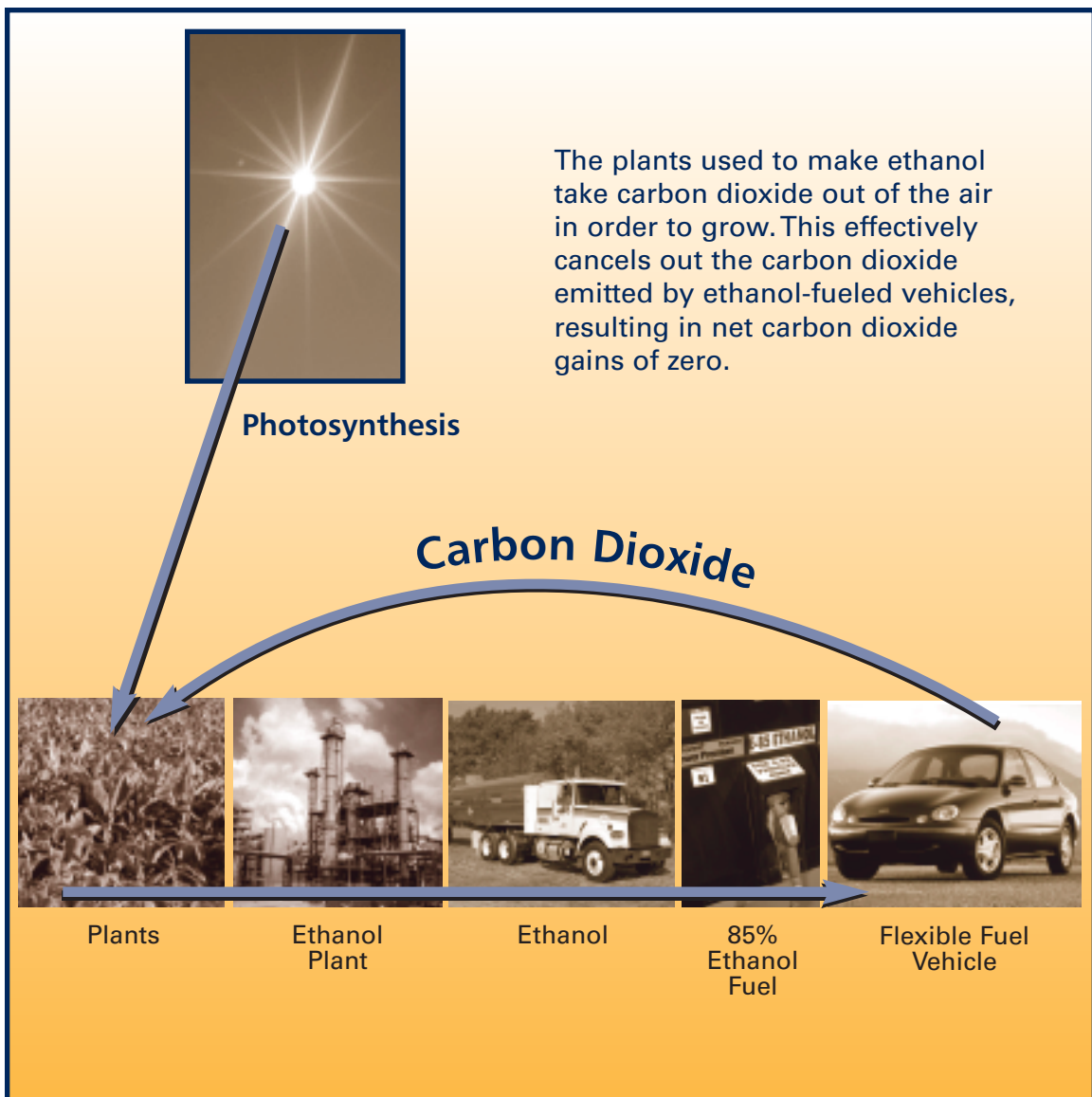


Figure 2. E85 Is an Environmentally Friendly Fuel

regardless of the fuel. More emissions can leak from a vehicle when it is sitting than when it is operating! The buildup 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 fewer highly volatile components than gasoline and so has fewer emissions resulting from evaporation.

# E85 Fuel Specifications and 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.

Unlike gasoline, ethanol conducts electricity; and while this property does not result in an increased incidence of safety issues, this ability requires that all aluminum products be removed from a typical gasoline dispensing system. To reduce the chance for failure or contamination of alcohol equipment and systems, select proper materials and control the fuel composition. The American Society for Testing and Materials (ASTM) and the American Automobile Manufacturers Association (AAMA) have established standards for E85. While the two standards are similar, only the ASTM standards are discussed in this section.

## ASTM Fuel Standard Specification

The ASTM standard specification for fuel ethanol, designated ASTM Ed75Ed85 (*d* stands for *denatured*), 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 D4806. (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 geographical fuel regions can be found in **Appendix A**). In

cold weather, more gasoline is added to the blend to avoid starting problems. 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 difficulties associated with winter cold start and are similar to the seasonal adjustments that are currently made in most of the gasoline sold in 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, commonly used as the denaturant of fuel ethanol, is also an excellent blend stock for the hydrocarbon portion of E85.

## Fuel Additives

According to U.S. Environmental Protection Agency (EPA) regulations, all commercial grades of gasoline must contain certain additives, detergents, and inhibitors. After blending the gasoline with denatured alcohol to make E85, any additives that were in the gasoline are now in the E85 (although at reduced levels). Although 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 detergent additives by “additizing” the entire batch of E85 and not just the hydrocarbon component can result in poor vehicle operation.

**Table 3. ASTM D5798-99 Standard Specification for Fuel Ethanol for Automotive Spark-Ignition Engines**

Property	Value for Class			Test Method
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	38-59	48-65	66-83	ASTM D4953, D5190, D5191
psi	5.5-8.5	7.0-9.5	9.5-12.0	
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 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 are totally incompatible with alcohols. When these materials (such as aluminum) come in contact with ethanol, they may dissolve in the fuel, which may damage engine parts and may result in poor vehicle driveability. Even if parts do not fail, running an ethanol-fueled vehicle with contaminated fuel may cause deposits that could eventually harm the engine. The materials and parts presented in this guidebook perform well with E85.

The following sections describe parts and equipment that are compatible with fuel ethanol. They should be available from your usual petroleum equipment supplier. You can find a list of alcohol-compatible equipment at <http://www.e85fuel.com/information/manufacturers.btm>.

The NEVC and the Petroleum Equipment Institute have worked together to gather the most comprehensive summary of alcohol-compatible equipment possible; however, other approved parts may be available.

Some materials become degraded by contact with fuel ethanol blends having high alcohol concentrations. Zinc, brass, lead, and aluminum are 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, polyurethane, cork gasket material, leather, polyvinyl chloride (PVC), polyamides, methyl-methacrylate plastics, and certain thermo and thermoset plastics. Nonmetallic materials that have been successfully used for transferring and storing fuel ethanol include nonmetallic thermoset reinforced fiberglass, thermo plastic 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.

## Fuel Storage and Dispensing



The technology for storing and dispensing gasoline can be applied to alcohol fuels such as E85 because alcohols and alcohol blends, like gasoline, are liquid fuels 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. They can be obtained from your usual supplier.

### IMPORTANT!

Before planning any fuel storage system, check your local building and fire codes. While fuel ethanol (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 Procedures on page 17).

### Using Existing Fueling Systems

In many cases, existing gasoline, diesel, or other hydrocarbon fueling systems may also be used to store and dispense fuel ethanol. Most metal underground storage tanks that meet EPA December 1998 codes, can be used to store E85. Many underground fiberglass tanks that meet EPA standards may also be used to store E85. However, fiberglass storage tanks manufactured prior to 1992, **MAY NOT** be able to handle E85. If you wish to use an existing fiberglass underground storage tank that was manufactured prior to 1992 to store E85, contact the NEVC for additional information.

If an existing underground storage tank 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 that will be used for the E85, it must be cleaned because storing gasoline underground causes some particulates to settle out and form a sludge. Introducing alcohol into these tanks will place this sludge into suspension and will lead to serious problems

with vehicle driveability.

There are several methods for cleaning sludge from the bottom of a tank. Each method must be completed by a certified and bonded company familiar with cleaning petroleum storage tanks.

1. Use a “filter agitator” device. This method is similar to cleaning a swimming pool. The filter agitator is lowered into the tank and moves the product to allow a filter to catch the suspended particulates.
2. Physically enter the tank and steam clean the sludge.
3. Use a robotic cannon to liquefy the sludge. After being liquefied, the sludge is pumped out of the tank and disposed of at an approved site. This method of removal may occasionally harm the walls of the tank, making it unfit for fuel storage.
4. Place a chemical cleaner in the tank to clean the walls. The remaining particulates may then be pumped out of the tank and disposed of.

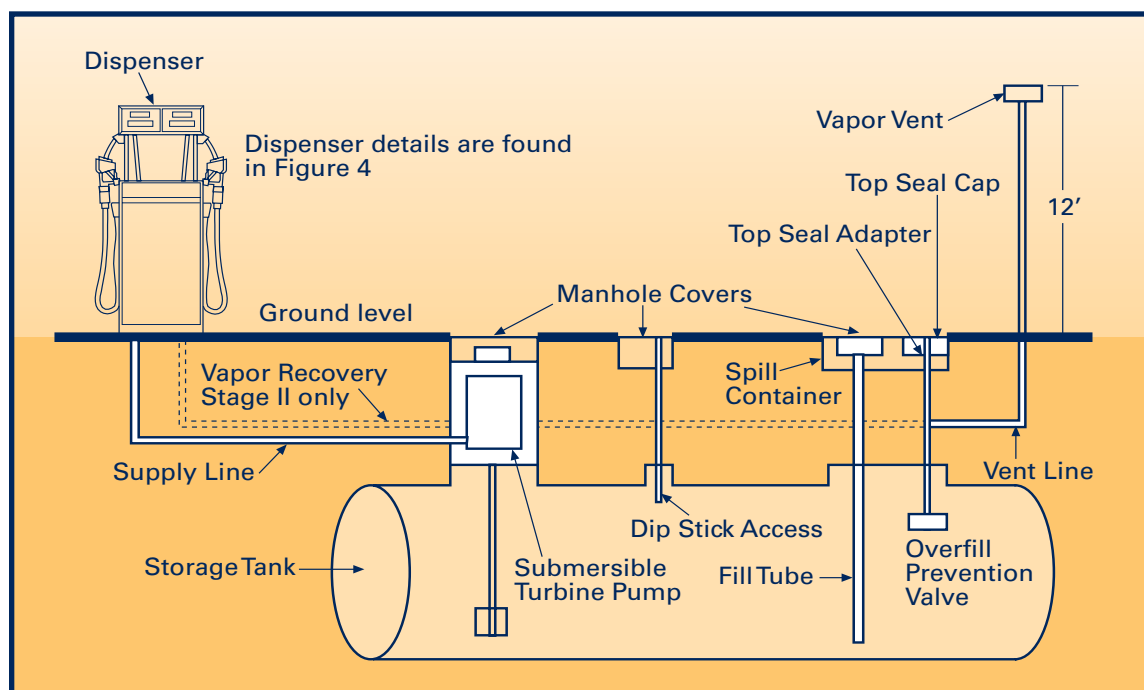
The method you use will depend on your particular situation, the type of fuel that has been stored in the tank, and state and local environmental regulations.

### **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. Single- or double-wall fiberglass tanks are non-corrosive and may be used when approved by Underwriters Laboratories, Inc., for storing fuel ethanol.

### **Aboveground Tanks**

Several companies manufacture aboveground storage tanks that may be used for



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

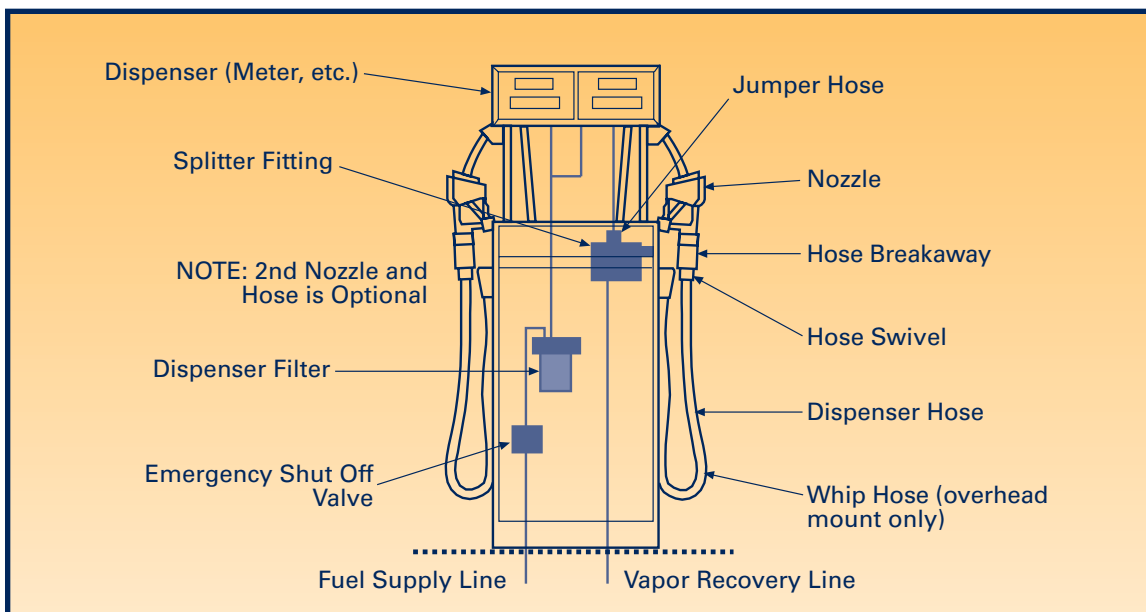


Figure 4. E85 Dispensing Equipment

E85. Generally, aboveground storage tanks are smaller than underground storage tanks 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.

### Dispensers

Companies that produce E85-compatible pump dispensers include Bennett Pump Company and Tokheim Corporation. 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.

### 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 above-ground and underground installations are discussed in the sections that follow. Again, your supplier can help you obtain E85-compatible parts and equipment.

Avoid 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 result in poor vehicle performance.

**In-Line Filters.** A 1-micron, in-line filter is recommended for fuel ethanol dispensing equipment. This size filter will trap most of the debris and impurities that might be present in the storage tank and prevent them from being transferred to the vehicle during refueling. A number of companies produce 1-micron E85-compatible fueling filters. Check the NEVC Web site for the most current information.

**Dispenser Hoses.** The type of hose used for dispensing E85 depends on the type of





vapor recovery system in the geographic area. Stage II Vapor Recovery systems require different fueling hose systems than do areas with Stage I only systems. Goodyear Tire and Rubber Company is one reliable manufacturer for this item.

When specifying materials for your refueling facility, contact equipment vendors for the latest information and use the components with the highest resistance to deterioration from continuous contact with fuel alcohols. In some cases, equipment specified for use with fuel methanol will be available. Because fuel methanol is even more corrosive than fuel ethanol, components and materials certified for fuel methanol use will almost always be acceptable for fuel ethanol use.

**Nozzles.** Aluminum nozzles should not be used with E85, and nozzles made from any aluminum alloy must be used with caution. A nickel-plated nozzle is the best choice. A few companies that manufacture nozzles are Emco Wheaten Retail Corporation, Modern Welding Company Subsidiaries, and Newberry Tanks and Equipment, Inc.

**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.

**Piping.** The best choice for underground piping is nonmetallic corrosion free pipe. Schedule 40 black iron pipe and galvanized pipe may be used, but will require corrosion protection to meet EPA requirements. You may purchase piping from a number of manufacturers such as Advanced Polymer Technology (APT), Ameron International, and Environ Products Inc. Do not use conventional zinc-plated steel piping for fuel ethanol. Pipe thread sealant, when needed, must be Teflon tape or Teflon-based pipe-thread compound. If secondary piping is needed, thermoset reinforced fiberglass or thermoplastic double-wall piping should be used.

## Signage

Tanks containing ethanol fuel must be labeled. A bronze pentagon decal, as shown below, with “E85” in black must label the fillbox and fillbox cover.



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

1. Painting the decal on the top of the cover or on the rim of the fillbox
2. Attaching a tag to the fillpipe adapter
3. Screwing a tag into the fillbox rim
4. Fitting a plastic or fiberglass insert into the rim of the fillbox

Each state, along with the U.S. Department of Transportation, has developed certain signage to place at refueling stations. You should contact your state’s 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 NEVC at [nevc@e85fuel.com](mailto:nevc@e85fuel.com) or by calling 877-485-8595.



## E85 Quality Assurance

Once your E85 refueling station is installed, taking simple operational precautions can ensure 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 DOE National Alternative Fuels Hotline at <http://www.afdc.doe.gov/hotline.html> or by calling 800-423-1363.

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

1. Electrical conductivity (see **Appendix B**).
2. Particulate content

Because it is possible to perform the conductivity test and the test for hydrocarbon content in the field, these tests should be performed often.

1. Hydrocarbon content (see Procedure for Determining Hydrocarbon Content of Fuel Ethanol in **Appendix B**)
2. Reid vapor pressure



## Shipping Procedures

To ensure the high quality of your fuel, you should 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, or for a list of laboratories that perform E85 tests, visit the DOE Alternative Fuels Hotline Web site at

<http://www.afdc.doe.gov/hotline.html> or call 800-423-1363. To safely ship a sample of the fuel, follow all of your shipper's requirements for hazardous materials. Be sure that the following information appears on the outside of the package:

1. DOT Shipping Name:  
"Flammable Liquid NOS"  
(Ethyl Alcohol and Gasoline)
2. Identification Number:  
"NA1993"
3. Diamond Labels:  
Health 2, Flammability 3, Reactivity 0
4. Label:  
"Flammable Liquid"
5. Arrow Label:  
"This End Up"

A 1-gallon container compatible with ethanol is recommended. The SturdeeSeal UN 4G gasoline combination package is one product that has been successfully used for this purpose. The combination package contains a unmarked 1-gallon metal can with an epoxy phenolic lining, fiberboard, polyethylene bag, and closing tape. For more information, go to <http://www.e85fuel.com/information/manufacturers.htm>.

# 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 and poisonous and may contain additives that are harmful, even in casual contact. Also, do not confuse fuel ethanol with alcohol intended for human consumption—fuel ethanol can poison 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

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

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.

### ***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 generally release less heat than gasoline fires, but any fires should be taken seriously. 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.



Before constructing any refueling installation, consult your local fire marshal. Regulations governing the safe handling of fuel ethanol vary from area to area. Only your local officials will know the regulations in force in your locale.

### 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 marshal or the NFPA for copies of these standards.

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

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

Symptoms of Exposure		
<ul style="list-style-type: none"> <li>✗ Dullness of memory and concentration</li> <li>✗ Impaired motor coordination</li> <li>✗ Drowsiness, stupor, and finally coma</li> </ul>		
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

# Case Study— Establishing an E85 Refueling Facility at Mammoth Cave National Park, Kentucky



Courtesy of NPS Photo

In 1998 Mammoth Cave National Park was approached by the Kentucky Corn Growers Association about the possibility of installing an E85 refueling station to serve the park’s fleet of vehicles. Following discussions with park management, Mammoth Cave implemented an E85 infrastructure program to acquire an approved aboveground storage tank, ethanol-compatible equipment, and E85 fuel.

Subsequently, Mammoth Cave National Park has acquired several FFVs. Completing the Mammoth Cave National Park E85 infrastructure program has allowed the park to operate its FFVs primarily on E85. This allows the Mammoth Cave fleet to meet EPCRA requirements (see page 3), to reduce the use of fossil fuels, and to positively impact the environment in the park.

## Installing the E85 Refueling Station

In 1998 the NEVC entered into a cooperative agreement with the Southeast Regional Biomass Energy Program (SERBEP). This contract obligated the NEVC (and its project partners the National Corn Growers Association and the Kentucky Corn Growers Association) to provide up to \$15,062 to install an E85 refueling site at Mammoth Cave National Park. The contract also obligated the SERBEP to provide financial support (not to exceed \$5,000) for a total estimated project cost of \$20,062.

Subsequently, the NEVC and Mammoth Cave National Park entered into a Memorandum of Agreement (MOA), which stated that the NEVC would:

1. Provide financial support to purchase one fully ethanol-compatible, 3000-gallon, aboveground fuel storage tank.
2. Provide financial support to purchase accessories and ancillary equipment for dispensing E85 from the tank.
3. Coordinate the first delivery of E85 fuel.
4. Assist with ordering the tank and equipment.
5. Agree that upon completion of installation, the tank, equipment, and all ancillary equipment would become the property of Mammoth Cave National Park.

In turn, the MOA required Mammoth Cave National Park to:

1. Rent from the General Services Administration one ethanol-fueled vehicle in 1998 and replace comparable vehicles (initial estimate of 16) with E85 vehicles as the vehicles meet replacement standards.

Case Study—Establishing an E85 Refueling Facility at Mammoth Cave National Park

2. Operate E85 vehicles exclusively on E85 fuel while within range of the Mammoth Cave National Park E85 refueling facility.
3. Coordinate billing and fuel usage documentation.
4. Purchase and maintain card reader/computer system.
5. Coordinate fuel delivery.
6. Order any replacement parts.
7. Furnish and coordinate installation of tank and equipment, including electrical and concrete pad.
8. Secure state fire code approval for installation.

**Project Results**

As described earlier in the original MOA between the NEVC and Mammoth Cave National Park, the tank was to be a 3000-gallon, steel, aboveground tank. The cost for this tank and the associate pumping equipment was approximately \$5,400.

Park management subsequently determined that this type of installation was inconsistent with the other refueling stations in the park. The existing refueling

tanks were concrete-encased steel, so the equipment specifications for the E85 fuel system were modified to ensure consistency with other fueling equipment.

Table 5 indicates the specific equipment and costs associated with the project.

Installation of the tank was completed in the Winter of 1999.

**Project Recommendations and Conclusions**

The Mammoth Cave National Park E85 Project provides an excellent example of cooperation between several nonprofit organizations and two federal agencies. In this project, financial support was made available by the Kentucky Corn Growers Association and the Kentucky Corn Promotion Council.

Federal support was generated by the cooperative measures of both the SERBEP, administered by the Tennessee Valley Authority, and Mammoth Cave National Park, an entity of the U.S. Department of Interior’s National Park Service.

**Table 5. Total Cost of Tank and Accessories**

<b>Cost of Tank and Accessories</b>	<b>\$16,007</b>
<b>Dispensing Equipment (all alcohol compatible)</b>	<b>\$3,400</b>
<ul style="list-style-type: none"> <li>• Single hose pump</li> <li>• 1 micron fuel filter</li> <li>• Alcohol whip hose</li> <li>• 8 feet of pump hose</li> <li>• Breakaway valves</li> <li>• Swivel hose</li> <li>• Fuel nozzle</li> <li>• Anti-siphon valve</li> </ul>	
<b>Cost to Offload Tank</b>	<b>\$440</b>
<b>Tank Connections and Internal Plumbing</b>	<b>\$454</b>
<b>Wire System and Program to Existing Fleet Management System Operated by Mammoth Cave National Park</b>	<b>\$1,915</b>
<b>Total Cost of Project</b>	<b>\$22,216</b>

Note: The type of pump used was a GasBoy Model #9152A, alcohol compatible. GasBoy is a division of Tohkeim, Inc.



Courtesy of NPS Photo

The Mammoth Cave National Park E85 Project was not completed without experiencing problems. The primary difficulty was the delivery of the 3000-gallon aboveground storage tank. As described previously, the E85 project was initiated in August 1998, and originally scheduled to be completed by September 30, 1998. However, during late Summer and Fall of 1998, a large number of fuel retailers across the nation were engaged in replacing fuel storage tanks in order to meet the EPA's Underground Storage Tank requirements. As a result, demand for new fuel storage tanks was extremely high and Mammoth Cave was unable to take delivery of the tank until December 1998.

## Appendix A: Geographical Fuel-Marketing Regions

State and Fuel Marketing Region	Volatility Class by Month											
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
<b>Alabama</b>	2	2	2	2	2/1	1	1	1	1	1/2	2	2
<b>Alaska</b>												
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
<b>Arizona</b>												
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
<b>Arkansas</b>	3	3	3/2	2/1	1	1	1	1	1/2	2	2/3	3
<b>California</b>												
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
<b>Colorado</b>												
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
<b>Connecticut</b>	3	3	3	3/2	2	2/1	1	1	1/2	2	2/3	3
<b>Delaware</b>	3	3	3/2	2	2/1	1	1	1	1/2	2	2/3	3
<b>District of Columbia</b>	3	3	3/2	2	2/1	1	1	1	1/2	2	2/3	3
<b>Florida</b>												
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
<b>Georgia</b>	3	3/2	2	2/1	1	1	1	1	1	1/2	2	2/3
<b>Hawaii</b>	1	1	1	1	1	1	1	1	1	1	1	1
<b>Idaho</b>	3	3	3	3/2	2	2	2/1	1/2	2	2/3	3	3
<b>Illinois</b>												
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
<b>Indiana</b>	3	3	3	3/2	2/1	1	1	1	1/2	2/3	3	3
<b>Iowa</b>	3	3	3	3/2	2	2/1	1	1	1/2	2/3	3	3
<b>Kansas</b>	3	3	3	3/2	2	2/1	1	1	1/2	2/3	3	3
<b>Kentucky</b>	3	3	3/2	2	2/1	1	1	1	1.2	2	2/3	3
<b>Louisiana</b>	2	2	2	2/1	1	1	1	1	1	1/2	2	2
<b>Maine</b>	3	3	3	3/2	2	2/1	1	1/2	2	2/3	3	3
<b>Maryland</b>	3	3	3/2	2	2/1	1	1	1	1/2	2	2/3	3
<b>Massachusetts</b>	3	3	3	3/2	2	2/1	1	1	1/2	2	2/3	3
<b>Michigan</b>												
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



## Appendix A: Geographical Fuel-Marketing Regions—continued

State and Fuel Marketing Region	Volatility Class by Month											
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Minnesota	3	3	3	3	3/2	2/1	1	1/2	2	2/3	3	3
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	1/2	2/3	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

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## Appendix B: 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

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

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.

### 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.

## Appendix C: Pricing Sheet - Winter Blend



### National Ethanol Vehicle Coalition

3118 Emerald Lane • Jefferson City, MO 65109 • 573-365-8445  
 email: nevc@E85Fuel.com web: www.e85fuel.com

This worksheet has been prepared to illustrate the use of the federal tax incentives that are available 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:

Number of gallons of fuel	10,000	Enter # of gallons to be purchased
Terminal price of unleaded/gallon	\$ 0.96	Enter local costs in shaded area.
Terminal price of ethanol/gallon	\$ 1.41	Enter local costs in shaded area.
Federal excise tax on unleaded/gallon	\$ 0.184	Set by federal law
State excise tax on unleaded	\$ 0.20	Enter state tax rate in shaded area.
Federal excise tax on E85/gallon	\$ 0.1295	Set by federal law

#### COST OF E85

Net price from Distributor/Blender	
Cost of unleaded (15% of total gallons)	\$ 2,880.00
Cost of ethanol (85% of total gallons)	\$ 9,870.00
Federal excise tax on E85	\$ 1,295.00
State excise tax on unleaded	\$ 2,000.00
Cost of E85 before fuel tax credit	\$ 16,045.00
Fuel tax credit	\$ (3,165.00)
<b>Net cost of E85</b>	<b>\$ 12,880.00</b>
Cost/gallon of E85 after credit	\$ 1.29

#### BASE CASE COST OF UNLEADED GASOLINE

Net price from Distributor/Blender	
Cost of unleaded (100% of total gallons)	\$ 9,600.00
Federal excise tax on unleaded	\$ 1,840.00
State excise tax on unleaded	\$ 2,000.00
<b>Net cost of unleaded</b>	<b>\$ 13,440.00</b>
Cost/gallon of gasoline	\$ 1.34
<b>Savings per gallon of E85 over unleaded</b>	<b>\$ 0.06</b>

<b>Fuel Tax Credit (FORM 6478)</b>	
# Gallons of ethanol used	7,000
Credit % per gallon	\$ 0.54
	3,710.00
<b>Less reduction of credit due to reduced excise tax</b>	
# of gallons	10,000
reduction of excise tax %	0.0545
	\$ (545.00)
<b>Net fuel tax credit</b>	<b>\$ 3,165.00</b>

#### Notes to explanation:

- \* 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 = \$0.184/ gallon, E85 = \$0.1295/gallon. Forms that apply: IRS Forms 8849 and 6478. 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 lower federal excise tax on E85 in situations where the higher excise tax has been paid. This form is filed separately from a company's income tax return.
- \* Form 6478 to claim the fuel tax credit is filed with the quarterly income tax return.
- \* Retailers that install (at their own expense) alternative fuel refueling property may be eligible for additional federal income tax deductions. (Clean Fuel Refueling Property) IRS Publication 535, Chapter 15. This provision of the tax code allows for accelerated depreciation of certain clean fuel vehicle refueling property. The deduction is limited to \$100,000 cumulatively per location. Recapture rules apply should the property cease to qualify as a clean fuel vehicle refueling site. (E85 is classified by the IRS as a Clean Fuel.)

The use of federal income tax credits become 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 relates 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 tax advisors.

For copies of any of these forms or publications, please contact NEVC.

## Appendix C: Pricing Sheet - Summer Blend



### National Ethanol Vehicle Coalition

3118 Emerald Lane • Jefferson City, MO 65109 • 573-365-8445  
 email: nevc@e85fuel.com web: www.e85fuel.com

This worksheet has been prepared to illustrate the use of the federal tax incentives that are available 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:

<b>Number of gallons of fuel</b>	<b>10,000</b>	<b>Enter # of gallons to be purchased</b>
<b>Terminal price of unleaded/gallon</b>	<b>\$ 1.01</b>	<b>Enter local costs in shaded area.</b>
<b>Terminal price of ethanol/gallon</b>	<b>\$ 1.41</b>	<b>Enter local costs in shaded area.</b>
<b>Federal excise tax on unleaded/gallon</b>	<b>\$ 0.184</b>	<b>Set by federal law</b>
<b>State excise tax on unleaded</b>	<b>\$ 0.20</b>	<b>Enter state tax rate in shaded area.</b>
<b>Federal excise tax on E85/gallon</b>	<b>\$ 0.1295</b>	<b>Set by federal law</b>

#### COST OF E85

Net price from Distributor/Blender	
Cost of unleaded (15% of total gallons)	\$ 1,515.00
Cost of ethanol (85% of total gallons)	\$ 11,985.00
Federal excise tax on E85	\$ 1,295.00
State excise tax on unleaded	\$ 2,000.00
<b>Cost of E85 before fuel tax credit</b>	<b>\$ 16,795.00</b>
Cost/gallon of E85 before credit	<u>\$ 1.67</u>
Fuel tax credit	\$ (3,960.00)
<b>Net cost of E85</b>	<b><u>\$ 12,835.00</u></b>
Cost/gallon of E85 after credit	<u>\$ 1.28</u>

<b>Fuel Tax Credit (FORM 6478)</b>	
<b># Gallons of ethanol used</b>	<b>8,500</b>
<b>Credit % per gallon</b>	<u>\$ 0.53</u>
	<b>4,505.00</b>
<b>Less reduction of credit due to reduced excise tax</b>	
<b># of gallons reduction of excise tax %</b>	<b>10,000</b>
	<u>0.0545</u>
	<b>\$ (545.00)</b>
<b>Net fuel tax credit</b>	<b>\$ 3,960.00</b>

#### BASE CASE COST OF UNLEADED GASOLINE

Net price from Distributor/Blender	
Cost of unleaded (100% of total gallons)	\$ 10,000.00
Federal excise tax on unleaded	\$ 1,840.00
State excise tax on unleaded	\$ 2,000.00
<b>Net cost of unleaded</b>	<b><u>\$ 13,940.00</u></b>
Cost/gallon of gasoline	<u>\$ 1.39</u>
<b>Savings per gallon of E85 over unleaded</b>	<b><u>\$ 0.11</u></b>

#### Notes to explanation:

- \* 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 = \$0.184/ gallon, E85 = \$0.1295/gallon. Forms that apply: IRS Forms 8849 and 6478. 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 lower federal excise tax on E85 in situations where the higher excise tax has been paid. This form is filed separately from a company's income tax return.
- \* Form 6478 to claim the fuel tax credit is filed with the quarterly income tax return.
- \* Retailers that install (at their own expense) alternative fuel refueling property may be eligible for additional federal income tax deductions. (Clean Fuel Refueling Property) IRS Publication 535, Chapter 15. This provision of the tax code allows for accelerated depreciation of certain clean fuel vehicle refueling property. The deduction is limited to \$100,000 cumulatively per location. Recapture rules apply should the property cease to qualify as a clean fuel vehicle refueling site. (E85 is classified by the IRS as a Clean Fuel.)

The use of federal income tax credits become 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 relates 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 tax advisers.

# Appendix D: 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 Ed85

*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%
Natural Gasoline CAS 008-006-619				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	NA
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
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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 D: Material Safety Data Sheet for E85–continued

### Section V – Reactivity Data

Stability	Unstable		Conditions to Avoid None in normal use.
	Stable	X	
Incompatibility ( <i>Materials to Avoid</i> ) 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		Conditions to Avoid None in normal use.
	Will Not Occur	X	

### Section VI – Health Hazard Data

Route(s) of Entry:	Inhalation? (A)	Skin? (B)	Ingestion? (C)
Health Hazards ( <i>Acute and Chronic</i> ) (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? Not determined	IARC Monographs Not determined	OSHA Regulated? 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, & 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 NA			

# For More Information

## General

### U.S. Department of Energy

Alternative Fuels Data Center  
1617 Cole Blvd.  
Golden, CO 80401  
[www.afdc.doe.gov](http://www.afdc.doe.gov)

National Alternative Fuels Hotline  
800-423-1DOE (toll-free)  
email: [hotline@afdc.nrel.gov](mailto:hotline@afdc.nrel.gov)

### National Ethanol Vehicle Coalition\*

3118 Emerald Lane, Suite 100  
Jefferson City, MO 65109  
573-635-8445  
877-485-8595  
[www.e85fuel.com](http://www.e85fuel.com)

### National Renewable Energy Laboratory

1617 Cole Boulevard  
Golden, CO 80401-3393  
303-275-4453  
[www.nrel.gov](http://www.nrel.gov)

### Governors' Ethanol Coalition

Nebraska Energy office  
1111 O Street  
P.O. Box 95085  
Lincoln, NE 68509  
402-471-2867  
[www.ethanol-gec.org](http://www.ethanol-gec.org)

### National Corn Growers Association

1000 Executive Parkway, Suite 105  
St. Louis, MO 63141  
314-275-9915  
[www.ncga.com](http://www.ncga.com)

### Renewable Fuels Association

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

U.S. Environmental Protection Agency  
Division of Regulatory Programs & Technology  
2565 Plymouth Road  
Ann Arbor, MI 48105  
734-668-4296  
[www.epa.gov](http://www.epa.gov)

The National Ethanol Vehicle Coalition maintains a comprehensive web site at [www.E85fuel.com](http://www.E85fuel.com) which includes a complete listing of all equipment approved to handle and dispense E85 and a listing of vehicle availability.

## Ethanol Fuel Codes and Safety

### National Fire Protection Association

1 Batterymarch Park  
P.O. Box 9101  
Quincy, MA 02269-9101  
617-984-7259  
[www.nfpa.org](http://www.nfpa.org)

## Standards

ASTM International  
100 Bar Harbor Drive  
West Conshohocken, PA 19428-2959  
Publications and Customer Service  
610-832-9585  
[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)

## Materials

Convault  
4109 Zeering Road  
Denair, CA 95316  
209-632-7571  
[www.ConVault.com](http://www.ConVault.com)

\* For the name of the contact nearest your area, call the National Ethanol Vehicle Coalition at 877-485-8595.



## For More Information

Filter Product Inc.  
8314 Tiogawoods Drive  
Sacramento, CA 95828

EMCO Wheaton  
2300 Industrial Park Drive  
Wilson, NC 27893  
252-243-0150  
[www.emcowheaton.com](http://www.emcowheaton.com)

Goodyear  
3 Harding Place  
Little Ferry, NJ 07643  
201-242-5550  
[www.goodyear.com](http://www.goodyear.com)

OPW Fueling Components  
9393 Princeton-Glendale Road  
P.O. Box 405003  
Cincinnati, OH 45240-5003  
800-422-2525  
[www.opw-fc.com](http://www.opw-fc.com)

Tokheim Co.  
560 31st Street  
Marion, IA 52302  
319-362-4847  
[www.tokheimco.com](http://www.tokheimco.com)

U-Fuel, Inc.  
5110 Fairview Drive  
P.O. Drawer 1511  
Eu Claire, WI 54701  
715-836-0905  
[www.ufuel.com](http://www.ufuel.com)

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### Alternative Fuel Vehicles

DaimlerChrysler Corp.  
Alternative Fuel Vehicle Sales and Marketing  
27777 Franklin Road  
Southfield, MI 48034  
248-948-3644  
[www.fleet.chrysler.com/afv.jsp](http://www.fleet.chrysler.com/afv.jsp)

Ford Motor Co.  
Alternative Fuels Program  
The American Road  
Dearborn, MI 48121  
877-ALT-FUEL  
[www.ford.com/en/ourvehicles/environmentalvehicles/default.html](http://www.ford.com/en/ourvehicles/environmentalvehicles/default.html)

General Motors  
Alternative Fuels  
300 Renaissance Center  
Detroit, MI 48265  
313-665-2958  
[www.gm.com/automotive/innovations/altfuels/](http://www.gm.com/automotive/innovations/altfuels/)

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### Alcohol-Fueled Vehicle Technician Training

Central Community College, Platte Campus  
P.O. Box 1027  
Columbus, NE 68602-1027  
402-562-1267  
[www.megavision.net/cc/](http://www.megavision.net/cc/)

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### Containers

Labelmaster  
5724 N. Pulaski Road  
Chicago, IL 60646-6797  
800-621-5808  
[www.labelmaster.com](http://www.labelmaster.com)

# For More Information

U.S. Department of Energy  
Office of Energy Efficiency and Renewable Energy  
1000 Independence Ave., S.W.  
Washington, DC 20585-0121

To obtain print copies of this document contact:

U.S. Department of Energy  
Alternative Fuels Data Center  
Phone: (800) 423-1363  
e-mail: [hotline@afdc.nrel.gov](mailto:hotline@afdc.nrel.gov)



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