Effects of Biodiesel Blends On Leak Detection for Underground Storage Tanks and Lines

Amended Final Report

PREPARED FOR:

Biodiesel Industry Advisory Panel

Amended January 2011
Originally Submitted August 2010

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Preface

This report presents the results of an independent third-party review of the effects of various blends of biodiesel on different leak detection technologies as they are applied to underground storage tanks and pipelines. The purpose was to identify any adverse effects that might compromise the capability of these leak detection devices to detect leaks as specified by the USEPA.

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Executive Summary

The purpose of this project was to determine the effect of biodiesel on the available leak detection systems that are currently in use in fueling stations across the USA. These systems have been in place since the 1990 and have been used extensively in both gasoline and diesel fuel without any major issues for most systems. In fact most of the problems with these systems have been due to human error such as mis-programming or malfunctioning of the electronics. Problems with the operational issues usually resulted in elimination of the method from the approval process thus eliminating them from significant numbers of installations.

More recently with the introduction of gasoline/alcohol blends and petro diesel/biodiesel, serious issues have been raised as to the suitability of the available leak detection systems with these new fuels. It was therefore desirable to conduct a comprehensive review of the measurement principles to determine if leak detection systems could be expected to perform reliably in these new fuels, and in particular, biodiesel blends.

Most of the considerations in this document focused on B20, a blend of 80% petro diesel and 20% biodiesel. However, many of the conclusions for B20 and lower blends would also apply to blends over B20 such as B21 to B99 or even pure biodiesel, B100.

Blends containing 5% biodiesel or less are now considered by UL and ASTM as conventional diesel fuel requiring no further testing than has been done with petrodiesel. This evaluation comes to that same conclusion for leak detection systems for blends of B5 and lower.

It has been our observation over many years of testing leak detection hardware that almost all leak detection systems will work with virtually any liquid as long as the components in contact with the fuel are not degraded by the contact. While some data is available for compatibility, the compatibility issues were not directly addressed in this document. Individual manufactures of leak detection equipment will need to determine if their equipment will be compromised by use with biodiesel.

Our conclusion is that, based on the operational principles of most leak detectors, there should be no problems with the currently available systems in biodiesel up to 20% and probably much higher. The only factor we deemed of serious enough for additional consideration involves the compatibility of the components of the leak detectors in contact with the fuel. The systems will, of course, need to be calibrated for the biodiesel blends just as they are for petrodiesel and the float and other components must be compatible with the known combinations where high biodiesel concentrations might degrade the leak detection system.

1.0 Background

The National Biodiesel Board (NBB) has commissioned a review of leak detection systems that could be used to monitor tanks and pipelines containing biodiesel fuels. This was a proactive move to ascertain whether or not biodiesel might present problems for the existing leak detection systems and to address these issues as expeditiously as possible. Accordingly we have reviewed all of the currently approved leak detection methods for any operational details that might be impacted by contact with biodiesel.

The federal Environmental Protection Agency (USEPA) has issued a series of documents[1] that describe the procedures to be used to verify that leak detection equipment meets the performance requirements of the Federal Register.[2] The relevant sections of this document can be found in Attachment A. The question at issue is whether the testing that has already been completed on petrodiesel is sufficient to consider that same equipment also acceptable for biodiesel or biodiesel blends.

Additionally, the test procedures are listed with the National Workgroup on Leak Detection Evaluations (NWGLDE).[3] Their web site also lists leak detection methods that have been evaluated and found to meet the requirements of the EPA. These leak detection methods are organized by the type of leak detection (e.g. tank or pressurized piping), by the technology used, and by the company that provides the leak detection equipment.

A wide variety of leak detection systems were reviewed for this report. We concluded that if biodiesel were to affect a leak detection method, the method would need to be evaluated to determine the potential effect on the technology used by the method for making its required measurements. Whether the basic measurements used by the leak detection method are used to detect a leak in an underground tank, an aboveground tank, or a line would not be affected by the use of a biodiesel product if the basic measurements are not affected by the biodiesel. Consequently, the analysis concentrates on the different measurement technologies and assesses whether these would be affected by the use of biodiesel rather than petro diesel.

[1] "Standard Test Procedures for Evaluating Leak Detection Methods," EPA/530 UST-90/001-7, March to October 1990. Seven different procedures were developed for different leak detection methods and released between March and October 1990.

[2] 40CFR Part 280, Subpart D. (see Attachment **D)**

[3] In 1994, the EPA established the National Work Group for Leak Detection Evaluations, which consists of a group of State and Federal Regulators that review leak detection evaluations, new evaluation protocols, and other issues affecting the leak detection and underground storage tank industry.

2.0 Biodiesel Characteristics

Biodiesel Production

Biodiesel (B100) is defined as “a fuel comprised of mono-alkyl esters of long-chain fatty acids derived from vegetable oils or animal fats.” In addition, it must meet all of the parameters as defined within the ASTM specification D6751, “Standard Specification for Biodiesel Fuel Blend Stock (B100) for Middle Distillate Fuels.” Biodiesel has been registered with the U.S. EPA as a fuel and a fuel additive under Section 211(b) of the Clean Air Act.

Biodiesel is composed of several types of organic compounds. In fact, the number of major components in biodiesel is much less than for petro diesel. For purposes of this document, the discussion has been primarily on biodiesel obtained from soybean oil due to the prevalence of research information available on soybean oil based biodiesel in the US. Biodiesel can be obtained from many other sources such as various other vegetable oils and animal fats. However, the ASTM specifications limit the physical and chemical properties of the finished biodiesel within tight ranges independent of the feedstock or process used for its production so discussion of the effects of biodiesel on leak detection methods is valid for any product meeting the definitions in ASTM D6751 for B100 or ASTM D7467 for blends between B6 and B20.

Biodiesel is a diesel replacement fuel for use in diesel engines. It is manufactured from plant oils e.g., (soybean oil, cottonseed oil, canola oil), recycled cooking greases or oils (e.g., yellow grease), or animal fats (beef tallow, pork lard). 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 plants or animals, and these too are renewable. Used cooking oils are mostly plant based, 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 and this process is referred to as transesterification. Roughly speaking, 100 pounds of oil or fat are reacted with 10 pounds of a short-chain alcohol (usually methanol) in the presence of a catalyst (usually sodium hydroxide [NaOH] or potassium hydroxide [KOH]) to form 100 pounds of biodiesel and 10 pounds of glycerin. Glycerin is a sugar, and is a co-product of the biodiesel process.

Biodiesel Specifications

The specifications for biodiesel and petro diesel are contained in various ASTM documents, which can be found in Table 1 below.

The specifications for 100% biodiesel (B100) are contained in ASTM D6751. All biodiesel must meet D6751 prior to being blended with petrodiesel. ASTM D6751 has been improved recently to include additional parameters for longer term fuel stability and degradation, as well as improvements to insure that blends of D6751 B100 with petrodiesel will operate down to their cloud point similar to petrodiesel that does not contain biodiesel.

The specifications for petrodiesel are contained in ASTM D975, which now permits the blending of up to 5% biodiesel as a fungible component. D975 requires the B100 to meet D6751 prior to blending. As such, B5 or lower blends are now considered just ‘normal’ diesel fuel and meet the same physical and chemical parameters as petrodiesel containing no biodiesel. Based largely on the acceptance of B5 in D975, along with additional internal testing, there is good agreement with the diesel engine and vehicle companies for acceptance of B5 in existing diesel powered equipment. In addition, UL has recently announced they see no additional needs for B5 beyond the testing already completed on pure petrodiesel.

The specifications for biodiesel blends (with petro diesel) from 6% to 20% are found in ASTM D7467. D7467 also contains the same exact physical and chemical parameters and limits as D975, but includes additional measurements for long term fuel stability (6 hour stability induction period, acid number of 0.3 maximum) and an allowance for a slightly higher (i.e. slightly safer) T-90 distillation temperature. Blends containing between 20% and 100% of biodiesel would have characteristics intermediate between the specifications of ASTM 6751 and ASTM 7467.

The ASTM D6751, D975, and D7467 specifications have been designed so that if the two parent fuels meet their specifications prior to blending the blends will automatically meet their specification. Therefore, the important quality control is at the parent fuel level. Petro diesel that meets ASTM D975 can be blended with biodiesel meeting ASTM D6751, and blends between 6% and 20% will automatically meet the specifications of ASTM D7467.

The National Biodiesel Board has also instigated a national BQ-9000 quality program for the biodiesel industry in the USA to provide further confidence and assurance that biodiesel will meet its ASTM specifications. According to a recent independent survey of the Department of Energy’s National Renewable Energy Laboratory (NREL), BQ-9000 companies consistently met ASTM D6751 and about 70% of the volume of biodiesel sold in the US is sold by BQ-9000 companies.

Table 1. ASTM Specifications for Diesel and Biodiesel

ASTM Document #	**Title**	**Blend**
ASTM D975	Standard Specification for Diesel Fuel Oils	Petro diesel (D100), incl. up to 5% biodiesel (B5)
ASTM D6751	Standard Specification for Biodiesel Fuel Blend Stock (B100) for middle Distillate Fuels	100% Biodiesel (B100)
ASTM D7467	Standard Specification for Diesel Fuel Oil, Biodiesel Blend (B6 to B20}	Biodiesel blends from 6% to 20%. (B6 to B20)

The definition of biodiesel recognized by both the EPA for fuel registration purposes and the Internal Revenue Service (IRS) for the blender's tax credit is the definition in ASTM D6751: A fuel comprised of mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats, designated B100, and meeting the requirements of ASTM D 6751.

3.0 Leak Detection Characteristics and the Biodiesel Effect on Them

In this section, each technology is described; then each is assessed as to whether or not or to what extent the use of biodiesel instead of petro diesel would affect the technology.

There are many leak detection systems available, many of which are based on the same operational principles. For example, an automatic tank gauge using a magnetostrictive probe (the most popular way to monitor for leaks in underground tanks) relies on an accurate level measurement combined with an accurate estimate of the temperature behavior of the fuel during the test. Using the temperature changes and the coefficient of expansion, the level change can be accurately monitored. Level changes due to temperature are used to correct the measured level change to get an accurate estimate of the change in the volume of fluid in the tank during the leak test.

Information of this type is tabulated in Table 2 for all of the currently used systems for detecting leaks in motor fuel tanks. Only the basic measurement parameters are listed. There are very many refinements that separate the excellent methods from the less than excellent methods in use. The minor, but important, adjustments are usually proprietary and would not be a factor in determining their suitability for use in biodiesel. The compatibility of components with biodiesel is not included in this table as they were not considered to a basic operating principle. Compatibility is discussed in a later part of this report and can usually be fixed by selecting a different media.

Table 2. Important Parameters for Leak Detection Systems   Page 1 of 2

Leak Detection Methods	Parameter									
	Level	Temp.	C of E	Water	Viscosity	Density	Pressure	Meter Calib.	Fuel Delivery	Other
Volumetric Systems										
Automatic Tank Gauges (ATGS)										
Magnetrstrictive Probes	Yes	Yes	Yes	Yes	No	Yes	No	No	No	
Acoustic Methods	Yes	Yes	Yes	Yes	No	No	No	No	No	Acoustic signal from leak
CITLDS - Continuous ATGS	Yes	Yes	Yes	Yes	No	Yes	No	No	No	
Capacitance Probes(1)	Yes	Yes	Yes	Yes(1)	No	No	No	No	No	
Mass Based Systems	Yes	No	No	Yes	No	Yes	Yes	No	No	
Acoustic Methods	Yes	No	No	Yes	No	Yes	No	No	No	Time of Flight
Inventory Reconciliation										
SIR - Manual	Yes	No	No	Yes	No	No	No	Yes	Yes	
SIR - data from ATGS	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	
CITLDS - Continuous Reconciliation	Yes	Yes	Yes	Yes/No	No	No	No	Yes	Yes	

Table 2. Important Parameters for Leak Detection Systems (continued)

	Parameter									
Leak Detection Methods	**Level**	**Temp.**	**C of E**	**Water**	**Viscosity**	**Density**	**Pressure**	**Meter Calib.**	**Fuel Delivery**	**Other**
Nonvolumetric Methods										
Acoustic –Tanks	No	No	No	No	No	No	No	No	No	Acoustic signal from leak
Acoustic – Lines	No	No	No	No	No	No	No	No	No	Acoustic signal from leak
Tracers	No	No	No	No	No	No	No	No	No	Soil Porosity, water table
Fuel Sensitive Polymers (2)	No	No	No	No	No	No	No	No	No	Above water Table (2)
Interstitial Methods (3)										
Liquid Filled	Yes	No	No	No	No	No	No	N/A	N/A	
Vacuum	Yes	No	No	No	No	No	Yes	N/A	N/A	
Pressure	Yes	No	No	No	No	Yes	Yes	N/A	N/A	
Sensor - liquid ingress	Yes	No	No	No	No	No	No	N/A	N/A	Depends on liquid sensor
Pipelines										
Pressure Decay	No	No	No	No	No	No	Yes	Yes	N/A	
Constant Pressure	No	No	No	No	No	No	Yes	Yes	N/A	
Mechanical Leak Detectors	No	No	No	No	Yes	No	Yes	No	N/A	
CITLDS-Pipelines	No	No	No	No	Yes	No	Yes	Yes	N/A	

(1) - Capacitance probes cannot be used in fuels containing water or alcohols

(2) - Must contact fuel, cannot be used at previously contaminated sites

(3) – Does not depend on product

In general, leak detection methods are designed to detect a loss of liquid from a tank or line and to identify and/or compensate for factors other than a leak that might lead to a loss of volume. As such, leak detection methods generally are not sensitive to the particular liquid that is in the container they are testing.

ASTM Specifications D6751 provides specifications for biodiesel (B100) in terms of a number of physical and chemical properties. ASTM D975 contains similar specifications for petro diesel, and ASTM D7467 has specifications for blends from 6% to 20% of biodiesel in petro diesel. Those characteristics that are important for leak detection are compared in Table 3 and are quite similar. Table 3 has been abstracted from several sources, including the ASTM specification documents and research reports on biodiesel[1]. Since the standard petro diesel and the biodiesel are similar, it is unlikely that leak detection methods would perform differently on the two liquids, or on the various blends of them.

Table 3. Select Properties of Petro diesel and Biodiesel

Fuel Property	Petro diesel No.2	Biodiesel B6-20	Biodiesel B100
Fuel Standard	ASTM D975	ASTM D7467	ASTM D6751
Kinematic Viscosity @ 40 C (104 F)	1.3-4.1	1.9-4.1	1.9-6.0
Cloud Point C (F)	-35 to 5 (-31 to 41)	Intermediate	-3 to 15 (26 to 50)
Specific Gravity kg/l @ 15.5 C (60 F)	0.85	0.85-0.856	0.88
Density lb/gal @ 15.5 C (60 F)	6.98-7.16	6.98-7.34	7.07-7.42
Thermal Coefficient of Expansion[1]	~0.00045	~0.00045	~0.00045
Compatibility issues	None	None	Cuprous alloys, some rubber compounds

[1]Depends on specific gravity—the same API tables are used for Petro diesel and Biodiesel

Biodiesel has a nominal specific gravity of 0.88 in comparison to No. 2 diesel at 0.85 and No. 1 diesel at 0.80. Due to the ASTM specifications for pure biodiesel, biodiesel meeting D6751 exhibits less variation in specific gravity than that between Number 1 and Number 2 petrodiesel.

Number 2 diesel fuel has cloud points between -31F and +41F, while biodiesel generally has higher cloud points (between +26F and +50F). Higher cloud point and pour point can lead to plugging of filters and forming a gel layer at the bottom of aboveground tanks in cold temperatures with both Number 2 diesel and biodiesel. This is more likely to happen with pure biodiesel than with pure petrodiesel. Use of blends, such as B5 or B20, helps serve to mitigate any differences between these blends and their petrodiesel only counterpart.

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1 "Biodiesel Handling and Use Guide, 4th Edition," NREL/TP 540 43672, revised January 2009, available electronically at http://www.osti.gov/bridge. "Biodiesel Technical Information, ADM, available at http://www.biodiesel.org. 40 CFR 80 SubPart M, Amended February 3, 2010. Reynolds, Robert E., "Changes in Diesel Fuel," available for download at Petro dieselFuel@yahoo.com.

B100 is not compatible with some hoses and gaskets that are compatible with B20 (see "Elastomer Compatibility Testing of Renewable Diesel Fuels", NREL and SwRI Technical Report, NLRE/TP-540-38834, November 2005). Because most testing has been on B20 or B100, and not on intermediate blends, adverse effects on hoses and gaskets associated with higher blends may take some time to develop and users may go for many months without a problem.

Biodiesel is a better solvent than petro diesel, which may cause high concentrations of biodiesel (or B100) to dissolve tank sediments left by petrodiesel over time which can clog filters in either warm or cold weather, especially when switching to biodiesel for the first time. The tank cleaning effect has not been evident with B5 and lower blends, and occurs in approximately 2% of the cases upon switching over with B20 blends. Once the sediment have been cleaned, the need for filter changes returns to normal.

Most of the characteristics listed in the ASTM specifications do not affect leak detection technologies. For example, the sulfur levels in the fuel will not affect the temperature or level measurements. However, there is a possibility that the specific gravity (or density) of the product, the thermal coefficient of expansion, and the cloud or pour point might affect certain leak detection technologies. In addition, there are some material compatibility issues with B100 and biodiesel blends above 20% that might affect some leak detectors if they are constructed with materials with the compatibility problems. For example, some mechanical line leak detectors have brass components which may cause premature fuel degradation and filter clogging with high biodiesel blends and some elastomers are not compatible with high biodiesel blends. The manufacturers of the equipment may need to substitute components constructed of other materials or recommend specific precautions (such as the use of fuel stability additives or metal chelators) to users when using high biodiesel blends. The potential effect of these is discussed with each leak detection technology below.

4.0 Parameters of Interest in Leak Detection Systems

Level Measurement

Volumetric leak detection technologies use level measurement as an essential part of the method. The main approaches to level measurement are a magnetostrictive probe, an ultrasonic probe, a buoyancy probe, a pressure sensor, or a capacitance probe. Often a level measurement is coupled with a temperature sensor and a temperature correction to account for temperature changes during the testing.

These level measurement technologies are used in automatic tank gauging leak detection tests and tank tightness tests. They are also used to check for leaks in sumps or in reservoirs connected to liquid-filled interstices monitoring double-walled underground storage tanks.

Magnetostrictive probes

This system uses a float containing magnets to measure the level. The measurement is made electronically by sending an electronic pulse down a wire. The pulse reacts with the magnetic field produced by the magnets in the float and reflects back up to the electronic control. The time for this signal to be sent and received is used to compute the level of the float. The density of the product could affect the float. However, although the float might be slightly higher in biodiesel due to its slightly higher density, this would not affect the leak detection test, as the leak detection test relies on measuring the level change during a fixed time period. The different levels of the float could affect the estimate of the total product in the tank or vessel in a minor way, but this would not affect tracking the level change over time. The change in density between number 2 diesel and biodiesel (B100) is about 3%, while the difference between number 1 diesel and number 2 diesel is about 5%. With B20 this difference is reduced to about half a percent, and it is even lower for lower blends of biodiesel. Consequently, with the small difference in density between biodiesel and diesel, this change in sensitivity would not be important to the function of the leak detector.

Ultrasonic probe

This system uses an ultrasonic pulse passed through the liquid coupled with the time of flight or speed of sound to measure the level. The density of the liquid could affect the speed of sound and the time of flight. However, the ultrasonic probes have a number of calibration rods in them, so the signal is self-calibrating because it corrects for the speed of sound by using the known, fixed distances to the calibration rods to account for different speeds of sound due to density changes. Consequently, the level measured by an ultrasonic probe would not be affected by the different product density. It is unlikely that fuel temperatures would fall below the cloud point, but cloudiness could affect some types of ultrasonic systems. For biodiesel blends, this will need to be considered by manufacturers of this equipment in a similar way to considerations used for number 2 which can also cloud in low temperatures, although the issue with pure biodiesel may require more attention than with number 2 petrodiesel.

Buoyancy Probe

A buoyancy probe uses a float suspended from a load cell. The load cell measures the buoyant force on the float. As the product level increases, the buoyant force increases, reducing the weight on the load cell. As the product level falls, there is less buoyancy and the load cell sees an increased weight. The change in the weight or force measured by the load cell is used to track small changes in product level. A change in the density of the product would change the sensitivity of the system. For a denser product, smaller level changes would result in larger changes in the force measured by the load cell. The change in density between diesel and biodiesel (B100) is about 3%. With B20 this is reduced to about half a percent, and it is even lower for lower blends of biodiesel. Consequently, with the small difference in density between biodiesel and diesel, this change in sensitivity would not be important to the function of the leak detector.

Mass Measurements

Another way to measure the liquid level and track changes is to use a pressure sensor. As the height of the liquid column above the pressure sensor changes, the pressure changes and this can be converted to a liquid level measurement. This type of system has the advantage that if the pressure sensor is at the bottom of the tank, the system is is self-correcting for temperature changes and thermal expansion in vertical cylinders and can be mathematically corrected for horizontal tanks. The product density could affect this measurement, since the pressure is proportional to the liquid level times the product density. Any problems of this type can be corrected mathematically. The difference in density between diesel and biodiesel (B100) is about 3%. With B20 this is reduced to about half a percent, and it is even lower for lower blends of biodiesel. Tracking small changes would not be seriously affected by the difference in density between biodiesel and diesel.

Capacitance Probe

The capacitance probe uses the electrical capacitance of a circuit with the product as the dielectric of a capacitor to measure level. Although there are still a fair number of the probes in service, there are no manufactures who currently offer these types of probes. They do not work well in alcohol blends or when exposed to water.

As the product level changes, the length of the capacitor that has the product as its dielectric, compared to the length with air as the dielectric, changes, and this change is converted into a level measurement. The parameter that could affect this type of probe would be the dielectric constant of the product. The similar chemical make up of the products makes the dielectric constant of biodiesel and biodiesel blends similar to that of petro diesel.[2] B100 has higher conductivity than petro diesel. However, petro diesel with low conductivity usually has an additive to increase the conductivity to lower the risk of problems with static electricity. This additive makes typical values similar for

2 "Electrical Conductivity of Biodiesel," National Biodiesel Board, testing to ASTM Standard D2624 conducted by Williams Pipeline.

petro diesel and biodiesel. In any event, the level measurement is made by observing the change in conductivity or dielectric constant between the product and water. Biodiesel has a large difference in dielectric constant from that of water, so the small changes in conductivity or dielectric constant with biodiesel should not affect this measurement system. Capacitance probes are not currently manufactured, although there are still some older systems in the field that use them.

Temperature Measurement

Temperature measurements are important for volumetric methods. The temperature of the fuel is easily obtained using thermocouples, RTD's thermistors or other measurement device. The temperature sensors are readily installed within the fuel by inclosing them in a protective housing such as the probe shaft. Since they are protected from direct contact with fuel, the type of liquid surrounding the housing is incidental to the temperature measurement and is not affected by the type media surrounding the temperature sensor.

In many leak detection systems, the liquid level measurement is converted to a volume based on the geometry of the tank. Once the volume has been determined, it is tracked over a period of time to check for changes that might be caused by a leak. Usually the temperature of the product is tracked also and used to compensate the volume for any temperature changes that occur during the test. The volume change depends on the size of the temperature change, the initial volume of the liquid, and the thermal coefficient of expansion. Originally, there was thought to be somewhat of a difference in the thermal coefficient of expansion between biodiesel and petro diesel. However, more recent test data have convinced the Environmental Protection Agency to recommend that the standard ASTM tables[3] used for petro diesel also be adopted for finding the thermal coefficient of expansion for biodiesel.

Generally, leak detection systems that use the thermal coefficient of expansion in temperature compensations determine the value of the coefficient for the product and enter it into the calculations. The API table gives the coefficient of expansion based on the product temperature and density (or specific gravity). Since the same table is recommended for both petro diesel and biodiesel, there should be no difficulty in adapting leak detection systems to use an appropriate coefficient of thermal expansion. This is especially true since the densities differences between pure biodiesel and pure number 2 (3% difference) diesel are less than the density difference between number 1 and number 2 (5% difference). Some leak detection systems that use a single parameter for the coefficient of expansion (such as some automatic tank gauges) and input it during the set-up of the system. Since the difference between biodiesel and number 2 is less than the difference between number 1 and number 2, the leak detection system should function adequately through use of a single parameter for all biodiesel and diesel fuel. In fact, the density of a number 1 biodiesel blend may be exactly the same as the density of a number 2 blend with no biodiesel. If the small density difference between fuels is important—whether it be for petrodiesel alone or for

3 “Standard Guide for Use of the Petroleum Measurement Tables,” American Petroleum Institute Refined Products Table 6B, as referenced in ASTM D1250-08.

biodiesel or biodiesel blends--users can use a slightly different constant depending on the exact density of the fuel in the tank.

Pressure measurements in piping

Leak detection for pressurized piping relies on some sort of pressure measurement in the pipe. There are different analytical approaches to using the pressure measurement over time. Some systems measure the volume of liquid needed to maintain a constant line pressure over a period of time. Others measure the pressure changes over set periods of time. Still others measure the times needed to observe a fixed pressure change. All of these rely on the same essential pressure measurement in the line over time. Due to the similar chemical and physical nature of biodiesel compared to petrodiesel both are considered incompressible liquids from a leak detection standpoint and there is no difference between diesel and biodiesel that would affect the pressure measurement in a pressurized line.

Some of the leak detection methods for pressurized piping also measure the temperature changes and compensate for the volume changes caused by thermal expansion or contraction. As discussed earlier, differences in the coefficient of thermal expansion could affect this compensation if an incorrect coefficient were used. However, as noted above, biodiesel, petro diesel, and biodiesel lends can use the same table for determining the coefficient of expansion, so that should not affect line leak detection.

Often, the leak detection systems have a capability of determining a waiting period that will provide sufficient temperature stability to reduce the thermal expansion or contraction to an insignificant level. Thus, these systems would not be affected by changes of the blend of biodiesel.

Other leak detection technologies

Water Ingress Detection

Automatic tank gauges are required to have a water sensor to detect any water or water-phase liquid at the bottom of the tank. If the presence of water is detected, they are required to be able to track changes in the water level in the tank. The most common method for this is to use a magnetostrictive probe, with a second float, that is constructed with a density so that it will sink in the pure product, but float on the water phase. With water having a specific gravity of 1.0 and diesel having a specific gravity of about 0.85, the water sensor float must have a density between these two. So long as the water sensor float maintains a specific gravity between that of the water phase and that of the product, the water detector will work. With a specific gravity of 0.88 for biodiesel, the allowable range of the specific gravity of the water sensor float is slightly more limited than for diesel, but this should not be a problem for the leak detector.

Another type of water sensor is based on capacitance. It relies on the difference in the dielectric constant between the water phase and the product to detect water. As discussed earlier, the substitution of biodiesel or a biodiesel blend should not affect the difference in the dielectric constants of the water and product enough to seriously affect the water detection.

Acoustical

There is a tank leak detection system that places the tank under reduced pressure and monitors for an acoustical signal caused by bubbles being drawn in below the liquid level. This system has been tested in products ranging from water to alcohol to gasoline, diesel, and motor oil and worked well. This system would not be affected by biodiesel or biodiesel blends substituted for diesel. One acoustical method of this type also monitors for water ingress during the test to check for a possible hole in the tank below the water table. It uses similar water sensors to those used by ATGS and so should also be able to detect leaks by water ingress.

Another acoustical approach places the tank under reduced pressure and monitors for an acoustical signal produced by air entering into the ullage space of the tank. Since this approach does not involve the type liquid in the tank, it would not be affected by the use of biodiesel or biodiesel blends.

Liquid Detection (Interstitial)

Double-walled tanks or piping sometimes use a liquid detector in the interstitial space to check that there are no leaks in either the inner or outer wall. A common approach is to have a reservoir for the liquid filling the interstitial space and to put a monitoring device on the liquid level in the reservoir. There are many approaches to monitoring the level. A number of approaches rely on a simple float triggering a switch if the level gets too high or too low. Others may use a magnetostrictive approach with a float or an ultrasonic measurement. Those devices that use some sort of float or buoyancy principle would not appear to be affected by biodiesel blends or B100. However, there are a number of methods in the NWGLDE listing that rely on other principles. These include capacitance, conductivity, refractive index of the liquid, hydrocarbon sensitive cables, hydrocarbon sensitive polymers, thermal conductivity, product permeable membranes, etc.

The liquid in the interstitial space is typically brine, Propylene Glycol or Ethylene Glycol. These liquids are not in contact with the fluid in the tank unless there is a breach in the inner wall. In any case, they are not affected by the product in the tank and can be approved for use up to B100. Those systems using capacitance, conductivity, refractive index, or thermal conductivity would not be adversely affected by B20 or B100. However, those systems that use hydrocarbon sensitive probes, hydrocarbon sensitive polymers, and product permeable membranes may need would need to be tested for blends over B20 to show that they work correctly.

Product Sensitive Cables

Product sensitive cables are sometimes used in leak detection in interstitial spaces, or in external areas. Typically these cables are sensitive to hydrocarbons. With blends that are substantially petrodiesel (i.e. 80% petrodiesel or above) it would be expected these cable would be effective, but with higher blends it is not clear they would respond in a way that would be protective. It would seem necessary to test each type for its response to biodiesel blends over B20. If a product sensitive cable is to be used, it should be confirmed that the particular type of cable will respond appropriately to biodiesel or the biodiesel blends over B20.

External Tracer Methods

This method works by adding a trace amount of a tracer compound to the product and monitoring the area around the tank or lines for the presence of the specialized tracer compound. The tracer compound should only be found outside the tank or lines if there is a leak or release of the product with the tracer in it. The tracer must be volatile and must migrate through the soil or backfill to the monitoring points. In addition, it must be capable of volatilizing out of the product. With blends that are substantially petrodiesel (i.e. 80% petrodiesel or above) it would be expected these tracers would be effective, but with higher blends it is not clear they would respond in a way that would be protective. Since B100 has different solubility characteristics from petro diesel, it would seem that the behavior of the tracer compound would have to be investigated before the tracer method could be used. That is, a tracer compound would have to be shown to be compatible with the B100 and blends higher than B20 and volatile and mobile enough to vaporize out of solution and move to the monitoring points.

Statistical Inventory Reconciliation

This method works by using a statistical analysis of the inventory data. The product deliveries, sales, and inventory in the storage system are carefully tracked on a frequent basis. Statistical analysis is used to determine whether there are any unexplained shortages of product. Since the basic data are the sales data, the delivery data, and a measurement of the tank inventory, the method is not dependent on the type of liquid product. Less volatile product is an advantage in that evaporation losses are easier to control. Based on the similarities of B100, B6-B20, and petro diesel, there should be no difficulty using this method with any blend of petro diesel and biodiesel.

Product detection on the water table

It is expected that a product detector that is used to monitor the water table in an observation well should work with biodiesel and blends as well as with diesel due to the similarity of density between biodiesel and petrodiesel. However, for blends higher than B20 there may be materials related issues that could affect its detection and this should be confirmed in installations where this approach is to be used.

Vapor sensors

External vapor monitoring in the vadose zone does not work well with diesel. It would not be expected to work with biodiesel, either. The problem is that the biodiesel has an even lower vapor pressure than petrodiesel and is not volatile enough for vapor monitoring to work well. This technology is not recommended nor should it be approved for biodiesel or biodiesel blends.

Vacuum/Pressure monitoring

Some double-walled tanks and pipes are monitored by sealing the interstitial space and keeping it at either a partial vacuum or an increased pressure relative to the atmosphere and to the product inside the vessel. In this case, the pressure in the interstitial space is monitored to detect leaks. Since this monitoring does not directly involve the liquid product, using biodiesel or a biodiesel blend in place of diesel would not affect this type of leak detection.

Other Considerations

Compatibility

Biodiesel (B100) is not compatible with all the materials that are compatible with petro diesel. However, biodiesel blends up to and including B20 have been shown not to have any compatibility problems with materials that can be used with petro diesel.[4]

Table 4 below lists both recommended and non-recommended elastomer and storage tank materials for use with B100. The compatibility of individual components should be confirmed with the manufacturer or vendor prior to use for leak detection systems that are in contact with biodiesel blends in excess of 20% biodiesel (B20) up to B100.

Table 4. Material Compatibility with Biodiesel (B100).

Recommended for B100	Not Recommended for B100
Teflon	Nitrile
Viton	Buna N
Fluorinated Plastics	Natural Rubber
Nylon	Copper. Brass. Bronze
Aluminum	Lead, Tin, Zinc
Carbon and Stainless Steel	Polypropylene. Polyethylene (Long term exposure will weaken
Fiberglass (tanks and piping)	

As can be seen in Table 4, B100 biodiesel is not compatible with all the materials that can be used with diesel. Vendors of leak detection equipment will need to review the list of materials that have compatibility problems with biodiesel to make sure that their equipment is compatible with biodiesel and blends. In particular, the presence of cuprous metal alloys—copper, brass, bronze—is not recommended as they can accelerate the oxidation of biodiesel resulting in the formation of sediments and gums in

4 "Biodiesel Handling and Use Guide, 4th Edition," NREL/TP 540 43672, revised January 2009, available electronically at http://www.osti.gov/bridge.

biodiesel that can clog vehicle filters. The effects with cuprous metals can be mitigated by the use of additives, natural passivation of the copper components, or limiting the total contact area and total time of exposure, or by replacement with biodiesel compatible parts.

In addition, pure biodiesel is not compatible with natural rubber and certain synthetic compounds while B20 blends are not affected. This would primarily affect float materials, but could also involve gaskets or seals.

Each vendor of leak detection equipment will need to review their equipment to determine whether it is compatible with biodiesel. If not, they will need to change materials to make the leak detection equipment compatible with biodiesel.

Mechanical Line Leak Detectors

Mechanical line leak detectors are used with pressurized piping to guard against large (3 gallon per hour) leaks. These devices function by checking the time needed for the line to pressurize after the submersible pump has been turned off. If the pressure does not rise fast enough, a flow restrictor remains in place, limiting the flow rate to about 3 gallons per hour. If the line pressure reaches the set point within a specified time, the flow restrictor pops open, allowing full flow.

At least two manufacturers have brass components in their mechanical line leak detectors. While these will function correctly with lower blends of biodiesel (up to B20), they may eventually be expected to experience problems with higher blends, especially with B100 and if fuel is not constantly being pumped through the system and allowed to contact the brass component for extended periods of time.

Leak detection evaluations do not investigate the material compatibility of the components of leak detection systems. Consequently, there is no general information about the material compatibility with leak detection systems. As a result, each manufacturer will need to be made aware of the compatibility issues and take responsibility for ensuring that their equipment is compatible with biodiesel blends.

Cold Temperature Issues

Biodiesel has a higher cloud point and pour point than petro diesel. Depending on the feedstock for the biodiesel, these temperatures can be 20 to 30 degrees F higher than for petro diesel. Biodiesel will also gel at a higher temperature than petro diesel. In most of the United States, these temperatures would not pose a problem in underground storage tanks, as the temperature generally remains above freezing. However, if the product gets sufficiently cold, it will cloud (form wax-like crystals or particles) and could cause problems in passing through filters. If the product gelled, many leak detection methods would not work as they are designed for liquids. On the other hand, the gel would not leak. The leak detection methods should not be affected by these factors, provided that the temperature of the product remains above the cloud and pour points. These same types of considerations are needed for number 2 diesel fuel, although high biodiesel blends may require more attention.

Stability Issues

Diesel fuel is considered to have better stability in general than biodiesel, and with some care and attention has been shown to be able to be stored and used without issue, sometimes over periods of years. In order to secure the ASTM specifications for biodiesel blends (D975, D7467), a stability parameter was added to the pure biodiesel specification (D6751) in 2008. There is no stability parameter in D975 for conventional petrodiesel, and based on the stability data with biodiesel meeting the new stability specification ASTM passed the allowance of up to 5% biodiesel meeting D6751 into D975 without the need for the addition of a separate stability parameter for D975. For B6 to B20 blends, in order to help insure adequate stability two additional parameters related to stability were added to D7467. These parameters were set to insure a six-month shelf life of the fuel, although data showed most fuels meeting the new stability specifications could be stored for 1 year or longer. If fuel is to be stored for longer than 6 months, the NBB recommends the addition of fuel stabilizers which have been shown to be extremely effective, as well as monitoring of the acid value overtime. It is recommended that B100 that is to be used as a blend stock should be blended with petro diesel as soon as practical as this tends to enhance its stability.

Water Solubility

The solubility of water in biodiesel varies somewhat with the particular source of biodiesel and the temperature of the fuel, however the solubility remains quite low—on the order of 0.1% (1000 parts per million) or less with B100. This is a similar level of water solubility as with conventional gasoline, but is slightly higher than conventional petrodiesel. Water solubility with B20 blends is lower and is more similar to that of petrodiesel. Because of the low solubility of water in pure biodiesel and biodiesel blends, there should not be a problem in detecting water ingress because significant water will form a separated water-phase at the bottom of the tank in a similar manner as that of conventional gasoline or petrodiesel. This water layer can be detected by either float-type or capacitance-type water sensors (or water-finding paste with manual sticking). Consequently, leak detection methods that use water detection should be able to detect water ingress with biodiesel and biodiesel blends.

5.0 Regulatory Issues

Regulatory Issues

Leak detection system for Underground Storage Tanks (UST's) have been mandated since January 1990. The details can be found in CFR 40 280 Part D. The relevant part of this regulation has been provided in Attachment A of this document. The key requirements in this document have been highlighted. The implementation of these rules was mandated on the States beginning in January of 1990.

In essence, several leak detection options are provided. At the same time, several leak detection evaluation protocols were developed to by the USEPA to assure that leak detection systems had been properly evaluated. These documents can be found at the NWGLDE website (www.NWGLDE.org).

An important part of the approval of biodiesel involves the acceptance of biodiesel fuels by various State agencies. One of these issues revolves around the possible impact of biodiesel on the leak detection systems that are mandatory for underground storage tanks containing motor fuels including both tanks and underground pipelines. Until recently only two broad categories of fuel were considered. These two categories were diesel fuel and gasoline. No distinction was made between various grades of fuel or their source. The result was that some systems were evaluated using gasoline and some with diesel fuel.

Since this time, the National Workgroup for Leak Detection Evaluations (NWGLDE) was formed to review all of the evaluations for specific leak detection systems. Their primary function has been to review all of the required third party evaluations of leak detection systems to verify that the evaluations have been conducted as specified in the evaluation procedures and that they are appropriately applied.

The NWGLDE has subsequently become the de facto group controlling the acceptance of leak detection systems. They are not a regulatory agency and have no direct legal authority. However, the widespread recognition that methods on this list have been reviewed by qualified personnel has led to the acceptance of the list by almost all States that now view the list as the primary qualification for acceptance of leak detection methods for their States.

Some States have gone beyond the NWGLDE approvals and have developed their own list of approved methods. California, Florida, Wisconsin, and perhaps a few other states have additional reviews and have developed their own list of approved methods. In effect, to not be on the list means that the vendor will not be able to market their equipment effectively. The bottom line is that in order to sell leak detection equipment the vendor must have their system on the NWGLDE list.

With the advent of gasohol and biodiesel the issue of how these new types of fuel might impact the leak detection systems were raised. Accordingly this project was implemented to review the characteristics of biodiesel and biodiesel blends to determine as much as possible whether or not these fuels will impact on the leak detection systems currently in use.

To gain approval and become listed on the NWGLDE website certain requirements must be met in the submission of the request for review. These requirements have been provided in Attachment B of this document. Virtually all of the vendors of leak detection systems have their equipment listed and are approved for use in gasoline blends including up to 5%-10% of ethanol and diesel. Given the data on biodiesel blends up to B20, there should not be a problem in adding the approval for blends up to B20. However, for higher blends, and B100, some material compatibility issues may arise.

Compatibility issues have been investigated by several groups including UL, NREL, and Southwest Research for common elastomers found in diesel engines and fueling systems for B20 and lower blends. More work is planned on blends between B20 and B100, and for those materials which may not have been tested yet and that are not commonly found in vehicles.. This issue has also been reviewed extensively by the manufacturers of diesel engines. This document considers the compatibility of biodiesel only for leak detection systems.

The specific requirements for getting biodiesel and biodiesel blends accepted by the NWGLDE is not currently well defined. One of the major objectives is to provide reliable information to this group so that the use of biodiesel will not be a problem for listing leak detection systems. At this time there are no specific procedures to gain approvals for leak detection systems in biodiesel.

Perhaps the most important objective of this document is to assist the NWGLDE in developing requirements for the acceptance of leak detection systems for use in biodiesel blends from B5 to B20. One approach is to develop blanket approval for biodiesel for all systems currently approved for use in Petro diesel. This might be done by showing that the effects of biodiesel on leak detectors is not a problem.

The NWGLDE might require that all vendors of leak detection equipment to apply for listings specific to their equipment. This option might provide a reasonable basis for each vendor to get their approvals. This could be done either for the B5 to B20 range, or, if convincing data are available and are included, it might allow listing up to B100.

A third possible option would be to require additional testing of the leak detection equipment in biodiesel blends. Indeed, this will be necessary for some systems. To require it for all systems and for all blends would be a difficult and costly process for several reasons. Third party evaluations are expensive and the process is complicated by the fact that large volumes of diesel fuel are available at third party testing laboratories and this diesel fuel is typically stored and used over several years. If both biodiesel blends and petrodiesel are needed, this would require that the fuel used for testing be changed periodically at considerable cost.

6.0 Conclusions and Recommendations

Because of the similarity in physical and chemical properties between biodiesel and petro diesel, most of the leak detection methods listed on the National Work Group for Leak Detection Evaluation web site will work with biodiesel. This is particularly true for blends up to 20% (B5 to B20), for which hardly any methods would require further evaluation. For higher percentage blends up to B100, there are a few methods that might need further consideration. For some of these, the equipment needs to be reviewed for material compatibility with B100. For others, some testing with the B100 will be needed to confirm that the method works or has been adapted to work with biodiesel. The following is a list of the leak detection methods listed on the web site with the conclusion and recommendation listed for each method. When a recommendation is made for B100, it should be taken as applying to blends between 20 and 100%, i.e. B20 to B100.

Blends of 5% biodiesel or less are now considered just conventional diesel fuel and now fall under the same diesel fuel specifications (ASTM D975) as fuel containing no biodiesel. No further testing is required for blends of B5 and less for leak detection approvals beyond that which has already been done for petrodiesel. Thus they are not mentioned in the summary below and should be considered covered by existing approvals for petrodiesel.

Aboveground storage tank (AST) leak detection method

There are two technologies listed in this method: an in-tank mass based system and an out-of-tank tracer method. For the in-tank method, the vendor needs to confirm that the materials are compatible with B100. Other than that, no further testing is needed. For the tracer method, testing is needed to confirm that the tracer chemical is compatible with B100 and volatilizes and transports adequately.

Automatic electronic line leak detector

All the vendors use some type of line pressure monitoring over time. All should be accepted for biodiesel from B5 to B20. For blends up to B100, each vendor needs to check that his equipment does not have material compatibility problems with B100. If there are no materials compatibility problems, they should be accepted for use with B100.

Automatic mechanical line leak detector

These systems should be accepted for blends B5 to B20. Some manufacturers are known to use brass fittings that come into contact with the product and would thus be not compatible with B100. Others use a diaphragm that might have compatibility problems. Each vendor needs to review the material compatibility of his equipment. Provided there are not compatibility problems or that any found are resolved, the systems should be accepted for B100.

Automatic tank gauging method

A review of the technologies employed for level measurement (magnetostrictive, ultrasonic, capacitance, mass buoyancy) indicated that these systems should be accepted for blends B5 to B20. For B100, the systems need to be checked for material compatibility particularly the floats. Some floats may not be compatible with B100. When the compatibility issue is resolved, these systems should be accepted for B100.

Bulk underground storage tank leak detection method (50,000+ gallons)

One of these methods is a tracer method and the same comments apply as in the aboveground bulk storage tank case. The tracer material needs to be tested with B100 to make sure it performs adequately.

The other methods in this group use technology that should be accepted for B5 to B20. For B100, each vendor should check the material in the equipment for compatibility to ensure that there are no problems with floats or other components. When the compatibility issue is resolved, the methods should be accepted for use with B100.

Continuous In-tank leak detection method (ATG)

These methods should be accepted for B5 to B20 biodiesel blends. For B100, each vendor should check for material compatibility with the equipment. When the material compatibility issues are resolved, the method should be accepted for B100.

Continuous In-tank leak detection method (continual reconciliation)

These methods should be accepted for B5 to B20 biodiesel blends. For B100, each vendor should check for material compatibility with the equipment. When the material compatibility issues are resolved, the method should be accepted for B100.

Continuous interstitial monitoring method (liquid filled)

These methods should be accepted for B5 to B20 biodiesel blends. If the vendor specifies the liquid used in the interstitial space, then there is no compatibility issue and the system should be accepted for B100. If the liquid in the interstitial space can be the product, then the method of monitoring the liquid level should be tested to confirm that it works with B100 for hydrocarbon sensitive probes, hydrocarbon sensitive polymers, or product permeable membranes. For other methods with B100, each vendor should check for material compatibility with the equipment. When the material compatibility issues are resolved, the method should be accepted for B100.

Continuous interstitial line monitoring method (pressure/vacuum)

These methods should be accepted for B5 to B20 biodiesel blends. For B100, each vendor should check for material compatibility with the equipment. When the material compatibility issues are resolved, the method should be accepted for B100.

Continuous interstitial tank monitoring method (pressure/vacuum)

These methods should be accepted for B5 to B20 biodiesel blends. For B100, each vendor should check for material compatibility with the equipment. When the material compatibility issues are resolved, the method should be accepted for B100.

Interstitial detector (liquid phase)

There are many different technologies for detecting the liquid in the interstitial space. If the vendor specifies the liquid (e.g. water, brine) in the interstitial space then the system should be accepted for biodiesel including B100. If the liquid in the interstitial space can be the product, then the method of monitoring the liquid level should be tested to confirm that it works with B100 for hydrocarbon sensitive probes, hydrocarbon sensitive polymers, or product permeable membranes. For other methods with B100, each vendor should check for material compatibility with the equipment. When the material compatibility issues are resolved, the method should be accepted for B100.

Interstitial tank tightness test method

These systems are all based on a specified liquid or on vacuum. They should be accepted for biodiesel, including B100.

Large diameter line leak detection method (6+ inches in diameter)

There are a variety of technologies here. One is a tracer method. The chemical tracer needs to be evaluated for use in B100.

The other methods are based on pressure or vacuum. These should be acceptable for B5 to B20. Subject to a compatibility review, they should be acceptable for B100.

Line tightness test method

One of these is a tracer method. The chemical tracer needs to be evaluated for use in B100.

The other methods are based on pressure or vacuum. These should be acceptable for B5 to B20. Subject to a compatibility review, they should be acceptable for B100.

Non-volumetric tank tightness test method (tracer)

The chemical tracer needs to tested for compatibility for use with B100.

Non-volumetric tank tightness test method (ullage)

This method should be accepted for biodiesel, including B100, as it is based on a pressure difference in the ullage space of the tank, not directly involving the product.

Non-volumetric tank tightness test method (vacuum)

This method should be accepted for biodiesel, including B100, as it is based on a pressure difference in the ullage space of the tank, not directly involving the product.

Out of tank product detector (liquid phase)

All of these technologies are based on product characteristics. They include product solubility, product permeability, or optical properties which should be acceptable for B20 and lower blends. While it is possible they may also be acceptable for higher blends, these products should be tested to confirm their performance with blends higher than B20.

Out of tank product detector (vapor phase)

Most of these methods do not work well with low volatility products, such as diesel. Biodiesel has lower volatility than diesel fuel, and therefore none of these methods are considered acceptable for biodiesel or biodiesel blends and they should not be allowed for leak detection with biodiesel or biodiesel blends.

Statistical Inventory Reconciliation (qualitative)

These methods should be accepted for biodiesel blends B5 to B20. Some materials used for securing the physical inventory measurements (i.e. sticks/probes used to determine tank level) may not be compatible with blends higher than B20. Subject to a compatibility review, they should be accepted for B100.

Statistical Inventory Reconciliation (quantitative)

These methods should be accepted for biodiesel blends B5 to B20. Some materials used for securing the physical inventory measurements (i.e. sticks/probes used to determine tank level) may not be compatible with blends higher than B20. Subject to a compatibility review, they should be accepted for B100.

Volumetric tank tightness test method (overfill)

These methods should be accepted for biodiesel blends B5 to B20. They are temporarily installed to run the test, so unless there are known compatibility issues with B100, they should be accepted for B100.

Volumetric tank tightness test method (underfill)

These methods should be accepted for biodiesel blends B5 to B20. Some materials used for securing the physical inventory measurements (i.e. sticks/probes used to determine tank level) may not be compatible with blends higher than B20 on a long-term basis. Subject to a compatibility review, they should be accepted for B100.

Water Ingress Detection

This is not a stand-alone leak detection method, but is used as a supplement to automatic tank gauging, statistical inventory reconciliation, and one type of vacuum acoustical tank test. The water sensors used should work with biodiesel blends and pure biodiesel as well as they do with petrodiesel, and while the solubility of water in pure biodiesel is somewhat higher than with petro-diesel, it is in the same range as that of gasoline and not high enough to be problematic (in contrast to ethanol blends).

The findings are summarized in Table 5 on the following page.

Table 5. Leak Detection Compatibility with Biodiesel (B20, B100).

Leak Detection Type	Up to B20	B21 - B100
AST (in-tank)	OK	If compatible, OK
AST (tracer)	OK	Tracer needs evaluation
Auto Elec. line leak Detector	OK	If compatible, OK
Mechanical line leak detector	OK	If compatible, OK
ATGS	OK	If compatible, OK
Bulk UST (in-tank)	OK	If compatible, OK
Water (ingress) sensor	OK	If compatible, OK
Bulk UST (tracer)	OK	Tracer needs evaluation
CITLDS (ATG)	OK	If compatible, OK
CITLDS (cont. reconciliation)	OK	If compatible, OK
Cont. Interstitial monitor (liquid filled specified)	OK	OK
Cont. Interstitial monitor (liquid product contact: HC sensitive probes, polymers, permeable membranes)	OK	Needs evaluation of compatibility/functionality
Cont. Interstitial monitor (liquid product contact: all others)	OK	If compatible, OK
Cont. line Interstitial monitor (press/vac)	OK	If compatible, OK
Cont. tank interstitial (press/vac)	OK	If compatible, OK
Liquid detection in interstice (liquid fill specified)	OK	OK
Liquid detection in interstice (liquid product contact: HC sensitive probes, polymers, permeable membranes)	OK	Needs evaluation of compatibility/functionality
Liquid detection in interstice (liquid product contact: all others)	OK	If compatible, OK
Interstitial tank tightness test	OK	OK
Large diameter lines (tracer)	OK	Tracer needs evaluation
Large diameter lines (press/vac)	OK	If compatible, OK
Line tightness test (tracer)	OK	Tracer needs evaluation
Line tightness test (press/vac)	OK	If compatible, OK
Non-vol tank tightness test (tracer)	OK	Tracer needs evaluation
Non-vol tank tightness test (ullage)	OK	OK
Non-vol tank tightness test (vacuum)	OK	OK
Out-of-tank product detector (liquid phase: HC sensitive probes, polymers, permeable membranes)	OK	Needs evaluation of compatibility/functionality
Out-of-tank product detector (vapor phase)	No	No
SIR (qualitative)	OK	If equip. compatible, OK
SIR (quantitative)	OK	If equip. compatible, OK
Overfill volumetric tank tightness tests	OK	OK
Underfill vol tank tightness tests	OK	If compatible, OK

Attachment A

Federal Regulations for
Underground Storage Tanks

(4) Recent compliance with release detection requirements (§ 280.45); and

(5) Results of the site investigation conducted at permanent closure (§ 280.74).

(c) *Availability and Maintenance of Records.* Owners and operators must keep the records required either:

(1) At the UST site and immediately available for inspection by the implementing agency; or

(2) At a readily available alternative site and be provided for inspection to the implementing agency upon request.

(3) In the case of permanent closure records required under § 280.74, owners and operators are also provided with the additional alternative of mailing closure records to the implementing agency if they cannot be kept at the site or an alternative site as indicated above.

Subpart D—Release Detection

§ 280.40 General requirements for all UST systems.

(a) Owners and operators of new and existing UST systems must provide a method, or combination of methods, of release detection that:

(1) Can detect a release from any portion of the tank and the connected underground piping that routinely contains product;

(2) Is installed, calibrated, operated, and maintained in accordance with the manufacturer's instructions, including routine maintenance and service checks for operability or running condition; and

(3) Meets the performance requirements in § 280.43 or 280.44, with any performance claims and their manner of determination described in writing by the equipment manufacturer or installer. In addition, methods used after the date shown in the following table corresponding with the specified method except for methods permanently installed prior to that date, must be capable of detecting the leak rate or quantity specified for that method in the corresponding section of the rule (also shown in the table) with a probability of detection (Pd) of 0.95 and a probability of false alarm (Pfa) of 0.05.

Method	Section	Date after which Pd/Pfa must be demonstrated
Manual Tank Gauging.	280.43(b)	December 22, 1990.
Tank Tightness Testing.	280.43(c)	December 22, 1990.
Automatic Tank Gauging.	280.43(d)	December 22, 1990.
Automatic Line Leak Detectors.	280.44(a)	September 22, 1991.
Line Tightness Testing.	280.44(b)	December 22, 1990.

(b) When a release detection method operated in accordance with the performance standards in § 280.43 and § 280.44 indicates a release may have occurred, owners and operators must notify the implementing agency in accordance with subpart E.

(c) Owners and operators of all UST systems must comply with the release detection requirements of this subpart by December 22 of the year listed in the following table:

SCHEDULE FOR PHASE-IN OF RELEASE DETECTION

Year system was installed	Year when release detection is required (by December 22 of the year indicated)				
	1989	1990	1991	1992	1993
Before 1965 or date unknown.	RD	P			
1965–69		P/RD			
1970–74		P	RD		
1975–79		P		RD	
1980–88		P			RD
New tanks (after December 22) immediately upon installation.					

P=Must begin release detection for all pressurized piping as defined in § 280.41(b)(1).

RD=Must begin release detection for tanks and suction piping in accordance with § 280.41(a), § 280.41(b)(2), and § 280.42.

(d) Any existing UST system that cannot apply a method of release detection that complies with the requirements of this subpart must complete the closure procedures in subpart G by the date on which release detection is required for that UST system under paragraph (c) of this section.

[53 FR 37194, Sept. 23, 1988, as amended at 55 FR 17753, Apr. 27, 1990; 55 FR 23738, June 12, 1990; 56 FR 26, Jan. 2, 1991]

§280.41 Requirements for petroleum UST systems.

Owners and operators of petroleum UST systems must provide release detection for tanks and piping as follows:

(a) *Tanks.* Tanks must be monitored at least every 30 days for releases using one of the methods listed in §280.43 (d) through (h) except that:

(1) UST systems that meet the performance standards in §280.20 or §280.21, and the monthly inventory control requirements in §280.43 (a) or (b), may use tank tightness testing (conducted in accordance with §280.43(c)) at least every 5 years until December 22, 1998, or until 10 years after the tank is installed or upgraded under §280.21(b), whichever is later;

(2) UST systems that do not meet the performance standards in §280.20 or §280.21 may use monthly inventory controls (conducted in accordance with §280.43(a) or (b)) and annual tank tightness testing (conducted in accordance with §280.43(c)) until December 22, 1998 when the tank must be upgraded under §280.21 or permanently closed under §280.71; and

(3) Tanks with capacity of 550 gallons or less may use weekly tank gauging (conducted in accordance with §280.43(b)).

(b) *Piping.* Underground piping that routinely contains regulated substances must be monitored for releases in a manner that meets one of the following requirements:

(1) *Pressurized piping.* Underground piping that conveys regulated substances under pressure must:

(i) Be equipped with an automatic line leak detector conducted in accordance with §280.44(a); and

(ii) Have an annual line tightness test conducted in accordance with §280.44(b) or have monthly monitoring conducted in accordance with §280.44(c).

(2) *Suction piping.* Underground piping that conveys regulated substances under suction must either have a line tightness test conducted at least every 3 years and in accordance with §280.44(b), or use a monthly monitoring method conduct in accordance with §280.44(c). No release detection is required for suction piping that is designed and constructed to meet the following standards:

(i) The below-grade piping operates at less than atmospheric pressure;

(ii) The below-grade piping is sloped so that the contents of the pipe will drain back into the storage tank if the suction is released;

(iii) Only one check valve is included in each suction line;

(iv) The check valve is located directly below and as close as practical to the suction pump; and

(v) A method is provided that allows compliance with paragraphs (b)(2) (ii)–(iv) of this section to be readily determined.

§280.42 Requirements for hazardous substance UST systems.

Owners and operators of hazardous substance UST systems must provide release detection that meets the following requirements:

(a) Release detection at existing UST systems must meet the requirements for petroleum UST systems in §280.41. By December 22, 1998, all existing hazardous substance UST systems must meet the release detection requirements for new systems in paragraph (b) of this section.

(b) Release detection at new hazardous substance UST systems must meet the following requirements:

(1) Secondary containment systems must be designed, constructed and installed to:

(i) Contain regulated substances released from the tank system until they are detected and removed;

(ii) Prevent the release of regulated substances to the environment at any time during the operational life of the UST system; and

(iii) Be checked for evidence of a release at least every 30 days.

NOTE. The provisions of 40 CFR 265.193, Containment and Detection of Releases, may be used to comply with these requirements.

(2) Double-walled tanks must be designed, constructed, and installed to:

(i) Contain a release from any portion of the inner tank within the outer wall; and

(ii) Detect the failure of the inner wall.

(3) External liners (including vaults) must be designed, constructed, and installed to:

(i) Contain 100 percent of the capacity of the largest tank within its boundary;

(ii) Prevent the interference of precipitation or ground-water intrusion with the ability to contain or detect a release of regulated substances; and

(iii) Surround the tank completely (i.e., it is capable of preventing lateral as well as vertical migration of regulated substances).

(4) Underground piping must be equipped with secondary containment that satisfies the requirements of paragraph (b)(1) of this section (e.g., trench liners, jacketing of double-walled pipe). In addition, underground piping that conveys regulated substances under pressure must be equipped with an automatic line leak detector in accordance with §280.44(a).

(5) Other methods of release detection may be used if owners and operators:

(i) Demonstrate to the implementing agency that an alternate method can detect a release of the stored substance as effectively as any of the methods allowed in §§280.43(b) through (h) can detect a release of petroleum;

(ii) Provide information to the implementing agency on effective corrective action technologies, health risks, and chemical and physical properties of the stored substance, and the characteristics of the UST site; and,

(iii) Obtain approval from the implementing agency to use the alternate release detection method before the installation and operation of the new UST system.

§280.43 Methods of release detection for tanks.

Each method of release detection for tanks used to meet the requirements of §280.41 must be conducted in accordance with the following:

(a) *Inventory control.* Product inventory control (or another test of equivalent performance) must be conducted monthly to detect a release of at least 1.0 percent of flow-through plus 130 gallons on a monthly basis in the following manner:

(1) Inventory volume measurements for regulated substance inputs, withdrawals, and the amount still remaining in the tank are recorded each operating day;

(2) The equipment used is capable of measuring the level of product over the full range of the tank's height to the nearest one-eighth of an inch;

(3) The regulated substance inputs are reconciled with delivery receipts by measurement of the tank inventory volume before and after delivery;

(4) Deliveries are made through a drop tube that extends to within one foot of the tank bottom;

(5) Product dispensing is metered and recorded within the local standards for meter calibration or an accuracy of 6 cubic inches for every 5 gallons of product withdrawn; and

(6) The measurement of any water level in the bottom of the tank is made to the nearest one-eighth of an inch at least once a month.

NOTE: Practices described in the American Petroleum Institute Publication 1621, "Recommended Practice for Bulk Liquid Stock Control at Retail Outlets," may be used, where applicable, as guidance in meeting the requirements of this paragraph.

(b) *Manual tank gauging.* Manual tank gauging must meet the following requirements:

(1) Tank liquid level measurements are taken at the beginning and ending of a period of at least 36 hours during which no liquid is added to or removed from the tank;

(2) Level measurements are based on an average of two consecutive stick readings at both the beginning and ending of the period;

(3) The equipment used is capable of measuring the level of product over the full range of the tank's height to the nearest one-eighth of an inch;

(4) A leak is suspected and subject to the requirements of subpart E if the variation between beginning and ending measurements exceeds the weekly or monthly standards in the following table:

Nominal tank capacity	Weekly standard (one test)	Monthly standard (average of four tests)
550 gallons or less.	10 gallons	5 gallons.
551–1,000 gallons.	13 gallons	7 gallons.
1,001–2,000 gallons.	26 gallons	13 gallons.

(5) Only tanks of 550 gallons or less nominal capacity may use this as the sole method of release detection. Tanks of 551 to 2,000 gallons may use the method in place of manual inventory control in §280.43(a). Tanks of greater than 2,000 gallons nominal capacity may not use this method to meet the requirements of this subpart.

(c) *Tank tightness testing.* Tank tightness testing (or another test of equivalent performance) must be capable of detecting a 0.1 gallon per hour leak rate from any portion of the tank that routinely contains product while accounting for the effects of thermal expansion or contraction of the product, vapor pockets, tank deformation, evaporation or condensation, and the location of the water table.

(d) *Automatic tank gauging.* Equipment for automatic tank gauging that tests for the loss of product and conducts inventory control must meet the following requirements:

(1) The automatic product level monitor test can detect a 0.2 gallon per hour leak rate from any portion of the tank that routinely contains product; and

(2) Inventory control (or another test of equivalent performance) is conducted in accordance with the requirements of §280.43(a).

(e) *Vapor monitoring.* Testing or monitoring for vapors within the soil gas of the excavation zone must meet the following requirements:

(1) The materials used as backfill are sufficiently porous (e.g., gravel, sand, crushed rock) to readily allow diffusion of vapors from releases into the excavation area;

(2) The stored regulated substance, or a tracer compound placed in the tank system, is sufficiently volatile (e.g., gasoline) to result in a vapor level that is detectable by the monitoring devices located in the excavation zone in the event of a release from the tank;

(3) The measurement of vapors by the monitoring device is not rendered inoperative by the ground water, rainfall, or soil moisture or other known interferences so that a release could go undetected for more than 30 days;

(4) The level of background contamination in the excavation zone will not interfere with the method used to detect releases from the tank;

(5) The vapor monitors are designed and operated to detect any significant increase in concentration above background of the regulated substance stored in the tank system, a component or components of that substance, or a tracer compound placed in the tank system;

(6) In the UST excavation zone, the site is assessed to ensure compliance with the requirements in paragraphs (e) (1) through (4) of this section and to establish the number and positioning of monitoring wells that will detect releases within the excavation zone from any portion of the tank that routinely contains product; and

(7) Monitoring wells are clearly marked and secured to avoid unauthorized access and tampering.

(f) *Ground-water monitoring.* Testing or monitoring for liquids on the ground water must meet the following requirements:

(1) The regulated substance stored is immiscible in water and has a specific gravity of less than one;

(2) Ground water is never more than 20 feet from the ground surface and the hydraulic conductivity of the soil(s) between the UST system and the monitoring wells or devices is not less than 0.01 cm/sec (e.g., the soil should consist of gravels, coarse to medium sands, coarse silts or other permeable materials);

(3) The slotted portion of the monitoring well casing must be designed to prevent migration of natural soils or filter pack into the well and to allow entry of regulated substance on the water table into the well under both high and low ground-water conditions;

(4) Monitoring wells shall be sealed from the ground surface to the top of the filter pack;

(5) Monitoring wells or devices intercept the excavation zone or are as close to it as is technically feasible;

(6) The continuous monitoring devices or manual methods used can detect the presence of at least one-eighth of an inch of free product on top of the ground water in the monitoring wells;

(7) Within and immediately below the UST system excavation zone, the site is assessed to ensure compliance with

the requirements in paragraphs (f) (1) through (5) of this section and to establish the number and positioning of monitoring wells or devices that will detect releases from any portion of the tank that routinely contains product; and

(8) Monitoring wells are clearly marked and secured to avoid unauthorized access and tampering.

(g) *Interstitial monitoring.* Interstitial monitoring between the UST system and a secondary barrier immediately around or beneath it may be used, but only if the system is designed, constructed and installed to detect a leak from any portion of the tank that routinely contains product and also meets one of the following requirements:

(1) For double-walled UST systems, the sampling or testing method can detect a release through the inner wall in any portion of the tank that routinely contains product;

NOTE: The provisions outlined in the Steel Tank Institute's "Standard for Dual Wall Underground Storage Tanks" may be used as guidance for aspects of the design and construction of underground steel double-walled tanks.

(2) For UST systems with a secondary barrier within the excavation zone, the sampling or testing method used can detect a release between the UST system and the secondary barrier;

(i) The secondary barrier around or beneath the UST system consists of artificially constructed material that is sufficiently thick and impermeable (at least 10^{-6} cm/sec for the regulated substance stored) to direct a release to the monitoring point and permit its detection;

(ii) The barrier is compatible with the regulated substance stored so that a release from the UST system will not cause a deterioration of the barrier allowing a release to pass through undetected;

(iii) For cathodically protected tanks, the secondary barrier must be installed so that it does not interfere with the proper operation of the cathodic protection system;

(iv) The ground water, soil moisture, or rainfall will not render the testing or sampling method used inoperative so that a release could go undetected for more than 30 days;

(v) The site is assessed to ensure that the secondary barrier is always above the ground water and not in a 25-year flood plain, unless the barrier and monitoring designs are for use under such conditions; and,

(vi) Monitoring wells are clearly marked and secured to avoid unauthorized access and tampering.

(3) For tanks with an internally fitted liner, an automated device can detect a release between the inner wall of the tank and the liner, and the liner is compatible with the substance stored.

(h) *Other methods.* Any other type of release detection method, or combination of methods, can be used if:

(1) It can detect a 0.2 gallon per hour leak rate or a release of 150 gallons within a month with a probability of detection of 0.95 and a probability of false alarm of 0.05; or

(2) The implementing agency may approve another method if the owner and operator can demonstrate that the method can detect a release as effectively as any of the methods allowed in paragraphs (c) through (h) of this section. In comparing methods, the implementing agency shall consider the size of release that the method can detect and the frequency and reliability with which it can be detected. If the method is approved, the owner and operator must comply with any conditions imposed by the implementing agency on its use to ensure the protection of human health and the environment.

§ 280.44 Methods of release detection for piping.

Each method of release detection for piping used to meet the requirements of § 280.41 must be conducted in accordance with the following:

(a) *Automatic line leak detectors.* Methods which alert the operator to the presence of a leak by restricting or shutting off the flow of regulated substances through piping or triggering an audible or visual alarm may be used only if they detect leaks of 3 gallons per hour at 10 pounds per square inch line pressure within 1 hour. An annual test of the operation of the leak detector must be conducted in accordance with the manufacturer's requirements.

(b) *Line tightness testing.* A periodic test of piping may be conducted only if it can detect a 0.1 gallon per hour leak rate at one and one-half times the operating pressure.

(c) *Applicable tank methods.* Any of the methods in §280.43 (e) through (h) may be used if they are designed to detect a release from any portion of the underground piping that routinely contains regulated substances.

§280.45 Release detection recordkeeping.

All UST system owners and operators must maintain records in accordance with §280.34 demonstrating compliance with all applicable requirements of this subpart. These records must include the following:

(a) All written performance claims pertaining to any release detection system used, and the manner in which these claims have been justified or tested by the equipment manufacturer or installer, must be maintained for 5 years, or for another reasonable period of time determined by the implementing agency, from the date of installation;

(b) The results of any sampling, testing, or monitoring must be maintained for at least 1 year, or for another reasonable period of time determined by the implementing agency, except that the results of tank tightness testing conducted in accordance with §280.43(c) must be retained until the next test is conducted; and

(c) Written documentation of all calibration, maintenance, and repair of release detection equipment permanently located on-site must be maintained for at least one year after the servicing work is completed, or for another reasonable time period determined by the implementing agency. Any schedules of required calibration and maintenance provided by the release detection equipment manufacturer must be retained for 5 years from the date of installation.

Subpart E—Release Reporting, Investigation, and Confirmation

§280.50 Reporting of suspected releases.

Owners and operators of UST systems must report to the implementing agency within 24 hours, or another reasonable time period specified by the implementing agency, and follow the procedures in §280.52 for any of the following conditions:

(a) The discovery by owners and operators or others of released regulated substances at the UST site or in the surrounding area (such as the presence of free product or vapors in soils, basements, sewer and utility lines, and nearby surface water).

(b) Unusual operating conditions observed by owners and operators (such as the erratic behavior of product dispensing equipment, the sudden loss of product from the UST system, or an unexplained presence of water in the tank), unless system equipment is found to be defective but not leaking, and is immediately repaired or replaced; and,

(c) Monitoring results from a release detection method required under §280.41 and §280.42 that indicate a release may have occurred unless:

(1) The monitoring device is found to be defective, and is immediately repaired, recalibrated or replaced, and additional monitoring does not confirm the initial result; or

(2) In the case of inventory control, a second month of data does not confirm the initial result.

§280.51 Investigation due to off-site impacts.

When required by the implementing agency, owners and operators of UST systems must follow the procedures in §280.52 to determine if the UST system is the source of off-site impacts. These impacts include the discovery of regulated substances (such as the presence of free product or vapors in soils, basements, sewer and utility lines, and nearby surface and drinking waters) that has been observed by the implementing agency or brought to its attention by another party.

Attachment B

Procedures for Listing on the
National Work Group on Leak
Detection Evaluations (NWGLDE)

<u>{Insert Company Name Here on Company Letterhead}</u>
<u>{Insert date here}</u>

To: National Work Group on Leak Detection Evaluation (NWGLDE)

{INSERT company name} requests that the Model(s) **{INSERT model number or description of current listing for petrodiesel here}** Leak Detection System(s) be listed for use with Biodiesel or Biodiesel Blends in accordance with the white paper produced by KWA, Inc.

This request is for listing *(choose appropriate level)*

_____Biodiesel Blends of B20 and below

_____Pure Biodiesel (B100)

This listing will be valid only for biodiesel blends that meet their appropriate ASTM specification (i.e. ASTM D975 for blends of B5 and lower; ASTM D7467 for blends higher than B5 up to and including B20) made with pure biodiesel (B100) meeting D6751 prior to blending, and for pure biodiesel (B100) that meets ASTM D6751.

All other approvals relative to tank or line size or other physical parameters determined by a recognized independent laboratory for the Model **{INSERT model number or description of current listing for petrodiesel here}** system will remain in effect.

In making this request, **{INSERT company name}** confirms the components of this leak detection system that come in contact with the biodiesel or biodiesel blend listed are compatible with the blends being requested for listing.

Modifications to the existing listing forms have been attached for the convenience of the NWGLDE members.

Respectfully submitted,
____
Title, (authorized company spokesman)

Attachment C

Bibliography

Bibliography

"Elastomer Compatibility Testing of Renewable Diesel Fuels", NREL and SwRI Technical Report, NLRE/TP-540-38834, November 2005).

Biodiesel Handling and Use Guide, 4th Edition," NREL/TP 540 43672, revised January 2009, available electronically at http://www.osti.gov/bridge. "Biodiesel Technical Information, ADM, available at http://www.biodiesel.org. 40 CFR 80 SubPart M, Amended February 3, 2010. Reynolds, Robert E., "

Changes in Diesel Fuel," available for download at Petro dieselFuel@yahoo.com.

"Standard Test Procedures for Evaluating Leak Detection Methods," EPA/530 UST-90/001-7, March to October 1990. Seven different procedures were developed for different leak detection methods and released between March and October 1990.

40CFR Part 280, Subpart D. Regulations for Underground Storage Tanks

1994, the EPA established the National Work Group for Leak Detection Evaluations, which consists of a group of State and Federal Regulators that review leak detection evaluations, new evaluation protocols, and other issues affecting the leak detection and underground storage tank industry. Group members include Greg Bareta, Lamar Bradley, Curt Johnson, Helen Robbins , Mike Juranty, William Moore, Shaheer Muhanna, Marcia Poxon, Peter Rollo and Tim Smith. (see NWGLDE website for contact information)

"Biodiesel Handling and Use Guide, 4th Edition," NREL/TP 540 43672, revised January 2009, available electronically at http://www.osti.gov/bridge. "Biodiesel Technical Information, ADM, available at http://www.biodiesel.org. 40 CFR 80 SubPart M, Amended February 3, 2010. Reynolds, Robert E., "Changes in Diesel Fuel," available for download at Petro dieselFuel@yahoo.com.

"Electrical Conductivity of Biodiesel," National Biodiesel Board, testing to ASTM Standard D2624 conducted by Williams Pipeline.

"Standard Guide for Use of the Petroleum Measurement Tables," American Petroleum Institute Refined Products Table 6B, as referenced in ASTM D1250-08.

ASTM Standards
- D7467-09 Diesel Fuel Oil, Biodiesel Blend (B6 to B20)
- D975-09a Standard Specification for Disel Fuel Oils

D 6751-08 Standard Specification for Biodiesel Fuel Blend Stock (B100) for Middle Distillate Fuels

"RIN Temperature Correction Factors for Biodiesel", Department of Biological Engineering, Dalhousie University, April 2005