NCPCM
North Carolina Petroleum & Convenience Marketers
Fueling North Carolina's Future

7300 Glenwood Avenue
Raleigh, North Carolina 27612
Phone 919-782-4411
Web site: www.ncpcm.org

The intent of this document is to provide information to NCPCM Petroleum Marketing Industry members. It will not serve as engineering design, permit approvals, construction documents, and equipment approvals or for any other purpose.

USE OF BIOFUELS AS AN ALTERNATIVE MOTOR FUEL

Timothy Laughlin, P.E.
Technical Affairs Director

United States Energy Policy Acts (EPACT) of 2005 & 2007

2005 U.S. Energy Independence & Security Act -Biofuel provisions

- **The Energy Policy Act of 2005 (Pub.L. 109-058) is a statute that was passed by the United States Congress on July 29, 2005, and signed into law by President George W. Bush on August 8, 2005.**
- **Increases the amount of biofuel (usually ethanol & soy oils) that must be mixed with gasoline/diesel sold in the United States to triple the current requirement (7.5 billion gallons by 2012).**

2007 U.S. Energy Independence & Security Act -Biofuel provisions

- **Signed Dec 19 2007, sets Renewable Fuel Standard (RFS) requiring fuel producers to use at least 36 Billion gallons of biofuel in 2022.**
- **Nine (9) Billion gallons for 2008 and 15.2 Billion gallons by 2011, up from the current level of about 6 Billion gallons. Approximately 16 Billion gallons will come from cellulosic biofuels (ethanol made from renewable biomass).**
- **Requires DOE, USDA, EPA to study effects of biofuels on grains, livestock, food, energy, forest products.**
- **Prohibits franchise agreements from restricting sale of renewable fuels.**
- **Requires the development of federal renewable fuel infrastructure grant program-covering up to 33% of costs for installing dispensers/tank.**

The nation's gasoline supply must include 7.76 percent renewable fuel content in 2008, according to an Environmental Protection Agency (EPA). The agency said it is increasing the renewable fuel standard to comply with the new minimum of nine billion gallons of renewable fuel that the United States must use in 2008 under the Energy Independence and Security Act signed into law in December 2007. The law increases the overall volume of renewable fuels that must be blended each year, reaching 36 billion gallons in 2022. While the Energy Independence and Security Act requires a "substantial change" in the 2008 standard, the EPA believes that the required renewable production capacity will come on line this year. In addition, EPA said that at current oil prices, it expects the volume of renewable fuel required by the new law for 2008 to be used economically.

Sustained high world oil prices and the passage of the Energy Policy ACTs of 2005 and 2007 have encouraged the use of agriculture-based ethanol and biodiesel in the transportation sector; however, both the continued growth of the biofuels industry and the long-term market potential for biofuels depend on the resolution of critical issues that influence the supply of and demand for biofuels. For each of the major biofuels—corn-based ethanol, cellulosic ethanol, and biodiesel—resolution of technical, economic, and regulatory issues remains critical to further development of biofuels in the United States.

US EPA 40 CFR PART 112 REGULATIONS (SPCC SPILL PLANS) ON BIOFUELS STORED IN ABOVEGROUND STORAGE TANKS (ASTS).

Ethanol rated as 200 proof or 100% ethyl alcohol is excluded from US EPA 40 CFR parts 112 "Spill Prevention Control and Countermeasure" (SPCC) regulations. However, if the ethanol is denatured, and if the denaturant is gasoline or other "oils" then that tank is regulated and must have an SPCC Plan prepared by a registered engineer. If a facility uses gasoline as the denaturant, which is defined as a "petroleum oil" in 40 CFR Part 112.2, then the "storage capacity" defined in Part 112.2 is "the shell capacity of the container." Therefore, any containers used to store oil or fluids that include oil would need to be considered when determining whether a facility's overall oil storage capacity exceeds the SPCC or FRP applicability threshold.

In summary, once the determination is made that oil at a facility could reasonably be expected to be discharged to navigable water in quantities that may be harmful then, because gasoline is an oil; tanks storing ethanol denatured gasoline are oil tanks and the shell capacity of such tanks must be included in the facility's total oil storage capacity when determining applicability under 40 CFR Part 112, including the SPCC and/or FRP requirements.

For B-100 or other Biodiesel Blends: Under 40 CFR Part 112 Subpart C—Requirements for Animal Fats and Oils and Greases (AFVO), and Fish and Marine Mammal Oils; and for Vegetable Oils, including Oils from Seeds, Nuts, Fruits, and Kernels. All AFVO's regardless if neat or blends must have an SPCC Plan prepared by registered engineer. If AFVO is stored in USTs, and is over 42,000 gallons (aggregate capacity) and is not regulated by 40 CFR 280 or a State program under 40 CFR 281, than this facility would have to prepare an SPCC Spill Plan.

INTERNATIONAL FIRE CODES (IFC) ON BIOFUEL FACILITIES

All biofuel installations at a minimum must comply with:

CHAPTER 22 SERVICE STATIONS AND REPAIR GARAGES:

- **Refers to facilities that dispenser biofuels to motor vehicles.**

CHAPTER 27 HAZARDOUS MATERIALS - GENERAL PROVISIONS:

- **Refers to facilities that store biofuels in bulk for retailing, blending, production or refining.**

CHAPTER 34 FLAMMABLE AND COMBUSTIBLE LIQUIDS:

- **Refers to facilities that store biofuels in bulk for retailing, blending, production or refining.**

Neat Ethanol or blends of gasoline/ethanol is considered a Class I Flammable Liquid. B-100 is considered a Class IIIB Combustible Liquid. Other blends of biodiesel (B-2, B-5, and B-20) are considered a Class II Combustible Liquid.

BIODIESEL

The following is summarized from *Biodiesel Handling and Use Guidelines*, Second Edition, March 2006, US Department of Energy, DOE/GO-102006-2288 web link at: http://www.nrel.gov/vehiclesandfuels/npbf/pdfs/40555.pdf

Biodiesel is a renewable fuel manufactured from vegetable oils, animal fats, and/or recycled cooking oils. Biofuel means any commercially produced liquid or gaseous fuel that is derived from agricultural crops or residues or from forest products or byproducts as distinct from petroleum or other fossil carbon sources.

Biodiesel may be used either alone or in blends with conventional gasoline or diesel fuels to propel motor vehicles or may be used in whole or in part to fire heating devices or any stationary power device. Biodiesel is gaining popularity because of these characteristics:

- **Renewable, domestic product**
- **Displace petroleum derived diesel fuel**
- **Can be used in most diesel equipment with no modifications or only minor modifications**

- **Can reduce global warming gas emissions**
- **Can reduce tailpipe emissions with slight increase of Nitrogen Oxides (NOxs)**
- **Nontoxic and biodegradable**
- **High flashpoint and low volatility so it does not ignite as easily as petrodiesel**

Biodiesel in its pure form is B100 but is available in various blends with petroleum diesel. The most common blend is B20 which is 20 percent biodiesel and 80 percent petro diesel. It is also used in smaller percentages of 1% to 2% (B1 or B2) as a lubricating (lubricity) fuel additive. Although many people use the term *biodiesel* only

Note that biodiesel is not limited to the use of diesel engines. Biodiesel can be use for heating as well. Biodiesel is a diesel replacement fuel that is manufactured from vegetable oils, recycled cooking greases or oils, or animal fats. Because plants produce oils from sunlight and air, and can do so year after year on cropland, these oils are renewable. Animal fats are produced when the animal consumes plant oils and other fats, and they too are renewable. Used cooking oils are mostly made from vegetable oils, but may also contain animal fats. Used cooking oils are both recycled and renewable. The biodiesel manufacturing process converts oils and fats into chemicals called long chain mono alkyl esters, or biodiesel. These chemicals are also referred to as fatty acid methyl esters or FAME.

In the manufacturing process, 100 pounds of oils or fats are reacted with 10 pounds of a short chain alcohol (usually methanol) in the presence of a catalyst (usually sodium or potassium hydroxide) to form 100 pounds of biodiesel and 10 pounds of glycerin. Glycerin is a sugar, and is a co-product of the biodiesel process.

The American Society for Testing and Materials (ASTM) specification for B100 (pure biodiesel) in the United States is D6751-06e1 and/or D6751-02a. Any biodiesel used in the United States must meet ASTM D6751-06e1 and/or 02a standard.

The definition of biodiesel within ASTM D6751 describes long chain fatty acid esters from vegetable or animal fats that contain only one alcohol molecule on one ester linkage. Raw or refined vegetable oils contain three ester linkages and are therefore not legally B100 biodiesel. Biodiesel can be made from methyl, ethyl, isopropyl, and other alcohols, but most biodiesel research focuses on methyl esters and virtually all commercial production in the United States today uses methyl esters. Some research has occurred on ethyl esters (biodiesel produced with ethanol as the alcohol rather than methanol), however higher ethanol prices relative to methanol, lower ethyl ester conversions, and the difficulty of recycling excess ethanol internally in the process, have hampered ethyl ester production in the commercial marketplace.

Raw or refined vegetable oil, or recycled greases that do not meet the specifications of ASTM D6751 do not meet the definition of biodiesel. This is very important to anyone seeking to claim a tax credit for the use or sale of biodiesel.

The chemicals likely to be involved in the various chemical processes used to make or store biodiesel include the following:

- **Methanol (Very flammable & toxic with Flash Point of 52° F.)**
- **Ethanol-Other Alcohols**
- **Sodium Hydroxide**
- **Potassium Hydroxide**
- **Phosphoric Acid**
- **Vegetable Oil Petroleum Based Oils: Such as Diesel, #1 heating oil, #2 heating oil, and others**
- **Glycerin**

Biodiesel is a renewable-based diesel substitute with commercial markets in the United States. Biodiesel is composed of mono-alkyl esters of long-chain fatty acids derived from vegetable oils or animal fats. It is similar to distillate fuel oil (diesel fuel) and can be used in the same applications, but it has different chemical, handling, and combustion characteristics. Biodiesel can be blended with petroleum diesel in any fraction and used in compression-

ignition engines, so long as the fuel system that uses it is constructed of materials that are compatible with the blend. The high lubricity of biodiesel helps to offset the impact of adopting US EPA's Ultra Low-Sulfur Diesel (ULSD).

Common blends of biodiesel are 2 percent, 5 percent, and 20 percent (B2, B5, and B20). Individual engine manufacturers determine which blends are warranted for use in their engines, but generally B5 blends are permissible and some manufacturers support B20 blends. Blends of biodiesel are distributed at stations throughout the United States. Some States have mandated levels of biodiesel use when in-State production reaches prescribed levels.

Predominant feedstocks for biodiesel production are soybean oil in the United States, rapeseed and sunflower oil in Europe, and palm oil in Malaysia. Biodiesel also can be produced from a variety of other feedstocks, including vegetable oils, tallow and animal fats, and restaurant waste and trap grease.

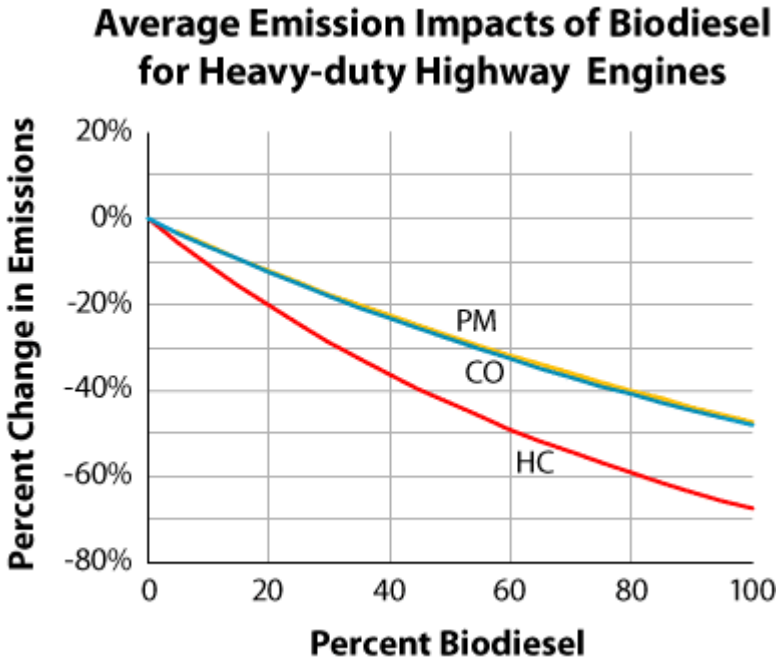
To produce biodiesel, raw vegetable oil is chemically treated in a process called transesterification. The properties of the biodiesel (cloud point, pour point, and cetane number) depend on the type of feedstock used. Crude glycerin, a major byproduct of the reaction, usually is sold to the pharmaceutical, food, and cosmetic industries.

Raw or refined vegetable oil, or recycled greases that do not meet the specifications of ASTM D6751 do not meet the definition of biodiesel. This is very important to anyone seeking to claim a tax credit for the use or sale of biodiesel. See Page 17 for more on Federal Tax Credits.

BIO DIESEL EMISSIONS VS. CONVENTIONAL DIESEL

From US DOE Alternative Fuels Data Center; http://www.afdc.energy.gov/afdc/

Analysis completed by the Environmental Protection Agency (EPA) in 2002 compiled the most robust data set on biodiesel tailpipe emissions from heavy-duty engines. The findings were published in A Comprehensive Analysis of Biodiesel Impacts on Exhaust Emissions (PDF File Here), a report that analyzes data from 39 studies. It concludes that biodiesel decreases emissions of particulate matter (PM), carbon monoxide (CO), and hydrocarbons (HC) commensurately with its blend level, as shown in the figure below.



Source: EPA 2002

Later studies show that biodiesel particulate matter (PM) emissions are not only reduced but are less toxic. These studies are analyzed in Impact of Biodiesel Fuels on Air Quality and Human Health (PDF File Here), which concluded that the PM from B100 (100% biodiesel) and B20 (20% biodiesel, 80% diesel) is 20% and 5%, respectively, less toxic than PM from diesel.

EPA's study also found a slight increase in NO_x emissions (2% for B20). However, Effects of Biodiesel Blends on Vehicle Emissions (PDF File Here), published by the National Renewable Energy Laboratory (NREL), presented data and analysis suggesting that B20 has no net impact on oxides of nitrogen (NO_x) emissions. This study attributes EPA's reported increase to a dataset that was not adequately representative of all on-highway engines. The following table combines EPA's results with those of NREL.

These and nearly all other diesel and biodiesel emissions studies do not include evaporative emissions. This is because an inconsequential amount of these fuels evaporates due to their extremely low Reid vapor pressure.

Average Heavy-Duty Emission Impact of B20 Relative to Average Conventional Diesel	
Air Pollutant	**Percent Change for B20**
NO_x	0.0
PM	-10.1
Carbon Monoxide	-11.0
Hydrocarbons	-21.1

By providing more corn and soy bean products, supports the agriculture communities of the United States.

- **Reduction of Carbon Dioxide**

When used as a fuel, studies have indicates that growing corn and soy beans overall reduces carbon dioxide emissions

- **Land Use and Productivity**

With a limited supply of cropland available for biofuel feedstocks, increasing yield (bushels per acre) on an annual basis could significantly boost available supplies of corn and soybeans without requiring additional land.

BIO DIESEL BLENDING EXAMPLE:

Have 10,000 gallons of B-20 Bio Diesel and 30,000 gallons of conventional diesel fuel. I want to blend to achieve 30,000 gals. of B-5 Bio Diesel.
Using ratios the amount of soy oil in my end blend is 5% x 30,000 gals. = 1500 gallons of soy oil & 28,500 gallons of conventional diesel.
Therefore I need to start with a B-20 blend that has 1500 gallons of soy—
1,500 gals. = B20 x 20% or 1500/0.20 = 7,500 gals. of B20 Blend needed.
30,000 gals B5 – 7,500 gals B20 = 22,500 gals. conventional diesel needed.
CHECK:
(7,500 gals B20 – 1,500 gals Soy Oil) + 22,500 conventional diesel = 28,500gals. conventional diesel which checks with our original B5 blend of 30,000 gallons.

ETHANOL

Excerpts From: FUEL ETHANOL, Industry Guidelines, Specifications, and Procedures Renewable Fuels Association, One Massachusetts Ave. NW, Suite 820, Washington DC 20001: Phone: (202) 289-3835, Website: http://www.ethanolrfa.org/

In the transportation sector, ethanol is the most widely used liquid biofuel in the world. In the United States, nearly all ethanol is blended into gasoline at up to 10 percent by volume to produce a fuel called E10 or "gasohol." E-85 a 15% blend of conventional gasoline with 85% ethanol is also growing in market share with more E-85 approved vehicles in the market. E10 fuel is widely available in many States, while E85 has limited availability, at stations clustered mostly in the mid-western States.

Ethanol can be produced from any feedstock that contains plentiful natural sugars or starch that can be readily converted to sugar. Popular feedstocks include sugar cane (Brazil), sugar beets (Europe), and maize/corn (United States). Ethanol is produced by fermenting sugars. Corn grain is processed to remove the sugar in wet and dry mills (by crushing, soaking, and/or chemical treatment), the sugar is fermented, and the resulting mix is distilled and purified to obtain anhydrous ethanol. Major byproducts from the ethanol production process include dried distillers' grains and solubles, which can be used as animal feed. On a smaller scale, corn gluten meal, gluten feed, corn oil, CO_2, and sweeteners are also byproducts of the ethanol production process used in the United States.

With additional processing, plants (switch grass) and other biomass residues (including urban wood waste, forestry residue, paper and pulp liquors, and agricultural residue) can be processed into fermentable sugars. Such potentially low-cost resources could be exploited to yield significant quantities of fuel-quality ethanol, generically termed "cellulosic ethanol." Cellulose in biomass can be broken down into fermentable sugars by either acid or enzymatic hydrolysis. The main byproduct, lignin, can be burned for steam or power generation. Alternatively, biomass can be converted to synthesis gas (hydrogen and carbon monoxide) and made into ethanol by the Fischer-Tropsch process or by using specialized microbes.

Currently, no large-scale cellulosic ethanol production facilities are operating or under construction. There are Federal and private financial incentives that provide R&D for bringing the first cellulosic ethanol production facilities on line between 2010 and 2015, with a total capacity of 250 million gallons per year. Cellulosic ethanol currently is not cost-competitive with gasoline or corn-based ethanol, but considerable R&D by the National Renewable Energy Laboratory and its partners has significantly reduced the estimated cost of enzyme production. Although technological breakthroughs are inherently unpredictable, further significant successes in R&D could make cellulosic ethanol a viable economic option for expanded ethanol production in the future. Some have speculated that when R&D break outs are achieve, cellulosic ethanol can be produce for about a $1.00 per gallon.

Cellulosic biomass from switchgrass, hybrid willow and poplar trees, agricultural residues, and other sources has significant supply potential, possibly up to 4 times the potential of corn. Switchgrass and poplars could be grown on poor crop lands, where corn/soy beans cannot be grown economically.

Not to be discussed in this paper, critics have pointed to a number of drawbacks that have been associated with ethanol production from corn, more so than biodiesel.

- **Resource Utilization and Land Availability**

Currently, corn and soybean feedstocks for biofuels are grown almost exclusively on prime agricultural land in the Midwest.

- **Crop Competition**

Competition will favor those crops most profitable for farmers, accounting for such factors as growing region, farming practice, and soil type. Currently, corn and soybeans are competitive energy crops, and also used as food/meal crops.

- **Role of Co-products in Biofuel Economics**

The value of co-products will play a significant role in determining which crops are most profitable for farmers to grow and biofuel producers to use.

- **Market Effects of Biofuel Growth**

The feedstocks used to produce biofuels currently make up only 15 percent of available crop matter and are located at the end of a long agricultural supply chain.

- **Biofuel Distribution Infrastructure**

Another issue that could limit the growth of the U.S. biofuels industry is development of the necessary infrastructure for collecting, processing, and distributing large volumes of biofuels to urban centers where most of the fuel would be consumed. Biofuel pipelines are currently in the planning, construction and testing phases.

- **Consumer Demand, Awareness, and Attitudes**

Biofuel production capacity is expanding rapidly in response to heightened market demand resulting from high petroleum prices, favorable tax incentives, and consumer concerns over environmental and energy security issues. The market potential for biofuel blends (E10, B5, and B20) remains significantly larger than current production levels and will continue to absorb the biofuel supply for the foreseeable future

- **Availability of Biofuel Vehicles**

The long-term market potential for biofuels will also depend on the availability of light-duty vehicles capable of using rich biofuel blends.

- **Energy Density of Bio Fuels**

The discussion over energy density of bio-fuels versus conventional petroleum motor fuels is still hotly debated. (more is this on page 7)

- **Market Effects of Government Policy**

Federal and State government policy and regulation of biofuels will affect the development of the biofuels industry, both now and in the future.

Of course pro arguments exist for the expanded use of biofuels.

- **The geo-political argument**

Energy independence from countries that use their energy resources as blackmail to advance their unfriendly US agendas.

- **Benefits the United States Farmer**

BIOFUEL CHEMICAL CHARACTERISTICS

Property	Denatured ETHANOL[1]	E-10 Gasoline	SOY OIL (B-100)	B-20 SOY Bio-Diesel
Octane R+M/2	112.5	87.5	Cetane=56	Cetane=49
Oxygen wt%	33%	3.5%	11.1%	2.4%
Reid Vapor Pressure psi[2]	2.3	8.2-13.0	±0.04	±0.04
Energy Content btus/gallon	±78,000 (average)	±112,650 (average)	118,170 LHV	127,259 LHV
Boiling Point ºF End BP	152-174	385	±658	± 675
Density #/gal @ 60ºF	6.58	6.13	7.34	7.14
Water Content Vol.% Max	0.01%	0.01%	0.05%	0.05%
Sulfur	10 ppm	30 ppm average	15 ppm	15 ppm (ULSD)
Flash Point ºF[3]	55ºF	-40±ºF	635-645ºF	±302ºF

TABLE NOTES:

1) Denatured refers to the required "poisoning" of ethanol before it leaves the production plant. Typically, this is done by blending in 3% to 5% gasoline to ensure fuel ethanol is not consumed by humans.

2) The vapor pressure of ethanol is lower than that of gasoline. However, the addition of ethanol to gasoline, especially at lower concentrations, can actually increase the vapor pressure of the mixture to greater than that of gasoline.

3) At low temperature (32°F), E-85 vapor is more flammable than gasoline vapor. However at normal temperatures, E-85 vapor is less flammable than gasoline, because of the higher autoignition temperature of E-85. Ethanol vapors are heavier than air and disperse rapidly. Flashpoint for E85= -20 to -4° F, Considerations: Pure Ethanol (Upper Explosive Limit (UEL)=19% Lower Explosive Limit (LEL)=3.3%) and E85 (UEL=19% LEL=1.4%) have a wider range of flammability than gasoline (UEL=7.7% LEL=1.4%) and gasoline has a lower flash point (SEALED CONTAINERS/TANKS WITH E-85 MAY EXPLODED IF IGNITION OCCURS)

US EPA GASOLINE VOLATILITY REID VAPOR PRESSURE (RVP) REGULATIONS

It should also be noted that the US EPA in accordance with the Clean Air Act Amendments of 1990, published a final rule on December 12, 1991, which provides that, to qualify for the one (1) psi allowance, summertime gasoline must contain denatured, anhydrous ethanol. The concentration of ethanol, excluding the required denaturing agent, must be at least 9% and no more than 10% (by volume) of the gasoline. See 40 CFR. 80.27(d) (2).

Therefore the RVP allowance is limited to ethanol blends containing a minimum of 9% ethanol and a maximum of 10%. Regarding the one (1) psi allowance for ethanol blends applies to all qualifying summertime gasoline in both 7.8 psi and 9.0 psi standard areas.

"Ethanol blenders" strictly as any person operating a refinery at which gasoline is produced solely through the addition of ethanol to gasoline, and at which the quality or quantity of gasoline is not altered in any other manner. A blender that uses raffinate (RBOB) as a fuel component thus could not be classified as an "ethanol blender," but rather would be classified as a "refiner."

When ethanol and gasoline are "splash" blended in a truck operated by a common carrier, usually there are two "ethanol blenders" subject to the RVP regulations: the common carrier company and the company that hired the common carrier. The regulations define an "ethanol blender" as any person who owns leases, operates, controls, or supervises an ethanol blending plant. In this situation, US EPA would consider the truck as the ethanol blending plant. The company that owned and/or operated the truck would thus meet the definition of "ethanol blender," and in the event of a violation would be responsible for meeting the defense for an "ethanol blender" found at 40 CFR 80.28(g)(6) of the regulations.

The company that hired the truck in most situations would meet the definitions both of "ethanol blender" and "distributor," 40 CFR 80.2(l), for "causing the transportation or storage of gasoline at any point between any gasoline refinery or importer's facility and any retail outlet or wholesale purchaser-consumer's facility," and in the event of a violation would be required to meet the defenses at 40 CFR 80.28(g)(3) and (g)(6).

Under the regulations, where a violation is detected at an ethanol blending plant, the distributor, carrier, and refiner or importer of the gasoline which was blended with ethanol are deemed to be in violation, in addition to the ethanol blender. 40 CFR 80.28(d) (1). The company that operated the terminal and provided the component gasoline would meet the definition of a gasoline distributor and in the event of a violation would be liable unless it is able to establish the defense for distributors found at 40 CFR 80.28(g)(3).

E-0 TO E-50: US EPA considers gasoline and must meet RVP requirements.

E-9 to E-10: This blend gets a 1.0 psi vapor pressure allowance/waiver (see above).

E-15: Is not covered by 1.0 psi vapor pressure allowance/waiver.

E-51 and above (E-85) is not considered Gasoline by US EPA and therefore does not have to meet the RVP requirements.

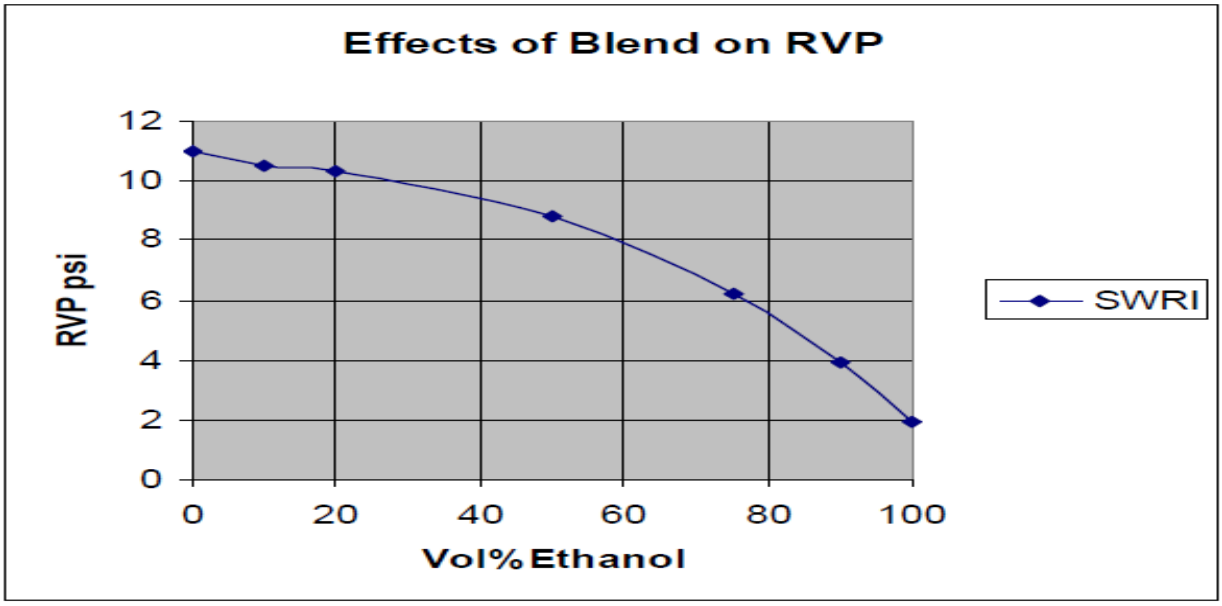


Figure 4 – Bailey & Russell Data for Reid Vapor Pressure

motor gasoline's. Legally -compatible blends must meet octane standards, ASTM, IRS and US EPA regulations. Most blends now work from combination of 90% gasoline and 10% denatured ethanol.

In August 2012, an Addendum to API RP-1626 Storing and Handling Ethanol and Gasoline-ethanol Blends at Distribution Terminals and Filling Stations (2010) was released.

Changes as Follows: Section 7.3.4.4 Blending Dispensers

Equipment suppliers are developing ethanol-compatible dispensers that can dispense multiple ethanol blend concentrations by combining or directly delivering blend stock components from two storage tanks (i.e. one storage tank will hold motor gasoline or BOB and the other tank will hold "ethanol fuel"). Blending dispensers are required to meet all listing, material compatibility, and approval requirements as described in previous sections for single-product dispensers.

Denatured ethanol (E-98) should not be stored at fuel dispensing facilities at this time unless headspace flammability concerns with storing high-ethanol fuels are addressed and dispensers listed for denatured ethanol service are available.

The vapors in the headspace above denatured ethanol are flammable at temperatures that are typical to those in many storage tanks and present a more significant ignition hazard than "ethanol fuel". **As the ethanol content of fuel decreases, the flammability risks decrease. The existing U.S. standards governing the storage of gasoline do not fully address the risk of storing high ethanol content fuels at fuel dispensing facilities.**

The storage of denatured ethanol will require fuel dispensing facility operators to take special precautions regarding the choice of tanks, piping, fittings and blending dispensers. All components will need to be compatible with denatured ethanol and special attention should be paid to sealing materials for connections and pipe thread sealants.

At the time of publication, no Nationally Recognized Testing Laboratory has developed a standard to test and prove the safety and suitability of critical dispensing equipment using denatured ethanol as an inlet stream to blend fuels. As such, there are no blending dispensers, pumps, or impact valves listed to accept denatured ethanol.

Additionally, there are currently no listed flame arrestors for the vapor pathways of tanks containing high ethanol content fuels…

Should a fuel dispensing facility choose to blend E10 from gasoline and "ethanol fuel", the resulting Ethanol Blend may not contain adequate levels of detergent additives.

EXAMPLES OF ETHANOL FUEL BLENDING:

I need 10,000 gallons total of E-10 blend.
10,000 x 0.10 = 1,000 gallons denatured ethanol needed for blend.
So I check using percentage formula--
(10,000-1,000)/10,000 = 0.90 or 90% gasoline
0.9 x 10,000 = 9,000 gals. gasoline-- ok
0.1 x 10,000 = 1,000 gals. denatured ethanol -- ok

Another way that is not mathematically correct:
I start off with 9,000 gallons of gasoline and I want to make it an E-10 blend.
Add 10% of gasoline volume: (9,000 x 0.10) = 900 gallons or 10% of the gasoline volume.
So I add 900 gallons of denatured ethanol making the total blend of 9,900 gallons.
Check using math percentage formulas for accuracy:
(9,900-900)/9,900 = 0.91 or 91% gasoline, this is not a true E-10 blend.
0.09 x 9,900 = 891 gals. of ethanol (actual is 900 not ok)
0.91 x 9,900 = 9009 gals. gasoline (actual is 9,000 not ok)
9,009 + 891 = 9,900 gallons of E-9 blend.

YOU MUST CALCULATED PERCENTAGES FROM THE TOTAL BLENDED VOLUME

So what I end up with is under blending if my goal is E10 and when you consider that the denatured ethanol is denatured at 2 to 3% with gasoline or other hydrocarbons, under blending becomes more of a problem.

CONSIDERATION OF OCTANE BLENDING

E-10 blends have different densities then gasoline, so meters that are calibrated to gasoline densities may also affect blend ratios.

Example I: 100 gals of 89 using 90.5 & 87: (Octane blending is considered Linear Relationship)
Typical 60/40 blend .60 X 90.5 = 54.4 .40 X 87 = 34.8
Check
100 x 89 = V87 X O87 + V90.5 X O90.5
8900 = V87 X 87 + 100-V87 X 90.5
8900 = V87 X 87 + 9050-90.5V87
8900 = 87V87 + 9050-90.5V87
8900-9050 = 87V87-90.5V87
-150 = -3.5V87
V87 = -150/-3.5
V87 = 42.85
8900 = 87 x 42.85 + 57.15 x 90.5 OK

Example II:

I can blend 87 octane with 112 octane denatured ethanol for E-10 blend.
Example- (Octane blending is considered Linear Relationship)
87 octane x 0.90 = 78.3 octane (90%)
111 octane x 0.10 = 11.2 octane (10%)
Together octane blend is 78.3 + 11.2 = 89.5 octane (ok to sell as mid grade)

I can blend 85 octane with 112 octane denatured ethanol for E-10 blend.

Example III:
85 octane x 0.90 = 76.5 octane (90%)
111 octane x 0.10 = 11.2 octane (10%)
Together octane blend is 76.5 + 11.2 = 87.7 octane (ok to sell as low grade)

Say I want to blend mid grade 89 octane gasoline with denatured ethanol to make a E-10 high grade motor fuel or 93 octane.
The following formula should be used.
(V4 x O4) = (V1 x O1) + (V2 x O2) + (V3 x O3)
Where--

Volume 1	**= V1**
Octane 1	**= O1 (89 Octane)**
Volume 2	**= V2**
Octane 2	**= O2 (93 Octane)**
Volume 3	**= V3**
Octane 3	**= O3 (112 Octane)**
Final Volume blend 4	**= V4**

Final Octane blend 4= O4 (93 Octane)

Also:
V1 + V2 + V3= V4 or V4-V3-V2 = V1

EXAMPLE IV:
I want to make 1000 gallons of 93 octane with a mix of 112, 93 and 89 octane's.
I know V4 = 1000 gallons and I know O4 is 93 octane. I know O1 is 89 octane; O2 is 93 octane and O3 is 112 octane.
So the formula becomes:
(1000 x 93) = (V1 X 89) + (V2 X 93) + (V3 X 112)

At this point the formula can be solved in two ways. Using Algebra or Percentage means.
Using the percentage formulas above 1000 Gals. of 93 octane has 100 Gals. of 112 (V3) denatured Ethanol @10% LEGAL LIMIT Maximum for final E-10 high octane blend.
Therefore:
1000-100 = 900 GALLONS OF 93 AND 89 OCTANE BLENDED MIX. 900= V1 + V2
(1000 X 93) = (V1 X 89) + (V2 X 93) + (100 X 112)
93,000 = (V1 X 89) + (V2 X 93) + (11,200)
93,000 – 11,200 = ((V1 X 89) + (V2 X 93) + (11,200))-11,200
81,800 = (V1 X 89) + (V2 X 93)
81,800 = (V1 X 89) + ((900-V1) X 93))
81,800 = (89V1) + (83,700-93V1)
81,800 - 83,700 = (89V1) + (83,700-93V1) – 83,700)
-1900 = (89V1) + (-93V1)
-1900 = -4V1
V1 = -1900/-4
V1 = 475 gallons of 89 octane
V2 = 900- 475 = 425 gallons of 93 octane
V3 = 100 gallons of 112 octane denatured ethanol
Check:
(V4 x O4) = (V1 x O1) + (V2 x O2) + (V3 x O3)
1000 x 93 = (475 x 89) + (425 x 93) + (100 x 112)

93,000 = 42,275 + 39,525 + 11,200 OK
Use this formula for any combinations of octane blends from 84 to 112 octane's.

Octane Incremental Change Due to the Addition of 10% Fuel Ethanol

Base Gasoline AKI	Average AKI	Lowest AKI	Highest AKI	Final Blend AKI
84.0	2.97	2.60	3.26	86.97
84.5	2.90	2.54	3.21	87.40
85.0	2.83	2.47	3.15	87.83
85.5	2.76	2.41	3.10	88.26
86.0	2.69	2.35	3.05	88.69
86.5	2.63	2.28	2.99	89.13
87.0	2.56	2.22	2.94	89.56
87.5	2.49	2.16	2.89	89.99
88.0	2.42	2.09	2.83	90.42
88.5	2.36	2.03	2.78	90.86
89.0	2.29	1.97	2.73	91.29
89.5	2.22	1.90	2.67	91.72
90.0	2.15	1.84	2.62	92.15
90.5	2.08	1.78	2.57	92.58
91.0	2.02	1.71	2.51	93.02
91.5	1.95	1.65	2.46	93.45
92.0	1.88	1.59	2.41	93.88
92.5	1.81	1.52	2.35	94.31
93.0	1.75	1.46	2.30	94.75
93.5	1.68	1.40	2.25	95.18
94.0	1.61	1.33	2.19	95.61

This table is based on non-oxygenated base gasoline. The incremental change of octane varies due to the composition of the base fuel. A high level of saturates in the base fuel will have the largest increase. The lowest represents the 5-percentile and the highest the 95-percentile. The average blend value of ethanol is 112.6 Anti-Knock Index (AKI) for regular gasoline and 111.5 AKI for premium grades.

ETHANOL EMISSIONS (E-10) vs. Conventional Gasoline:

From US DOE Alternative Fuels Data Center; http://www.afdc.energy.gov/afdc/ From: Ethanol in Gasoline: Environmental Impacts and Sustainability (Renewable and Sustainable Energy Reviews, Vol. 9, Issue 6, December 2005, pp. 535-555), and the other is Ethanol Fueled Motor Vehicle Emissions: A Literature Review.

Most studies concluded that, when compared to gasoline, E10 reduces carbon monoxide (CO), hydrocarbons (HC), particulate matter (PM), and air toxics (except acetaldehyde, which forms directly from the combustion of ethanol). The first paper (Ethanol in Gasoline) explains that E10 has mixed results on formaldehyde emissions and discusses a study that showed formaldehyde emissions to be dependent on ambient temperature.

Of the 12 studies Ethanol in Gasoline analyzed for oxides of nitrogen (NO_x) findings, six showed that E10 increases NO_x emissions; three show mixed results, and three show similar or lower emissions. However, NO_x emissions exhibit a strong dependence on the fuel/air ratio, implying that engine optimization for E10 could decrease emissions. This agrees with a study that finds NO_x emissions depend on the engine operating condition more than the ethanol content of gasoline/ethanol blends. It also agrees with a study that found E10 to increase NO_x emissions in vehicles manufactured after 1986 but decrease them in older vehicles.

Evaporative Emissions

The Ethanol in Gasoline report also reviewed four studies that found E10 to increase evaporative emissions by 20% to 80%. This is largely because at low-blend levels, ethanol increases the Reid vapor pressure (RVP) of gasoline (making it evaporate more easily) and makes the vapor more permeable through fuel lines. It should be noted that the RVP for E10 can be, and frequently is, adjusted to adhere to the same volatility standards as gasoline. Evaporative and permeative emissions are also highly dependent on temperature, vehicle activity, and vehicle system materials. The majority of these emissions occur when the car is sitting or refueling, so they are not dispersed as widely as tailpipe emissions.

Combined Tailpipe and Evaporative Emissions

When both tailpipe and evaporative emissions are considered, Niven found that E10 showed increases in total hydrocarbon, non-methane organic species, and air toxic emissions, while substantially increasing the ozone forming potential relative to gasoline.

Pollutant	E10 Tailpipe	E10 Tailpipe Plus Evaporative*
CO	Reduce	Reduce
HC	Reduce	Increase
PM	Reduce	NA
NO_x	Increase (mixed)	Increase
1,3-Butadiene	Reduce	NA
Benzene	Reduce	NA
Formaldehyde	Mixed**	Increase
Acetaldehyde	Increase	Increase
Ozone forming potential	NA	Increase
NMHC	Reduce	Increase

ENERGY CONTENT per FUEL VOLUME

The following is summarized from: Annual Energy Outlook (AEO)-2007, US Department of Energy (DOE), Energy Information Administration (EIA) web link at: http://www.eia.doe.gov/oiaf/analysispaper/biomass.html

On a volumetric basis, ethanol and biodiesel have lower energy contents than do gasoline and distillate fuel oil, respectively. The below table compares the energy contents of various fuels on the basis of Btu per gallon and gallons of diesel or gasoline equivalent. The table shows both the low and high heating value (BTUs/gallon)). The lower energy content of ethanol and biodiesel generally results in a commensurate reduction in miles per gallon when they are used in engines designed to run on gasoline or diesel. Small-percentage blends of ethanol and biodiesel (E10, B2, and B5) result in smaller losses of fuel economy than do biofuel-rich blends (E85 and B20).

Today, most fuel ethanol is used in gasoline blends, where it accounts for as much as 10 percent of each gallon of fuel—a level that all passenger cars can accommodate. In higher blends, ethanol can make up as much as 85 percent of each gallon of fuel by volume. In the future, increased use of ethanol as a transportation fuel will raise the issue of fuel volume versus energy content.

Ethanol contains less energy per gallon than conventional gasoline. A gallon of ethanol has only two-thirds the energy of a gallon of conventional gasoline, and the number of

miles traveled by a given vehicle per gallon of fuel is directly proportional to the energy contained in the fuel.

E-10 (10 percent ethanol) has 3.3 percent less energy content per gallon than conventional gasoline. E-85 (which currently averages 74 percent ethanol by volume) has 24.7 percent less energy per gallon than conventional gasoline. Assuming that engine thermal efficiency remains the same whether the vehicle burns conventional gasoline, E-10, or E-85. This means that 1.03 gallons of E-10 or 1.33 gallons of E-85 are needed for a vehicle to cover the same distance that it would with a gallon of conventional gasoline. Although the difference is not expected to have a significant effect on purchases of E10, AEO2007 assumes that motorists whose vehicles are able to run on E-85 or conventional gasoline will compare the two fuels on the basis of price per unit of energy.

The issue of gasoline energy content first arose in the early 1990s with the introduction of oxygenated gasoline made by blending conventional gasoline with 15 percent MTBE or 7.7 percent ethanol by volume. When oxygenated gasoline was introduced, MTBE was the blending agent of choice. Since then, ethanol has steadily replaced MTBE in oxygenated and RFG blends. The fuel economy impact of switching from MTBE-blended gasoline to an ethanol blend is smaller than the impact of switching from conventional gasoline. For example, changing from 15 percent MTBE to 7.7 percent ethanol in blended gasoline results in a reduction in energy content of only 1.2 percent per gallon of fuel, and changing from 15 percent MTBE to 10 percent ethanol results in a reduction of 1.9 percent.

ENERGY CONTENT OF BIOFUELS VS. CONVENTIONAL PETROLEUM

Fuel	Net Heating Value HHV Btu/gal.	Gallons of Diesel Equivalent
No. 2 Petroleum Diesels	129,500 LHV to 138, 690 HHV	
Biodiesel (B100 Soy)	128,520 HHV	0.93
B20 Blend (B20 Soy)	136,656 HHV	0.98
B2 Blend (B2 Soy)	138,487 HHV	0.999

Fuel	Net Heating Value HHV Btu/gal.	Gallons of Gasoline Equivalent
Petroleum Gasoline's	115,500 LHV to 125,072 HHV	
Denatured Ethanol (E97)	76,000 to 84,262 HHV	0.67
E-85 Blend	90,383 HHV	0.72
E-15 Blend	118,950 HHV	0.95
E-10 Blend	120,991 HHV	0.97

- **The above table shows both the low heating value (LHV-the amount of heat released by the fuel, ignoring the latent heat of vaporization of water) and the high heating value (HHV the amount of heat released by the fuel, including the latent heat of vaporization of water).**
- **In addition to the ethanol, one bushel of corn produces 12.4 lb of 21% protein feed, 3 lb of 60% gluten meal, 1.5 lb of corn oil, and 17.0 lb of carbon dioxide. Ethanol is also known as ethyl alcohol or grain alcohol. Like gasoline, ethanol contains hydrogen and**

carbon, but ethanol also contains oxygen in its chemical structure. The oxygen makes ethanol a cleaner burning fuel than gasoline.

Regulatory Announcement
EPA Announces E15 Partial Waiver Decision and Fuel Pump Labeling Regulations

In two recent actions under the Clean Air Act (CAA), the EPA granted partial waivers that allow gasoline containing greater than 10 volume percent (vol%) ethanol up to 15 vol% ethanol (E15) for use in model year (MY) 2001 and newer light-duty motor vehicles, subject to certain conditions. In a final rulemaking implementing the partial waivers, the EPA is establishing several measures to mitigate misfueling of vehicles, engines and equipment no subject to the E-15 waivers. Specifically, the rule prohibits the use of gasoline containing more than 10 percent by volume of ethanol in vehicles, engines and equipment not covered by the partial waiver decisions.

The final rule also requires all E15 fuel dispensers located at retail and wholesale consumer–purchaser sites to have a specific notification label. In addition, the rule requires that product transfer documents (PTDs) specifying ethanol content and Reid Vapor Pressure (RVP) accompany the transfer of gasoline blended with ethanol through the fuel distribution system, and a survey of retail stations to ensure compliance with E15 labeling, ethanol content and other requirements. The rule also modifies the Reformulated Gasoline (RFG) program to allow fuel manufacturers to certify batches of E15. Finally, a provision in the rule denies a petition for rulemaking to require retail stations to offer for sale gasoline containing 10 percent by volume of ethanol or less.

IMPORTANT! E-15 MAY NOT BE SOLD FOR MODEL YEAR 2001 AND NEWER CONVENTIONAL FUELED VEHICLES UNTIL THE EPA COMPLETES A CERTIFICATION PROCESS FOR SUCH USE. UNTIL THE E-15 CERTIFICATION PROCESS IS COMPLETE, E-15 MAY ONLY BE SOLD FOR USE IN FLEX-FUELED VEHICLES. U. S. EPA ANNOUNCE WHEN THE E-15 FUEL CERTIFICATION PROCESS IS COMPLETED.

EPA ISSUES LONG AWAITED RULE ON E-15 GASOLINE MISFUELING MITIGATION MEASURES:

The U.S. EPA issued a long awaited final rule on E-15 misfueling mitigation measures. The rule is necessary to ensure proper storage, dispensing and use of E-15 gasoline blends authorized under the EPA's partial waiver decisions in 2010. The waivers authorized use of E-15 in model year 2001 and newer motor vehicles only. As expected, the EPA does not provide petroleum retailers with blanket liability protection for consumer misfueling at the pump. Instead, compliance with the misfueling mitigation requirements in the final rule only reduces the risk of liability for marketers. The rule does not address E-15 compatibility with underground storage tank and dispensing systems. The rule includes a number of provisions including flexibility in dispenser label design, retailer exemption from E-15 sampling and testing requirements. The requirements of the rule take effect November 1, 2011: Highlights of the rule include the following:

MISFUELING PROHIBITION: Incorporates a legal prohibition against the use of E-15 in model year 2000 and older vehicles into EPA air regulations under 40 CFR 80.

DISPENSER LABEL REQUIREMENTS: Requires an E-15 dispenser warning label that includes an ethanol content notification together with a legal and technical warning against use in vehicles older than model year 2001. The EPA coordinated E-15 label design and content with the Federal Trade Commission (FTC) to avoid duplicative labeling requirements by the two agencies. The following E-15 dispenser label is required under the final rule:

Significantly, the rule requires only E-15 dispensers to be labeled. An agency proposal to require labeling of all ethanol blends was dropped from the final rule. The EPA also adopted for approved alternative E-15 dispenser labels.

Placement of the label will depend on the type of pump that is used. In the case of pumps with one nozzle dispensing several grades of gasoline, the regulations direct the retailer to place the label above the selector button dispensing E15 or otherwise place it so that it is clear which button is dispensing E15. In the case of pumps with a nozzle for each grade, the regulation directs the retailer to place the label where consumers will see it when they are making their fuel selection.

NEW PTD LANGUAGE FOR ETHANOL AND RVP CONTENT OF GASOLINE REQUIRED BY NOVEMBER 1, 2011

EPA is requiring the use of new product transfer document language (PTD) describing ethanol and RVP content of gasoline beginning November 1, 2011. The new PTD language was finalized by the EPA as part of the E-15 misfueling mitigation rule issued in July *2011.* The misfueling mitigation rule also mandates the use of a specific dispenser label for E-15 blends.

However, the dispenser label is not required until the EPA completes the registration and certification process for E-15 blends required before the blend can be sold for use in model year 2001 and newer conventional fueled vehicles. The certification process is ongoing and will not likely be complete until sometime next year. In the meantime, compliance with the following PTD requirements for gasoline products by November 1, 2011:

***PRODUCT TRANSFER DOCUMENT REQUIREMENTS:* The final rule requires specific ethanol and RVP content language to appear on all gasoline PTDs. Two separate sets of PTD language are required depending on the point of oxygenation. The first set of PTD language requirements is for gasoline or blend stock transferred *before* oxygenates are blended while the second set is for gasoline transferred *after* oxygenate blending. New PTD language is also required for gasoline that contains no oxygenates.**

(1) PTDS FOR GASOLINE TRANSFERRED BEFORE OXYGENATE BLENDING:

- **PTDs for conventional gasoline blendstock used for oxygenate blending with ethanol to create conventional gasoline or gasoline transferred *upstream* of an oxygenate blending must contain the following:**
  The name and address of the transferor;
  The name and address of the transferee;
  The volume of conventional blendstock for oxygenate blending or gasoline;

The location of the conventional blendstock for oxygenate blending or gasoline at the time of the transfer; and The date of the transfer.

- **PTDs for summertime RVP gasoline must include the maximum RVP stated in the following format:**
  "The RVP of this gasoline does not exceed [fill in appropriate value]"

- **PTDs for ethanol blends subject to the 1 psi RVP waiver must include the maximum ethanol content, the maximum RVP content and a regulatory warning stated in the following format:**

"Suitable for the special RVP provisions for ethanol blends that contain between 9 and 10 vol % ethanol."

"The RVP of this blendstock/gasoline for oxygenate blending does not exceed [Fill in appropriate value] **psi.**

"The use of this gasoline to manufacture a gasoline-ethanol blend containing anything other than between 9 and 10 volume percent ethanol may cause a summertime RVP violation."

- **PTDs for gasoline not eligible for the 1 psi RVP waiver provision, information regarding the suitable ethanol content stated as follows:**
  "Suitable for blending with ethanol at a concentration of no more than 15 vol % ethanol."

(2) PTDS FOR GASOLINE TRANSFERRED AFTER OXYGENATE BLENDING:

- **PTDs for gasoline ethanol blends *downstream* of oxygenate blending – except to the ultimate consumer - must contain the following information:**

The name and address of the transferor;
The name and address of the transferee;
The volume of gasoline being transferred;
The location of the gasoline at the time of the transfer;
The date of the transfer; and

One of the following states which accurately describes the gasoline-ethanol blend:
For gasoline containing no ethanol (E0), the following statement;
"E0: Contains no ethanol. The RVP does not exceed [fill in appropriate value] psi."

For gasoline containing less than 9.0 volume percent ethanol, the following statement:
"EX – Contains up to X% ethanol. The RVP does not exceed [fill in value] psi."
***The "X" refers to the maximum volume percent ethanol present in the gasoline.**

For gasoline containing between 9.0 and 10.0 volume percent ethanol (E10), the following:
"E10: Contains between 9 and 10 vol % ethanol. The RVP does not exceed [fill in appropriate value] psi. The 1.0 psi RVP waiver applies to this gasoline. Do not mix with gasoline containing anything other than between 9 and 10 vol % ethanol."

For gasoline containing greater than 10.0 volume percent and not more than 15.0 volume percent ethanol (E15), the following statement:
"E15: Contains up to 15 vol % ethanol. The RVP does not exceed [fill in appropriate value] psi;"

For all other gasoline that contains ethanol, the following statement:
"EXX-Contains no more than XX% ethanol,"
***XX equals the volume % ethanol.**

(3) OTHER PTD REQUIREMENTS:

- **PTDs must be kept on file for five years. EPA approves that the new language may be printed on the back of the PTD so long as there is a notice on the front directing the reader**

to the back. EPA also approved the use of pre-approved abbreviations of words contained in the required notice due to space limitations on PTDs.

SAMPLING AND TESTING SURVEY REQUIREMENTS: To ensure compliance with the misfueling mitigation measures contained in the final rule, the EPA is requiring an ongoing sampling and testing implementation survey of retail and wholesale purchaser-consumer sites. The E-15 survey is modeled after current private consortium surveys for RFG and ULSD. Under the rule, any gasoline refiner, gasoline importer, ethanol blender, ethanol producer, or ethanol importer who manufactures, introduces into commerce, sells or offers for sale E15, gasoline, blendstock for oxygenate blending, ethanol, or gasoline-ethanol blend intended for use in or as E15 must conduct a sampling and testing survey. The EPA is allowing surveys to be based on geographic areas where E-15 is sold rather than on a nationwide basis since E-15 will initially be introduced only in limited regional markets. Retail wholesale/purchaser consumer sites subject to the survey are selected at random. The survey must be conducted quarterly and include sampling and testing for ethanol content (15% max), RVP content (9.0 psi max in summertime) and dispenser labeling (all retail and wholesale purchaser/consumer E-15 dispensers). Retailers and wholesale purchaser/consumers will have no advanced warning of the sampling and testing survey. EPA exempts retailers and wholesale purchaser-consumers from conducting sampling and testing requirements. However, retailers and wholesale purchaser-consumers must nevertheless participate in the survey if E-15 is sold at the site.

1 POUND PSI RVP WAIVER FOR ETHANOL BLENDS: The EPA did not expand the current 1 pound per square inch RVP waiver currently allowed for summertime ethanol blends between 9 and 10% to E-15 blends. Instead these blends will require a specially formulated blendstock to ensure summertime RVP compliance.

PENALTIES: The maximum penalty for violation of the E-15 misfueling mitigation requirements is the same for all violations of the Clean Air Act - $37,500 per day, per violation for as long as the violation occurs.

You can access the rule and related documents on EPA's Office of Transportation and Air Quality: (OTAQ) Web site at: http://www.epa.gov/otaq/regs/fuels/additive/e15/

For more information, please contact EPA's Fuels Program at:
U.S. Environmental Protection Agency, Office of Transportation and Air Quality (6405J)
1200 Pennsylvania Avenue NW; Washington, DC 20460; Phone: 202-343-9755

BIOFUELS MATERIALS COMPATIBLY

From: Storage and Dispensing of Fuels containing Ethanol Blends.
PUBLISHED FROM VARIOUS ETHANOL & EQUIPMENT WEB SITES
Most equipment compatibly data from: http://www.pei.org/

There are four major areas of concern for low and high-ethanol fuel blends:

1) Phase separation occurs when enough water contaminates the gasoline, causing the ethanol to attach itself to the water molecules, leaving two distinct layers in the storage tank: a gasoline-only layer at the top and an ethanol/water layer along the bottom. The gasoline becomes saturated and the ethanol/water separate. The water will descend to the bottom of the tank while the ethanol rises. Conventional gasoline can dissolve up to 150 parts per million of water at 70°F, the situation is different for gasoline oxygenated with 10% ethanol. This 90% gasoline/10% ethanol blend can dissolve up to 7,000 ppm of water at 70°F. When this blend is cooled, both the water and some of the ethanol become insoluble. Contacting the blend with more water also draws ethanol from the blend. The result, in both cases, is two layers of liquid—an upper ethanol-deficit gasoline layer and a lower ethanol-rich water layer. This phase

separation of the gasoline/ethanol mix lowers the octane number and may cause knocking in an engine, while the engine will not run at all on the ethanol/water layer.

Phase separation also affects the Reid Vapor Pressure (RVP) which could cause air quality violations. For this reason, it is not recommended to switch back and forth retail conventional gasoline and Ethanol blends.

As far as E85 is concerned, according to the New England Interstate Water Pollution Control Commission's *L.U.S.T. Line* of May 2006, phase separation may also occur in this fuel, but not as often, since approximately 4% water is needed. This is a large amount of water for a fueling system and would only result under extreme conditions. When this happens, pumps are essentially dispensing gasoline, water or denatured ethanol, in violation of the law and potentially damaging to vehicles. In addition, the water found at the bottom of such tanks has PH problems (acidity or alkalinity) and cause tank leaks through accelerated corrosion. Fuel ethanol (E-10 blends) mixes with water, but it separates at concentrations (greater than 0.55% to 1.0%). Lower ethanol blends like E-5 have been known to phase separate at water concentrations as little as 0.20%. Once contaminated, can't be separated without distillation.

The lower the temperature, the lower the water tolerance, meaning that at 60°F a 10% ethanol blend will tolerate approximately 0.5% water. However, at 10°F that tolerance can be reduced to approximately 0.3%. Because of these properties, an E-10 fuel system that is near its saturation point at 60°F may experience phase separation if there is a sudden reduction in temperature.

Another property of ethanol blends is that they are hygroscopic, meaning they absorb moisture from the air, raising the potential for phase separation during storage if the tank is vented to the atmosphere and is subject to condensation formation as a result of temperature change.

2) Solvency: Alcohol has the ability to dissolve organic material. Although E10 and E85 fuels have differing concentrations of ethanol, each has the ability to dissolve the petroleum based sediment, particulates and lacquers found in fuel tanks previously dispensing gasoline or diesel fuel. This will cause problems ranging from clogged filters to damage to vehicle engines. It is very important that existing tanks designated for conversion are thoroughly cleaned and inspected.

3) Metal Corrosion: Ethanol can cause scouring or loosening of deposits on internal surfaces of tanks and piping in steel UST systems. Also, ethanol is not compatible with soft metals such as zinc, copper brass, lead, and aluminum which are commonly found in conventional fuel storage tanks. Existing USTs must be cleaned before contact with ethanol/ethanol blended fuels. Please see the Steel Tank Institute at http://www.steeltank.com/ for more information

4) Permeation of Elastomers and Polymers: Ethanol is not compatible with pre 1992 plastics, and some but not all fiberglass, cork gaskets, natural rubber, leather and polyurethane adhesives (used in older fiberglass piping). These materials will crack, crumble, dissolve or fail when exposed to high concentration ethanol blends. Also, tank leak detection equipment (existing probes in ATG systems) may not be compatible and may not work in ethanol blend fuels.

The technology for storing and dispensing gasoline can be applied to alcohol fuels such as E85 because alcohols and alcohol blends, like gasoline, are liquid fuels at ambient pressures and temperatures. However, only E85-compatible materials should be used in the storage and dispensing systems. Most operating problems with ethanol-fueled vehicles have been traced to contaminated fuel. Consequently, choosing the right materials for fuel storage and dispensing systems and following proper fuel handling procedures are crucial for successfully operating ethanol-fueled vehicles. Although material research and testing is expected to continue, the parts and materials discussed herein have performed well with E85. They can be obtained from your usual supplier.

Using Existing Fueling Systems for Ethanol or E-85

In many cases, existing gasoline, diesel, or other hydrocarbon fueling systems may also be used to store and dispense fuel ethanol. Most metal underground storage tanks that meet EPA December 1998 codes can be used to store E85. Many underground fiberglass tanks that meet EPA standards may also be used to store E85. Most double wall fiberglass storage tanks are all compatible with neat ethanol or methanol. However, only single wall fiberglass tanks were intended for use with typical ethanol gasoline (i.e. 10% ethyl or 5% methyl alcohol). The question about older fiberglass tank compatibility with E-10 blends are OK with due diligence. If there is a case for using an existing fiberglass tank, either Containment Solutions or Xerxes have service personnel who will apply a lining and certify for E-85 Blends. (more on fiberglass tanks with ethanol here: http://www.fiberglasstankandpipe.com/white.htm)

It is generally accepted practice that E-10 blends are mostly compatible with petroleum gasoline handling materials with the exception that alcohol dispenser filters are highly recommended.

Tanks

Cleaning Tanks

If another type of fuel was stored in the tank that will be used for the E85, it must be cleaned because storing gasoline underground causes some particulates to settle out and form sludge. Introducing alcohol into these tanks will place this sludge into suspension and will lead to serious problems with vehicle drivability. There are several methods for cleaning sludge from the bottom of a tank. Each method must be completed by a certified and bonded company familiar with cleaning petroleum storage tanks.

1) Use a "filter agitator" device. This method is similar to cleaning a swimming pool. The filter agitator is lowered into the tank and moves the product to allow a filter to catch the suspended particulates.
2) Physically enter the tank and steam clean the sludge.
3) Use robotic cannon to liquefy the sludge. After being liquefied, the sludge is pumped out of the tank and disposed of at an approved site. This method of removal may occasionally harm the walls of the tank, making it unfit for fuel storage.
4) Place a chemical cleaner in the tank to clean the walls. The remaining particulates may then be pumped out of the tank and disposed of. E85. Generally, aboveground storage tanks are smaller than underground storage tanks and are typically installed in capacities of 1000 to 2000 gallons. Tanks may be constructed of stainless steel, cold-finished steel, or fiberglass. The use of plated/lined metal tanks is generally not recommended.

Newer fuels, while solving some environmental issues, have created the need for more frequent cleaning of their storage tanks. If left unchecked, a long list of issues can arise, including frequent filter changes at the dispenser and the resulting longer fill times for the consumer, bacterial contamination and phase separation from the presence of water.

Over time, several techniques have been developed to address the issue of cleaning the storage tank or the product. These include the suck out, bottom snake, fuel polishing, the dreaded cut and enter, and rotary impingement cleaning.
Suck Out – The suck out is performed using a DOT-approved vacuum truck and, as the name implies, draws most of the product out of the vessel. The hope is some of the contamination and sludge will be removed. The tank is then refilled with fresh product and, in some cases, an algaecide is added.
Bottom Snake – A second approach is to insert a flexible hose into one end of the vessel and force it to snake across the bottom. As it moves, a suction pump draws any sludge, water or product it encounters out of the tank and through a simple filter. Everything that makes it through the filter is drummed for disposal, including both undesirable components and good product.

Fuel Polishing – A third alternative, fuel polishing, is similar to the bottom snake, but offers the benefit of returning the good product to the tank. In this approach, the fuel is drawn out of the tank with either a snake or rigid stinger. It passes through two or more different mesh filters and a water separator. A fuel-conditioning magnet may be employed along with an algaecide injector. The cleaned and filtered product is then returned to the tank through another opening.

Cut and Enter – The last resort is the cut and enter. When all else fails, men enter the tank with pressure washers. If the vessel is a UST, the pad must be cut, a portion of the cover must be removed prior to reaching the vessel, and then the tank is cut open for entry.

Cleaning Method 1: Fuel Polishing Supplement

A rotary impingement cleaner can be used to clean ASTs and USTs in several different ways, depending on the end-user's preferences. First, it can be used as a supplement to the fuel polishing method. When the cleaned product is returned to the vessel by the circulation pump, it can be directed through a cleaning head. This will cause the removal of debris from all surfaces of the tank, including the top and additional agitation of the pool of product at the bottom. The tank must contain a minimal amount of product to fully realize the impingement benefits of this type of device. Also, if algaecide is used, it ensures application of the chemical over the entire internal surface. One must question, though, why polish the fuel but not the tank?

In this scenario, the operating pressure is low, typically less than 50 psi with a flow rate of about 25 gpm. This combination prevents the sprayed fuel from atomizing and keeps the pumps motor at usable amperage for a standard 120v receptacle. Most vessels can be cleaned from a single insertion point. Proper grounding is imperative.

Cleaning Method 2: Water and Larger Pump

A second method uses water as the wash liquid coupled with a larger pump, such as one found on a tow-behind trailer. Pressures can be well over 100 psi using about 50 gpm in the setup. Under these conditions, even the largest tanks can be cleaned from a single drop point. However, effluent disposal and necessary tank drying are natural side effects of using water. In addition to cleaning tanks that are still in service, when decommissioning or inspecting tanks, this is the method of choice.

Cleaning Method 3: Water and Pressure Washer

A final option uses a slightly smaller cleaner and water. The water is delivered using a large truck-mounted pressure washer. Flow rates start at about 8 gpm and pressures will be in the hundreds of psi. The effluent will be less, but the user sacrifices the convenience of a single insertion point. It should be noted that the amount of time it takes to clean a vessel depends on the level of soil, but most petroleum storage tanks can be cleaned in 10 to 15 minutes.

As newer fuels hit the market, a clean UST or AST is a must. The next time you have a filter, water, bacteria or sludge problem, make sure you clean not only the fuel, but the entire tank, too.

By: Robert E. Delaney, Ph.D., chairman of Gamajet Cleaning Systems Inc., located in Exton, Pennsylvania, 1-877-GAMAJET and on the Web at www.gamajet.com.

Dispensers

Underwriters Laboratories (UL) announced a new certification path for fuel dispensers for mid-level ethanol blends up to E25. With the new certification path, manufacturers of dispensers, assemblies and components now have three certification options to choose from to balance market needs and provide flexibility as advances are made in ethanol blending.

As of August 3, 2009, UL is providing three certification paths for dispensers of pre-blended fuels. They are:

1. **UL 87 for gasoline and ethanol fuel blends up to E10**
2. **The established requirements of Subject 87A-E85, which address gasoline and ethanol fuel blends up to E85**
3. **The new certification path in Subject 87A-E25, which addresses gasoline and mid-level ethanol fuel blends up to E25**

UL set the new requirements for fuel dispensers based on research of multiple blend concentrations and their effects on components. There is increased potential for different types of damage to materials and components at blends above E-25 and, as a result, there are more stringent requirements for dispensers for use with these higher blend levels. This new mid-level option, up to E-25, provides a less stringent certification path than what is required for E-85.

Prior to August 1, 2009, UL had two certification paths for gasoline and ethanol fuel dispensing units, UL87 for blends up to E-10 and Subject 87A for blends up to E-85. UL first announced Subject 87A covering E-85 dispensers in October of 2007. The additional level to Subject 87A for E-25 will help assure that mid-level pre-blended fuels, if adopted, can be dispensed safely.

Companies that produce E85-compatible pump dispensers include Bennett Pump Company, Dresser Wayne and Gilbarco Corporation. The E85 dispenser must use iron, unplated steel, or stainless steel in the fuel path. In the case of vane-type pumps, avoid impellers made from soft metals (zinc, brass, lead, aluminum). Steel or an engineering polymer with a high chemical resistance will give excellent results.

Gilbarco Veeder-Root announced in March 2010, a warranty upgrade on its line of standard fuel dispensers to cover ethanol blends up to E-15. Previously, these dispensers were only warranted for ethanol blends up to E-10. This change is important to petroleum marketers because the EPA is likely to approve the use of E-15 product for conventional fueled vehicles later this year. Petroleum marketers have expressed concern over the possible invalidation of dispenser warranties should the EPA move to an E-15 standard. While the warranty protection only applies to UL 87 approved Gilbarco Veeder Root dispensers manufactured in North America since April 1, 2008, it represents the first time equipment manufacturers have recognized the potential fallout from a possible E-15 approval. The models covered by the warranty expansion include the Gilbarco Encore and Legacy series dispensers, as well as the Gasboy Atlas product line. Along with equipment warranty issues, a move to E-15 could also have an impact on insurance coverage, vehicle warranties, local fire marshal requirements and liability for consumer misfueling.

While the announcement is welcome news, it does not cover all dispensers and does nothing to address local fire marshal regulations that require the use of UL approved equipment. UL has no intention of "officially" approving the use of E-15 product in existing petroleum storage and dispensing equipment although the national safety testing organization has concluded that blends up to E-15 have no adverse impact on this equipment.

In June, 2010, Growth Energy announced that Underwriters Laboratory (UL) has simultaneously issued certifications to both the Gilbarco Veeder-Root Encore®E-85 fueling dispenser and a Dresser Wayne dispenser. These fuel pumps are now completely certified and approved for dispensing any range of fuel ethanol from E-10 through E-85. At this time, the ethanol industry is also seeking to obtain UL certification for blender pumps

General Dispensing Equipment

Dispenser hoses, nozzles, and fitting connectors are the same for aboveground and underground fuel storage systems. Parts that differ for aboveground and underground installations are discussed in the sections that follow. Again, your supplier can help you obtain E85-compatible parts and equipment. Avoid components made from zinc, brass, lead, aluminum, or other soft metals. The ethanol fuel may cause leaching from such soft metals, which may contaminate the vehicle's fuel system and could result in poor vehicle performance.

In-Line Filters

A 1-micron, in-line filter is recommended for fuel ethanol dispensing equipment (E-85). This size filter will trap most of the debris and impurities that might be present in the storage tank and prevent them from being transferred to the vehicle during refueling. A number of

companies produce 1-micron E85-compatible fueling filters. It may be possible to use 5, 10 or 30 micron filters for E-10 blends if so allowed by local regulations and in accordance with manufactures warranties.

Proper filtration can detect phase separation. Special phase separation dispenser filters will notify the operator of the condition by slowing fuel flow to less than one gallon per minute. This "slow flow" condition is a signal that water is present and that the tanks should be tested for phase separation.

In order to ensure that their water-detecting properties are used to their maximum capabilities, these phase-separation-sensing filters should generally be changed after six months in service, after dispensing 500,000 gallons of fuel, at any point when a reduction in flow rate is detected or at any time the fuel-load composition is changed.

Handlers of fuels containing ethanol also have to remember that high concentrations of ethanol will scour tanks, hoses and other fueling components, resulting in a lot of contaminants being thrown at the filter. Because of this, filters should be changed more often when tanks are being converted from gasoline-only use to being used with fuels containing any level of ethanol. Before this conversion, it is also wise to dry out wholesale storage tanks and properly prepare retail storage tanks and dispensers for the new fuel

Dispenser Hoses

The type of hose used for dispensing E85 depends on the type of vapor recovery system in the geographic area. Stage II Vapor Recovery systems require different fueling hose systems than do areas with Stage I only systems. Goodyear Tire and Rubber Company is one reliable manufacturer for this item. When specifying materials for your refueling facility, contact equipment vendors for the latest information and use the components with the highest resistance to deterioration from continuous contact with fuel alcohols. In some cases, equipment specified for use with fuel methanol will be available. Because fuel methanol is even more corrosive than fuel ethanol, components and materials certified for fuel methanol use will almost always be acceptable for fuel ethanol use.

Nozzles

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

Fittings and Connectors

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

Piping

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

Signage

Tanks containing ethanol fuel must be labeled. A bronze pentagon decal, with "E85" in black must label the fillbox and fillbox cover. The labels should be placed on the fillboxes and fillbox cover in one of the following ways.

1. Painting the decal on the top of the cover or on the rim of the fillbox

2. Attaching a tag to the fillpipe adapter
3. Screwing a tag into the fillbox rim
4. Fitting a plastic or fiberglass insert into the rim of the fillbox.

What can tank owners/operators do?

1) Have the system cleaned and inspected by an Ethanol specialist prior to the introduction of a low ethanol blend (E-10).
2) Install a certified Ethanol system when storing a high ethanol blend (E-85).

All of the following equipment must be compatible with the ethanol blend fuel before being stored or dispensed.

Tanks, Fill pipe/drop tube; Auto shut off valve or overfill valve; Internal lining material used on relined tanks; Submersible pump; Gaskets, bushings, couplings; Line leak detectors Leak Detection Equipment (ATG probes, floats, sump sensors); Piping materials; Pipe adhesives/glues; Flex connectors, grommets; Filters; Dispensers; Hoses; Nozzles Spill containment and sumps

Ethanol blends in commercial aviation fuels is not allowed. Ethanol blends in marine craft should be in compliance with manufactures recommendations. Ethanol blends for two-stroke engines should be in compliance with manufactures recommendations.

BIODIESEL MATERIALS

From Biodiesel Handbook & Guidelines

http://www.nrel.gov/vehiclesandfuels/npbf/feature_guidelines.html

There is an ASTM spec on the pure biodiesel (B100) blendstock, ASTM D 6751. ASTM has also published a standalone standard/specification for a B20 biodiesel blend, engine manufacturers are pushing for this for warranty reasons.

Most states currently test B20 blends as diesel fuel and test it per D 975. At present many people feel if the diesel meets specs and the B100 meets specs, there should be no problem with the blended fuel. There are a couple of problems with this. If the blend is unusual (B50, B65, etc.) States have no specs to test against and don't know how it will perform in equipment.

B100 will degrade, soften, or seep through some hoses, gaskets, seals, elastomers, glues, and plastics with prolonged exposure. Some testing has been done with materials common to diesel systems but more data is needed on the wide variety of grades and variations of compounds that can be found in these systems, particularly with B100 in U.S. applications. Nitrile rubber compounds, polypropylene, polyvinyl, and Tygon materials are particularly vulnerable to B100. Before handling or using B100, contact the equipment vendor or OEM and ask if the equipment is suitable for B100 or Biodiesel. In some cases, the vendor may need the chemical family name for biodiesel (i.e. the methyl esters of fats and oils) to look up the information or even the exact chemical name of some of the biodiesel components such as methyl oleate, methyl linoleate, methyl palmitate, or methyl stearate. There have not been significant material compatibility issues with B20.

Older vehicles, manufactured before approximately 1993, are more likely to contain seals, gaskets, etc., that will be affected by B100 over long periods of time. Modern rebuild kits or engines after 1993 may contain biodiesel compatible materials, but not always. Ask your vehicle manufacture for recommendations.

Most tanks designed to store diesel fuel will store B100 with no problem. Acceptable storage tank materials include aluminum, steel, fluorinated polyethylene, fluorinated polypropylene, Teflon®, and most fiberglass. If in doubt, contact the tank vendor or check the National Biodiesel Board.

Brass, bronze, copper, lead, tin, and zinc may accelerate the oxidation of diesel and biodiesel fuels and potentially create fuel insolubles (sediments) or gels and salts when reacted with some fuel components. Lead solders and zinc linings should be avoided, as should

copper pipes, brass regulators, and copper fittings. The fuel or the fittings will tend to change color and insolubles may plug fuel filters. Affected equipment should be replaced with stainless steel, carbon steel, or aluminum.

These guidelines should be followed for storing biodiesel (B100) in winter:

- **B100 should be stored at temperatures at least 5°F to 10°F higher than the cloud point of the fuel. A storage temperature of 40°F to 45°F is fine for most B100, although some B100 fuels may require higher storage temperatures. B100 can be stored underground in most cold climates without additional considerations because underground storage temperatures are normally above 45°F. All above ground fuel systems should be protected with insulation, agitation, heating systems, or other measures if temperatures regularly fall below the cloud point of the fuel (24 hour exposure to 38 degrees). This precaution includes piping, tanks, pumping equipment, and the vehicles. Many small-scale B2 blenders store B100 in drums or totes indoors during winter months.**
- **The cloud point of B100 starts at 30°F to 32°F for most of the vegetable oils that are made up primarily of mono- or poly-unsaturated fatty acid chains and can go as high as 80°F or higher for animal fats or frying oils that are highly saturated. It should be noted that the pour point of B100 is usually only a few degrees lower than the cloud point, so once biodiesel "begins to freeze," gelling can proceed rapidly if the temperature drops only a few degrees further.**

Many states have Statement of Compatibility forms or Conversion Guidelines included in their state Notification form for Underground Storage Tanks or Aboveground Storage Tanks. For detailed information regarding specific storage and dispensing equipment for E-blends, please visit the following websites:

WEB SITE LINKS:
www.e85fuel.com
www.ethanol.org
http://www.eere.energy.gov/afdc/e85toolkit/
http://www.ethanolrfa.org
http://www.epa.gov/otaq/fuels/index.htm

NOTE ON FIRE FIGHTING WITH ETHANOL BLENDS

Summary, Full article originally published by the National Fire Protection Association (NFPA) March, 2008. https://www.nfpa.org/

Pushed by government mandates, shipments of ethanol and gasoline/ethanol blends are soaring across the United States. An overwhelming majority of these shipments are handled without incident. Transporters and petroleum terminaling facilities do an outstanding job.

Unfortunately, incidents do happen. Worse still, many emergency responders lack the training and equipment to safely and effectively handle these ethanol events. It's not an exaggeration to say that the potential for a major tragedy is growing by the day.

First and foremost, there are major differences in the way ethanol fires and spills must be handled compared with gasoline incidents. Fires and spills involving ethanol and ethanol/gasoline blends pose some complex challenges for emergency responders.

Since 2000, there have been 26 major ethanol fires in the United States, and firefighters have not had particularly good success combating those blazes, according to David White, president of Fire & Safety Specialists Inc. In most cases, the tanks containing the ethanol products burned to the ground before the firefighters were able to extinguish the fire.
It's important to understand that blazes involving E85 (85% ethanol and 15% gasoline) and other ethanol/gasoline blends containing more than 10% ethanol must be treated differently

than traditional gasoline fires. That's because ethanol is a polar/water-miscible flammable liquid (one that mixes readily with water) that will degrade the effectiveness of firefighting foam that is not alcohol resistant.

Researchers reported earlier this year that most of the firefighting foams typically used for gasoline blazes are ineffective on ethanol and ethanol/gasoline blends. Only two foam formulations (AR-AFFF and AR-FFFP) proved effective with ethanol blends from E10 through E95. However, AR-AFFP was successful on E95 only at higher application rates, and it failed a burn-back test. Only AR-AFFF passed a sprinkler application, which is typical of the fire suppression systems at many storage terminal loading racks.

Some firefighters still believe that they can achieve success by flooding an ethanol fire with water. Unfortunately, ethanol remains combustible even when it is diluted to a 10% level in water. That means an ethanol fire in a 100,000-gallon storage tank would continue burning even after an application of 900,000 gallons of water. (The issue becomes the cleanup and disposal of fire fighting materials. End of reference)

Ethanol: Spills (less than one inch deep) can be controlled and extinguished by dilution with water but are more quickly extinguished by "alcohol type" foams or dry chemical applications. Tank fires can only be controlled and extinguished by the use of "alcohol type" foams.

Spill Fires: Preferred foams are polymeric AR-AFFF or ATC (Alcohol Type Concentrate), fluoroprotein, and AR-FFFP, in that order, for performance of blanket and security of the area. "Alcohol type" and AFFF will produce most rapid fire knockdown, while the "alcohol type" and fluoroprotein will give the best protection against reflash. Small spill fires can be extinguished with BC extinguishers.

According to the American Petroleum Institute (API) RP-1626 Storing and Handling Ethanol and Gasoline–Ethanol Blends at Distribution Terminals and Service Stations, 1st 1985, Gasoline should be added to the tank truck before ethanol, to ensure that the vapor in the compartment is above the upper flammable limits.

From Author: The Local Authority Having Jurisdiction and/or the local code official may require your ethanol blending operation to have FOAM fire protection. From the IFC Fire Code Chapter 34 Flammable & Combustible Liquids
3403.2 Fire protection. Fire protection for the storage, use, and dispensing, mixing, handling and on-site transportation of flammable and combustible liquids shall be in accordance with this chapter and applicable sections of Chapter 9.
3404.2.9.1 Fire protection. Fire protection for above-ground tanks shall comply with Sections 3404.2.9.1.1 through 3404.2.9.1.4.
3404.2.9.1.1 Required foam fire protection systems. When required by the code official, foam fire protection shall be provided for above-ground tanks, other than pressure tanks operating at or above 1 pound per square inch gauge (psig) when such tank, or group of tanks spaced less than 50 feet apart measured shell to shell, has a liquid surface area in excess of 1,500 square feet, and is in accordance with one of the following:
1. Used for the storage of Class I or II liquids.
2. Used for the storage of crude oil.
3. Used for in-process products and is located within 100 feet (30 480 mm) of a fired still, heater, related fractioning or processing apparatus or similar device at a processing plant or petroleum refinery as herein defined.
4. Considered by the code official as posing an unusual exposure hazard because of topographical conditions; nature of occupancy, proximity on the same or adjoining property, and height and character of liquids to be stored; degree of private fire protection to be provided; and facilities of the fire department to cope with flammable liquid fires.

The most likely danger from ethanol fire emergencies is not from incidents involving cars and trucks running on ethanol-fuel (E-10) blends, but instead from tanker trucks and rail cars

carrying large amounts of denatured ethanol or E-85, terminals, and bulk plants facilities and the movements of E-95 from the transport facility to the terminals. That is the pre-dominant product. E-85 is mixed at the terminal and shipped to retail and distributors. With ethanol fires, extinguishment must involve an ATC/AR (alcohol type concentrate/alcohol resistant) foam specifically designed for polar solvents.

Ethanol blends up to 10% with gasoline burn very similar to pure gasoline fires. Whether blended with gasoline or not, ethanol is highly flammable. Ethanol burns different from gasoline. Neat ethanol or denatured ethanol produces an almost smokeless fire. Unlike methanol, ethanol has a red visible flame. It takes 10 gallons of water to extinguish a 1 gallon ethanol fire.

Gasohol, E10, fires may be extinguished using conventional aqueous film-forming foam or alcohol resistant foam, but increased application rates are necessary.

Any ethanol gasoline blends greater than 10% ethanol can only be extinguished with alcohol resistant type foams. All other types of foam or water additives are ineffective as the foam blanket is destroyed when it strikes the fuel surface.

For locations that serve as a site for transferring ethanol or ethanol-blended fuels, a Hazardous Material Management Plan may be required by the Local Authority Having Jurisdiction and/or the local code official (Per IFC Chapter 27, Section 2701.5.1).

US DOT PLACARDING REGULATIONS for BIOFUELS

ALTERNATIVE FUELS SHIPPING PAPER:

The federal HAZMAT regulations requires a person who offers hazardous materials for transportation to describe the material on a shipping paper (bill of lading, product transfer documents) pursuant to 49 CFR 172.

The U.S. Department of Transportation's (DOT) Pipeline and Hazardous Materials Safety Administration (PHMSA) recently issued a letter of interpretation on the proper shipping names for bio-diesel and ethanol when mixed with diesel fuel and gasoline, respectively. The new DOT interpretation would have required petroleum marketers to change shipping paper entries for biodiesel and ethanol blends, neither of which could be shipped under the "diesel fuel" or "gasoline" shipping names. Instead, shippers would be required to label diesel fuel/biodiesel and gasoline/ethanol blends as "diesel fuel solution" and "flammable liquid" respectively.

DOT CHANGES SHIPPING PAPER ENTRIES AND PLACARDING FOR ETHANOL BLENDS

The U.S. DOT's Pipeline and Hazardous Material Safety Administration (PHMSA) issued a final rulemaking on January 28, 2008, that requires new shipping paper entries and placards for gasoline blended with ethanol. PHMSA said the changes are necessary because alcohol blends require different emergency response techniques than straight gasoline. Under the new requirements the shipping paper entries for ethanol blends are as follows:

Blends	OLD Shipping Paper Entry	Shipping Paper Entry Under New Rule
Gasoline up to 10% ethanol content	Gasohol, 3, NA1203, PG II	"NA1203, Gasohol, 3, PG II" *or* "UN1203, Gasoline, 3, PG II" "Gasoline" "Gasohol" 3 (Flammable Liquid).
Gasoline over 10% and up to 20% ethanol	Gasohol, 3, NA1203, PG II	"UN 3475, Ethanol and Gasoline Mixture, 3, PG II"
E-85	Flammable liquid, n.o.s., 3, UN1993, PG II	"UN 3475, Ethanol and Gasoline Mixture, 3, PG II"
Alcohol up to 5% Gasoline	Alcohols, n.o.s., 3, UN1987, PG II	"UN1987, Alcohols, n.o.s., 3, PG II" *or* "NA 1987, Denatured Alcohol, 3, PG II" *or* "UN3475, Ethanol and Gasoline Mixture, 3, PG II"

New placards will also be required for gasoline blended with ethanol in concentrations over 10 percent. Under current regulations, PHMSA allows cargo tanks vehicles with multiple compartments containing different fuels to display a single placard representing the fuel with the lowest flashpoint. Generally, the placard "1203" is used to cover all petroleum distillates contained within a multi-compartment cargo tank. Under the PHMSA rule, this placard will no longer be permitted for ethanol blended with gasoline in concentrations over 10 percent. Instead, compartments with ethanol blends over 10 percent must be marked with a "3475" placard.

Moreover, anytime a compartment contains an ethanol blend over 10 percent, each compartment in the cargo tank vehicle must be individually placarded to the specific fuel it contains. Marketers may still display a single placard for the fuel with the lowest flashpoint in a multiple compartment vehicle if the gasoline blend being transported is 10 percent ethanol or less. In addition, PHMSA is allowing ethanol blended with 5 percent gasoline (E-95) to be marked with the "1987" placard instead of the new 3475 placard. Compliance with the rule is required by January 28, 2010. Voluntary compliance is effective immediately.

The U.S. DOT's Pipeline and Hazardous Materials Safety Administration (PHMSA) explained that proper shipping names for biodiesel blends over B-5 must contain the word "mixture" or "solution". For example, the proper shipping name for a B-20 blend would be "Diesel Fuel Solution 3, NA1993 PG III". PHMSA reasoned that the proper shipping name changes were necessary because biodiesel mixtures required different emergency response procedures than unblended diesel fuel, kerosene or heating oil. This interpretation required petroleum marketers to switch from the traditional proper shipping name "Diesel Fuel, 3 NA 1993 PG III" to the new "mixture" or "solution" entry. Last week PHMSA reversed itself in a new letter of interpretation dated February 28, 2008 (Ref No. 07-0235) explaining that the "mixture" or "solution" entry is not required for biodiesel blends. The letter states:

"It is the opinion of this office that a biodiesel blend may be appropriately described using a proper shipping name that describes its intended application. Thus, a blend of heating oil and biodiesel may be described as "fuel oil", a blend of kerosene and biodiesel may be described as "kerosene" and a blend of diesel fuel and biodiesel may be described as "diesel fuel". Since the names describe the material's intended application, the addition of the qualifying word "mixture" or "solution" is not required. This guidance differs from guidance provided in our November 28, 2007 response on this issue and [PHMSA] apologize[s] for any confusion that may result."

Petroleum marketers may drop the words "mixture" or "solution" from biodiesel blend shipping paper entries.

FEDERAL TRADE COMMISSION ISSUES BIODIESEL DISPENSER LABELS

BACKGROUND: Section 205 of the Energy Independence and Security Act of 2007 directs the Federal Trade Commission (FTC) to require new biodiesel content labels for all dispensers.
COMPLIANCE DATE: Labels must be placed on all biodiesel and biomass-based diesel dispensers no later than December 16, 2008.

DEFINITIONS:

- **Biodiesel - Biodiesel mean the monoalkyl esters of long chain fatty acids derived from plant or animal matter that meet EPA fuel registration regulations and ASTM standard D6751 requirements.**
- **Biomass-Based Diesel - Biomass-based diesel means a diesel fuel substitute produced from non-petroleum renewable resources that meets EPA registration requirements and includes fuel derived from animal wastes, including poultry fat and poultry wastes and other waste materials, or from municipal solid waste, sludge and oils derived from wastewater. Biomass-based diesel *does not* include biodiesel as defined above.**

NOTE: The North Carolina Department of Agriculture Consumer Services Section (NCDA-CS) requires the following on "APPLICATION FOR REGISTRATION OF GASOLINE / DIESEL FUEL BRAND NAME" Form.
See: http://www.ncagr.gov/standard/licenses/documents/BrandName.pdf

NOTE-2 on Form
In No. 1, the brand name always includes the base name and usually includes some type of grade designation or some term which indicates the grade of fuel, for example: "Goodgas Premium", " Goodgas Plus", "Goodgas Unleaded Regular", or "Brand X Diesel No. 2". The registered brand name should be the same as the name displayed on the dispenser. Please note that the same brand name cannot be registered with two different sets of specifications. For example, "Goodgas Unleaded Regular" if registered as a straight gasoline, cannot be registered as a gasohol unless an appropriate additional term is included, such as, "Goodgas Unleaded Regular - Contains Ethanol". Biodiesel or Biodiesel Blend shall include a capital B followed by the numerical value of the percentage of biodiesel fuel and ending with the word biodiesel, for example: "Brand X B20 Biodiesel."

Example NCDA-CS Bio-Diesel Label blends above 5%.

TANNERS B-10 BIODIESEL BLEND

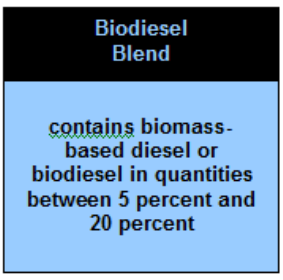
OR

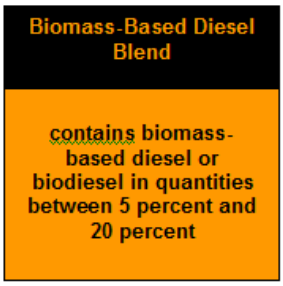
OPIE B-15 BIODIESEL BLEND

FTC COMPLIANCE - Required Dispenser Labels: (NCDA-CS regulates dispenser labels for NC.)

- **FTC & NCDA-CS: Blends Up to 5% - No dispenser label required. (This is also approved by NCDA-CS)**

- **FTC-Blends Greater than 5% and up to 20% - The label must state:**

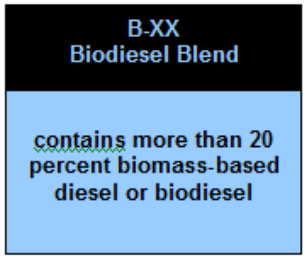


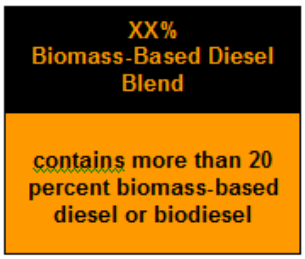


*** Any specific designation of biodiesel content (B-2, B-5, B-10, B-15 etc.) *may* be displayed if desired. Use "B-X" where X=biodiesel volume content and place before the words "Biodiesel Blend" in the black box of the blue label. Any specific designations of biomass-**

based diesel content (2%, 5% 10% or 15% etc.) *may* be displayed. Place the numerical percentage of the biomass content before "Biomass-Based Diesel Blend" in the black box of the orange label.

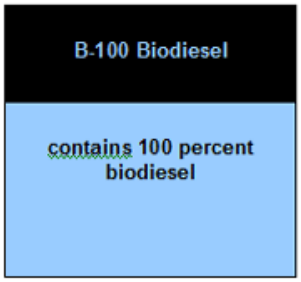
- **FTC-Blends greater than 20% - The label must state:**

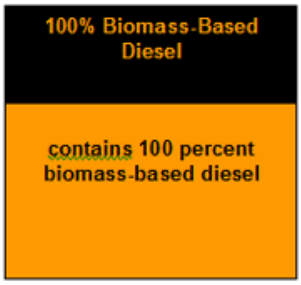




*** XX denotes the percentage of biodiesel or biomass-based diesel in the diesel fuel blend.**

- **100% biodiesel or bio-mass based diesel blends - The label must state:**





LABEL PLACEMENT: The label, or labels, must be placed conspicuously on the dispenser face in full view of consumers and as near to the price per unit as reasonably practicable.
FUEL RATING CERTIFICATION: In each transfer a fuel distributor makes to anyone who is not a consumer, the biodiesel content or biomass-based diesel content of the blend must be certified on the delivery ticket, bill or lading product transfer document or invoice that accompanies transfer of the fuel. Certification is made by indicating on the transfer document the volume percentage of the biodiesel or biomass-based diesel contained in the blend. Example: "B-5" or "B-20" or "Contains 20% biodiesel". Most distributors are already complying with these requirements.
RECORD KEEPING REQUIREMENTS: The FTC requires distributors and retailers to keep documents containing fuel certifications for one year. Retailers and distributors are already required to keep such records under existing EPA and DOT regulations so no additional record keeping burden is added by this rule.

Ethanol Market Penetration

See http://www.afdc.energy.gov/afdc/ethanol/market.html for full reports

Domestically produced ethanol has the potential to displace a significant amount of U.S. petroleum consumption. A joint U.S. Department of Energy (DOE)/U.S. Department of Agriculture (USDA) study found that 1.3 billion tons of biomass—predominantly cellulosic feedstocks—could be produced for biofuel production in the United States annually with only modest changes in farming practices (see the report). This quantity of feedstocks could be used to produce enough biofuels—mostly ethanol—to satisfy about one third of current U.S. petroleum demand. The potential could be even larger if technology is developed to take advantage of additional forms of biomass such as algae.

The potential of biomass-derived fuels is key to U.S. petroleum displacement goals. The Energy Policy Act of 2005 established a nationwide renewable fuels standard requiring use of 7.5 billion gallons of renewable fuel by 2012. The Energy Independence and Security Act of 2007 boosted this renewable fuels standard substantially, requiring 36 billion gallons of annual renewable fuel use by 2022. Of this requirement, 21 billion gallons must be "advanced biofuels"—fuels that cut greenhouse gas emissions by at least 50%—including 16 billion gallons of cellulosic biofuels. Visit the Renewable Fuels Association Web site for more information about the Renewable Fuels Standard.

DOE and USDA are leading a multi-agency effort to achieve these ambitious goals. The National Biofuels Action Plan outlines the collaborative strategy. For additional details, visit the DOE Biomass Program, USDA Energy, and Biomass Research & Development Initiative Web sites.

Ethanol primarily replaces gasoline as a fuel for passenger vehicles. The table below shows the penetration of ethanol, flexible-fuel vehicles (FFVs), and E85 stations into the gasoline market. As of 2007, about 3% of gasoline-vehicle fuel consumption—4.6 billion gasoline gallon equivalents (GGEs)—was attributed to ethanol, which was produced almost entirely from corn and consumed predominantly in the form of low-level blends.

US Ethanol Bio-Refinery Locations: http://www.ethanolrfa.org/bio-refinery-locations/

U.S. FEDERAL BIOFUELS INCENTIVES

Biodiesel Blenders Tax Credit (available 2005-2013):

IRS ISSUES GUIDANCE ON CHANGES TO BIODIESEL TAX CREDIT

NOTE: On January 2, 2013, Congress reinstated the one-dollar per gallon biodiesel blender's credit through December 31, 2013 and retroactive to January 1, 2012. The federal blender's credit for alcohol mixtures has not been reinstated. The IRS will issue guidance on claim filing procedures for the retroactive biodiesel credit.

The Internal Revenue Service issued guidance (11-2008) on changes to the federal biodiesel tax credit resulting from a revision to the requirements of American Society for Testing and Materials (ASTM) D6751 Biodiesel Standard. The revised ASTM D6751 took effect on October 13, 2008. Under the IRS code, only biodiesel that conforms to ASTM D6751 is eligible for the current 50 cent federal tax credit for each gallon of biodiesel blended with diesel fuel and the $1.00 per gallon credit for blending with agri-biodiesel. *(ends 12-31-2011*

***ISSUE*: THE IRS guidance allows a transition period during which biodiesel that conforms to the *old* ASTM D6751 - in effect before October 13, 2008 - still qualifies for the federal tax credit.**

Beginning October 1, 2009, only product that meets the revised ASTM D6751-08 standard will qualify for the one dollar per gallon federal biodiesel tax credit. In addition, all producer certificates must certify after September 30, 2009 that the product meets "ASTM D6751-08" in order to qualify for the federal biodiesel tax credit.

***OVERVIEW OF THE TAX CREDIT:* Sections 40A, 6426 and 6427(e) of the Internal Revenue Code (IRC) provide tax credits for the production, sale and use of biodiesel and biodiesel mixtures. Section 40A(d)(1) defines biodiesel as monoalkyl esters of long chain fatty acids derived from plant or animal matter that meet EPA fuel registration requirements *and* ASTM D6751. In order to be eligible for the credit, blenders are required under IRC 6426(c)(4) to obtain a certificate from the biodiesel producer that certifies the biodiesel used in the mixture conforms to ASTM D6751. On October 13, 2008, the ASTM revised the standard for D6751 by adding a cold soak filtration test for biodiesel.**

COMPLIANCE TRANSITION PERIOD: **If a claim relates to the production, sale, or use of biodiesel or a biodiesel mixture, and the production sale or use occurs before April 1, 2009, a certificate that states the biodiesel covered by the claim meets the requirements of D6751 is valid if the biodiesel meets the requirements of ASTM D6751 in effect either *BEFORE* or *AFTER* October 13, 2008.**

If a claim relates to the production, sale or use of biodiesel or a biodiesel mixture *and* the production sale or use occurs on or after April 1, 2009, a certificate that the biodiesel covered by the claim meets the requirements of ASTM D6751 is valid only if the biodiesel satisfies the requirements of ASTM D6751 in effect after the October 13 revision adding a cold soak filtration test.

***BOTTOM LINE: You may c*ontinue to blend biodiesel that conforms to the old ASTM D6751 standard and still be eligible for the federal tax credit until April 1, 2009. Beginning April 1, 2009, only biodiesel that meets the new ASTM D6751 standard, as revised effective October 13, 2008, is eligible for the federal tax credit. You shall ensure that, after April 1, 2009, all certificates from producers refer to "ASTM D6751-08".**

- **A $1.00/ gallon tax credit for "agri-biodiesel" (1st use vegetable oils and animal fats-including palm and fish oil) and a $.50/gallon tax credit for biodiesel produced from recycled oils and animal fats is available for biodiesel blended with petroleum diesel. The benefit of the credit is calculated based on the percent of biodiesel blended with petroleum diesel, so that a 20% of "agri-biodiesel" is worth .20 per gallon. Biodiesel blended fuel is defined as any blend equal or greater than 1 gallon of diesel fuel with 999 gallons of biodiesel.**
- **Blenders must register with the IRS to claim the tax credit by completing Form 637-M. Contact local IRS field office for further information about the registration process and timing. Registration can take a considerable amount of time. Contact: IRS Southeast field office manager: Willie Clayton (407) 660-5822 Ext. 210.**
- **Registered blenders claim the tax credit on Form 720. A blender does not have to have a tax liability to receive the credit. A direct link to IRS forms is: http://www.irs.gov/formspubs/lists/0,,id=97817,00.html.**
- **On-road and off-road diesel fuel are eligible for the blenders credit.**

For more information contact: http://www.biodiesel.org/

Volumetric Ethanol Excise Tax Credit (VEETC) (available 2005-2009):

EXPIRED* EXPIRED**** EXPIRED**** EXPIRED**** EXPIRED**** EXPIRED*******

REDUCED FEDERAL ETHANOL TAX CREDIT GOES INTO EFFECT JANUARY 1, 2009

Beginning January 1, 2009, the federal tax credit for ethanol blends is reduced from 51 cents for every gallon of ethanol mixed with gasoline to 45 cents (5.1 cpg to 4.5 cpg for E-10 blends). The reduced rate is the result of changes made by Congress in the 2008 Farm Bill. Under the bill, the 51 cpg tax credit rate is reinstated anytime the IRS makes a determination that ethanol production for the previous calendar year falls below 7.5 billion gallons.

The IRS recently announced that ethanol production for 2008 is estimated to be 11.1 billion gallons. As a result, the federal ethanol tax credit rate is reduced to 45 cents per gallon beginning January 1, 2009. Claims for the ethanol tax credit are filed on IRS Form 720 Quarterly Federal Excise Tax Return. The ethanol credit must first be taken against existing federal motor fuel excise tax liability for the quarter in which the claim is made. If the amount of the ethanol credit in a claim exceeds a person's tax liability for any quarter, an income tax credit or refund is available

to the blender.

An income tax credit may be filed on IRS Form 720 Quarterly Federal Excise Tax Return or IRS Form 4136 Credit for Excise Tax Paid on Fuels. An income tax refund may be filed on IRS Form 8849 Claim for Refund of Excise Taxes. The IRS is in the process of updating Forms 720, 4136 and 8849 to reflect the new 2009 rate.

- **Allows for a tax refund of 45 cents per gallon on each gallon of ethanol blended with gasoline to be paid within 20-28 days of blending gasoline with ethanol. For E85 (85% ethanol, 15% gasoline) the credit is equal to 0.3825 cents per gallon. For E10, the credit is worth .045 cents per gallon. The credit is available until 2010.**
- **VEETC eliminates the need of the alcohol fuels income tax credit which was cumbersome and subject to alternative minimum tax requirements. VEETC provides credit for every gallon of ethanol used in the marketplace without regard to the income of the taxpayer or whether the ethanol is used in a taxed fuel or tax exempt fuel.**
- **Blenders must register with the IRS to claim the tax credit by completing Form 637-M. Contact local IRS field office for further information about the registration process and timing. Registered blenders may claim the credit weekly for refunds greater than $200 with Form 8849, quarterly with Form 720 or annually with Form 4136. The same refund forms are used for both biodiesel and ethanol blending.**

For more information visit: http://www.ethanolrfa.org

Refueling Infrastructure Tax Credit:

- **The 2005 Energy Bill provides a 30% tax credit (up to $30,000) for refueling equipment for E85 ethanol, compressed natural gas, liquefied petroleum gas, hydrogen, and biodiesel blends containing at least 20 percent biodiesel. The Internal Revenue Service (IRS) has recently published Form 8911 *Alternative Fuel Vehicle Refueling Property Credit* which provides instructions and guidelines to obtain the credit.**

1. There is a 30% federal tax credit (up to $30,000) for E85 refueling equipment placed in service before December 31, 2009. The credit is claimed through IRS Form 8911, in addition there is a 15% NC state tax credit for E85 equipment http://www.afdc.energy.gov/afdc/laws/?afdc/5770/0

2. Tax information and IRS Forms here:

- **http://www.ethanol.org/index.php?id=59&parentid=29**
- **U.S. Government Web Site: http://www.afdc.energy.gov/afdc/about.html**
- **State Tax Credits: http://www.afdc.energy.gov/afdc/laws/state**
- **Federal Tax Credits: http://www.eere.energy.gov/afdc/progs/view_ind_fed.php/afdc/319/0**
- **IRS information, visit IRS Form 637 and IRS publication 510.**

Post Script on Air Pollution Emissions:

The EPA is determining whether to execute a largely undefined energy-law mandate that requires biofuels emit at least 20 percent less greenhouse gas (GHG) emissions over the lifecycle span than conventional petroleum fuels. Some scientists have argued that direct and indirect emissions from biofuels lifecycle GHG emissions might actually be higher than convention petroleum fuels. A thorough biofuel lifecycle GHG emission study would include the carbon released from soils in forest areas which are converted to grow feedstock to produce biofuels. The EPA must also decide whether to include in its study the carbon footprint impact from biofuels produced in countries other than the United States.

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