U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Handbook for Handling, Storing, and Dispensing E85

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Disclaimer

Acknowledgements

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Every effort has been made to ensure that this manual is accurate, complete, and comprehensive at the time of publication. It 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.

Contents

Abbreviations and Acronyms

AFDC .... Alternative Fuels and Advanced Vehicles Data Center
AFV ..... Alternative Fuel Vehicle
AHJ ..... Authorities Having Jurisdiction
AST ..... Aboveground Storage Tank
BTU ..... British Thermal Unit
CO2 ..... Carbon Dioxide
CRC ..... Coordinating Research Council
DOE ..... U.S. Department of Energy
DOT ..... U.S. Department of Transportation
E10 ..... 10% ethanol, 90% gasoline
E85 ..... 85% ethanol, 15% hydrocarbons
EPA ..... U.S. Environmental Protection Agency
EPAct .... Energy Policy Act
FFV ..... Flexible Fuel Vehicle
RFA ..... Renewable Fuels Association
UL ..... Underwriters Laboratories, Inc.
UST ..... Underground Storage Tank

Introduction

This document serves as a guide for blenders, distributors, sellers, and users of E85 as an alternative motor fuel. It provides basic information on the proper and safe use of E85 and offers supporting technical and policy references.

E85 is an alternative motor fuel authorized by the Energy Policy Act (EPAct) of 1992, Section 301(2). As defined by EPAct, E85 is composed of 85% fuel grade ethanol and 15% hydrocarbons in the gasoline boiling range. Ethanol is a renewable, domestically produced fuel that can be made from grains, such as corn or wheat, or from biomass or cellulose sources, such as prairie grass and agricultural, forestry, or municipal waste matter. Several research studies show that E85 has the potential to substantially reduce petroleum fuel use and greenhouse gas emissions (GHGs).[1]

Driven by increasing gasoline prices, the market for E85 is growing. With consumer demand for alternative fuel vehicles (AFVs) increasing, auto manufacturers are working to produce more flexible fuel vehicles (FFVs), which are capable of operating on E85 or gasoline or a combination of the two. As of May 2010, there were 8.35 million FFVs on U.S. roads, and automakers were planning to produce several million more each year. FFVs are available in most vehicle classes, including sedans, minivans, trucks, and sport utility vehicles. The number of E85 fueling stations is growing rapidly nationwide. As of June 2010, there were 2,051 retail stations (out of 162,000 nationwide) offering E85 across the country.

Several key factors affecting E85 growth and acceptance were recently addressed. The U.S. Environmental Protection Agency (EPA) issued a guidance document to states defining a process by which they could determine whether "Stage II" gasoline vapor recovery equipment would be required for new E85 pumps. In October 2007, Underwriters Laboratories, Inc., (UL) established standardized testing procedures for E85 fuel dispensers that address the unique properties of alcohol fuels when blended with gasoline. This testing standard (UL Subject 87A) was updated in August 2009. In addition, UL announced equipment listed for E85 use in June 2010. See Appendix F for detailed information.

There are many federal and state tax incentives and credits to encourage the installation of E85 infrastructure and use of the fuel. For a comprehensive list of these programs, visit the State and Federal Incentives and Laws section of the AFDC at *www.afdc.energy.gov/afdc/laws*.

Ethanol and E85 Properties, Specifications, and Information

Also known as ethyl alcohol or grain alcohol, ethanol (C_2H_5OH) is an oxygenated hydrocarbon compound. It is produced primarily from grain, such as corn or wheat. The starch contained in the grain is converted into sugar and fermented to produce ethanol. Ethanol can also be produced by hydrolysis of cellulose contained in plant-based materials, including corn stalks, wheat stalks, other agricultural or forestry waste, and municipal waste. Several processes currently being developed for cellulose-derived ethanol include enzymatic and acid hydrolysis and thermal processes. Cellulose-derived ethanol and E85 are expected to be a necessary component to meeting various state and national renewable fuel standards.

While ethanol for beverages and fuel are produced by a similar process, fuel ethanol is "denatured" by adding 2% hydrocarbons, such as natural gasoline to make it unfit for human consumption. Natural gasoline, a low-octane gasoline boiling-range hydrocarbon that is a by-product of natural gas production, can be used as a denaturant. Descriptive properties of fuel ethanol and E85 are listed in Table 1. Ethanol is a flammable, colorless liquid with a faint alcohol odor. The color of ethanol/gasoline blends depends on the color of the gasoline in the blend. Blends may also have a gasoline-like odor.

Ethanol is a motor fuel that can be blended with gasoline. However, the unique chemical properties of ethanol must be accommodated in order to maintain engine performance, emissions, fuel economy, and driveability under all operating conditions. Since the heat of vaporization of ethanol is more than twice the value of gasoline, it does not vaporize as readily under cold temperature conditions and until the engine reaches operating temperature. To ensure proper cold temperature engine start and warm-up operation in all regions of the United States, ethanol is blended with at least 15% hydrocarbons, which is more volatile than ethanol. In other countries, such as Brazil, where northern U.S. cold temperatures are not often encountered, it may be more practical to use neat (100%) ethanol. However, even in Brazil, most FFVs are equipped with small gasoline reservoirs that can be used for cold-temperature

Ethanol Production, Blending, and Distribution

- Ethanol is produced at an ethanol plant. Prior to transporting, the fuel must be denatured by adding approximately 2% hydrocarbons, such as natural gasoline, to render it unfit for human consumption. A corrosion inhibitor is also added.
- 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 and diesel fuel.
- A fuel carrier orders a tanker of E85.
- The fuel supplier dispenses 8.5 parts denatured ethanol to 1.5 parts hydrocarbons into the tanker truck.
- The fuel carrier delivers E85 to the retail fuel marketer for sale to the public.

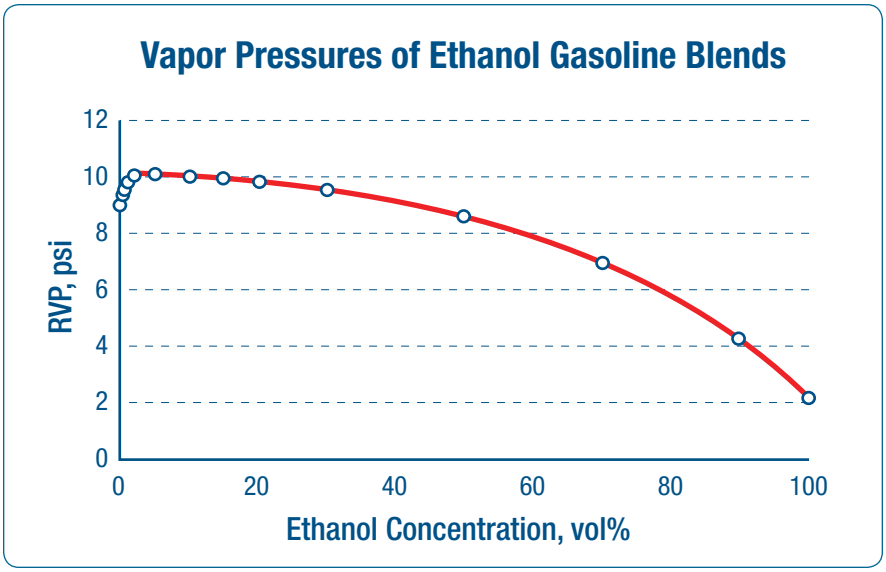

Figure 1. Vapor Pressures of Ethanol/Gasoline Blends, SAE International Paper 852116, "Volatility Characteristics of Gasoline-Alcohol and Gasoline-Ether Fuel Blends"

engine starting. Unlike gasoline, ethanol vaporizes within a narrow temperature range. The combination of higher heat of vaporization and narrow vaporization temperature range requires careful attention to the hydrocarbon blending components and creates challenges for managing cold-start emissions.

With sufficient heat energy, ethanol vaporizes at a lower temperature than many of the hydrocarbons in gasoline and requires adjustment of the gasoline blending components to prevent high temperature vapor lock. Low-level ethanol/gasoline blends, up to about 20% ethanol, exhibit an increase in vapor pressure of about 1 psi, which should be compensated by adjusting the base gasoline properties. The opposite is true with high-level ethanol blends, such as E85, where a high vapor pressure gasoline blending component is needed to increase the vapor pressure of the blend to meet ASTM International specifications, which are discussed later in this section. Also unique to low-level ethanol blends, permeation of fuel system elastomer materials is substantially increased. Testing has confirmed that this is not the case with E85.[2]

Due to the reduced energy content of ethanol per gallon compared to gasoline, vehicle fuel economy on E85 is typically about 25% less compared to gasoline (measured in miles per gallon). Table 2 offers a comparison of the properties of E85 to those of methanol, ethanol, and gasoline.

Table 1. Properties of Fuel Ethanol and E85

Property	Comment
Vapor Density	Ethanol vapor, like gasoline vapor, is denser than air and tends to settle in low areas. Ethanol/gasoline blends, including E85, should be treated like gasoline blends with respect to handling and safety.
Solubility in Water	Ethanol is extremely hydroscopic (i.e., attracts water). Water should be removed to the extent possible from fuel ethanol handling, storage, and distribution equipment. A small amount of water is soluble in E85, but at higher concentrations, the gasoline portion will separate from the ethanol/water mixture.
Energy Content	For identical volumes, ethanol contains approximately 30% less energy than gasoline depending on the gasoline formulation. As a result, vehicle fuel economy of E85 can be expected to be reduced by about 25% depending on the gasoline formulation and the individual vehicle.
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/gasoline blends are slightly more dense than gasoline.
Conductivity	Ethanol and ethanol blends have increased electrical conductivity compared to gasoline. This can affect materials compatibility due to increased corrosion of certain metal junctions and exposed electrical connections.
Air-Fuel Ratio	Due to the oxygen content in ethanol, the ideal or “stoichiometric” air-fuel ratio for E85 is a lower value than it is for gasoline (i.e., fewer pounds of air per pound of fuel). FFVs are designed to detect ethanol and properly adjust the air-fuel ratio.
Toxicity	Pure ethanol in small amounts is not toxic and is not considered carcinogenic; however, fuel ethanol and ethanol/gasoline blends must be treated as toxic and carcinogenic due to the addition of hydrocarbons and gasoline.
Flammability	Depending on the hydrocarbon blending component, the vapor concentration in the storage tank head space of many E85 blends can fall into the flammable range. This is a concern primarily at low ambient temperatures.

Table 2. Fuel Properties of Ethanol, Gasoline, and E85			
Property	**Ethanol**	**Gasoline**	**E85**
Chemical Formula	C_2H_5OH	C_4 to C_{12} Hydrocarbons	C_4 to C_{12} Hydrocarbons and Oxygenated Hydrocarbons
Main Constituents (% by weight)	52 C, 13 H, 35 O	85-88 C, 12-15 H	57 C, 13 H, 30 O
Octane (R+M)/2	98-100	86-94	95-97
Lower Heating Value (British thermal unit (BTU) per gallon)	76,300	116,900	83,600- 89,400
Gasoline Gallon Equivalence (v/v gasoline)	1.5	1	1.3-1.4
Miles per Gallon Compared to Gasoline	67%	–	73%
Reid Vapor Pressure (psi)	2.3	7-16	7-12
Ignition Point—Fuel in Air (%)	3-19	1-8	*
Temperature (approx.) (°F)	850	495	*
Specific Gravity (60/65°F)	0.794	0.72-0.78	0.78
Cold Weather Starting	Poor	Good	Fair**
Air-Fuel Ratio (by weight)	9	14.7	10
Hydrogen-Carbon Ratio	3.0	1.85	2.75-2.95

*Depends on hydrocarbon blending component properties.
**Depends on the fuel being blended to specifications.

Most transportation fuel sold in the United States is manufactured to ASTM specifications. ASTM International is a voluntary consensus standards organization that creates and maintains fuel quality specifications established by committees composed of vehicle and engine manufacturers, fuel system equipment manufacturers, fuel producers, fuel users, and other interested parties, such as state fuel-quality regulators. Although ASTM standards are recognized by federal and most state governments as the primary means of ensuring fuel quality. EPA and most states have passed regulations and laws, which require gasoline to meet all or a portion of the ASTM gasoline guidelines. Various specifications for ethanol, E85, and denaturant are included in Appendix B. Also included are California specifications for denatured ethanol and denaturant.

Seasonally Adjusted Blends

The properties of ethanol for E85 blending should meet ASTM D4806. The ethanol content of E85 is seasonally adjusted to improve vehicle cold-start and warm-up performance. Denatured ethanol content can range from 68% to 85% by volume. The ASTM specification for E85 is ASTM D5798 "Specification for Fuel Ethanol (Ed75-Ed85) for Automotive Spark Ignition Engines" (see Table 3). Much like gasoline, the volatility of E85 is also adjusted seasonally and geographically by volatility class for vehicle cold-start and warm-up performance by increasing the proportion of light hydrocarbons during colder months. The seasonal and geographical volatility classes are determined by ASTM and contained in ASTM D5798. (A complete breakdown of geographical and seasonal volatility classes can be found in Appendix A.)

The octane of E85 is much higher than gasoline, ranging from 96 to 97 (R+M)/2 depending on hydrocarbon content. The energy content of E85 is lower than gasoline and ranges from approximately 83,600 BTU/

Table 3. ASTM D5798-10 Standard Specification for Fuel Ethanol (Ed75-Ed85) for Automotive Spark-Ignition Engines			
Property	**Value for Class**		
ASTM Volatility Class	1	2	3
Ethanol Plus Higher Alcohols (minimum volume %)	79	74	68
Hydrocarbons (including denaturant) (volume %)	17-21	17-26	17-30
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
Lead (maximum, mg/L)	2.6	2.6	3.9
Phosphorus (maximum, mg/L)	0.2	0.3	0.4
Sulfur (maximum, mg/kg)	210	260	300
	All Classes		
Methanol (maximum, volume %)	0.5		
Higher Aliphatic Alcohols, C3-C8 (maximum volume %)	2		
Water (maximum, mass %)	1.0		
Acidity as Acetic Acid (maximum, mg/kg)	50		
Inorganic Chloride (maximum, mg/kg)	1		
Total Chlorine as Chlorides (maximum, mg/kg)	2		
Gum, Unwashed (maximum, mg/100 mL)	20		
Gum, Solvent-Washed (maximum, mg/100 mL)	5.0		
Copper (maximum, mg/100 mL)	0.07		
Appearance	Product shall be visibly free of suspended or precipitated contaminants (shall be clear and bright).		

gallon to 89,400 BTU per gallon (depending on the hydrocarbon content) compared to the typical gasoline energy content of approximately 116,100 BTU per gallon. Thus a gallon of E85 contains approximately 72% to 77% as much energy as a gallon of gasoline.

Hydrocarbons

Although unleaded gasoline has been used to blend E85, a higher volatility component, such as natural gasoline (a high-volatility, low-octane byproduct of natural gas production), can be used to meet ASTM volatility requirements due to the low vapor pressure of ethanol. It is important to meet ASTM volatility requirements to reduce the occurrence of flammable vapor regimes in vehicle fuel tanks. Due to the different types of hydrocarbon components that have been used in E85, the range of vapor flammability in tanks is wider than gasoline. The National Renewable Energy Laboratory compared the fuel tank headspace flammability of seven E85 fuel blends, two gasoline samples, and denatured ethanol.[3] Headspace vapors for the two gasoline samples became flammable when the temperature dropped to approximately -19°C (-2°F) and -25°C (-13°F) or lower. The E85 blends, on the other hand, produced flammable vapors at temperatures below values ranging from -2°C (28°F) to -22°C (-8°F). Denatured ethanol was found to be flammable at room temperature and all temperatures down to approximately -6°C (22°F). Therefore, stations should not store denatured ethanol for blending E85 or other ethanol blends due to risk of explosion.

Table 4. Flammability Limits of Gasoline and Ethanol		
Fuel Gas	Lower Explosive or Flammable Limit (LEL/LFL) (% in air)	Upper Explosive or Flammable Limit (UEL/UFL) (% in air)
Gasoline	1.4	7.6
Ethanol	3.3	19

Fuel Additives

According to EPA regulations, all commercial grades of gasoline must contain specified levels of additives, detergents, and corrosion inhibitors. A corrosion inhibitor should be added to the ethanol portion of the E85 blend according to Renewable Fuels Association (RFA) recommendations.[4] The hydrocarbon component of E85 should contain the EPA-specified levels of detergent additives and corrosion inhibitors; however the RFA and vehicle manufacturers do not recommend the use of detergent additives in the ethanol portion of the E85 blend. Overuse of additives with E85 may result in poor vehicle operation. RFA has also made certain recommendations about appropriate detergent treatment of E85. Some detergents, such as polyisobutylene amine, have performed poorly in FFV operation. At some blend levels, these additives may precipitate out of the blend resulting in excessive fuel system deposition. Consequently, to minimize the occurrence of additive-related problems, RFA has issued a recommendation to contact them directly concerning additives.[4]

NREL and the Coordinating Research Council (CRC) collaborated to survey U.S. summer and winter E85 against ASTM D5798 standards. A summary of the results of 123 samples each season is contained in CRC Report No. E-85. Additional E85 CRC fuel quality survey data can be obtained from Report Nos. E-79 and E-79-2.[5]

Materials Recommendations

As with all liquid motor fuels, it is important to maintain proper fuel handling and housekeeping practices to minimize contamination. Certain materials commonly used with gasoline may be incompatible with high-level alcohol blends. Some materials may degrade over time, potentially leading to equipment problems. It may also contaminate the fuel, which may adversely affect vehicle fuel system operation or cause component malfunction and lead to degraded driveability and performance. The materials and components presented in this handbook have performed satisfactory in the field with E85.

In general, E85 can cause corrosion of some soft metals and reduce the tensile strength of some nonmetallic materials. It may also cause swelling and loss of function on certain nonmetallic materials. E85 acts like a "cleaning agent" and will initially mobilize sludge in storage tanks. Only E85-compatible materials should be used in the storage and dispensing systems. Zinc, brass, lead, and aluminum have shown sensitivity to degradation. Terne-plated steel (lead/tin/alloy coating), which has been commonly used for vehicle fuel tanks, and lead-based solder are also incompatible with E85. Use of these metals should be avoided due to the possibility of fuel contamination and potential impacts on vehicle operation. Unplated steel, stainless steel, black iron, and bronze have shown acceptable resistance to E85 corrosion.

Nonmetallic materials that degrade when in contact with fuel ethanol include natural rubber, polyurethane, cork gasket material, leather, polyvinyl chloride, nylon 6/6, methyl-methacrylate plastics, and certain thermoplastic and thermoset polymers. Nonmetallic materials successfully used for transferring and storing ethanol include thermoset-reinforced fiberglass, thermoplastic piping, and thermoset-reinforced fiberglass tanks (as listed for this application by UL). Contact with E85 causes some elastomers to swell.

Storing and Dispensing E85

The equipment used to store and dispense gasoline and diesel fuels is similar to the equipment used for alcohol-based fuels. Like gasoline, alcohol-based fuels are liquid at ambient pressures and temperatures. However, only E85-compatible materials should be used in ethanol storage and dispensing systems.

Although fuel-related vehicle problems with ethanol-blended gasoline have become relatively infrequent, most recent problems have been related 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 materials research and testing is expected to continue, the components and materials discussed in this handbook have performed well with E85.

Stage II vapor recovery systems are required to be used at gasoline dispensing facilities located in serious, severe, and extreme nonattainment areas for ozone under section 182(b)(3) of the Clean Air Act. In December 2006, EPA issued a guidance letter to states describing conditions under which Stage II vapor recovery could be removed from E85 dispensers. Generally, state governments are permitted to remove Stage II controls from E85 dispensers where widespread use of vehicle Onboard Refueling Vapor Recovery controls can be demonstrated (see Appendix E for the EPA letter). State regulatory authorities should be consulted to determine applicability in each situation.

In addition to the information provided in this section, DOE compiled a list of field success stories on E85 installation, handling, and use, along with other helpful case studies and lessons learned.[6] Page 22 of this handbook features a checklist detailing key items to consider when adding or converting equipment to dispense 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 (USTs) that meet the EPA's December 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 an existing UST is used to store E85 and the tank is either metal or fiberglass certified for E85, proper steps should be taken.

Tanks

According to U.S. Department of Transportation (DOT) Office of Pipeline Safety compatibility regulations,[7] all USTs and aboveground storage tanks (ASTs) must be made of or lined with materials that are compatible with the substance stored. Compatibility is defined as the ability of two or more substances to maintain their respective physical and chemical properties upon contact with one another for the design life of the tank system under conditions likely to be encountered. Product piping, including that within the dispensers is considered part of the UST or AST system and needs to be compatible with the substance stored and dispensed through it. American Petroleum Institute publication 1626, "Storing and Handling Ethanol and Gasoline Blends at Distribution Terminals and Service Stations" may be used to comply with the compatibility requirements in the regulations.

Prior to planning any fuel storage system, local building and fire codes must be checked. While E85 falls under the same handling and storage requirements as gasoline within the provisions of National Fire Protection Agency Standards 30 and 30A, local fire provisions and regulations must be considered, including the use of UL listed dispensers. Additional provisions will be added to the codes to address the polar solvent nature of E85. For more information, see the Safety Codes section of this handbook.

Cleaning Tanks: Tanks previously used for storing other types of fuel may be used for E85 if the tank is properly cleaned. During storage, debris and moisture can build up over time to form sludge or "water bottoms." Since ethanol is miscible with water, when introducing E85 or another ethanol blend to a previously used petroleum fuel storage tank, the ethanol will mix with the water bottoms and the "solvent action" of ethanol will remove any sludge build-up and result in contaminated fuel. More than 20 years of experience in handling low-level ethanol blends has helped to address the accumulation of debris and water in the fuel distribution and storage system. However, proper cleaning procedures should be put in place for tanks that have been used for other petroleum products, and proper housekeeping procedures should be instituted to limit debris and water contamination.

There are several methods for cleaning sludge from storage tanks. They are listed below. It's important to note that all of the methods must be completed by a certified and bonded company 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 with no tank downtime. The optic sweep can locate and remove water, sludge, bacteria, rust particles, and sediment while customers continue to pump.
- **Steam Cleaning:** This method involves physically entering the tank, steam cleaning it, 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 of.

Choosing the appropriate cleaning technique will depend upon the type of fuel that has been stored in the tank, availability of the service, and state and local environmental regulations.

Underground Tanks: Double-walled, low-carbon, cold-finished steel tanks may be used, but welded tanks are preferable and must be corrosion protected to meet EPA requirements. Plated metal tanks should not be used. Pre-1992, single- and double-wall fiberglass tanks may be used when listed for the purpose by UL.

Aboveground Tanks: Most ASTs can be used to store E85. ASTs are usually smaller than USTs and are typically installed in capacities of 1,000 to 2,000 gallons. Tanks may be constructed of stainless steel, cold-finished steel, or fiberglass. The use of plated metal tanks is not recommended.

UL Listing

Many permitting and construction officials, or "authorities having jurisdiction" (AHJs), require that fueling equipment be UL listed. In June 2010, UL completed research to assess the safety-related performance of dispenser assemblies using E85. UL developed Subject 87A for testing fuel dispensers and hanging hardware and other related equipment with E85. A complete list of UL-listed E85 equipment is available in Appendix F.

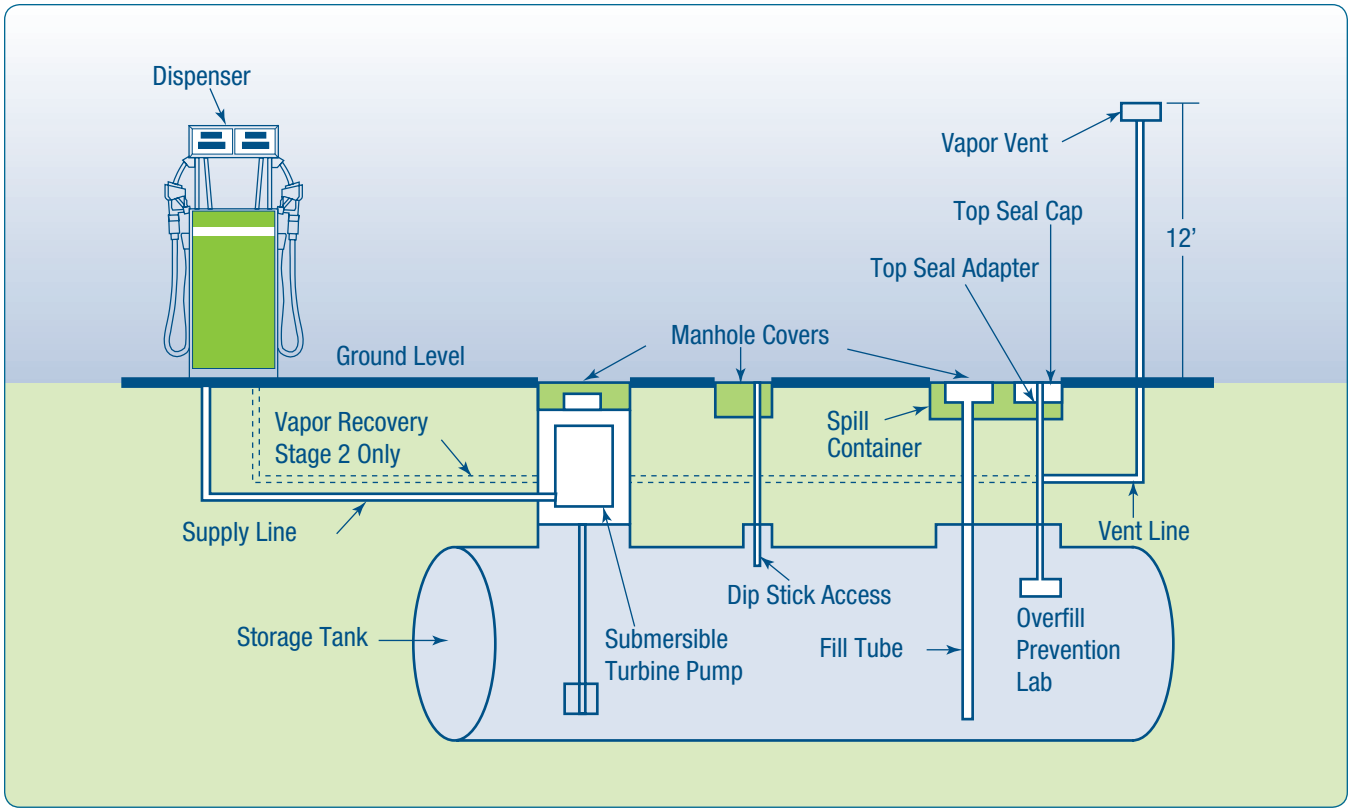

Figure 2. Typical Fuel Dispenser and Underground Storage Piping

Dispensers

As a general rule, E85 dispensers must use iron, unplated or stainless steel, or other suitably applied and tested materials in the fuel path. For vane-type pumps, impellers made from soft metals (such as zinc, brass, lead, aluminum) should be avoided. Steel or an engineering polymer with a high chemical resistance is recommended for best results. Use of non-compatible dispenser materials may lead to leaks, premature meter inaccuracies, and introduction of contaminants into the fuel. Table 5 shows dispensers listed for use with E85 fuel.

Table 5. UL-Listed Dispensers

Manufacturer	Model
Dresser Wayne	G520
Dresser Wayne	G610
Dresser Wayne	G620
Dresser Wayne	Ovation E
Gilbarco	Encore 300
Gilbarco	Encore 500
Gilbarco	Encore 550

*See Appendix F for detailed model numbers.

Hanging Hardware

The hanging hardware consists of the nozzle, swivel, hose, whip hose, and breakaway. Table 6 shows hanging hardware listed for use with E85 fuel. A complete list of UL-listed E85 equipment is available in Appendix F.

Table 6. UL-Listed Hanging Hardware

Equipment	Manufacturer	Model
Breakaway	OPW Fueling Systems	OPW66V-0492
Hose	Veyance	Flexsteel Futura Ethan-all
Nozzle	OPW Fueling Systems	21GE and 21GE-A
Swivel	OPW Fueling Systems	241TPS-0492

As previously noted, components made from zinc, brass, lead, aluminum, or other soft metals should be avoided. Fuel ethanol may attack such soft metals, which may cause leaks and contaminate the fuel, leading to deposits in the vehicle fuel system and possibly impairing vehicle performance and causing safety concerns.

Stainless steel or nickel-plated nozzles have been used successfully with E85; however, the surface plating should be inspected periodically for signs of degradation. As with gasoline, dispenser hoses for E85 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 areas with Stage I controls. For E85, hose materials with the highest resistance to alcohol should be used.

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. In recent years, several component manufacturers 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 carry the fuel from the tank to the dispenser. Typically, pressurized systems require both continuous and periodic leak detection tests, as well as other line tightness testing and precautions. If a suction system has a check valve solely at the dispenser, leak detection testing may not be required and possibly fewer line tests will be required.

Piping

Nonmetallic, corrosion-proof pipe is recommended for underground piping. According to UL Standard 971 ("Standard for Nonmetallic Underground Piping For Flammable Liquids"), products that have been tested for compatibility with high-concentration alcohol blends (ethanol and methanol) should be used. 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 have filters with a nominal rating of 50% for particles 5 microns or larger and an absolute rating of 99% for particles 10 microns or larger. These ratings mean the filter can capture the given percentage of the particles of the stated size.

Multi-pass testing recently replaced previous rating methods and is recognized by SAE International and other industry organizations. Multi-pass testing is used to count the number of particles of a given size before and after fluid passes through a filter. From these measurements, a Beta ratio is formulated by dividing the number of particles upstream by the number of particles downstream. E85 dispenser filters should have a Beta ratio of 100 for 10 micron particles and a ratio of two for 5-micron particles.

For more information on filter ratings, see Technical Service Bulletin 89-5R3 on the Filter Manufacturers Council's Web site (www.filtercouncil.org/techdata/tsbs/89-5R3.pdf).

Fittings and Connectors

To avoid degradation, all fittings, connectors, and adapters that will be in contact with the fuel should be made of materials such as stainless steel (best choice), black iron, or bronze. If aluminum or brass fittings are used, they must be nickel-plated to avoid any contact between the bare metal and the fuel. The surface plating should be inspected periodically for evidence of degradation.

Signs, Labels, and Stickers

Most states, DOTs, and AHJs require specific E85-related signage at refueling stations. Contact the appropriate official in your area to determine the required signage for E85. Storage tanks containing E85 must be labeled on all fillboxes and fillbox covers with a bronze pentagon, as shown at right, and "E85" printed in black in the middle of the pentagon.

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

- Paint the decal on the top of the fillbox 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.

In addition, the Federal Trade Commission requires that a small sticker, as shown at right, be placed on the face of the fuel dispenser as close as possible to the price per unit of fuel.

E85 tanks and dispensers must be labeled with decals indicating the fuel is not gasoline or diesel.

E85 Quality Assurance

Following the installation of an E85 fueling station, several operational precautions can help 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. At a minimum, the following items should be checked every one to two months, depending on how frequently the station is used:

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

Shipping Procedures

To ensure high fuel quality, periodic sampling and analysis by a gasoline or chemical analysis laboratory is recommended. 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 hazardous material shipping requirements and include the following information 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

Be sure to use ethanol-compatible shipping containers specifically designed for this purpose.

Safety Procedures

Health Considerations

Fuel ethanol should be handled in the same manner as gasoline. Personal exposure should be minimized. Like gasoline, fuel ethanol is flammable, poisonous, and may contain additives that can be harmful even with casual contact. Fuel ethanol is poisonous and should not be consumed.

Exposure to fuel ethanol can occur by inhalation (breathing in its vapors), absorption (getting it on the skin or in the eyes), or ingestion (swallowing it). The various symptoms of exposure to fuel ethanol are shown in Table 7.

Table 7. First Aid Treatments for Exposure to Fuel Ethanol		
Symptoms of Exposure	• Dullness of memory and concentration • Impaired motor coordination • Drowsiness, stupor, and coma	
Exposure	**First Aid Treatment**	**Treatment Compared to Gasoline Exposure**
Inhalation	Move away from the vapors to fresh air, and contact medical personnel immediately.	Same
Skin Absorption	Immediately wash skin with soap, and flush skin with plenty of water for at least 15 minutes. Remove contaminated clothing, and contact medical personnel.	Same
Eye Absorption	Immediately flush eyes with plenty of water for at least 15 minutes, and contact medical personnel.	Same
Ingestion	Lie down, keep warm, do not induce vomiting, and contact medical personnel immediately.	Different

Fire Safety Considerations

Fuel ethanol fires require specific equipment, materials, and training. Recent testing of fire-fighting agents sponsored by the Ethanol Emergency Response Coalition using the UL 162 test methodology revealed that conventional gasoline fire-fighting methods and chemicals are not likely to be effective on ethanol-fueled fires.[8] Only foams containing an alcohol-resistant polymer should be used, and only foams classified as AR-AFFF passed all UL requirements. These recommendations should be applied to all ethanol blends including low-level blends such as E6 and E10, and high-level blends such as E85.

Before constructing any refueling installations, the local fire marshal should be consulted to determine local regulations governing safe alcohol fuel handling procedures.

Responding to Ethanol Incidents, a video presentation developed in conjunction with the RFA, the International Fire Chiefs Association, General Motors, Independent Liquid Terminals Association, ANSUL Innovative Fire Solutions, and Williams Fire and Hazard Control, is a technical presentation directed primarily at ethanol plant operators and first responders, such as fire marshals. It is a good training tool that documents ethanol fire-fighting foam test results and educates viewers on how to deal with ethanol-related spills and fires. In addition, the film explores how ethanol-blended fuels are produced and distributed. The DVD is available through the RFA Web site for a nominal fee,[9] or it can be viewed free of charge online at www.ethanolrfa.org.

Safety Codes

Safety standards for handling and storing E85 are the same as those for gasoline. The National Fire Protection Agency (NFPA) has two standards that apply to ethanol blends: NFPA 30, "Flammable and Combustible Liquids Code" and NFPA 30A, "Automotive and Marine Service Station Code." These codes contain information on refueling facilities, storage, and handling requirements for all flammable and combustible liquids. NFPA assigns ethanol fuels (including E95 and E85) to the same class as gasoline. Copies of these standards can be obtained through the Office of the State Fire Marshal or the NFPA Web site.[10] An example material safety data sheet for E85 is shown in Appendix C.

Flexible Fuel Vehicles

Original equipment manufacturers place labels like these inside fuel doors to identify vehicles as FFVs.

To safely and effectively operate a vehicle on E85, the vehicle must be compatible with high-level ethanol blends. In the United States, E85 FFVs are certified with the EPA and sold by several vehicle manufacturers. Vehicles manufactured for use with E85 can run on gasoline, E85, or any combination of both. Although nearly all gasoline-fueled passenger cars and light-duty trucks sold in the last 20 years have been designed to operate on E10, substantial modifications are made to FFVs so they can use higher concentrations of ethanol up to E85 (85% ethanol/15% hydrocarbons) without adverse effects on fuel system materials, components, on-board diagnostics (OBD) systems, or driveability.

Vehicle manufacturers identify FFVs with a label inside the fuel door that indicates E85 or gasoline capability.

E85 causes some elastomers, rubbers, and polymers (plastics) to swell or lose shape. In addition, E85 increases the electrical conductivity of the fuel, which can promote corrosion of some metals. Alcohol fuels also attract and absorb water. Modifications to fuel system materials and components, such as the fuel pump, fuel level sender, and fuel injectors, are required for FFVs. Additional sensors and computer capability may also be needed. The extent of the modifications throughout the fuel system and electronic engine control system make aftermarket or field modification of existing vehicles complicated and costly.

The list of fuel-system components that must be modified for FFVs is extensive. Examples include, but are not limited to, hoses and other rubber components, such as fuel pump and fuel pressure regulator diaphragms and fuel injector o-rings to address possible leakage and permeation of fuel and vapor. Modified electrical wiring and connectors are required for submersed components, such as the fuel-level sender and fuel pump. Increased evaporative emissions carbon canister capacity, a modified fuel tank vapor pressure sensor and modified engine valve and valve seat materials may also be required. Both metal and plastic fuel tanks must be designed to accommodate E85. For example, traditional terne-plated steel (lead-tin-alloy coating) fuel tanks and monolayer high-density polyethylene fuel tanks are not compatible with E85.

Because a gallon of E85 contains less energy content than a gallon of gasoline, the fuel system must be designed to provide sufficient fuel flow. This includes the fuel pump and fuel injectors. To provide sufficient operating range on a tank of fuel, FFVs might require additional fuel tank capacity.

Flexible fuel capability for ethanol concentrations ranging from 0% to 85% involves the use of either a flexible fuel sensor or a computer calculation based on oxygen sensor information. Many 2006 and later model year FFVs have eliminated the sensor in favor of the computer calculation method. The engine control computer adjusts engine fueling for the reduced energy content and oxygen content of ethanol. Both the reduced energy content and the oxygen content of ethanol requires additional fuel to maintain the proper air/fuel ratio under the various engine operating loads and conditions. Different vaporization characteristics of ethanol require modified engine fueling strategies under engine cold start and warm up conditions as well. This requires additional engine control computer capacity and modified software and calibration.

If E85 is used in a vehicle not compatible with high-blend alcohol fuels, fuel system materials and components may be affected over time and lead to leaks. Driveability, performance, and emissions may also be affected; and the OBD system may trigger the “service engine” light and set diagnostic codes related to lean engine operation.

EPA has established rules and guidelines for vehicle alternative fuel conversions. Each vehicle and engine combination must be certified separately with EPA, which includes filing the necessary paperwork and

conducting extensive emission testing at a laboratory capable of performing the EPA required testing. Comprehensive information is available on EPA's certification procedures for alternative fuel conversions and conversion kits on EPA's Web site.[11]

Most of the motor fuel used in Brazil is either a 22% ethanol blend or a hydrated ethanol consisting of 93% ethanol and 7% water, and most of the vehicles currently sold in Brazil are flexible-fuel capable. These FFVs are different than U.S. FFVs in several ways. Brazilian FFVs are manufactured to different safety and emission standards and could not be sold in the United States without extensive modification and certification to meet U.S. requirements. The engines and fuel systems are designed to operate on 22% anhydrous ethanol, 100% hydrated ethanol, or any combination of these fuels. The design requirements are different for these vehicles, including the addition of a small one-liter underhood gasoline tank to facilitate engine starting in cold weather (less than 50°F).

FFVs manufactured by several major auto companies are available in the U.S. marketplace. Many of these vehicles are available at no additional cost compared to conventional gasoline-fueled vehicles, and some FFVs carry a nominal additional charge. For a list of FFVs available for purchase, visit the Fuel Economy Web site at *www.fueleconomy.gov*.

Federal and state governments have established incentives for the purpose of advancing the use of all forms of alternative transportation fuels. For a list of these programs, visit the State and Federal Incentives and Laws section of the AFDC Web site at *www.afdc.energy.gov/afdc/laws*.

Emissions

In the United States, E85-capable FFVs are required to meet applicable EPA and California standards for exhaust and evaporative emissions on E85 and gasoline. Modern passenger cars and light trucks employ very sophisticated electronic engine and emission control systems. Since E85 FFVs are designed to meet the same emission standards on both gasoline and E85, criteria pollutant levels of hydrocarbons, carbon monoxide, and oxides of nitrogen are generally considered equivalent on both fuels.

Ethanol produced from corn blended as E85 can achieve a 40% reduction in fossil energy use and about a 20% reduction in greenhouse gas emissions compared to gasoline.[12] Larger reductions can potentially be achieved if the ethanol is produced from cellulose derived biomass.

CRC Project No. E80 is currently measuring exhaust and evaporative emissions on gasoline and several ethanol blends (including E85) with results expected in 2010. The National Renewable Energy Laboratory reviewed studies that compared the emissions from vehicles fueled with E85 and gasoline, finding a wide range of tailpipe emissions results from E85-fueled light-duty vehicles.[13] Compared with gasoline-fueled vehicles, E85-fueled vehicles tended to produce lower oxides of nitrogen, carbon monoxide, benzene, and 1,3-butadiene emissions and higher formaldehyde and acetaldehyde emissions.

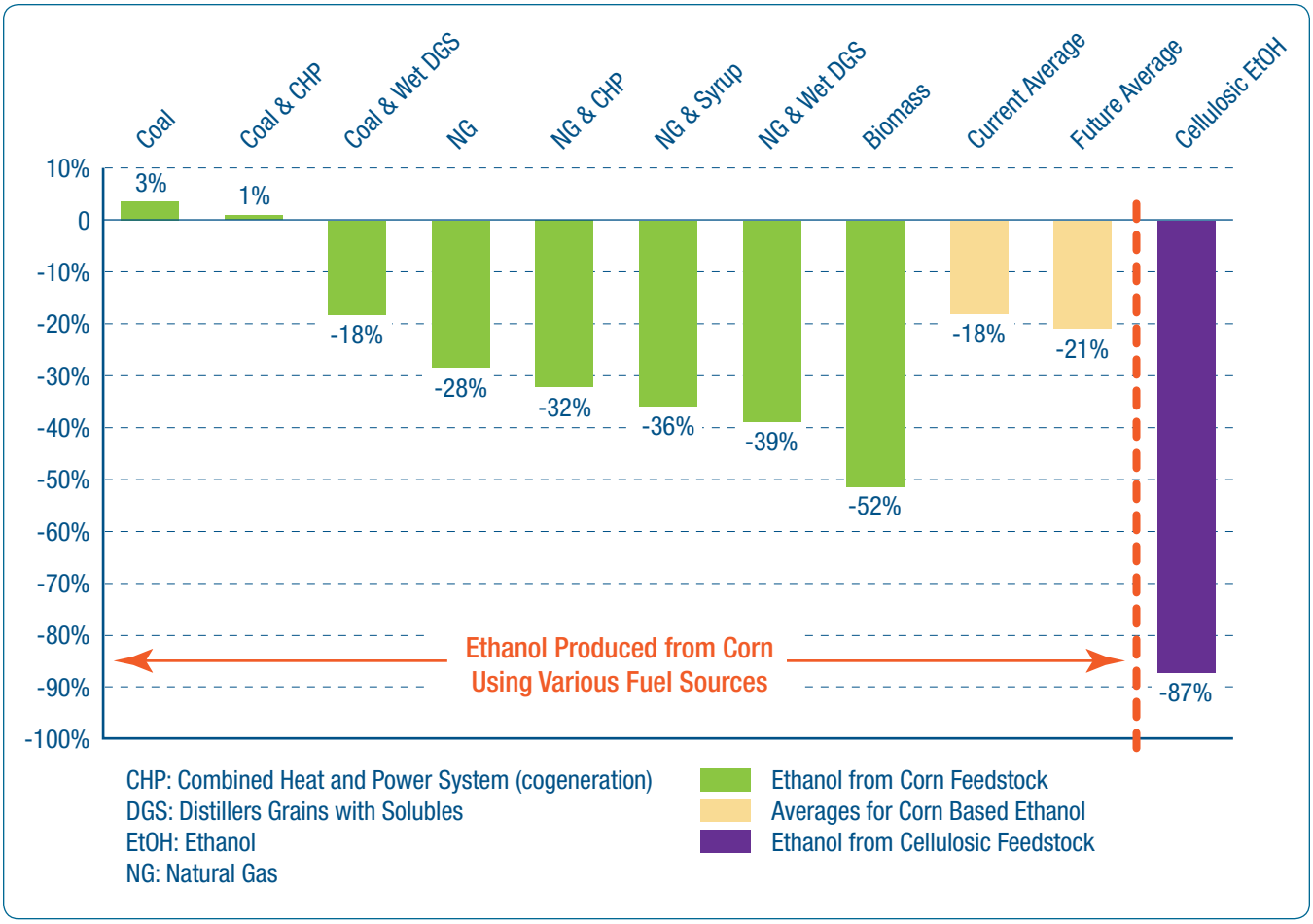

Figure 3. Well-to-Wheels GHG Emission Changes: Fuel Ethanol Relative to Gasoline, Michael Q. Wang, Center for Transportation Research, Argonne National Laboratory, February 2007

Benefits and Limitations of Using E85

Benefits

Ethanol has a positive energy balance: Ethanol has a positive energy balance when production is evaluated in terms of fossil energy use. First, the issue itself can be confusing since the energy balance (the ratio of energy in the fuel to energy required to produce it) of any fuel including gasoline will always be less than one. In evaluating the energy balance of any fuel, the type of energy, as well as the amount of energy, must be considered. Figure 4 compares the energy required to produce gasoline and ethanol. It illustrates that the production of ethanol from corn has a positive energy balance (i.e., only 0.74 Btu of fossil energy from petroleum, natural gas, and coal are required to produce 1 Btu of energy contained in ethanol). Although 1.75 Btu of total energy is required, 60% of that energy comes from sunlight during photosynthesis of corn plant growth. Much less fossil energy is required to produce ethanol than gasoline.

E85 can be an effective option to reduce gasoline use: Figure 4 illustrates that with a petroleum energy ratio of 0.1, ethanol produced from either corn or cellulose is an effective option to reducing petroleum fuel use. E85 and FFVs have the potential to be effective options for reducing petroleum fuel use compared to popular technologies, such as hybrid electric vehicles. EPA's fuel economy rating of the hybrid version of a popular compact car is 48 mpg compared to 34 mpg for the conventional car. At 11,000 miles per year,

that represents a gasoline savings of 94 gallons per year. A popular full-size truck FFV is rated by EPA at 15 mpg on gasoline and 12 mpg on E85. Operated on E85 for 11,000 miles, the FFV has the potential to save 477 gallons of gasoline per year. There are currently about 6 million E85 FFVs in the U.S. However, to realize the potential for petroleum fuel-use reduction, E85 infrastructure must be developed to become widely available to U.S. consumers.

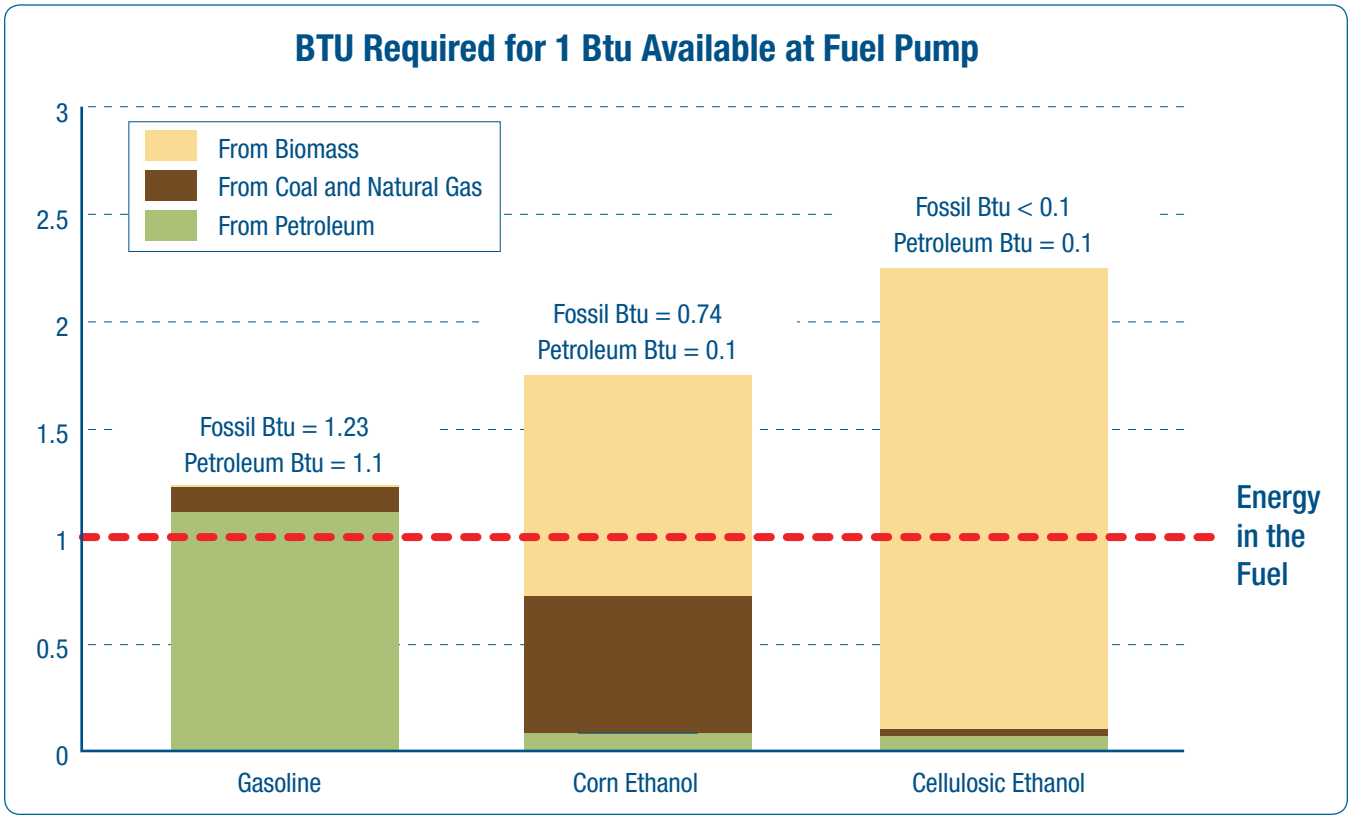

Figure 4. Energy Balance of Gasoline and E85, Argonne National Laboratory Center for Transportation Research, Michael Q. Wang

A viable near-term alternative to petroleum-based fuels is needed to address the anticipated growth in transportation energy demand. ExxonMobil estimates that alternative transportation fuels will be needed to supplement petroleum fuels. In addition, alternative fuels are needed to help address potential petroleum supply and price shocks due to geo-political and weather disruptions. Alternative fuels are also needed to address numerous policy initiatives aimed at reducing dependency on petroleum fuels. Since ethanol is a liquid fuel, it can be readily integrated with petroleum-based fuels and

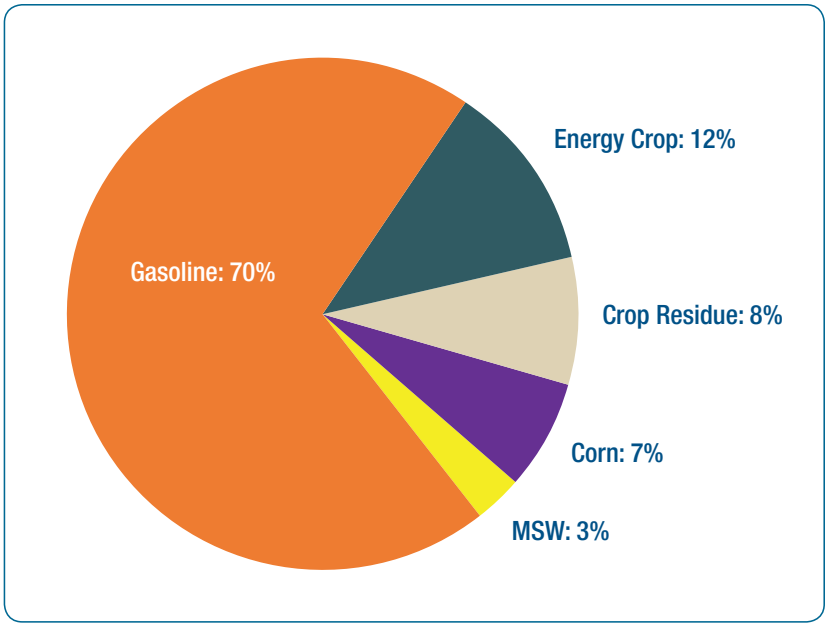

Figure 5. Practical Estimate of Potential U.S. Ethanol Portion of Light-Duty Vehicle Fuels (Year 2020), Based on Joint Research by University of Toronto, Heather MacLean and General Motors, 2005

infrastructure. It is estimated that ethanol from all sources has the potential to displace as much as 30% of U.S. petroleum fuel use in 15 to 20 years.[14] [15] [16]

E85 reduces greenhouse gas emissions: On a life-cycle basis, including fuel production and distribution, E85 made with corn ethanol reduces carbon dioxide (CO_2) emissions by approximately 20%. When E85 is made from cellulose materials, such as corn and wheat stalks or forestry waste, it can reduce greenhouse gases by 75%.

E85 reduces emissions of some regulated toxics: Exhaust emissions from the combustion of gasoline contain small amounts of regulated toxics, such as benzene and 1,3-butadiene. E85 reduces the emissions of these toxics substantially. While E85 acetaldehyde emissions are increased, the carcinogenicity of this regulated toxic is rated much lower.

E85 is an alternative fuel that can take advantage of existing infrastructure: Because E85 is a liquid fuel, only minor modifications are required to fuel dispensing stations to accommodate E85. This includes storage tanks, pumps, hoses, and dispensers, as described in the next section of this handbook. Ethanol is currently shipped to distribution terminals via trucks and rail cars. Due to ethanol's affinity for water, it is impractical to use existing petroleum fuel pipelines. However, in the future when larger quantities of ethanol are used, dedicated pipelines may be put in place to distribute the fuel to terminals for blending with gasoline.

Substantial modifications to conventional vehicles are necessary to provide E85 flexible-fuel capability. Modifications typically consist of fuel system material and component upgrades, as well as additional software, engine calibration, and engineering to meet emission, fuel economy, and performance requirements.

Limitations

The lower energy content of E85 reduces vehicle fuel economy and range. Due to the reduced energy content of ethanol, E85 can be expected to reduce vehicle fuel economy in miles per gallon by 23% to 28%. This means more frequent fills and about 25% less range on a tank of fuel. However, on a life-cycle basis including fuel production and distribution, E85 made with ethanol from corn can reduce fossil energy use by 40%.

E85 is not widely available: As of June 2010, there were just 2,052 U.S. stations that sold E85 compared to the latest count of about 162,000 conventional gasoline stations. Government and industry have worked to increase the number of E85 stations from essentially zero 10 years ago to the current number. Federal and state incentives are now available to help stimulate E85 infrastructure development. The successful establishment of several hundred E85 stations in Minnesota's Minneapolis-St. Paul metropolitan area has demonstrated the potential for E85 infrastructure growth in major U.S. cities.

Not all vehicles can use E85: Although there are almost 8 million E85 FFVs registered in the United States, this represents just 2% of the vehicle fleet. U.S.-based auto manufacturers continue to produce substantial numbers of FFVs.

Misfueling: As E85 becomes more widely available with attractive retail pricing, the risk that non-FFVs will be fueled with E85 will increase. Not only is this illegal, it may result in some short- and long-term vehicle fuel system component failures and driveability complaints. The risk of misfueling indicates the need for prominent signage at fueling stations and a large-scale public education program to properly inform consumers.

References

1 Well-to-Wheels Analysis of Advanced Fuel/Vehicle Systems: A North American Study of Energy Use, Greenhouse Gas Emissions, and Criteria Pollutant Emissions; Norman Brinkman, Michael Wang, Trudy Weber, Thomas Darlington; May 2005.

2 *www.crcao.com*. Coordinating Research Council; Recent Reports and Study Results, CRC Reports No. E-65-3 Fuel Permeation, No. E-67 Ethanol Effects on Exhaust Emissions, and Nos. E-79 and E-79-2 Study of E85 in the U.S.

3 *www.nrel.gov/docs/fy09osti/44040.pdf*. An Experimental and Modeling Study of the Flammability of Fuel Tank Headspace Vapors from High Ethanol Content Fuels, National Renewable Energy Laboratory, 2008.

4 *http://foodnfuel-ethanolrfa.bluestatedigital.com/page/-/rfa-association-site/Corrosion%20Inhibitor041910.pdf*. RFA.

5 *www.crcao.com*. Coordinating Research Council; Recent Reports and Study Results, CRC Reports No. E-85 National Survey of E85 Fuel Quality, No. E-65-3 Fuel Permeation, No. E-67 Ethanol Effects on Exhaust Emissions, and Nos. E-79 and E-79-2 Study of E85 in the U.S.

6 *www.afdc.energy.gov/afdc/ethanol/station_infrastructure.html*. AFDC Web site, E85 Infrastructure Development.

7 *www.phmsa.dot.gov*. DOT Pipeline and Hazardous Material Safety Administration, Office of Pipeline Safety

8 *www.iafc.org/displayindustryarticle.cfm?articlenbr=33678*. International Association of Fire Chiefs (IAFC), IAFC Partners with Ethanol Emergency Response Coalition.

9 www.ethanolrfa.org/documents/FireDVDOrderForm.pdf. Responding to Ethanol Incidents, RFA, DVD video order form.

10 *www.nfpa.org/categoryList.asp?categoryID=124&URL=Codes%20and%20Standards*. National Fire Protection Association.

11 *www.epa.gov/otaq/cert/dearmfr/cisd0602.pdf*. EPA Office of Transportation and Air Quality, alternative fuels manufacturer guidance letter for alternative fuel converters, February 3, 2006.

12 Fuel-Cycle Fossil Energy Use and Greenhouse Gas Emissions of Fuel Ethanol Produced from U.S. Midwest Corn, Argonne National Laboratory, Center for Transportation Research, Table IV-9, p 30.

13 *www.afdc.energy.gov/afdc/pdfs/technical_paper_feb09.pdf*. Effect of E85 on Tailpipe Emissions from Light-Duty Vehicles, Journal of the Air & Waste Management Association, 2009.

14 Biomass as Feedstock for a Bioenergy and Bioproducts Industry: The Technical Feasibility of a Billion-Ton Annual Supply, sponsored by DOE and the U.S. Department of Agriculture, Oak Ridge National Laboratory, April 2005.

15 Import Ethanol, Not Oil, Issues in Science and Technology; Lester B. Lave, W. Michael Griffin, p. 40-42, 2006.

16 *www.ethanolrfa.org/objects/pdf/outlook/RFA_Outlook_2007.pdf*. Ethanol Industry Outlook 2007, RFA.

Checklist for Installing E85 Dispensing Equipment or Converting Underground Storage Tanks

Dispensing Equipment

_____ Notify your licensed installer to review the applicable codes (generally NFPA 30A), then contact the local Authority Having Jurisdiction (AHJ), usually the building code office or local fire marshal to determine if there are any local code issues that should be addressed

_____ Notify the nearest fire department (and/or local first responders) that the site will soon be dispensing alcohol blended fuels. Verify that fire extinguishers and other on-site safety equipment (necessary to respond to leaks, spills, fires, etc.) are ethanol compatible.

_____ Use Underwriters Laboratories (UL) listed equipment or obtain a waiver from the local AHJ:

- Dispenser system (UL 87A)
- Fill hose and dispensing nozzle
- Emergency shut off valves
- Emergency breakaway devices
- Pumps
- Leak detection devices
- All other piping, equipment and materials must be approved by the manufacturer for its intended use

_____ Use a 5-10-micron alcohol-compatible dispenser filter. Do NOT use 10-micron gasoline or 30-micron diesel filters.

_____ Use ONLY an alcohol-compatible hose with E85.

_____ Use ONLY UL listed swivels, connectors, and nozzles with E85. Do NOT use aluminum gasoline nozzles.

_____ Calibrate the dispenser meter at time of conversion or new installation and two weeks later to verify meter accuracy with E85.

_____ Label dispenser with all E85 logos, cautionary, and trade commission decals. Use nozzle covers identifying E85 is not gasoline or diesel. Consider using hangtags, pump toppers, and other signage to educate your customers. Price sign inserts, curbside signs, and decals are available from industry associations.

_____ Train site operators and emergency response personnel responsible for this location on ethanol fuel safety procedures and the differences compared to gasoline.

Underground Tanks

_____ Notify your licensed installer and the state underground storage tank (UST) program of your intent to dispense E85. Your installer should determine if the age, composition, and condition of your tank and piping are safe for E85 use.

_____ Notify your UST insurance carrier to determine if it has additional requirements for E85 fuels.

_____ Obtain an amended insurance certificate showing coverage of E85 storage and dispensing. In the case of a conversion, clean the tank of all water and sediment. Ensure no water is present to protect the quality of your ethanol-blended fuels and your customers' vehicles (see API Publication 2015,

Checklist continued on next page.

Cleaning Petroleum Storage Tanks and NFPA 326, Standard for the Safeguarding of Tanks and Containers for Entry, Cleaning, or Repair, 199 Edition).

_____ Ensure all visible fittings and connections at the top of the tank are tight (no vapors escape and no water enters).

_____ Ensure the sump and spill containment covers will prevent water from entering the system. Identify the E85 fill port and paint the access cover according to API RP 1637. Make certain transport drivers cannot make fuel deliveries to the wrong fill pipe.

_____ As a precaution to address residual sludge and gum deposits that will be dissolved by ethanol, industry recommends the tank to be filled to 80% of capacity and kept as full as possible for seven to 10 days. The residual impurities will be more diluted in a larger quantity of E85 reducing the risk of vehicle problems. This practice is also likely to expose any problems related to sludge and gum deposits during the initial inspection period.

_____ Conduct a precision test of the tank system (0.1 gallon/hour leak rate) with an automatic tank gauging system within seven days after tank is filled to confirm the integrity of the system and that the leak detection equipment is operating properly. Report any "fail" results as required by the AHJ.

Maintenance

_____ Check for water regularly. Ensure that no water is contaminating your fueling system. If water is suspected or detected, track down its source and fix the problem immediately. The best way to guard against contamination is to properly clean and maintain the fueling system. Confirm no leaks exist in tank fill cap and containment reservoir before beginning your E85 operation. Water-detecting pastes, suitable for E85, may be available in the near future.

_____ If product seems to pump slowly, check and replace filters. Persistently clogged filters could indicate moisture or another source of contamination.

Information Resources

General

Alternative Fuels and Advanced Vehicles Data Center E85 Fleet Toolkit
www.eere.energy.gov/afdc/e85toolkit/

National Renewable Energy Laboratory
www.nrel.gov

U.S. Environmental Protection Agency
Office of Transportation and Air Quality
www.epa.gov/otaq/consumer/fuels/altfuels/altfuels.htm

California Air Resources Board
Fuels Programs
www.arb.ca.gov/fuels/fuels.htm

National Ethanol Vehicle Coalition
www.e85fuel.com

Renewable Fuels Association
www.ethanolrfa.org/

Governors' Ethanol Coalition
www.ethanol-gec.org

National Corn Growers Association
www.ncga.com

Ethanol Promotion and Information Council
www.epicinfo.org

American Coalition for Ethanol
www.ethanol.org

Clean Fuels Development Coalition
www.cleanfuelsdc.org

Ethanol Fuel Codes and Safety

Alternative Fuels and Advanced Vehicles Data Center E85 Fleet Toolkit
www.eere.energy.gov/afdc/e85toolkit/

National Fire Protection Association
www.nfpa.org

International Association of Fire Chiefs
www.iafc.org

Underwriters Laboratories
www.ul.com

Standards

ASTM International
www.astm.org

Underwriters Laboratories, Inc.
www.ul.com

U.S. Department of Transportation Pipeline and Hazardous Material Safety Administration
www.phmsa.dot.gov

Society of Automotive Engineers
www.sae.org

U.S. Environmental Protection Agency
Office of Transportation and Air Quality
www.epa.gov/otaq/consumer/fuels/altfuels/altfuels.htm

California Air Resources Board Fuels Programs
www.arb.ca.gov/fuels/fuels.htm

Alliance of Automobile Manufacturers
www.autoalliance.org

Equipment

Petroleum Equipment Institute
Ethanol Compatible Equipment Guide
www.pei.org/e85/

Fiberglass Tank and Pipe Institute
11150 South Wilcrest Dr., Suite 101
Houston, TX 77099-4343
www.fiberglasstankandpipe.com/

Flexible Fuel Vehicles

Alternative Fuels and Advanced Vehicles Data Center
www.eere.energy.gov/afdc/vehicles/flexible_fuel.html

National Ethanol Vehicle Coalition
Flexible Fuel Vehicle Listing
www.e85fuel.com/e85101/flexfuelvehicles.php?topic=For%20Fleets

Alliance of Automobile Manufacturers
www.autoalliance.org

Emissions

National Renewable Energy Laboratory
www.nrel.gov

Coordinating Research Council
www.crcao.com

U.S. Environmental Protection Agency
Office of Transportation and Air Quality
www.epa.gov/otaq/consumer/fuels/altfuels/altfuels.htm

California Air Resources Board Fuels Programs
www.arb.ca.gov/fuels/fuels.htm

Alliance of Automobile Manufacturers
www.autoalliance.org

Society of Automotive Engineers
www.sae.org

Appendix A: Geographical Fuel-Marketing Regions (ASTM D5798)

Geographical Fuel-Marketing Regions (ASTM D5798)												
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°	3	3	3	3/2	2	2/1	1	1	1/2	2/3	3	3
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	3	3	3	3/2	2	2/1	1	1/2	2	2/3	3	3
Upper	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 continued on next page.

Appendix A: Geographical Fuel-Marketing Regions (ASTM D5798)

Geographical Fuel-Marketing Regions (ASTM D5798) (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
Nevada - 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
New Mexico - 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
New York - 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
Oregon - 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
Pennsylvania - 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
Texas - 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
Washington - 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

Appendix B: Various Specifications for Fuel Ethanol, E85, and Denaturant

Table B1. Listing of ASTM Specifications for Ethanol and E85	
ASTM D4806	Standard Specification for Denatured Fuel Ethanol for Blending with Gasoline for Use as Automotive Spark-Ignition Engine Fuel
ASTM D5798	Standard Specification for Fuel Ethanol (Ed75-Ed85) for Spark-Ignition Engines
ASTM D7328	Standard Test Method for Determination of Total and Potential Inorganic Sulfate and Total Inorganic Chloride in Fuel Ethanol by Ion
ASTM D6423	Standard Test Method for Determination of pHe of Ethanol, Denatured Fuel Ethanol, and Fuel Ethanol (E75-E85)
ASTM D5501	Standard Test Method for Determination of Ethanol Content in Denatured Fuel Ethanol by Gas Chromatography
ASTM D4814	Standard Specification for Automotive Spark-Ignition Engine Fuel

ASTM D4806 standard sets guidelines for purity and other important properties for ethanol that is to be blended into gasoline. Major ethanol producers often establish additional guidelines that may exceed ASTM requirements. In addition, RFA has established specifications and quality standards for ethanol manufactured by its member companies (RFA Recommended Practice 911201). RFA Publication No. 96050117, "Fuel Ethanol: Industry Guidelines, Specifications and Procedures" also contains helpful information on fuel ethanol specifications.

Table B2. ASTM D4806 Standard Specification for Denatured Fuel Ethanol for Blending with Gasoline for Use as Automotive Spark-Ignition Engine Fuel		
Property	**Specification**	**ASTM Test Method**
Ethanol, volume %, min	92.1	D5501
Methanol, volume %, max	0.5	
Solvent-washed gum, mg/100 ml, max	5.0	D381
Sulfur, mass ppm, max	30	D6428, D5453, D2622
Water content, volume %, max	1.0	E203
Sulfate, mass ppm, max	4	D7318, D7319, D7328
Denaturant content, volume %, min volume %, max	1.96 5.0	
Inorganic chloride content, mass ppm (mg/L) max	40 (32)	D512
Copper content, mg/kg, max	0.1	D1688
Acidity (as acetic acid CH3C00H), mass% (mg/L), max	0.007 (56)	D1613
pHe	6.9–9.0	D6423
Appearance	visibly free of suspended or precipitated contaminants (clear & bright)	

Source: ASTM International Standards Worldwide, 100 Barr Harbor Dr., P.O. Box C700, West Conshohocken, PA, 19428, www.astm.org

Appendix B: Various Specifications for Fuel Ethanol, E85, and Denaturant

Table B3. California Denatured Ethanol Standards (In Addition to the Performance Requirements in ASTM D4806)		
Property	**Specification Limit**	**ASTM Test Method**
Sulfur, ppm max	10	D5453-93
Benzene, volume % max	0.006	D5580-95 test results of a sample of the denaturant multiplied by 0.0476
Olefins, volume % max	0.5	D6550-00 (modified) test results of a sample of the denaturant multiplied by 0.0476
Aromatics, volume % max	1.7	D5580-95 test results of a sample of the denaturant multiplied by 0.0476

California has promulgated additional specifications for denatured ethanol and the denaturant hydrocarbon that apply to ASTM D4806. The California Air Resources Board also plans to promulgate new specifications for E85 in 2008 in addition to ASTM D5798-99.

Table B4. California Denaturant Standards		
Property	**Specification Limit**	**ASTM Test Method**
Benzene, volume % max	1.1	D5580-95
Olefins, volume % max	10	D6550-00 (modified)
Aromatics, volume % max	35	D5580-95

Natural Gasoline Specifications and Test Methods

Scope: These specifications state the required properties of Natural Gasoline. Natural gasoline is a mixture of liquid hydrocarbons extracted from natural gas, composed principally of pentanes and heavier hydrocarbons, although varying amounts of butanes may be included, depending on the commercial grade.

Natural gasoline is defined further for commerical purposes by the following:

Product Characteristic	Specification	Test Method
Reid Vapor Pressure	10-34 pounds	ASTM D-323-82
Percentage evaporated at 140°F	25-85	ASTM D-216-77 (82)
Percentage evaporated at 275°F	not less than 90	ASTM D-216-77 (82)
End point	not more than 375°F	ASTM D-216-77 (82)
Corrosion	not more than classification 1	ASTM D-130-80 (modified)
Color	not less than plus 25 (Saybolt)	ASTM D-156-82
Reactive sulfur	Negative, "sweet"	GPA 1138

Source: Gas Processors Association, www.gasprocessors.com

Appendix B: Various Specifications for Fuel Ethanol, E85, and Denaturant

Table B5. Authorized Materials for Fuel Alcohol

Under 27 CFR 19.1005(b), the following materials are approved to render spirits unfit for beverage use and thus acceptable for withdrawal from alcohol fuel plants as fuel alcohol.

1. The materials listed in 27 CFR 19.1005(c), in the quantities specified there.

2. The following additional materials, in the following quantities, corresponding to the following specifications:

Material	Quantity Added to 100 Gallons of Distilled Spirits	Specifications
Natural gasoline	2 gallons or more	1. Natural gasoline (drip gas) is a mixture of butane, pentane, and hexane hydrocarbons extracted from natural gas. 2. Distillation range: No more than 10% of the sample may distill below 97° F.; at least 50% shall distill at or below 156° F.; and at least 90% shall distill at or below 209° F.
Ethyl tertiary Butyl ether (ETBE)	2 gallons or more	N/A
Raffinate	2 gallons or more	1. Octane (R+M/2): 66-70 2. Distillation, in Degrees F: - 10%: 120-150 - 50%: 144-180 - 90%: 168-200 - End Point: 216-285 3. API Gravity: 76-82 4. Reid Vapor Pressure: 5-11
Naphtha	2 gallons or more	1. API Gravity @ 60/60 Degrees F: 64-70 2. Lb/Gal: 5.845-6.025 3. Density: .7022-.7238 4. Reid Vapor Pressure: 8 P.S.I.A. Max. 5. Distillation, in Degrees F: - I.B.P.: 85 Max. - 10%: 130 Max. - 50%: 250 Max. - 90%: 340 Max. - End Point: 380 6. Copper Corrosion: 17. Sabolt Color: 28 Min.
Toluene	5 gallons or more	See 27 CFR 21.132

Source: U.S. Department of the Treasury Alcohol and Tobacco Tax and Trade Bureau, TTB.gov, www.ttb.gov/pdf/authorized_denaturants_fuel_alcohol.pdf

Material Safety Data Sheet

MSDS ID NO.: 0137SPE012
Revision date: 01/30/2004

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND THE COMPANY/UNDERTAKING

Product name: SSA E85
Synonyms: SSA ED75/ED85; E-75; E75; E-85; E85; Ethanol/Gasoline Fuel Blend; Fuel Ethanol ED75/ED85
Chemical Family: Gasoline/Ethanol
Formula: Mixture

Supplier:
Speedway/Superamerica LLC
P O BOX 1500
ENON OH 45501

Other information: 419-421-3070
Emergency telephone number: 877-627-5463

2. COMPOSITION/INFORMATION ON INGREDIENTS

E85 is a mixture of ethyl alcohol and gasoline that is approved for use in an automobile spark ignition engine. Can contain small amounts of dye and other additives (>0.02%) which are not considered hazardous at the concentrations used.

Product information

Name	CAS Number	Weight %	ACGIH Exposure Limits:	OSHA - Vacated PELs - Time Weighted Ave	Other:
SSA E85	Mixture	100			

Component Information

Name	CAS Number	Weight %	ACGIH Exposure Limits:	OSHA - Vacated PELs - Time Weighted Ave	Other:
Ethyl Alcohol	64-17-5	75-85	= 1000 ppm TWA	=1000 ppm TWA 1900 mg/m³ TWA	
Gasoline	Mixture	15-25	=300 ppm TWA; =500 ppm STEL		
Saturated Hydrocarbons	Mixture	008.3000 - 012.0000			
Aromatic Hydrocarbons	Mixture	003.0000 - 006.0000			
Xylene	1330-20-7	000.8000 - 002.3000	= 100 ppm TWA = 150 ppm STEL	= 100 ppm TWA = 150 ppm STEL = 435 mg/m³ TWA = 655 mg/m³ STEL	
Toluene	108-88-3	000.5000 - 002.3000	= 50 ppm TWA skin - potential for cutaneous absorption	= 100 ppm TWA = 150 ppm STEL = 375 mg/m³ TWA = 560 mg/m³ STEL	
Unsaturated Hydrocarbons	Mixture	000.2000 - 002.3000			
1,2,4-Trimethylbenzene	95-63-6	000.3000 - 000.7500	= 25 ppm TWA	= 125 mg/m³ TWA = 25 ppm TWA	
Benzene	71-43-2	000.1000 - 000.5000	= 0.5 ppm TWA = 2.5 ppm STEL skin - potential for cutaneous absorption	= 10 ppm TWA unless specified in 1910.1028 = 25 ppm Ceiling unless specified in 1910.1028 = 50 ppm STEL 10 min. unless specified in 1910.1028	OSHA Exposure Limit as specified in 1910.1028: =1.0 ppm TWA = 5 ppm STEL = 0.5 ppm Action Level
Ethyl Benzene	100-41-4	000.2000 - 000.5000	= 100 ppm TWA = 125 ppm STEL	= 100 ppm TWA = 125 ppm STEL = 435 mg/m³ TWA = 545 mg/m³ STEL	

Notes: The manufacturer has voluntarily elected to reflect exposure limits contained in OSHA's 1989 air contaminants standard in its MSDS's, even though certain of those exposure limits were vacated in 1992.

3. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW

THIS PRODUCT IS A CLEAR LIQUID WITH A STRONG HYDROCARBON ODOR. IT IS A VOLATILE AND EXTREMELY FLAMMABLE LIQUID THAT MAY CAUSE FLASH FIRES. KEEP AWAY FROM HEAT, SPARKS AND OPEN FLAME. CONTAINS BENZENE WHICH MAY CAUSE CANCER OR BE TOXIC TO BLOOD-FORMING ORGANS. NEVER SIPHON THIS PRODUCT BY MOUTH. IF SWALLOWED, THIS PRODUCT MAY GET SUCKED INTO THE LUNGS (ASPIRATED) AND CAUSE LUNG DAMAGE OR EVEN DEATH.

OSHA WARNING LABEL:

DANGER!
EXTREMELY FLAMMABLE.
ASPIRATION (INADVERTENT SUCTION) OF LIQUID INTO THE LUNGS CAN PRODUCE CHEMICAL PNEUMONIA OR EVEN DEATH.
CONTAINS BENZENE WHICH MAY CAUSE CANCER OR BE TOXIC TO BLOOD-FORMING ORGANS.

CONSUMER WARNING LABEL:

GASOLINE HEALTH AND SAFETY WARNING STATEMENT:

EXTREMELY FLAMMABLE, VAPORS MAY EXPLODE.
HARMFUL OR FATAL IF SWALLOWED.
LONG TERM EXPOSURE TO VAPORS HAS CAUSED CANCER IN LABORATORY ANIMALS.
KEEP FACE AWAY FROM NOZZLE WHILE FILLING.
KEEP NOZZLE AWAY FROM EYES AND SKIN.
NEVER SIPHON BY MOUTH.
DON'T OVERFILL TANK.
FOR USE AS A MOTOR FUEL ONLY.

STATIC ELECTRICITY, SPARK EXPLOSION, ELECTRONIC DEVICES WARNING:

DO NOT GET BACK IN YOUR VEHICLE WHILE REFUELING.
RE-ENTRY COULD CAUSE STATIC ELECTRICITY BUILD UP.
USE APPROVED CONTAINER.
PUT CONTAINER ON GROUND (NEVER ON OR IN A VEHICLE).
KEEP NOZZLE IN CONTACT WITH CONTAINER.
KEEP CELLULAR PHONES OR OTHER DEVICES IN YOUR VEHICLE DURING REFUELING.

Inhalation: Prolonged breathing of high ethanol vapor concentrations can produce headache, dizziness, nausea, incoordination and impaired vision. Excessive overexposure can cause central nervous system depression, loss of consciousness, liver damage and death resulting from respiratory failure.
Exposure to vapor concentrations of gasoline exceeding 1,000 ppm can cause respiratory irritation, headache, dizziness, nausea and loss of coordination. Higher concentrations may cause loss of consciousness, cardiac sensitization, coma and death resulting from respiratory failure.
Intentional overexposure to high concentrations of product vapors (such as huffing) can cause nervous system and brain damage, convulsions and sudden death from cardiac arrest.

Ingestion: Liquid ingestion can cause inebriation, headache, incoordination, gastrointestinal pain, nausea, and vomiting leading to central nervous system depression. Aspiration (inadvertent suction) of liquid into the lungs must be avoided as even small quantities in the lungs can produce chemical pneumonitis, pulmonary edema/hemorrhage and even death.

Skin contact: Prolonged and repeated liquid contact can cause defatting and drying of the skin and can lead to irritation and/or dermatitis.

Eye contact: Liquid may cause mild to severe irritation. Splash contact or high vapor concentrations can produce an immediate burning and stinging sensation.

Carcinogenic Evaluation:

Product information

Name	IARC:	NTP:	ACGIH - Carcinogens:	OSHA - Select Carcinogens:
SSA E85 Mixture	NE			

Notes:

The International Agency for Research on Cancer (IARC) has determined that there is inadequate evidence for the carcinogenicity of gasoline in humans. IARC determined that limited evidence of carcinogenicity in animals exists. IARC`s overall evaluation of gasoline, in spite of limited carcinogenicity evidence, has resulted in the IARC designation of gasoline as possibly carcinogenic to humans (Group 2B) because gasoline contains benzene.

IARC has determined that there is inadequate evidence for the carcinogenicity of gasoline engine exhaust in humans or animals. However, IARC`s overall evaluation on gasoline engine exhaust, in spite of the absence of carcinogenicity data, has resulted in the IARC designation of gasoline engine exhaust as possibly carcinogenic to humans (Group 2B) because of the presence of certain engine exhaust components.

The International Agency for Research on Cancer (IARC) has determined that there is sufficient evidence for the carcinogenicity of alcoholic beverages (ethanol) in humans (Group 1).

Component Information

Name	IARC:	NTP:	ACGIH - Carcinogens:	OSHA - Select Carcinogens:
Ethyl Alcohol 64-17-5	A2-Possible Human Carcinogen		A4 - Not Classifiable as a Human Carcinogen	
Xylene 1330-20-7			A4 - Not Classifiable as a Human Carcinogen	
Toluene 108-88-3			A4 - Not Classifiable as a Human Carcinogen	
Benzene 71-43-2	Supplement 7, 1987; Monograph 29, 1982	Known Carcinogen Reasonably Anticipated To Be A Carcinogen	A1 - Confirmed Human Carcinogen	Present
Ethyl Benzene 100-41-4	Monograph 77, 2000		A3 - Animal Carcinogen	

Notes:

The International Agency for Research on Cancer (IARC), the National Toxicology Program (NTP), and OSHA have determined that 1,3-butadiene is a chemical possibly carcinogenic to humans (Group 2B).

The International Agency for Research on Cancer (IARC) has concluded that ethyl benzene is possibly carcinogenic to humans (Group 2B).

4. FIRST AID MEASURES

Inhalation: If affected, move person to fresh air. If breathing is difficult, administer oxygen. If not breathing or if no heartbeat, give artificial respiration or cardiopulmonary resuscitation (CPR). Immediately call a physician. If symptoms or irritation occur with any exposure, call a physician.

Skin contact: Wash with soap and large amounts of water. Remove contaminated clothing. If symptoms or irritation occur, call a physician.

Ingestion: If swallowed, do not induce vomiting and do not give liquids. Immediately call a physician.

Eye contact: Flush eyes with large amounts of tepid water for at least 15 minutes. If symptoms or irritation occur, call a physician.

Medical conditions aggravated by exposure: Pre-existing eye, skin, respiratory, liver and/or kidney disorders may be aggravated by exposure to components of this product.
Pre-existing eye, skin, respiratory disorders and impaired liver function may be aggravated by overexposure to ethanol. Persons on disulfiram (antabuse) therapy should be aware that the ethyl alcohol in the product is hazardous to them just as is alcohol from any source. Disulfiram reactions (vomiting, headache and even collapse) may follow ingestion of small amounts of alcohol.

5. FIRE FIGHTING MEASURES

Suitable extinguishing media: For small fires, Class B fire extinguishing media such as CO2, dry chemical, foam (AFFF/ATC) or water spray can be used. For large fires, water spray, fog or foam (AFFF/ATC) should be attempted only by those ed and equipped with proper

Specific hazards: termined to be a flammable liquid mmunication Standard, and should Vapors may travel along the ntilation and ignited by many s, sparks, electric motors, static n sources at locations distant from material handling. Flashback can occur along vapor trail.
For additional fire related information, see NFPA 30 or the North American Emergency Response Guide 128.

Special protective equipment for firefighters: Avoid using straight water streams. Water may be ineffective in extinguishing low flash point fires, but can be used to cool exposed surfaces. Avoid excessive water spray application. Water spray and foam (AFFF/ATC) must be applied carefully to avoid frothing and from as far a distance as possible. Keep run-off water out of sewers and water sources.

Based on more recent testing of fire-fighting agents, these measures are no longer applicable. See page 16 of this handbook for more information.

Flash point:	-50 to 55 F
Autoignition temperature:	C.A. 495 F
Flammable limits in air - lower (%):	1.4 (Gasoline)
Flammable limits in air - upper (%):	19.0 (Ethanol)

NFPA rating:
Health: 1
Flammability: 3
Reactivity: 0
Other: -

HMIS classification:
Health: 1
Flammability: 3
Reactivity: 0
Special: *See Section 8 for guidance in selection of personal protective equipment.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions: Keep public away. Isolate and evacuate area. Shut off source if safe to do so. Eliminate all ignition sources. Advise authorities and National Response Center (800-424-8802) if substance has entered a watercourse or sewer. Notify local health and pollution control agencies, if appropriate. Contain liquid with sand or soil. Recover and return free product to proper containers. Use suitable absorbent materials such as vermiculite, sand, or clay to clean up residual liquids.

7. HANDLING AND STORAGE

Handling:

Comply with all applicable EPA, OSHA, NFPA and consistent state and local requirements. Use appropriate grounding and bonding practices. Store in properly closed containers that are appropriately labeled and in a cool well-ventilated area. Do not expose to heat, open flames, strong oxidizers or other sources of ignition. Do not cut, drill, grind or weld on empty containers since they may contain explosive residues. Avoid skin contact. Exercise good personal hygiene including removal of soiled clothing and prompt washing with soap and water.

For use as a motor fuel only. Product should never be used as a solvent due to its flammable and potentially toxic properties. Siphoning by mouth can result in lung aspiration which can be harmful or fatal.

Portable containers of 12 gallons (45 liters) or less should never be filled while they are in or on a motor vehicle or marine craft. Static electric discharge can ignite fuel vapors when filling non-grounded containers or vehicles on trailers. Containers should be placed on the ground. The nozzle spout must be kept in contact with the container before and during the entire filling operation. Use only approved containers. A buildup of static electricity can occur upon re-entry into a vehicle during fueling especially in cold or dry climate conditions. The charge is generated by the action of dissimilar fabrics (i.e., clothing and upholstery) rubbing across each other as a person enters/exits the vehicle. A flash fire can result from this discharge if sufficient flammable vapors are present. Therefore, do not get back in your vehicle while refueling. Cellular phones and other electronic devices may have the potential to emit electrical charges (sparks). Sparks in potentially explosive atmospheres (including fueling areas such as gas stations) could cause an explosion if sufficient flammable vapors are present. Therefore, turn off cellular phones and other electronic devices when working in potentially explosive atmospheres or keep devices inside your vehicle during refueling.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

PERSONAL PROTECTIVE EQUIPMENT

Engineering measures:	Local or general exhaust required in an enclosed area or with inadequate ventilation.
Respiratory protection:	Approved organic vapor chemical cartridge or supplied air respirators should be worn for exposures to any components exceeding the TLV or STEL. Observe respirator protection factor criteria cited in ANSI Z88.2. Self-contained breathing apparatus should be used for fire fighting.
Skin and body protection:	Use nitrile rubber, viton or PVA gloves for repeated or prolonged skin exposure.
Eye protection:	No special eye protection is normally required. Where splashing is possible, wear safety glasses with side shields.
Hygiene measures:	No special protective clothing is normally required. Select protective clothing depending on industrial operations. Use mechanical ventilation equipment that is explosion-proof.

9. PHYSICAL AND CHEMICAL PROPERTIES:

Appearance:	Clear Liquid
Physical state (Solid/Liquid/Gas):	Liquid
Substance type (Pure/Mixture):	Mixture
Color:	Clear or Colored
Odor:	Hydrocarbon
Molecular weight:	Not determined.
pH:	Neutral
Boiling point/range:	90-437 F
Melting point/range:	Not determined.
Decomposition temperature:	Not applicable.
Specific gravity:	0.70-0.77
Density:	5.9-6.3 lbs/gal
Bulk density:	No data available.
Vapor density:	No data available.
Vapor pressure:	43-776 mm Hg @ 100 F
Evaporation rate:	No data available.

Solubility:	Appreciable
Solubility in other solvents:	No data available.
Partition coefficient (n-octanol/water):	No data available.
VOC content(%):	100%
Viscosity:	No data available.

10. STABILITY AND REACTIVITY

Stability:	The material is stable at 70 F, 760 mm pressure.
Polymerization:	Will not occur.
Hazardous decomposition products:	Combustion produces carbon monoxide, aldehydes, aromatic and other hydrocarbons.
Materials to avoid:	Strong oxidizers such as nitrates, chlorates, peroxides.
Conditions to avoid:	Excessive heat, sources of ignition, open flame.

11. TOXICOLOGICAL INFORMATION

Acute toxicity:

Product information

Name	CAS Number	Inhalation:	Dermal:	Oral:
SSA E85	Mixture	No data available	n/a	n/a

Lifetime inhalation studies with full vaporized gasoline (67, 292 and 2,056 ppm) produced kidney damage and kidney tumors in male rats but not in female rats or male and female mice. Female mice developed a slightly higher incidence of liver tumors compared to controls at the highest exposure level. Results from separate studies with compounds producing similar effects, i.e., 1,4-dichlorobenzene and perchloroethylene, have shown that the kidney damage and kidney tumors develop via the formation of alpha-2u-globulin, a mechanism unique to the male rat. Humans do not form alpha-2u-globulin, therefore, tumors resulting from this mechanism are not relevant in humans. The biologic significance of the mouse liver tumor response with regard to human health risk is questionable.

This product may contain ethanol or ethyl alcohol at a concentration of >0.1% Intentional abuse, misuse or other massive exposure to ethanol may result in multiple organ damage and/or death. Chronic ingestion of large amounts of ethanol can cause cancer and damage to the liver, kidney, heart, brain, nervous system and stomach. Ethyl alcohol ingestion during pregnancy can adversely affect the unborn child. Studies in laboratory animals involving prolonged and repeated exposures have resulted in such effects as embryotoxicity, immunotoxicity and teratogenicity. Mutagenic effects have been reported in both in vitro and in vivo systems but usually at high dosages.

Summary of health effect information on gasoline engine exhaust:

Combustion of gasoline produces gases and particulates which include carbon monoxide, carbon dioxide, oxides of nitrogen and/or sulfur and hydrocarbons. Significant exposure to carbon monoxide vapors decreases the oxygen carrying capacity of the blood and may cause tissue hypoxia via formation of carboxyhemoglobin. Overexposure to CO can cause headache, nausea, nervous system depression, coma and death.

Summary of Health Effect Data on ED75/ED85 Components.

This product contains benzene at a level of >0.1%. Repeated or prolonged exposure to benzene at concentrations in excess of the TLV may cause serious injury to blood-forming organs. Significant chronic exposure to benzene vapor has been reported to produce various blood disorders ranging from anemia to certain forms of leukemia (cancer) in man. Benzene produced tumors in rats and mice in lifetime chronic toxicity studies, but the response has not been consistent across species, strain, sex or route of exposure. Animal studies on benzene have demonstrated immune toxicity, chromosomal aberrations, testicular effects and alterations in reproductive cycles and embryo/fetotoxicity, but not teratogenicity.

The product contains >1.0% ethyl benzene (EB). Rats and mice exposed to 750 ppm EB for 6 hours/day, 5 days/week for two years developed kidney tumors in male and femmale rats and lung tumors in male mice and liver tumor in female mice.

12. ECOLOGICAL INFORMATION

Ecotoxicity effects:

Product can cause fouling of shoreline and may be harmful to aquatic life in low concentrations. This product does not concentrate or accumulate in the food chain.

The aquatic toxicity of gasoline is as follows:

FreshwaterToxicity:
LD50 is 8 ppm at 96 hours in bluegill.
TLM is 90 ppm at 24 hours in juvenile shad.

SaltwaterToxicity:
LC50 is 2 ppm at 96 hours in mullet.
LD50 is 1.5 ppm at 96 hours in grass shrimp.
LC50 is 2 ppm at 96 hours in menhaden.
TLM is 91 ppm at 24 hours in juvenile shad.

13. DISPOSAL CONSIDERATIONS

Cleanup Considerations:

This product as produced is not specifically listed as an EPA RCRA hazardous waste according to federal regulations (40 CFR 261). However, when discarded or disposed of, it may meet the criteria of an "ignitable" hazardous waste (D001). This product could also contain benzene at >0.5 ppm and could exhibit the characteristics of "toxicity" (D018) as determined by the toxicity characteristic leaching procedure (TCLP). This material could become a hazardous waste if mixed or contaminated with a hazardous waste or other substance(s). It is the responsibility of the user to determine if disposal material is hazardous according to federal, state and local regulations.

14. TRANSPORT INFORMATION

49 CFR 172.101:

DOT:

Transport Information: This material when transported via US commerce would be regulated by DOT Regulations.

Proper shipping name:	Alcohols, N.O.S.
UN/Identification No:	UN 1987
Hazard Class:	3
Packing group:	II
DOT reportable quantity (lbs):	Not applicable.

TDG (Canada):

Proper shipping name:	Alcohols, N.O.S.
UN/Identification No:	UN 1987
Hazard Class:	3
Packing group:	II
Regulated substances:	Not applicable.

15. REGULATORY INFORMATION

Federal Regulatory Information:

US TSCA Chemical Inventory Section 8(b):	This product and/or its components are listed on the TSCA Chemical Inventory.
OSHA Hazard Communication Standard:	This product has been evaluated and determined to be hazardous as defined in OSHA's Hazard Communication Standard.

EPA Superfund Amendment & Reauthorization Act (SARA):

SARA Section 302: This product contains the following component(s) that have been listed on EPA's Extremely Hazardous Substance (EHS) List:

Name	CERCLA/SARA - Section 302 Extremely Hazardous Substances and TPQs
Ethyl Alcohol	NA
Gasoline	NA
Saturated Hydrocarbons	NA
Aromatic Hydrocarbons	NA
Xylene	NA
Toluene	NA
Unsaturated Hydrocarbons	NA
1,2,4-Trimethylbenzene	NA
Benzene	NA
Ethyl Benzene	NA

SARA Section 304: This product contains the following component(s) identified either as an EHS or a CERCLA Hazardous substance which in case of a spill or release may be subject to SARA reporting requirements:

Name	CERCLA/SARA - Hazardous Substances and their Reportable Quantities
Ethyl Alcohol	NA
Gasoline	NA
Saturated Hydrocarbons	NA
Aromatic Hydrocarbons	NA
Xylene	= 100 lb final RQ = 45.4 kg final RQ
Toluene	= 0.454 kg final RQ = 1 lb final RQ = 10 lb final RQ = 100 lb final RQ = 1000 lb final RQ = 4.54 kg final RQ = 45.4 kg final RQ = 454 kg final RQ
Unsaturated Hydrocarbons	NA
1,2,4-Trimethylbenzene	NA
Benzene	= 0.454 kg final RQ = 0.454 kg statutory RQ = 1 lb final RQ = 1 lb statutory RQ = 10 lb final RQ = 10 lb final RQ receives an adjustable RQ of 10 lbs based on potential carcinogenicity in August 14, 1989 final rule = 100 lb final RQ = 4.54 kg final RQ = 4.54 kg final RQ receives an adjustable RQ of 10 lbs based on potential carcinogenicity in August 14, 1989 final rule = 45.4 kg final RQ
Ethyl Benzene	= 100 lb final RQ = 1000 lb final RQ = 45.4 kg final RQ = 454 kg final RQ

SARA Section 311/312: The following EPA hazard categories apply to this product:

Acute Health Hazard.
Chronic Health Hazard.
Fire Hazard.

SARA Section 313: This product contains the following component(s) that may be subject to reporting on the Toxic Release Inventory (TRI) From R:

Name	CERCLA/SARA 313 Emission reporting:
Ethyl Alcohol	None
Gasoline	None
Saturated Hydrocarbons	None
Aromatic Hydrocarbons	None
Xylene	= 1.0 percent de minimis concentration
Toluene	= 1.0 percent de minimis concentration
Unsaturated Hydrocarbons	None
1,2,4-Trimethylbenzene	= 1.0 percent de minimis concentration
Benzene	= 0.1 percent de minimis concentration
Ethyl Benzene	= 0.1 percent de minimis concentration

State and Community Right-To-Know Regulations:
The following component(s) of this material are identified on the regulatory lists below:

Ethyl Alcohol

Louisiana Right-To-Know:	Not Listed
California Proposition 65:	developmental toxicity (when in alcoholic beverages); initial date 10/1/87
New Jersey Right-To-Know:	sn 0844
Pennsylvania Right-To-Know:	Present
Massachusetts Right-To Know:	Teratogen
Florida substance List:	Not Listed.
Rhode Island Right-To-Know:	Toxic, Flammable
Michigan critical materials register list:	Not Listed.
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	flammable - third degree
New Jersey - Environmental Hazardous Substances List:	Not Listed
Illinois - Toxic Air Contaminants	Not Listed
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	Not Listed

Gasoline

Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	Not Listed.
Pennsylvania Right-To-Know:	Not Listed.
Massachusetts Right-To Know:	Not Listed.
Florida substance List:	Not Listed.
Rhode Island Right-To-Know:	Not Listed
Michigan critical materials register list:	Not Listed.
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Not Listed
New Jersey - Environmental Hazardous Substances List:	Not Listed
Illinois - Toxic Air Contaminants	Not Listed
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	Not Listed

Saturated Hydrocarbons

Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	Not Listed.

Pennsylvania Right-To-Know:	Not Listed.
Massachusetts Right-To Know:	Not Listed.
Florida substance List:	Not Listed.
Rhode Island Right-To-Know:	Not Listed
Michigan critical materials register list:	Not Listed.
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Not Listed
New Jersey - Environmental Hazardous Substances List:	Not Listed
Illinois - Toxic Air Contaminants	Not Listed
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	Not Listed

Aromatic Hydrocarbons

Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	Not Listed.
Pennsylvania Right-To-Know:	Not Listed.
Massachusetts Right-To Know:	Not Listed.
Florida substance List:	Not Listed.
Rhode Island Right-To-Know:	Not Listed
Michigan critical materials register list:	Not Listed.
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Not Listed
New Jersey - Environmental Hazardous Substances List:	Not Listed
Illinois - Toxic Air Contaminants	Not Listed
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	Not Listed

Xylene

Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	sn 2014
Pennsylvania Right-To-Know:	environmental hazard
Massachusetts Right-To Know:	Present
Florida substance List:	Not Listed.
Rhode Island Right-To-Know:	Toxic, Flammable
Michigan critical materials register list:	Annual usage threshold = 100 pounds (all isomers)
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	flammable - third degree
New Jersey - Environmental Hazardous Substances List:	SN 2014
Illinois - Toxic Air Contaminants	Present
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	= 1 lb Land/Water RQ = 1,000 lbs Air RQ

Toluene

Louisiana Right-To-Know:	Not Listed
California Proposition 65:	developmental toxicity; initial date 1/1/91
New Jersey Right-To-Know:	sn 1866
Pennsylvania Right-To-Know:	environmental hazard
Massachusetts Right-To Know:	Present
Florida substance List:	Not Listed.
Rhode Island Right-To-Know:	Toxic, Flammable; skin
Michigan critical materials register list:	Annual usage threshold = 100 pounds
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	flammable - third degree
New Jersey - Environmental Hazardous Substances List:	SN 1866
Illinois - Toxic Air Contaminants	Present
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	= 1 lb Land/Water RQ = 1,000 lbs Air RQ

Unsaturated Hydrocarbons

Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	Not Listed.
Pennsylvania Right-To-Know:	Not Listed.
Massachusetts Right-To Know:	Not Listed.
Florida substance List:	Not Listed.
Rhode Island Right-To-Know:	Not Listed
Michigan critical materials register list:	Not Listed.
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Not Listed
New Jersey - Environmental Hazardous Substances List:	Not Listed
Illinois - Toxic Air Contaminants	Not Listed
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	Not Listed

1,2,4-Trimethylbenzene

Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	sn 1929 sn 2716
Pennsylvania Right-To-Know:	[present] environmental hazard
Massachusetts Right-To Know:	Present
Florida substance List:	Not Listed.
Rhode Island Right-To-Know:	Toxic
Michigan critical materials register list:	Not Listed.
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Not Listed

New Jersey - Environmental Hazardous Substances List:	SN 2716
Illinois - Toxic Air Contaminants	Present
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	Not Listed

Benzene

Louisiana Right-To-Know:	Not Listed
California Proposition 65:	carcinogen; initial date 2/27/87 developmental toxicity; initial date 12/26/97 male reproductive toxicity; initial date 12/26/97
New Jersey Right-To-Know:	sn 0197
Pennsylvania Right-To-Know:	environmental hazard; special hazardous substance
Massachusetts Right-To Know:	Carcinogen; Extraordinarily hazardous
Florida substance List:	Not Listed.
Rhode Island Right-To-Know:	Toxic, Flammable, Carcinogen; skin
Michigan critical materials register list:	Annual usage threshold = 100 pounds
Massachusetts Extraordinarily Hazardous Substances:	carcinogen; extraordinarily hazardous
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	[present]
New Jersey - Special Hazardous Substances:	carcinogen; flammable - third degree; mutagen
New Jersey - Environmental Hazardous Substances List:	SN 0197
Illinois - Toxic Air Contaminants	Present
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	= 1 lb Land/Water RQ = 10 lbs Air RQ

Ethyl Benzene

Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	sn 0851
Pennsylvania Right-To-Know:	environmental hazard
Massachusetts Right-To Know:	Present
Florida substance List:	Not Listed.
Rhode Island Right-To-Know:	Toxic, Flammable
Michigan critical materials register list:	Not Listed.
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	flammable - third degree
New Jersey - Environmental Hazardous Substances List:	SN 0851
Illinois - Toxic Air Contaminants	Present
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	= 1 lb Land/Water RQ = 1,000 lbs Air RQ

Canadian Regulatory Information:

Canada DSL/NDSL Inventory:	This product and/or its components are listed either on the Domestic Substances List (DSL) or the Non Domestic Substance List (NDSL).

Name	Canada - WHMIS: Classifications of Substances:	Canada - WHMIS: Ingredient Disclosure:
Ethyl Alcohol	B2; D2B	0.1% (English Item 684, French Item 805)
Xylene	B2; D2A; D2B	
Toluene	B2; D2A	1% (English Item 1578, French Item 1622)
1,2,4-Trimethylbenzene	B3	0.1% (English Item 1640, French Item 1684) 1% (English Item 1638, French Item 1682)
Benzene	B2; D2A	0.1% (English Item 153, French Item 277)
Ethyl Benzene	B2; D2A; D2B	0.1% (English Item 697, French Item 854)

16. OTHER INFORMATION

Additional Information: No data available.

Prepared by: Craig M. Parker Manager, Toxicology and Product Safety

The information and recommendations contained herein are based upon tests believed to be reliable. However, Speedway SuperAmerica (SSA) does not guarantee their accuracy or completeness nor shall any of this information constitute a warranty, whether expressed or implied, as to the safety of the goods, the merchantability of the goods, or the fitness of the goods for a particular purpose. Adjustment to conform to actual conditions of usage maybe required. SSA assumes no responsibility for results obtained or for incidental or consequential damages, including lost profits arising from the use of these data. No warranty against infringement of any patent, copyright or trademark is made or implied.

End of Safety Data Sheet

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.

Note: This method is appropriate for field testing only. If you need to test ethanol content for regulatory compliance, refer to D5501 within ASTM D5798.

Procedure for Testing Hydrocarbon Percent of Ethanol Fuel Samples Based on SAE International Paper 912421

Equipment for E85 testing

VWR Scientific phone # 800-932-5000

50 mL pipettes; Cat. # 52966-217	pack of 12/$212.18
Safety Bulb; Cat. # 53497-202	pack of 3/$18.45
100 mL cylinders; Cat. # 24762-117	pack of 4/$120

Procedure

- 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 less than 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).

Calculation

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

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

Appendix D continued on next page.

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

Procedure for Testing Conductivity of Ethanol Fuel Samples Based on ASTM D1125

Sampling

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.

Note: The scope and precision of the following method is not approved for fuels containing ethanol. It has, however, been applied to determine conductivity in these fuels. ASTM is working to develop an approved test for this purpose.

Equipment for conductivity testing

VWR Scientific phone # 800-932-5000

Conductivity Meter and gold plated dip cell. Cat # 23198-013 $380

Dip cell Cat. # 23198-016 $90

250 mL disposable polypropylene beaker Cat. # 13915-566 50/$20.30

Calibration and setup

Regularly calibrate the instrument according to manufacturer's specification 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 laid 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 give the units of uS/m.

Appendix E: EPA Memorandum to State Air Directors Concerning Removal of Stage II Vapor Recovery with E85 Dispensers *(page 1 of 5)*

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

DEC 12 2006

OFFICE OF
AIR QUALITY PLANNING
AND STANDARDS

MEMORANDUM

SUBJECT: Removal of Stage II Vapor Recovery in Situations Where Widespread Use of Onboard Refueling Vapor Recovery is Demonstrated

FROM: Stephen D. Page, Director
Office of Air Quality Planning and Standards

Margo Tsirigotis Oge, Director
Office of Transportation and Air Quality

TO: Regional Air Division Directors

The purpose of this memorandum is to provide guidance to States concerning the removal of Stage II gasoline vapor recovery systems where States demonstrate to EPA that widespread use of onboard refueling vapor recovery (ORVR) has occurred in specific portions of the motor vehicle fleet. The specific fleets addressed here include:

1. initial fueling of new vehicles at automobile assembly plants
2. refueling of rental cars at rental car facilities
3. refueling of flexible fuel vehicles at E85 dispensing pumps

Background

Stage II vapor recovery systems are required to be used at gasoline dispensing facilities located in serious, severe, and extreme non-attainment areas for ozone under section 182(b)(3) of the Clean Air Act (CAA). States have included these control measures in their federally-approved state implementation plans (SIPs) in the form of generally applicable regulatory requirements governing all gasoline dispensing facilities that exceed the relevant gasoline dispensing throughput criteria. However, section 202(a)(6) of the CAA allows EPA to revise or waive the section 182(b)(3) Stage II requirement for these ozone non-attainment areas after the Agency determines that ORVR is in widespread use throughout the motor vehicle fleet.

CAA section 202(a)(6) does not specify which motor vehicle fleet must be the subject of a widespread use determination before EPA may revise or waive the section 182(b)(3) Stage II requirement. Nor does the CAA identify what level of ORVR use in the motor vehicle fleet must be reached before it is "widespread." EPA expects the possibility of

different rates of the implementation of ORVR across different geographic regions and among different types of motor vehicle fleets within any region. Given this, EPA does not believe that CAA section 202(a)(6) must be read narrowly to allow a widespread use determination and waiver of the Stage II requirement for a given area or area's fleet only if ORVR use has become widespread throughout the entire United States, or only if ORVR use has reached a definite level in each area. Rather, EPA believes that section 202(a)(6) allows the Agency to apply the widespread use criterion to either the entire motor vehicle fleet in a State or non-attainment area, or to special segments of the overall fleet for which ORVR use is shown to be sufficiently high, and to base widespread use determinations on differing levels of ORVR use, as appropriate. Moreover, a single national rulemaking is not needed to grant such a waiver for a specific area. Instead, EPA believes that the Act allows the Agency to use an area-specific rulemaking approving a SIP revision to issue the section 202(a)(6) waiver for a relevant fleet in a non-attainment area, where a State meets the recommended criteria discussed below.

Various metrics have been studied for demonstrating widespread use of ORVR in motor vehicle fleets. One metric focuses on the percentage of vehicles in service that are ORVR-equipped. Based on our preliminary analysis, this metric seems to track fairly closely with the percentage of vehicle miles traveled (VMT) from ORVR-equipped vehicles, and with the percentage of gasoline sold which is dispensed to ORVR-equipped vehicles. In fact, since newer vehicles tend to be driven more miles than older models, VMT traveled by ORVR-equipped vehicles and gasoline dispensed to ORVR-equipped vehicles may exceed 95 percent in a 95 percent ORVR-equipped fleet.

Another metric that EPA considered is when VOC emissions resulting from the application of ORVR controls alone equal the VOC emissions when both Stage II vapor recovery systems and ORVR controls are used, after accounting for incompatibility excess emissions. The incompatibility excess emissions factor relates to losses in control efficiency when certain types of Stage II and ORVR are used together. Studies conducted in three northeastern states indicate that when the percentages of motor vehicles in service with ORVR, vehicle miles traveled by ORVR-equipped vehicles, or gasoline dispensed to ORVR-equipped vehicles are above 95 percent, then the widespread use metric based on comparable VOC emissions will likely have been reached. For this reason, EPA believes that if 95 percent of the vehicles in a fleet have ORVR, then widespread use will likely have been demonstrated.

1. Initial Fueling at Automobile Assembly Plants

Based on our preliminary analysis, EPA expects that if a State's submission of a SIP revision shows that 95 percent of the new vehicles fueled at an automobile assembly plant are equipped with ORVR, and that this level of ORVR use would not decrease, the Agency can determine that widespread use of ORVR has been achieved for the fleet of motor vehicles that are fueled at that facility.

Since model year 2000, all passenger cars have been required to have ORVR. Also since 2006, all light duty trucks, SUVs and medium duty vehicles are required to be equipped

with ORVR. There may be a few situations, such as the chassis for motorized mobile homes, which still do not have ORVR. However, the number of these would be small. It is apparent that at most automobile assembly plants greater than 95 percent of the vehicles manufactured would have ORVR. Many assembly plants manufacture 100 percent ORVR equipped vehicles. Only such new vehicles are expected to be fueled at the automobile assembly plants.

States desiring to remove the Stage II requirement for these facilities would need to submit a SIP revision that EPA would evaluate through notice and comment rulemaking. The SIP would need to demonstrate that the widespread use benchmark has been achieved and provide assurance that any facility wishing to remove Stage II equipment maintains its eligibility for its motor vehicle fleet. Any EPA SIP approval would also be subject to the CAA section 110(l) requirement that the revision not interfere with any applicable requirement concerning attainment and reasonable further progress, or any other requirement of the CAA.

2. Refueling of Rental Cars at Rental Car Facilities

Similarly, EPA expects that if a SIP revision submission demonstrates that 95 percent of the vehicles in an automobile rental fleet refueling at a rental car facility are equipped with ORVR and that this level of ORVR use would not decrease, then widespread use of ORVR could be found for the motor vehicle fleet refueling at that facility. Most large rental car companies rent current model vehicles that would all have ORVR. There may be truck rental companies which have older vehicles which do not have ORVR and that would not be able to demonstrate widespread use of ORVR for their fleets. As discussed above, any SIP revision would be subject to CAA section 110(l) and other applicable requirements, and State and local agencies should consider any potential transportation conformity impacts if Stage II is currently included in a SIP's on-road motor vehicle emissions budget.

3. Refueling Flexible Fuel Vehicles at E85 Dispensing Pumps

E85 is a motor vehicle fuel that is a blend of as little as 15 percent gasoline and up to 85 percent ethanol. (In wintertime applications, the ratio may be 30 percent gasoline and 70 percent ethanol.) Ethanol is ethyl alcohol, a type of alcohol which can be produced from renewable resources such as corn. Based on the agency's survey of existing SIPs, EPA believes that most States have defined "gasoline" (for purposes of controlling emissions of VOC from refueling activities) to include gasoline/alcohol blends that have the same volatility as E85. EPA's guidance for States in developing their Stage II SIPs in the early 1990s suggested that States use the same definition of "gasoline" as the one found in EPA's Standards of Performance for Bulk Gasoline Terminals at 40 C.F.R. 60.501, which includes "any petroleum distillate or petroleum distillate/alcohol blend having a Reid vapor pressure of 27.6 kilopascals (kPa) or greater which is used as a fuel for internal combustion engines." EPA recommended using this definition to most broadly reach situations in which refueling of motor vehicles results in evaporative VOC emissions that contribute to ozone non-attainment concentrations, and to avoid a narrow interpretation of what is "gasoline" that

would allow significant VOC emissions from motor vehicle refueling activities in non-attainment areas to go uncontrolled.

E85 can only be used in specially designed flexible fuel vehicles (FFVs), which have mostly been manufactured since 1998. Since these are newer vehicles, most of them are equipped with ORVR, and every FFV built today has ORVR. Thus, most vehicles refueling at E85 dispensing pumps are already having their evaporative emissions captured, as in the cases of late model rental cars refueling at rental car facilities and newly manufactured cars being fueled for the first time at automobile assembly plants. EPA estimates that 59 percent of FFVs in current use are equipped with ORVR. The percentage of FFVs with ORVR will continue to climb as older vehicles are taken out of service and new models join the fleet. Across different ozone non-attainment areas and between States, these percentages may vary.

EPA believes that encouraging the use of E85 as a motor vehicle fuel reduces emissions of other air pollutants such as CO and benzene, a known human carcinogen, and reduces emissions of greenhouse gases. In addition, based on available information, the Agency is concerned that there is currently a lack of certified Stage II equipment for E85 (which may require different materials of construction than conventional Stage II equipment), and that the timing for when certified E85-compatible equipment will become widely available is uncertain. This may unnecessarily hinder E85 distribution in areas that now require Stage II.

Unlike in the cases of automobile assembly plants and rental car facilities, EPA is not recommending a specific percentage of the FFV fleet that should have ORVR before widespread use could be determined. This is because most E85 compatible vehicles are already equipped with ORVR and this percentage is increasing over time, whereas for automobile assembly plants and car rental facilities very high percentages of ORVR use have in most cases already been reached and are not expected to further increase significantly. The general use of ORVR in FFVs, instead, is expected to significantly increase, as are the miles driven by and amount of fuel dispensed to recent ORVR-equipped FFVs compared to those manufactured before 2000 without ORVR.

Moreover, we believe that in determining whether widespread use of ORVR has been demonstrated, it is reasonable under section 202(a)(6) to consider the VOC emissions impacts of removing Stage II, and that those impacts may inform the percentage of ORVR-equipped vehicles that would need to be achieved for a specific motor vehicle fleet or in a specific non-attainment area. EPA expects that the air quality impact of allowing E85 refueling facilities to operate without Stage II controls would likely be minimal in most non-attainment areas. FFVs currently comprise about 2 percent of the total US fleet. Non-ORVR FFVs are less 1 percent of the total U.S. vehicle fleet. EPA estimates that non-ORVR FFVs participate in only about 0.5 percent of all refueling events. Furthermore, because of the relatively small number of stations that offer E85 (around 1,000 out of 170,000 total refueling stations) EPA believes that very few of these non-ORVR refueling events actually occur at E85 pumps.

Considering the factors discussed above, if an area can demonstrate that any increase in emissions caused by operating E85 fueling facilities without Stage II controls is so small as to clearly not interfere with attainment of the ozone standard or reasonable further progress or any other applicable CAA requirement, then EPA expects it could find that ORVR is in widespread use for FFVs when refueling at E85 facilities in this area. These areas could then allow E85 facilities to operate without Stage II controls, after modifying their SIPs such that E85 is not included within the definition of "gasoline" for purposes of Stage II vapor recovery controls (or after taking other necessary SIP revision action). As discussed above, States would need to submit SIP revisions affecting this change to their current Stage II SIPs, which EPA would evaluate through notice and comment rulemaking, subject to the provisions of CAA section 110(l). In addition, State and local agencies should consider if there are any transportation conformity impacts related to removing Stage II, if emissions reductions from Stage II are included in a SIP's on-road motor vehicle emissions budget. Due to the expected rapid growth of E85 installations, EPA will explore the development of ways to expedite the SIP revision process for States which are dealing with the E85 issue.

General Exclusions from Widespread Use Determinations

States in the ozone transport region (OTR) are still required to apply Stage II, or a comparable measure, in all areas under 184(b)(2) of the CAA. This requirement is not affected by any widespread use determination or waiver of the section 182(b)(3) requirement granted under section 202(a)(6). For the independent section 184(b)(2) "comparable measure" requirement to not prevent an appropriate removal of Stage II controls, OTR States may want to revisit their previously approved comparable measure SIPs to consider substituting available non-Stage II measures for the Stage II controls they currently require.

Also, some States have chosen to add Stage II vapor recovery system requirements in their SIPs for ozone nonattainment areas that are classified in a category lower than "serious." While it is not necessary for States to demonstrate ORVR is in widespread use in moderate or cleaner ozone non-attainment areas, a revision of previously adopted SIP requirements to specifically waive Stage II requirements in such areas would need to comply with the provisions of CAA section 110(l) and, as described above, consider any transportation conformity impacts as applicable.

This guidance for widespread use determinations for special sectors would not necessarily apply to widespread use determinations for the general motor vehicle fleet. Within the overall motor vehicle fleet, the rate of penetration of ORVR-equipped vehicles has not advanced at the same rapid rates as for the fleets discussed in this memorandum. EPA is still considering the possible criteria for determining widespread use for the general fleet.

Appendix F: UL E85 Fuel Dispensing Certified Equipment List

UL E85 Fuel Dispensing Certified Equipment List		
Manufacturer	**Equipment**	**Model**
Dresser Wayne	Dispensing Device	Model G620, with or without prefix E, followed by 1, 2 or 3, followed by D, with or without one or more of the following suffixes 5, 7A, 7B, 8, G, J, K, M, or Z, with or without one or more of the following suffixes A, B, C, F, H, J, M1 or W1
Dresser Wayne	Dispensing Device	Model G520, with or without prefix E, followed by 1, 2 or 3, followed by D, with or without one or more of the following suffixes 5, 7A, 7B, 8, G, J, K, M, or Z, with or without one or more of the following suffixes A, B, C, F, H, J, M1 or W1
Dresser Wayne	Dispensing Device	Model G610 with or without prefix E/, followed by 1, followed by D, with or without one or more of the following suffixes 7A, 7B, 8, J, K, or Z, with or without one or more of the following suffixes J, W1, S, S1 or S2
Dresser Wayne	Dispensing Device	Ovation Series, Model E, followed by R, followed by 1 or 2, followed by 1 or 2, followed by 1, followed by 1 or 2, followed by 1 or 2, followed by 0, followed by D, followed by 0, 1, 2 or 3, may be followed by one or more of the following option codes C, D, E, H, I, J, K, L, N, P, S, T, X, 6 or 7
Dresser Wayne	Backflow check/ pressure relief valve	WM11531-0001
Dresser Wayne	Meter	2PM-6E, with or without suffixes
Dresser Wayne	Meter	WM015802-0006
Gilbarco	Dispensing Device	Encore Series 300, Model N followed by A, followed by 0, 1, 2 or 3
Gilbarco	Dispensing Device	Encore Series 500, Model N followed by A, followed by 0, 1, 2 or 3
Gilbarco	Dispensing Device	Encore Series 550, Model N followed by A, followed by 0, 1, 2 or 3
Gilbarco	Dispensing Device	Encore Series 300, Model N followed by G, followed by 0, 1 or 6
Gilbarco	Dispensing Device	Encore Series 500, Model N followed by G, followed by 0, 1 or 6
Gilbarco	Dispensing Device	Encore Series 550, Model N followed by G, followed by 0, 1 or 6
Gilbarco	Dispensing Device	Encore Series 500, Model N followed by J, followed by 0 or 2
Gilbarco	Dispensing Device	Encore Series 550, Model N followed by J, followed by 0 or 2
Gilbarco	Dispensing Device	Encore Series 300, Model N followed by L or N, followed by 0, 1, 2 or 3
Gilbarco	Dispensing Device	Encore Series 300, Model N followed by L, followed by 8
Gilbarco	Dispensing Device	Encore Series 500, Model N followed by L, followed by 8
Gilbarco	Dispensing Device	Encore Series 550, Model N followed by L, followed by 8
Gilbarco	Dispensing Device	Encore Series 500, Model N followed by L or N, followed by 0, 1, 2 or 3
Gilbarco	Dispensing Device	Encore Series 550, Model N followed by L or N, followed by 0, 1, 2 or 3
Gilbarco	Dispensing Device	Encore Series 300, Model N followed by P3, P4 or P5
Gilbarco	Dispensing Device	Encore Series 300, Model N followed by B followed by 0, 1, 2, 3 or 4
Gilbarco	Dispensing Device	Encore Series 500, Model N followed by B followed by 0, 1, 2, 3 or 4
Gilbarco	Dispensing Device	Encore Series 550, Model N followed by B followed by 0, 1, 2, 3 or 4
Gilbarco	Dispensing Device	Encore Series 300, Models N followed by F followed by 0, 1, or 2

Manufacturer	Equipment	Model
Gilbarco	Dispensing Device	Encore Series 500, Models N followed by F followed by 0, 1, or 2
Gilbarco	Dispensing Device	Encore Series 550, Models N followed by F followed by 0, 1, or 2
Gilbarco	Dispensing Device	Encore Series 300, Models N followed by M followed by 0, 1, 2, or 3
Gilbarco	Dispensing Device	Encore Series 500, Models N followed by M followed by 0, 1, 2, or 3
Gilbarco	Dispensing Device	Encore Series 550, Models N followed by M followed by 0, 1, 2, or 3
Gilbarco	Check Valve Assembly	N23619-G4
Veyance	Hose Assembly	Flexsteel Futura Ethan-all
OPW Fuelng Components	Breakaway	OPW66V-0492
OPW Fuelng Components	Swivel Connector	241TPS-0492
OPW Fuelng Components	Hose Nozzle Valve	21GE
OPW Fuelng Components	Hose Nozzle Valve	21GE-A
OPW Fuelng Components	Shear Valves	10P-0152E85
OPW Fuelng Components	Shear Valves	10P-4152E85
Franklin Fueling	Submersible Turbine Pump	Basic Model designation STP with or without T, with AG, with or without F, with or without H, with or without R, with or without V, with or without W, with or without K, followed by 33, 75, 150, 200, VS2 or VS4, may be followed by A or B or C, followed by -XXX, where X is any numeric character or VL1, VL2 or VL3, followed by two characters
Franklin Fueling	Submersible Turbine Pump	Basic Model designation IST or IST VS4 with or without T, with AG, with or without F, with or without R, with or without V, with or without W, with or without K, with or without M, followed by 1, 2, 3, VL1, VL2 or VL3, followed by two characters
UL E85 Material Designation (not a finished part)		
Manufacturer	**Equipment**	**Model**
Dygert Peck	Gasket and Seal	V9701 (Viton A) for dynamic applications
Dygert Peck	Gasket and Seal	V9702 (Viton B) for static and dynamic applications
Dygert Peck	Gasket and Seal	V9703 (Viton GF) for static and dynamic applications
Dygert Peck	Gasket and Seal	V9704 (Viton GFLT) for static and dynamic applications
Fusion Inc	Gasket and Seal	V9701 (Viton A) for dynamic applications
Fusion Inc	Gasket and Seal	V9702 (Viton B) for static and dynamic applications
Fusion Inc	Gasket and Seal	V9703 (Viton GF) for static and dynamic applications
Fusion Inc	Gasket and Seal	V9704 (Viton GFLT) for static and dynamic applications
GE Mao Rubber Industrial Co	Gasket and Seal	N7060AA (Nitrile Thermoset Rubber) for static and dynamic applications
International Seal Co	Gasket and Seal	V121 (Fluorocarbon) for static and dynamic applications
International Seal Co	Gasket and Seal	V123 (Fluorocarbon) for static and dynamic applications

Manufacturer	Equipment	Model
Parco Inc.	Gasket and Seal	9131-75 (Fluorocarbon) for static and dynamic applications
Parco Inc.	Gasket and Seal	9124-65 (Fluorocarbon) for static and dynamic applications
Parco Inc.	Gasket and Seal	9167-60 (Fluorocarbon) for static and dynamic applications
Parco Inc.	Gasket and Seal	1932-75 (Fluorosilicone) for static applications only
Parker Hannifin	Gasket and Seal	V1163-75 (Fluorocarbon) for static and dynamic applications
Parker Hannifin – O-ring Div	Gasket and Seal	N0497-70 (Nitrile) for static and dynamic applications
Parker Hannifin – O-ring Div	Gasket and Seal	N1500-75 (Nitrile) for static and dynamic applications
Parker Hannifin – O-ring Div	Gasket and Seal	V1163-75 (Fluorocarbon) for static and dynamic applications
Parker Hannifin – O-ring Div	Gasket and Seal	V1263-75 (Fluorocarbon) for static and dynamic applications
Parker Hannifin – O-ring Div	Gasket and Seal	L1120-70 (Fluorosilicone) for static and dynamic applications
Parker Hannifin – O-ring Div	Gasket and Seal	V1436-75 (Silicone) for static and dynamic applications
Parker Hannifin – Seals Div	Gasket and Seal	VG273-75 (Fluorocarbon) for static and dynamic applications

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