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Compatibility Considerations for UST Systems

Final Report

October 2015

Emerging Fuels Task Force
Tanks Subcommittee

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ACKNOWLEDGEMENTS

This document was originally prepared and published in April 2013 by the Association of State and Territorial Solid Waste Management Official (ASTSWMO) Tanks Subcommittee's Alternative Fuels Workgroup (now referred to as the Emerging Fuels Task Force). ASTSWMO is an organization supporting the environmental agencies of the States and Territories (States). ASTSWMO's mission is to enhance and promote effective State and Territorial programs and to affect relevant national policies for waste and materials management, environmentally sustainable practices, and environmental restoration. The mission of the Emerging Fuels Task Force is to assist the States' and Territories' UST programs by providing resources and information related to managing the storage and releases of new fuels that are in use or in development.

The Task Force prepared this document with assistance from the U.S. Environmental Protection Agency (EPA) Office of Underground Storage Tanks (OUST) under Cooperative Agreements US-83536501 and US-83537701. The views expressed in this document are those of the ASTSWMO Emerging Fuels Task Force and its members, and do not necessarily reflect the policy or legal position of U.S. EPA or the ASTSWMO Board of Directors.

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Cover Photo: The picture shows corrosion and acetate crystal formation commonly found in STP sumps for systems storing gasoline-ethanol blends.

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OVERVIEW

The ASTSWMO Emerging Fuels Task Force developed this document to serve as a resource for State and Territorial underground storage tank (UST) program staff, UST owners and operators, equipment manufacturers, and contractors and consultants for the evaluation of equipment compatibility pursuant with EPA's compatibility requirement (40 CFR 280.32) specifically when storing motor fuels. Motor fuels are defined as:

> a complex blend of hydrocarbons typically used in the operation of a motor engine, such as motor gasoline, aviation gasoline, No. 1 or No. 2 diesel fuel, or any blend containing one or more of these substances (for example: motor gasoline blended with ethanol or diesel fuel blended with biodiesel).

While compatibility considerations apply to all motor fuels, the scope of this document is limited to motor fuel biofuel blends and ultra-low sulfur diesel (ULSD). For the purpose of this document, the term "biofuel blends" will mean either pure or blended biofuels.

This document includes links to informational resources created and maintained by other public and private organizations, as well as a compatibility search tool that draws from these resources. The ASTSWMO Emerging Fuels Task Force does not control or guarantee the accuracy, relevance, timeliness, or completeness of this outside information. Further, the inclusion of links to particular items in hypertext is not intended to reflect their importance, nor is it intended to endorse any views expressed or products or services offered by the author of the reference or the organization operating the server on which the reference is maintained.

This document also includes case summaries highlighting possible examples of equipment problems observed on UST systems previously storing motor fuels after changing to storing biofuel blends or ULSD. The actual cause of the problems were not documented and may not be the result of storing biofuel blends. All site-specific information provided in these summaries were prepared by individual State UST programs and provided to ASTSWMO for use in this compendium. ASTSWMO is not responsible for any of the information provided in the enclosed case summaries.

Updates of this document are envisioned to be prepared periodically as new information becomes available.

INTRODUCTION

New federal and State mandates such as the Renewable Fuel Standard have required a significant increase in biofuel blends production and use. This has resulted in an increase in the number of retail facilities storing and dispensing biofuel blends such as ethanol and biodiesel. Biofuel blends are produced from plant or animal products or wastes, as opposed to fossil fuel sources. Pure ethanol (E100) and biodiesel (B100) are examples of biofuels. Biofuel blends have significantly different characteristics than petroleum gasoline and diesel, and may not be compatible with certain existing UST components that were suitable for storing gasoline or diesel. Biofuel blends are produced by combining petroleum based fuel products with biofuels. Blends of 85 percent ethanol (E85) and 20 percent biodiesel (B20) are examples of biofuel blends.

In 2000, EPA moved forward with a rule to make heavy-duty trucks and buses run cleaner, and the Highway Diesel Rule, was finalized in January 2001. The rule required a 97 percent reduction in the sulfur content of highway diesel fuel from 500 parts per million (low sulfur diesel, or LSD) to 15 parts per million (ultra-low sulfur diesel, or ULSD). Refiners began producing the cleaner-burning diesel fuel, ULSD, for use in highway vehicles beginning June 1, 2006. ULSD was phased in for highway diesel fuel from 2006-2010. Low sulfur (500 ppm) and ULSD fuel was phased in for nonroad, locomotive, and marine (NRLM) engines from 2007-2014. Since the introduction of ULSD, State inspectors across the country have noted fuel seeps around certain gasket fittings in UST systems storing and dispensing ULSD, and an increase in the number of systems showing corrosion and the accumulation of related by-products in tank system components such as fuel filters.

Owners and operators of USTs regulated under 40 CFR part 280 are required to demonstrate compliance with U.S. EPA's compatibility requirement (40 CFR 280.32) when storing regulated substances, including motor fuels and biofuel blends containing greater than 10 percent ethanol or diesel containing greater than 20 percent biodiesel. 40 CFR Part 280.32 states "Owners and operators must use an UST system made of or lined with materials that are compatible with the substance stored in the UST system."

On October 13, 2015, the 2015 federal UST regulation will become effective. The updated regulation includes revisions to 40 CFR Part 280.32. In addition to notifying the implementing agency before switching to store biofuels and keeping certain records, the updated compatibility section requires the UST system be demonstrated compatible when storing biofuels through one or more of the following methods:

- certification or listing by a nationally recognized independent testing laboratory; or
- equipment or component manufacturer approval; or
- use another method determined by the implementing agency to be no less protective of human health and the environment.

Owners and operators should check with their implementing agency because some agencies may have compatibility requirements different from the federal regulation.

It is essential for owners and operators to clearly understand not only how to demonstrate UST system compatibility with motor fuels and biofuel blends to assure compliance with regulatory requirements but also to understand the potential risks of using equipment that is not compatible with the stored product. Properly evaluating systems for compatibility will help reduce the number of releases to the environment from equipment failure. Owners and operators should maintain compatibility records for the life of the equipment or component for all new or replaced equipment and for UST systems storing biofuel blends.

PRODUCT AND OPERATIONAL COMPATIBILITY

We sometimes tend to jump to the conclusion that an observed equipment issue is related to fuel incompatibility. While this may truly be the case in some situations, problems that occur after

switching fuel products may not necessarily be related to fuel product incompatibility with the materials used in the equipment.

Compatibility is the ability of two or more substances to maintain their relative physical and chemical properties while in contact with each other. It is important to remember that equipment manufacturers and nationally recognized independent testing laboratories typically test equipment compatibility in a laboratory setting under controlled conditions, usually with pure fuel products. Over the years the standard test methods have been refined to be more representative of intended use conditions. For example, a change was needed for the UL 971 standard because of an increase in reported field problems concerning the use of nonmetallic underground piping for flammable liquids. Previously, the standard required concentrated testing on individual materials or components in direct contact with fuel. Now complete piping systems (primary and secondary containment) are evaluated, including pre-conditioning of samples for long-term exposure and decreased allowable permeation limits. While these listing processes meet the requirements in 40 CFR Part 280.32, they may not be representative of the real world environmental conditions in which this equipment is operated, where water or contaminants may be present in the fuel product or in equipment.

The overall compatibility of the tank system includes compatibility with the fuel product stored and operational compatibility. Operational compatibility may be described as a stable physical, chemical and biological environment that prevents degradation of the fuel product or the equipment which contains it. To ensure operational compatibility, an owner or operator must use equipment that is appropriate for the physical environment under which it will operate. State program data suggests that States with high humidity and temperatures favorable to microbial growth may be having a greater incidence of corrosion problems that States with drier climates. Examples of operational compatibility issues include extensive rust buildup on turbine pump heads in certain UST sumps of ethanol blends or corrosion of certain in-tank metal components with ULSD both of which may be an effect of microbial activity. In some sumps experiencing heavy corrosion, for example, the ethanol in the fuel is only one contributor to creating a corrosive environment. Without water, the bacteria that convert the ethanol in to acetic acid could not thrive and the actual corrosive event could not occur. In ULSD, the presence of water provides an environment where microbial life can thrive, possible influencing the corrosion of internal metal components of the UST system equipment.

PROPERTIES OF BIOFUEL BLENDS

Biofuel blends have some significantly different characteristics from petroleum gasoline and diesel. A few noteworthy characteristics are their higher solubility, water absorption capacity, and conductivity when compared to conventional fuel.

Solubility: The solubility of ethanol and biodiesel are both higher than that of conventional gasoline or diesel, and so these blended fuels tend to have a “cleaning agent” effect in storage tank systems by mobilizing sludge in tanks. Because they can increase the solubility of gasoline and diesel to certain materials, ethanol and biodiesel can degrade, soften, and seep through certain hoses, gaskets, seals, elastomers, glues and plastics with prolonged exposure, so it is important to ensure your UST system equipment is compatible with the fuel you are storing.

Water absorption capacity: Ethanol and biodiesel also have the capacity to absorb more dissolved water than conventional gasoline or diesel, which can lead to phase separation and microbial growth. If too much water enters an UST storing ethanol blended fuels and the fuel becomes saturated with water, the fuel may separate with the ethanol and water forming a layer on the bottom of the UST underneath a layer of gasoline with little to no ethanol. Microbial activity, spurred by the presence of water and a food source (ethanol) can accelerate galvanic and pitting corrosion, commonly referred to as Microbial Induced Corrosion (MIC).

Conductivity: Both ethanol and biodiesel are more polar and conductive than conventional gasoline or diesel. Water, chemical contaminants, and salts in the fuel system can increase fluid conductivity. In conductive environments, anodic metals (soft metals like zinc, brass, lead, aluminum and copper) tend to corrode more readily in the presence of cathodic metals (steel).

PROPERTIES OF ULSD

ULSD also has some significantly different characteristics from its precursor “low sulfur diesel”, most notably the reduced sulfur content. Other noteworthy characteristics are its lower lubricity and oxidation stability.

Sulfur content: The presence of sulfur in diesel can have an adverse effect on microbial growth. Sulfur has anti-microbial properties, so it assumed that the reduction in allowable sulfur in diesel from 500 ppm to 15ppm may allow for more microbial activity.

Lubricity: The lubricity of diesel fuel decreases as sulfur is removed during the refining process. To compensate for this loss, lubricity additives are blended into ULSD to minimize engine wear. Biodiesel has lubricating properties and is sometimes blended into ULSD. ULSD may contain up to 5% biodiesel under the ASTM D975 diesel fuel standard because its performance in these blends is nearly identical to that of pure diesel. The net effect is that ULSD fuel may not be compatible with certain nonmetallic seals and gaskets.

Oxidation Stability: The natural anti-oxidation properties of diesel fuel also decrease as sulfur is removed during the refining process. There is some concern that ULSD, without the natural oxidation inhibitors which are removed by hydrotreating, may form peroxides during long-term storage. This can result in the buildup of oxidation products, commonly seen as rust or sediment buildup.

COMPATIBILITY EVALUATION CHECKLIST

Conversion and the installation of storage tank and dispensing systems for biofuel blends requires a thorough compatibility evaluation. Storage and dispensing systems manufactured for use with conventional fuels will generally require some modifications to maintain equipment material compatibility with the biofuel products. Both ethanol and biodiesel, stored as pure product or as a blended fuel, introduce different compatibility concerns for tanks, piping and dispenser components than gasoline blended with 10 percent or less ethanol or diesel blended with greater than five percent biodiesel.

The ASTSWMO Emerging Fuels Task Force developed a general template for use as a Compatibility Evaluation Checklist. The checklist is designed to ensure that all relevant components of the entire UST system are evaluated properly for compatibility. It provides a documentation record of the evaluation and also provides a summary of guidance information and responsibilities for owners and operators who intend to store biofuel blends. The compatibility evaluation search tool (described below) may be used to help identify available documentation to support component compatibility. States should tailor the checklist template to fit their particular program requirements and review process. This checklist is included in Appendix A of this document.

COMPATIBILITY EVALUATION SEARCH TOOL

To assist in determining whether certain equipment is compatible with a particular type of fuel, this Task Force is developing an online Compatibility Evaluation Search Tool. This search tool will enable a user to search for documented equipment manufacturer compatibility certifications based on fuel type or equipment components. Any user has the ability to submit and upload updated information related to compatibility of a particular product. The submitted information will be reviewed by the ASTSWMO Emerging Fuels Task Force prior to adding to the tool. It is the intent of the Task Force to periodically review the tool for updates from equipment manufacturers and State regulators.

The tool will be available on the ASTSWMO website in early-2016. For a preview of the tool, contact ASTSWMO staff or a member of the Task Force and a draft version will be provided.

CONSIDERATIONS FOR THE STORAGE OF BIOFUEL BLENDS AND ULSD

Utilizing a detailed component checklist such as that mentioned in the preceding section will help provide structure to the process of evaluating the proposed use of alternative fuels at regulated UST facilities. In some instances, the compatibility information clearly indicates what UST equipment must be upgraded. For example, nearly all system conversions for the storage of blends over E10, such as E15 or E85 will minimally require upgrades of the submersible turbine pumps (STPs) and overfill protection equipment.

Having a checklist is a good starting point to evaluate the compatibility of UST equipment. However getting definitive answers to compatibility questions may not always be simple and straightforward. This document is intended to focus on two key items of consideration with the storage of biofuel blends: concerns with existing equipment and the importance of water management.

It is beyond the scope of this document to delve into more detailed aspects of compatibility, or the various studies and topics which have implications for the storage of biofuel blends. For this reason, a number of references and resources are provided in Appendix B to assist the reader with further investigation.

Concerns with Existing Equipment

The compatibility evaluation of older equipment at existing UST facilities presents one of the biggest challenges and concerns with the storage of biofuel blends. Federal mandates require a significant increase in biofuels production and its use has triggered an increase in the number of retail facilities storing and dispensing biofuel blends. Most USTs across the country now store E10 as a conventional gasoline product and many locations store biodiesel blends up to B20 with little or no special consideration of compatibility. However, over the last decade several State inspectors and industry have noticed an apparent increase in corrosion issues in UST systems storing fuels blended with biofuels.

Many UST inspectors have seen the impact biofuel blends can have on the corrosion of equipment within STP sumps and an increased prevalence of leaks from equipment inside dispenser cabinets. Gaskets, adhesives, glues, and sealants (including the standard "pipe dope" commonly used on older systems) have not always been compatible with conventional motor fuels up to E10.

Compatibility issues have also been observed in some of the early generation flexible piping systems manufactured in the early to mid-1990s. Complicating piping compatibility questions is the fact that the UL standard (and corresponding allowable fuel permeability rates) have since become more stringent with subsequent revisions to the UL-971 standard and many owners, operators and State UST programs do not maintain detailed records for system components.

To build upon information brought forward by Task Force members, ASTSWMO informally requested that UST programs report observations or problems suspected to be related to equipment incompatibility. Information received in response to this request is included in Appendix C. These actual in-the-field observations will further the discussion and assessment on biofuel blends compatibility and storage/dispensing issues. Consequently, the Task Force has included a blank site case summary form in Appendix D and we encourage States to submit additional information about failures or observations that appear to be compatibility-related.

Importance of Water Management

At first glance, water management may not seem to have a direct connection with biofuel blends or ULSD and compatibility. In reality, UST systems storing biofuel blends or ULSD are particularly susceptible to impacts from inadequate water management.

The chemical and physical structure of biofuels allows interaction between the fuels and water which does not exist to the same degree with conventional fuels. Chemically ethanol and gasoline behave differently. Ethanol will readily dissolve in water, and is considered infinitely soluble in water, whereas gasoline has a much lower affinity for water. When water comes in contact with ethanol free gasoline in an UST, the majority of it tends to drop out as a water layer at the bottom of a tank. However, when water comes in contact with an ethanol blended fuels, because of differences in polarity and water absorption capacity, water will dissolve in the blended fuel to a much greater extent.

When the water reaches the maximum amount that the fuel blend can dissolve, any additional water will separate from the gasoline, and will drop to the bottom of the tank. Fuel density differences caused as a result of the water being bound up and suspended in ethanol blended fuels has affected the functionality of some leak detection devices that were not designed for use with ethanol blended fuels. . The prolonged accumulation of water in tanks also increases the likelihood of accelerated corrosion due to MIC.

Water Intrusion: Water can find its way into USTs through leaky riser joints or other tank top fittings. Water gets in through faulty spill bucket drains, or from careless operators or drivers who see liquid in the spill bucket and drain it into the tank. Water can also accumulate over time as the tank "breathes" in warm moist air from which water vapor condenses as it cools. Water will act as an electrolyte, causing internal UST corrosion which can eventually result in leaks.

Water can be monitored electronically with new ATG probes which measure water in various motor fuels including biofuel blends. One can also monitor for water using a tank gauging stick and water finding paste. **Very Important: The correct water finding paste compatible with the fuel stored must be used.**

Overall, the first line of defense against water is having a tight UST system that keeps water out. However, if water is detected within a tank it should be promptly removed. The National Institute of Standards and Technology (NIST) in their publication Handbook 130 address the acceptable amount of water in retail storage tanks. NIST HB 130 recommends water should not be allowed to accumulate above ¼ inch in retail storage tanks containing biofuel blends (gasoline alcohol blends or biodiesel blends), and not greater than 1 inch for gasoline and diesel fuel.

Microbial activity: In some instances, the presence of water in UST systems provides a suitable habitat for microbial growth, especially at the fuel-water interface. Microbes can consume and degrade ethanol biofuels or the ethanol in gasoline and form acid by-products that can contribute to corrosion in some UST system components. Reports of internal corrosion in USTs storing ULSD, where water bottoms are common and which may contain biodiesel or be contaminated with ethanol; this is likely at least partially a result of microbial activity. Signs of microbial activity include more frequently occurring plugged fuel filters, plugged fuel lines, erratic gauges, rotten-egg odor, and the requirement for frequent replacement of other components such as valves, rubber seals and hoses. Bacteria can grow in a water/vapor environment and attack different components of the storage tank system. Copper and brass are particularly susceptible to corrosion from the acids produced by microbes.

Field detection kits are available for verifying microbial growth. If excessive microbial growth is found, treatment may include tank cleaning to remove slime and sludge followed by treatment with a biocide. Diligent water monitoring is very important for preventing corrosion and other problems in UST systems storing biofuel blends. Other treatments such as the application of biocides, liquid or vapor space corrosion inhibitors, or displacing oxygen may also help address problems associated with microbial growth.

EPA AND OTHER RESOURCES

The Biofuels Web page [http://www.epa.gov/oust/altfuels/biofuels.htm] on the U.S. EPA's Office of Underground Storage Tanks (OUST) website is a recommended resource for information about biofuels, including technical and policy issues related to storing and dispensing of ethanol blends of gasoline and biodiesel. The 2015 federal UST regulation included new requirements for owners and operators of USTs thinking of storing fuels containing more than 10 percent ethanol or more than 20 percent biodiesel. These requirements included notification, demonstrating compatibility, and keeping records, and can be accessed at http://www.epa.gov/oust/ustsystm/compat.html. The Biofuels Web page also includes a link to the *Biofuels Compendium*, which contains links to resources relevant to storing ethanol and biodiesel in USTs and to cleaning up biofuel releases.

To better assess the leak potential if the ethanol content in gasoline increased from 10 volume percent to 15 volume percent, the U.S. EPA commissioned a study at Oak Ridge National Laboratory to determine the potential impacts if E15 fuel is stored in UST systems. Part of this effort was to develop an approach to estimate likelihood of failures and approaches for mitigating consequences associated with these failures. The study entitled *"Analysis of Underground Storage Tank System Materials to Increased Leak Potential Associated with E15 Fuel"* was published in July 2012 (see Appendix B). Conclusions from the study generally indicate that the materials used in existing UST infrastructures would not be expected to exhibit compatibility concerns when moving from E10 to E15, although significant changes to some polymer materials are likely when switching from an ethanol free gasoline to an E10 or E15 blend.

A 2012 hypotheses investigation conducted by the Clean Diesel Fuel Alliance and completed by the Battelle Memorial Institute (Battelle) on the Corrosion in Systems Storing and Dispensing Ultra Low Sulfur Diesel (ULSD) [Battelle Study No 10001550] found that a hypothesis worth further investigation is that ethanol identified in USTs storing ULSD is being consumed by bacteria that produce acetic acid as a result of its metabolic process. In 2014 and 2015 EPA was working on a field study of several dozen USTs storing ULSD as a follow-up to the 2012 investigation. At the time of this release, the study was pending peer-review prior to being released, but based on conversations with EPA it appears that corrosion of metal components in USTs storing ULSD appears to extremely common when using the sample population as a proxy. EPA also stated that this corrosion of metal presents a risk to the functionality of metal components if it remains unchecked. It appears that microbiologically influenced corrosion is likely playing a role in the prevalence of the corrosion, as favorable conditions for microbial growth were found in most USTs in the study. The completed report is expected to be released in early 2016.

REQUIREMENTS AND RECOMMENDATIONS

Ensuring UST systems are made of or lined with materials that are compatible with the biofuel blends stored can reduce the risk of releases due to material incompatibility. Perhaps the most effective protective measure against corrosion in USTs with any fuel type is preventing the accumulation of water in tanks.

In 2013, the Alternative Fuels Workgroup provided the following recommendations. Some of these recommendations were incorporated into the 2015 federal UST regulations. The 2015 federal UST regulation will be effective October 13, 2015. However, it will not immediately apply in 40 States and Territories with State Program Approval (SPA) until those States change their UST requirements or EPA withdraws SPA.

- Owners and operators should maintain compatibility records for the life of the equipment or component for all new or replaced equipment and for UST systems storing biofuel blends. The 2015 federal UST regulation only requires maintaining records of compatibility for certain components of the UST system storing biofuels for as long as the biofuel is stored.

- States should implement a notification requirement for change of fuel stored in a UST system, and a permitting process for installation of new or upgraded UST systems storing biofuel blends. Incorporate an equipment compatibility evaluation, such as the checklist included in this document. It is far easier to address compatibility issues prior to conversion. The 2015 federal UST regulation requires UST owners notify the implementing agency 30 days before switching to storing biofuels. There is no permitting process, but to comply with the compatibility regulation owners storing biofuels must keep records demonstrating compliance with the compatibility requirement as long as the biofuel is stored.

- States should require that owners and operators conduct periodic and annual walk through inspections of UST system by trained A/B operators. The 2015 federal UST regulation requires walk through inspections, but it does not require them to be conducted by A/B operators.

The following are some additional considerations:

- States should implement database tracking mechanisms for biofuel blends storage, use, and UST system components. Continuing to simply specify “gasoline” or “diesel” will not capture the extent of biofuel use. Database structure and registration forms should be specific enough to accommodate various biofuel blends and should allow for component based compatibility evaluations.

- States should require that owners and operators periodically monitor for the presence of water in the UST. Require prompt removal when more than 1/4 inch of water is detected in a UST containing biofuel blends (gasoline alcohol blends or biodiesel blends), and not greater than 1 inch for gasoline and diesel fuel.

- States should include its equipment compatibility evaluation methodology in their A/B operator training curriculum.

- Owners and operators should ensure existing UST systems are properly cleaned and free of water before switching to biofuel storage. Biofuels can act as a “cleaning agent” in an

UST removing sludge or rust plugs that may have previously prevented a tank from leaking.

- Owners and operators should ensure all tank top fittings are tight and will prevent ingress of water into the UST. This includes fill risers and spill buckets, ATG monitoring ports, vapor recovery risers, vent line risers including ball float ports, and bungs on other unused tank openings. Refer to the Steel Tank Institute (STI) publication *"Keeping Water Out of Your Storage System"*.

- Avoid using UST components made from zinc, brass, lead, aluminum, or other soft metals.

This document is intended to improve awareness and focus attention on the importance of an equipment compatibility evaluation prior to the storage of biofuel blends, and the management of water in these storage tank systems. This is a living document, which will be periodically updated as more information on equipment compatibility, biofuel blends, and ULSD becomes available.

APPENDIX A: COMPATIBILITY EVALUATION CHECKLIST - TEMPLATE

Conversion and the installation of storage tank and dispensing systems for ethanol or biodiesel blended fuels requires evaluation and modifications of conventional storage/dispensing systems to maintain equipment material compatibility with the ethanol and biodiesel blends. Both ethanol and biodiesel, as pure product and as blended fuel, introduces different compatibility concerns for tank, piping and dispenser components than gasoline blended with 10 percent or less ethanol or biodiesel blended with 20 percent or less diesel.

The following document is designed as a template that can be adopted to assist in the review of each associated component to verify compatibility and to document the owner/operator responsibilities prior to the conversion or installation of a storage tank system for the storage of ethanol blends greater than E10 and biodiesel blends greater than B20. States require different levels of biofuel blends to meet compatibility requirements and the template should be adjusted to meet these requirements. Additional examples provided by States are listed below.

- Colorado – Alternative/Renewable Fuels Compatibility Form:
  https://www.colorado.gov/pacific/atom/19011

- Iowa UST System Checklist for Equipment Compatibility:
  https://www.iowadnr.gov/Portals/idnr/uploads/forms/5421336.pdf

- Minnesota UST Alternative Fuel Compatibility Form:
  http://www.pca.state.mn.us/index.php/view-document.html?gid=18486

- Washington State Alternative Fuel Installation or Conversion Checklist:
  https://fortress.wa.gov/ecy/publications/publications/ecy070523.pdf

- South Carolina UST Alternative Fuel Installation Application/Conversion Notification Form:
  https://www.scdhec.gov/environment/docs/d-3885.pdf

- Wisconsin Storage Tank Alternative Fuel Installation/Conversion Application:
  http://dsps.wi.gov/er/pdf/bst/Forms_FM/ER-BST-FM-9-AlternativeFuels.pdf

UNDERGROUND STORAGE TANK BIOFUEL INSTALLATION / CONVERSION APPLICATION - TEMPLATE

INSTRUCTIONS: Part I of this form is to be submitted to the (STATE DEPT NAME) along with the plan for new installations, or submitted independently for conversions of existing systems from conventional motor fuels to blends greater than 10 percent ethanol or for diesel blends greater than 20 percent biodiesel. For existing tank systems, Part I of this form shall be completed and submitted for approval prior to the conversion of the storage tank system. If a manufacturer or model/brand cannot be determined, write "UNK in the corresponding box, write "HC" and the treatment material if a hard-coat treatment is used to achieve compatibility, write "NA" if the tank/piping system does not have the listed component. Use the comment section at the bottom of page one for "UNK" or "HC" explanations and attach analysis documentation for review.
Part II shall be given by the contractor to the owner/operator for completion prior to system operation and retained on-site for inspector review. "Listed / Verified Components" shall be confirmed and documented by a Nationally Recognized Testing Laboratory (NRTL) for use with the specific gasoline-ethanol / biodiesel blends. Underwriter Laboratories is one of the recognized NRTL that tests and lists such components.

Part I

1. OWNER INFORMATION	**2. PROJECT INFORMATION**	**3. CONTRACTOR INFORMATION**
Contact Person	Facility Name	Contractor or Professional Engineer Name
Company Name	Site Address	Mailing Address
Mailing Address	☐ City ☐ Village ☐ Town of:	City, State, Zip Code
City, State, Zip Code	County	Contact Person
Telephone Number ( ) Fax Number ( )		Telephone Number ( ) Fax Number ( )

4. Tank Information **Fuel blend to be stored - Ethanol Blend** _____ **Biodiesel Blend** _____

Tank Orientation: ☐ Underground ☐ Aboveground ☐ New Tank ☐ Existing Tank→Date Installed: _____ Registration ID #:_____

Tank leak detection method: ☐ Automatic tank gauging ☐ Continuous ATG ☐ Interstitial monitoring ☐ Statistical Inventory Reconciliation (SIR) ☐ Inventory control and tightness testing

Component:	**Equipment Manufacturer**	**Model/Brand**	**NRTL Listed or Verified by Manufacturer for Fuel to be stored**
Note: Tanks with interior linings will not be approved for alternative fuel storage unless documentation is provided for confirmation of compatibility.			
Tank construction material			☐ Listed ☐ Manufacturer Verified
Spill bucket			☐ Listed ☐ Manufacturer Verified
Overfill / Auto shut-off / Ball float			☐ Listed ☐ Manufacturer Verified
Drop tube			☐ Listed ☐ Manufacturer Verified
STP/Suction pump / O-rings / Gaskets			☐ Listed ☐ Manufacturer Verified
Leak detection probes			☐ Listed ☐ Manufacturer Verified
Sump monitoring sensors			☐ Listed ☐ Manufacturer Verified

5. Pipe Information: ☐ **New** ☐ **Existing** ☐ **Mixed** (New/Existing) **Manuf. Make/Model**_____**Existing Pipe Install Date:** _____

Configuration: ☐ Single wall ☐ Double wall **Type:** ☐ Steel ☐ Fiberglass ☐ Flexible ☐ Other _____ **Sumps:** ☐ Submersible ☐ Pipe Connections

Pipe fitting / valve material			☐ Listed ☐ Manufacturer Verified
Gaskets / seals			☐ Listed ☐ Manufacturer Verified
Pipe sealant / adhesive			☐ Listed ☐ Manufacturer Verified
Flex connector			☐ Listed ☐ Manufacturer Verified
Elec. Line leak detector			☐ Listed ☐ Manufacturer Verified
Mech. Flow restrictor			☐ Listed ☐ Manufacturer Verified

6. Dispenser Information: Dedicated Disp. Hose: ☐Yes ☐No **Blending dispenser:** ☐ Yes ☐No **Containment sump under dispenser:** ☐Yes ☐No

Dispenser / Suction Pump			☐ Listed ☐ Manufacturer Verified
Dispenser piping			☐ Listed ☐ Manufacturer Verified
Dispenser Sump			☐ Listed ☐ Manufacturer Verified
Dispenser sump sensor			☐ Listed ☐ Manufacturer Verified
Gaskets/seals			☐ Listed ☐ Manufacturer Verified
Blending valve			☐ Listed ☐ Manufacturer Verified
Check valve			☐ Listed ☐ Manufacturer Verified
Meter			☐ Listed ☐ Manufacturer Verified
Emergency valve			☐ Listed ☐ Manufacturer Verified
Fuel filters			☐ Listed ☐ Manufacturer Verified
Break-away device			☐ Listed ☐ Manufacturer Verified
Nozzle(s)/Swivel(s)			☐ Listed ☐ Manufacturer Verified
Hose(s) and hose fittings			☐ Listed ☐ Manufacturer Verified

Additional Comments:

I certify by signature that I have personally examined and/or am familiar with the information submitted to verify system biofuel compatibility, and the information is true, accurate, and complete.

_____ Date: _____

Signature of licensed petroleum equipment contractor or professional engineer

Part II

Responsibilities of Tank Owner/Operator before Blends of Greater than 10 percent Ethanol or 20 percent Biodiesel is Transferred to the Tank

- ❑ Determine equipment compatibility - Part I of this form.
- ❑ Inform the facility's UST insurance carrier of plans to convert to a gasoline-ethanol blend exceeding 10 percent ethanol or biodiesel exceeding 20 percent. The UST insurance carrier may have additional requirements other than what (STATE REG.) requires.
- ❑ Obtain an amended certificate of insurance indicating UST coverage for the ethanol or biodiesel blend stored and submit to the storage tank regulation office.
- ❑ Check for water in the tank. No level of water is acceptable for gasoline-ethanol blended fuels due to the possibility of phase separation.
- ❑ All visible fittings and connections at the top of the tank are tight (no vapors escape and no water enters).
- ❑ Verify the appropriate vent top (pressure vacuum / updraft) is present for the type of product being stored.
- ❑ Stage I Vapor Recovery installed and operational if required.
- ❑ Sump and spill containment covers secured to prevent water from entering. Spill buckets should not have drain back mechanisms.
- ❑ Water infiltration problems fixed if necessary.
- ❑ The tank has been cleaned of all water and sediment per API Publication 2015 and NFPA 326. Company providing service:
  Company providing service: _____
  City:_____ State: _____ Telephone #:_____
- ❑ How / where is product being disposed of: _____
- ❑ Fill labeling - Identify fill port and paint access cover according to API RP 1637.
- ❑ Dispenser labeling – label dispenser in compliance with State Regulations.

First Delivery

- ❑ Tank filled to 80 percent capacity (recommended by the Renewable Fuels Association or RFA) and kept as full as possible for 7 to 10 days.
- ❑ Conduct a precision test of the tank system (0.1 gph leak rate) with ATG system within seven days after tank is filled to make sure system is tight and leak detection equipment is operating properly. Report any "Fail" results.
- ❑ Test for water (use alcohol compatible paste if you stick your tanks) at the beginning of each shift for the first 48 hours after delivery (RFA). If there is water in the tank, remove it, find out how it got there and fix it so it doesn't occur again.
- ❑ Have dispenser calibrated prior to any retail sales.
- ❑ Prior to dispensing, notify State Regulator Inspector that ethanol or biodiesel has been delivered and the dispensing system is going operational.
- ❑ Submit a completed copy of this Biofuels Application Form to the State regulation office.

Ongoing Maintenance Responsibilities

- ❑ Check for water daily with your stick or ATG system. No level of water in the tank is acceptable.
- ❑ If product seems to pump slowly, check and replace filters.
- ❑ Calibrate dispenser meter at the time of conversion and two weeks after conversion to verify meter accuracy. Particulate materials may cause excessive meter wear, which would require more frequent meter calibration (API RP 1626)
- ❑ Conduct daily, visual inspections of the dispenser and dispenser sump (secondary containment) beneath the dispenser (if one is installed) and all the other items on the inspection form. This form must be kept on site and available for inspector review.

_____ _____

Tank Owner Signature **Company**

(Note: By signing, signer is acknowledging that all the above preparatory items have been conducted, and awareness of ongoing responsibilities.)

_____ _____

Print Tank Owner Name **Date**

Failure to submit this form with all items completed will result in the tank and dispenser being subject to red-tagging and immediate shutdown.

A tank with any "unknowns" will not be approved for service for gasoline-ethanol blends exceeding 10 percent ethanol or diesel blends exceeding 20 percent biodiesel without a statement from the licensed contractor or professional engineer stating that in their professional judgment the system is acceptable for service with biofuel. Without such statement the tank and dispenser will be subject to red-tagging and shutdown.

APPENDIX B: REFERENCES AND ADDITIONAL RESOURCES

Fiberglass Tank and Pipe Institute (FTPI). Ethanol Compatibility with Fiberglass UST Systems. January 2015. http://www.fiberglasstankandpipe.com/white-papers/general/ethanol-compatibility-with-fiberglass-ust-systems/

Interstate Technology Regulatory Council (ITRC). *Biofuels: Release Prevention, Environmental Behavior, and Remediation*. September 2011 http://www.itrcweb.org/Guidance/ListDocuments?TopicID=2&SubTopicID=1

Oak Ridge National Laboratory (ORNL). *Analysis of Underground Storage Tank System Materials to Increased Leak Potential Associated with E15 Fuel*. July 2012 http://info.ornl.gov/sites/publications/files/Pub36356.pdf

ORNL. *Intermediate Ethanol Blends Infrastructure Materials Compatibility Study: Elastomers, Metals, and Sealants*. March 2011 http://info.ornl.gov/sites/publications/files/Pub27766.pdf

Petroleum Equipment Institute (PEI). *Alternative Fuels Equipment Compatibility Guide*. http://resource.pei.org/altfuels/guide.asp.

PEI. *UST Component Compatibility Library*. http://www.pei.org/PublicationsResources/ComplianceFunding/USTComponentCompatibilityLibrary/tabid/882/Default.aspx.

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STI. *Keeping Water Out of Your Storage System*. May 2006. http://www.steeltank.com/Portals/0/pubs/KeepingWaterOutofYourStorageSystem_updated%20_2_.pdf.

STI - *E-85 Compatible Equipment List*. http://www.steeltank.com/Portals/0/pubs/E85/Ethanol-Component-List.pdf.

Underwriter Laboratories (UL). *Alternative Fuels*. http://www.ul.com/global/eng/pages/offerings/industries/energy/alternative/.

UL. *Standard for Safety for Steel Underground Tanks for Flammable and Combustible Liquids (UL-58)*. http://ulstandardsinfonet.ul.com/scopes/0058.html.

UL. *Nonmetallic Underground Piping for Flammable Liquids (UL-971)*. http://ulstandardsinfonet.ul.com/scopes/scopes.asp?fn=0971.html.

UL. Scopes for UL Outlines. http://ulstandardsinfonet.ul.com/outscope/.

- *SU 87A. Power-Operated Dispensing Devices for Gasoline and Gasoline/Ethanol Blends with Nominal Ethanol Concentrations Up to 85 Percent (E0 – E85).*
- *SU 87B. Power-Operated Dispensing Devices for Diesel Fuel, Biodiesel Fuel, Diesel/Biodiesel Blends with Nominal Biodiesel Concentrations up to 20 Percent (B20), Kerosene, and Fuel Oil*
- *SU 1856. UST Internal Upgrade and Lining Systems.*
- *SU 2583. Fuel Tank Accessories.*
- *SU 2447. Containment Sumps, Fittings and Accessories for Fuels.*

U.S. Department of Energy (DOE). Ethanol Fueling Infrastructure Development. http://www.afdc.energy.gov/afdc/fuels/ethanol_infrastructure.html.

U.S. DOE. Biodiesel Fueling Infrastructure Development. http://www.afdc.energy.gov/afdc/fuels/biodiesel_infrastructure.html.

U.S. DOE. Alternative Fuels Station Locator. http://www.afdc.energy.gov/afdc/fuels/stations.html.

U.S. DOE, National Renewable Energy Laboratory (NREL). *Dispensing Equipment Testing with Mid-Level Ethanol/Gasoline Test Fluid.* November 2010. http://www.afdc.energy.gov/afdc/pdfs/49187.pdf.

U.S. Environmental Protection Agency. Renewable Fuel Standard (RFS). http://www.epa.gov/otaq/fuels/renewablefuels/index.htm.

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APPENDIX C: CASE SUMMARIES – FUEL AND EQUIPMENT MATERIAL COMPATIBILITY OBSERVATIONS

In September 2012, the ASTSWMO Emerging Fuels Task Force began soliciting information about sites where it was suspected that the observed equipment issues may be related to changing fuel stored to a biofuel. Case summaries submitted by regulatory officials from States across the country are included for your review. The purpose of including these summaries is to draw attention to field observations following the introduction of biofuels. The Task Force intends to add case summaries to this list as they are received.

The Task Force has not done any material testing to verify that these observations were the result of compatibility issues between the equipment and the fuel used, does not endorse any of the findings, and is not responsible for the accuracy, completeness, or usefulness of any information presented in the case summaries. The views and opinions of case summary submitters do not necessarily state or reflect those of the ASTSWMO Emerging Fuels Task Force.

Case Summary No.	Location	Fuel	Equipment Involved	Tank Capacity	Equipment Age	Issue Location	Issue	Resolution
1	Phoenix, AZ	E10	Tank	10K	24 yrs	Tank	Cracks in lining of tank	Tank to be relined
2	Tucson, AZ	E10	Tank	10K	26 yrs	Tank	Failed TTT	Release confirmed, tank repaired
3	Yuma, AZ	E10	Tank	10K	28 yrs	Tank	Regular failed TTT	Tank repaired
4	Yuma, AZ	E10	Tank	10K	28 yrs	Tank	Premium failed TTT	Tank repaired
5	Irmo, SC	E85	Other	N/A	N/A	ATG, Spill bucket	Probe failed, cracked spill bucket less than 2 yrs old	spill bucket repaired, tank emptied/no longer in use
6	Hartsville, SC	E85	Other	N/A	N/A	ATG, dispenser	Probe failed, delivery of E85 into reg unleaded tank	Probe replaced with ethanol compatible version; delivery driver warned
7	Columbia, SC	E85	Other	N/A	N/A	STP/sump	Excessive corrosion	STP replaced with compatible version
8	West Columbia, SC	E85	Other			STP/sump	Excessive corrosion due to vapors in sump	STP found to be compatible, asked to monitor liquids in sump
9	Lexington, SC	E85	Other	N/A	N/A	STP	Appearance of corrosion from	Manufacturer agreed to monitor other US sites, no

							incompatible paint	further issues at site
10	Missouri	E10/E85	Other	N/A	N/A	Flex Connector	Stainless Steel turning blue	Due to ethanol vapors. Monitor liquid in sump. Replace flex as needed
11	Delaware	E85	Other	N/A	N/A	STP	Excessive corrosion	Monitored and replace as needed
12	Iowa	E85	Tank	10K	Unk	Tank	Corrosion hole unplugged when changed from E10 to E85	Release remediated and tank removed
13	Carlsbad, New Mexico	E10	Piping	N/A	N/A	End of piping run	Environ piping degraded	Piping replaced
14	Hobbs, New Mexico	E10	Tank	8K	22 yrs	Tank	FRP tank excessively brittle at removal 7/2011	Tank removed
15	St George, SC	E10	Piping	N/A	N/A	Steel components	Blue buildup on steel components of flex piping	Due to ethanol vapors. Monitor liquid in sump. Replace flex as needed
16	Boiling Springs, SC	E10	Piping	N/A	N/A	Piping in dispenser	UPP piping was growing	Monitor pipe and replace as needed
17	St. George, SC	E10	Other	N/A	N/A	Conduit box	Excessive corrosion	Monitored and replace as needed
18	Haleiwa, HI	E10	Tank	10K	26 yrs	Tank (multiple)	Water found due to crack in bottom	All tanks were lined
19	Kailua, HI	E10	Tank	10K	25 yrs	Tank (multiple)	Damaged internal liner	Release confirmed and all tanks removed
20	Waipahua, HI	E10	Tank	10K	23 yrs	Tank	Breach in inner shell	Tank lined twice and is TOU
21	Honolulu (Lawehana), HI	E10	Tank	10K	26 yrs	Tank (multiple)	Failed CSLD tank; severe breakdown of fiberglass	Tanks were lined
22	Kihei, HI	E10	Tank	10K	27 yrs	Tank (multiple)	Water found, spider web cracking	Release declared. Super tank closed in place, Regular tank lined

23	Miles City, MT	E10	Tank	4K	23 yrs	Tank	Internal corrosion - hole in tank	Catastrophic release. Tank removed

Case Summary 1

Site Location: Phoenix, AZ

Fuel Type: E10 Product Type: Gasoline (Premium)

Issue Type: Tank

Tank Issue:

Tank Construction: Double Walled Tank Material: FRP

Tank Capacity: 10,000 gallons Installation Date: 1987 Current Tank Age: 24 yrs

Description of Issue:
Premium Unleaded gasoline tank installed in 1987 (note: E10 was used as a "winter blend" in AZ fuel starting in approx. 1988). In October 2011 the owner noticed an inventory issue and called their contractor. Automatic tank gauge (ATG) results did not indicate a leak; however, the inspector went through inventory records and found several hundred gallons of fuel missing. The contractor conducted a tank tightness test that failed.

Supporting Pictures:
Damaged Internal Lining

Findings and Resolution:
The contractor called the inspector and the tank was emptied to mitigate any further release. The contractor contacted the manufacturer. A 10' x 10' hole was cut into the cement and the manufacturer entered the tank on November 1, 2011. The manufacturer discovered several cracks on the bottom of the tank. ADEQ was notified that the tank is to be re-lined.

Case Summary 2

Site Location: Tucson, AZ

Fuel Type: E10 Product Type: Gasoline (Premium)

Issue Type: Tank

Tank Issue:

Tank Construction: Unknown Tank Material: FRP

Tank Capacity: 10,000 gallons Installation Date: 1985 Current Tank Age: 26 yrs

Description of Issue:
Confirmed release was discovered on 5/18/2011. The owner/operator noticed a product loss. The initial tank tightness test documented an ullage failure; however, when the tank was removed, it was noted that a crack extended around the tank end cap.

Findings and Resolution:
A release from this tank was confirmed and though the owner/operator informed ADEQ that he intended to repair the tank, in July 2012 he decided to have the tank removed.

Case Summary 3

Site Location: Yuma, AZ

Fuel Type: E10 Product Type: Gasoline (Regular)

Issue Type: Tank

Tank Issue:

Tank Construction: Single Walled Tank Material: FRP

Tank Capacity: 10,000 gallons Installation Date: 1984 Current Tank Age: 28 yrs

Description of Issue:
In September 2011, the owner reported a failed ullage test.

Findings and Resolution:
Documentation provided states that the tank was repaired, re-tested and brought back into service

Case Summary 4

Site Location: Yuma, AZ

Fuel Type: E10 Product Type: Gasoline (Premium)

Issue Type: Tank

Tank Issue:

Tank Construction: Single Walled Tank Material: FRP

Tank Capacity: 10,000 gallons Installation Date: 1984 Current Tank Age: 28 yrs

Description of Issue:
In September 2011, the owner reported a failed ullage test. The owner also reported a confirmed release from this tank.

Findings and Resolution:
Documentation provided states that the tank was repaired, re-tested and brought back into service.

Case Summary 5

Site Name/Location: Irmo, SC

Fuel Type: E85 Product Type: Gasoline/Ethanol Blend

Issue Type: Other (STP, dispenser, spill bucket, tank probe, etc.)

Other Issues (STP, dispenser, spill bucket, tank probe, etc.):

Equipment involved: Automatic Tank Gauge (ATG probe) and spill bucket

Additional Details:
Tank Gauge probe
Spill Bucket was black accordion style- manufacturer unknown

Description of Issue:
On July 16, 2008 the SC inspector visited the site for a routine inspection. The inspector noted that the site was missing the required ATG printouts for the E85 tank. The inspector then noticed that the ATG probe did not appear to be functioning properly. In addition, they noted that the E85 spill bucket needed to be repaired even though the site had only been in operation for a couple of years. The spill bucket failed the hydrostatic test but the required samples came back below detectable limits. On August 21, 2009, the inspector visited the site for their routine compliance inspection and again noted that the ATG probe was not functioning properly

Findings and Resolution:
This site was one of 5 stores that had begun E85 operation prior to the creation of SC's Alternative Fuel Program. In both 2008 and 2009, the tank owner was required to conduct a tank tightness test. These tests passed so it was determined non passing printouts were related solely to the incompatibility of the probe. Spill bucket was repaired. After numerous attempts to get the tank owner (who was not the tank owner when tank was originally installed) to complete SC's "Alternative Fuel Checklist", they decided to empty the tank. It remains out of use at this time.

Case Summary 6

Site Location: Hartsville, SC

Fuel Type: E85 Product Type: Gasoline/Ethanol Blend

Issue Type: Other (STP, dispenser, spill bucket, tank probe, etc.)

Other Issues (STP, dispenser, spill bucket, tank probe, etc.):

Equipment involved: Automatic Tank Gauge (ATG probe), dispensers/delivery driver

Additional Details:
Tank Gauge probe

Description of Issue:
In 2005, prior to the introduction of the "Alternative Fuel Checklist", this site converted a tank to E85 without the knowledge of the SC UST Program. An inspector performing a routine inspection discovered that the upgrade had taken place. In 2007, the inspector returned for the annual inspection and noticed that several months of ATG printouts were missing. When the tank owner was questioned, he stated that the probe had dissolved because their contractor had installed a regular gasoline probe.

Supporting Pictures:
Corroded Incompatible ATG Probe

Findings and Resolution:
The tank owner was required to submit SC's "Alternative Fuel Checklist" showing that all equipment (including the probe) was compatible with E85. The checklist was received showing that the probe and all other equipment were now installed were now compatible.

Case Summary 7

Site Location: Columbia, SC

Fuel Type: E85 Product Type: Gasoline/Ethanol Blend

Issue Type: Other (STP, dispenser, spill bucket, tank probe, etc.)

Other Issues (STP, dispenser, spill bucket, tank probe, etc.):

Equipment involved: STP/STP sump

Additional Details:
Non retrofitted STP

Description of Issue:
In 2005, prior to the introduction of SC's "Alternative Fuel Checklist", this site converted a tank to E85 without the knowledge of the SC UST Program. In 2009, the inspector visited the site for a routine compliance inspection and noted excessive corrosion on the submersible pump. In addition, sheen was observed in the water found in the E85 submersible pump sump. There was extreme corrosion on the underside of the manway lid for the E85 submersible pump.

Findings and Resolution:
It was determined that the submersible pump assembly was not compatible with greater than 10 percent alcohol. In August 2009, the SC Division of UST Management requested and received an incomplete "Alternative Fuel Checklist". In September 2009, a completed checklist was received; however, the submersible pump had not been upgraded. In October 2009, a letter was submitted requesting that the site be "grandfathered in" and allowed to continue use of the incompatible submersible pump. SC denied the request and the pump was replaced in October 2009.

Case Summary 8

Site Location: West Columbia, SC

Fuel Type: E85 Product Type: Gasoline/Ethanol Blend

Issue Type: Other (STP, dispenser, spill bucket, tank probe, etc.)

For Other Issues (STP, dispenser, spill bucket, tank probe, etc.):

Equipment involved: STP

Description of Issue:
In 2005, prior to the introduction of SC's "Alternative Fuel Checklist", this site converted a tank to E85 without the knowledge of the SC UST Program. In June 2009, the inspector for the area visited the site for a routine compliance inspection and observed corrosion on the submersible pump.

Findings and Resolution:
In 2009, the SC Division of UST Management requested and received a complete "Alternative Fuel Checklist" showing that the submersible pump was compatible with high blend alcohol fuels. The owner was instructed to monitor the amount of liquids and vapors from the E85 tank that accumulate in the submersible pump sump and to not allow liquids to remain in the sump.

Case Summary 9

Site Location: Lexington, SC

Fuel Type: E85 Product Type: Gasoline/Ethanol Blend

Issue Type: Other (STP, dispenser, spill bucket, tank probe, etc.) __

Other Issues (STP, dispenser, spill bucket, tank probe, etc.):

Equipment involved: STP

Additional Details:
STP less than one year old in the picture; was brand new when installed

Description of Issue:
In early 2006, prior to the formal introduction of SC's "Alternative Fuel Checklist", this site converted a tank to E85 without the knowledge of the SC UST Program. In 2007, the inspector visited this site for a routine compliance inspection. The inspector noted excessive corrosion on the submersible pump head and its associated components.

Supporting Pictures:
Corroded STP

Findings and Resolution:
Upon receipt of a completed SC "Alternative Fuel Checklist", it was determined that the submersible pump was the appropriate "AG" (alternative fuel) model and therefore compatible with E85. The manufacturer of the submersible pump clarified that the E85 vapors had caused the paint on the submersible pump housing to run to cause the appearance of corrosion. It was confirmed that none of the internal components were affected. The manufacturer confirmed that the paint formulation used on the submersible pump had changed and that they would monitor other sites across the country for any further instances relating to paint degradation. The site was monitored for any further issues and to this date none have arisen.

Case Summary 10

Site Location: Various locations in Missouri

Fuel Type: E10/E85 Product Type: Gasoline/Ethanol Blend and Gasohol

Issue Type: Other (STP, dispenser, spill bucket, tank probe, etc.)

Other Issues (STP, dispenser, spill bucket, tank probe, etc.):

Equipment involved: stainless steel flex connectors

Description of Issue:
Inspectors conducting routine inspections at multiple facilities have observed that the stainless steel flex connectors had turned blue. Typically, ethanol does not react with stainless steel; therefore, it was unclear as to why they were turning blue.

Findings and Resolution:
Ethanol vapors in sumps can result in the formation of corrosive acidic conditions This can lead to an aggressive oxidation process on the threaded brass riser cap. Brass, normally very stable, is an alloy with a pretty high copper content. Because of the copper, any surface oxidation on the brass cap would embody a blue colored crust as an end result. Couple that with the metal to metal contact between the flex connector and the brass cap, and you now have a dissimilar metals corrosion cell created. With the brass actively oxidizing at an accelerated rate due to ethanol vapors being present, the stability of the brass is reduced. This allows for the stainless steel (being the more stable metal) of the flex connector to become the cathode. The corroding brass cap, due to the unstable state of aggressive oxidation, has now become the anode. The corroding brass electrons are passively being transferred or pushed to the stainless steel flex connector via the metal to metal contact. The electron transfer is such that the blue color of the copper oxide is migrating all over the stainless steel surface in an effort to "galvanically protect" the stainless steel, thus causing the "blue" flex connector.

Case Summary 11

Site Location: Delaware

Fuel Type: E85 Product Type: Gasoline/Ethanol Blend

Issue Type: Other (STP, dispenser, spill bucket, tank probe, etc.)

Other Issues (STP, dispenser, spill bucket, tank probe, etc.):

Equipment involved: STP

Description of Issue:
Corrosion beginning on the submersible pump and its associated components was noted.

Supporting Pictures:
Corrosion Beginning on an STP

Findings and Resolution:
Monitoring and replacement as needed

Case Summary 12

Site Location: Iowa

Fuel Type: E85 Product Type: Gasoline/Ethanol Blend

Issue Type: Tank

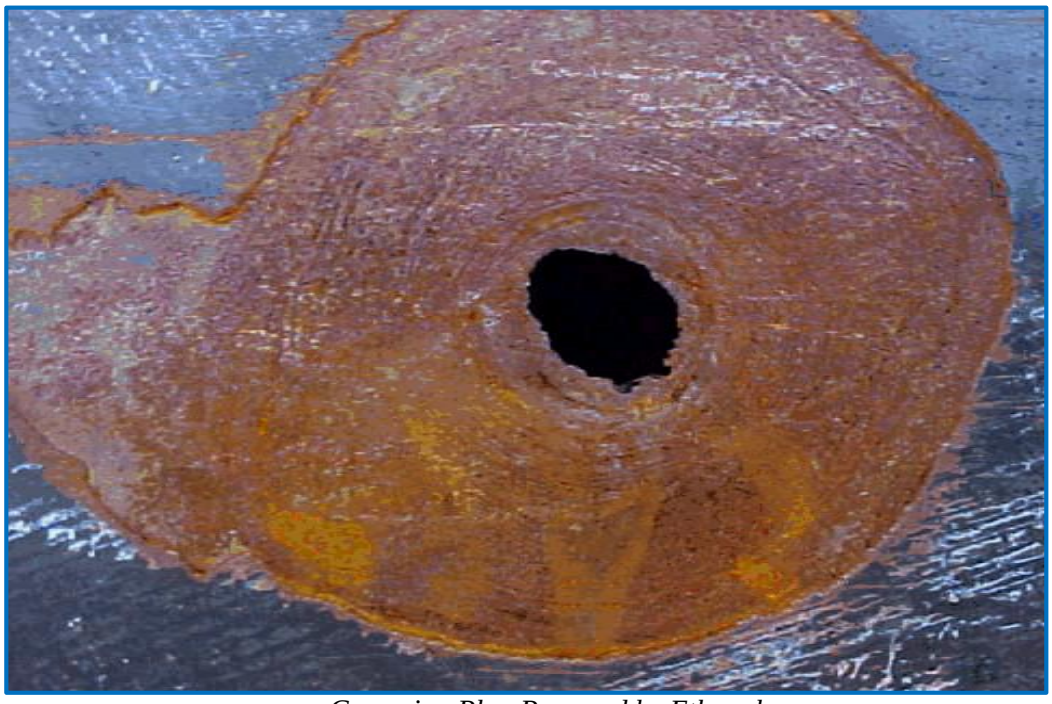
For Tank Issues:

Tank Construction: Single Walled Tank Material: Steel

Tank Capacity: 10,000 gallons Installation Date: unk Current Tank Age: unk

Description of Issue:
Tank tightness was not considered when converting from E10 to E85. Ethanol has the ability to dissolve previously plugged pinholes in storage tanks formed as a result of corrosion.

Supporting Pictures:



Corrosion Plug Removed by Ethanol

Findings and Resolution:
Release occurred. Tank was removed and remediation conducted.

Case Summary 13

Site Location: Carlsbad, New Mexico

Fuel Type: E10 Product Type: Gasoline (Premium)

Issue Type: Piping

Piping Issues:

Piping Construction: Double Walled Piping Material: Flex Installation Date: 1998

Additional Details:
DW Flexible Plastic

Description of Issue:
During a compliance inspection in 2009, a UST inspector found product in one of the two dispenser sumps. It was discovered that the piping was leaking from between the primary and secondary walls.

Supporting Pictures:
Damaged Environ Piping

Findings and Resolution:
During excavation of the piping around the premium STP, the UST inspectors found evidence of degradation of the outer secondary barrier. Upon further investigation, the inside of the piping was found to be deteriorated.

Case Summary 14

Site Location: Hobbs, New Mexico

Fuel Type: E10 Product Type: Gasoline (Regular/Premium)

Issue Type: Tank

Tank Issues:

Tank Construction: Single Walled Tank Material: FRP

Tank Capacity: 8,000 gallons Installation Date: 1989 Current Tank Age: N/A

Description of Issue:
During excavation and removal of tanks in July 2011, the contractor found out that he was unable to lift the tanks using the lifting lugs. The tanks were so brittle that they split in two when lifting lugs were used.

Findings and Resolution:
Tanks have been removed.

Case Summary 15

Site Location: St. George, South Carolina

Fuel Type: E10 Product Type: Gasoline (Regular)

Issue Type: Piping

Piping Issues:

Piping Construction: Double Walled Piping Material: Flex with steel components

Date of Installation: 2000

Description of Issue:
During a compliance inspection in September 2012, the UST inspector found a blue buildup on steel components associated with the flexible piping in the subpump.

Supporting Pictures:
Blue Buildup

Findings and Resolution:
Ethanol vapors possess acidic properties and can act as a corrosive catalyst in the sump environment. This can lead to an aggressive oxidation process (similar to Missouri case study).

Case Summary 16

Site Location: Boiling Springs, South Carolina

Fuel Type: E10 Product Type: Gasoline (Regular)

Issue Type: Piping

Piping Issues:

Piping Construction: Double Walled Piping Material: Flex with steel components

Date of Installation: August 2004

Description of Issue:
During a compliance inspection, it was noticed that the UPP pipe had started to bend (like previous generations of other flexible piping).

Supporting Pictures:
Bent UPP piping

Findings and Resolution:
Site was asked to monitor pipe for further damage.

Case Summary 17

Site Location: St. George, SC

Fuel Type: E10 Product Type: Gasoline (regular)

Issue Type: Other (STP, dispenser, spill bucket, tank probe, etc.)

Other Issues (STP, dispenser, spill bucket, tank probe, etc.):

Equipment involved: Conduit box and associated wiring within STP

Description of Issue:
Corrosion on lead and brass components of the conduit leading to white buildup.

Supporting Pictures
Corrosion on Conduit in STP

Findings and Resolution:
Monitor for further damage.

Case Summary 18

Site Location: Haleiwa, HI

Fuel Type: E10 Product Type: Gasoline (Regular and Premium as well as Diesel

Issue Type: Tank

Tank Issues:

Tank Construction: Single Walled Tank Material: FRP

Tank Capacity: 10,000 gallons Installation Date: 1986 Current Tank Age: 26 yrs

Description of Issue:
Prior to the storing of blended fuels, the USTs stored unleaded 87 and 92 octane as well as diesel. It was believed that the tanks had had been properly cleaned prior to the switching of products. The premium UST was placed in temporarily out of use (TOU) status on 12/18/2008 and was put back in service on 2/5/2009. The ATG detected the presence of water in the tank and as a result, the tank was placed back into TOU status on 2/10/2009. In 9/2009, an internal inspection of the tank was conducted. The results indicated a crack in the bottom of the tank.

Supporting Pictures:

92 Octane UST – breakdown observed during pre-blast inspection

92 Octane UST – deep crazing/crack observed during pre-blast inspection

92 Octane UST interior – water entering tank through crack

Findings and Resolution:

The internal inspection results yielded the following information:

- Super Tank: had a crack in the bottom, some breakdown of the gel coat, initial layer of the fiberglass mat and crazing was observed
- Regular Tank: slightly deteriorated gel coat was observed, some slight flaking and exposed fiber were found throughout the tank but no visible cracks noted
  Diesel Tank: slightly deteriorated gel coat was observed some slight flaking and exposed fiber were found throughout the tank but no visible cracks were observed.

The issue was resolved for all three tanks by having the USTs lined.

Case Summary 19

Site Location: Kailua, HI

Fuel Type: E10 Product Type: Gasoline (Regular and Premium)

Issue Type: Tank

Tank Issues:

Tank Construction: Single Walled Tank Material: FRP

Tank Capacity: 10,000 gallons Installation Date: 1987 Current Tank Age: 25 yrs

Description of Issue:
Prior to the storing of blended fuels, the USTs stored unleaded 87 and 92 octane. It was believed that the tanks had had been properly cleaned prior to the switching of products. The premium UST was placed in temporarily out of use (TOU) status in 6/2008 due to a suspected release. It was repaired and lined then brought back in service in 12/2009. A failed CSLD test was reported and as a result the tank was placed back into TOU status in 10/2010. An internal inspection of the tank revealed that the new liner was damaged. It was thought that the liner did not adhere to the fiberglass properly.

Supporting Pictures:
UST 92 Octane interior view: horizontal cracking in tank shell

UST 92Octane interior view: lining deteriorated

Findings and Resolution:
A release was confirmed and all USTs were removed in early 2012.

Case Summary 20

Site Location: Waipahua, HI

Fuel Type: E10 Product Type: Gasoline Premium

Issue Type: Tank

Tank Issues:

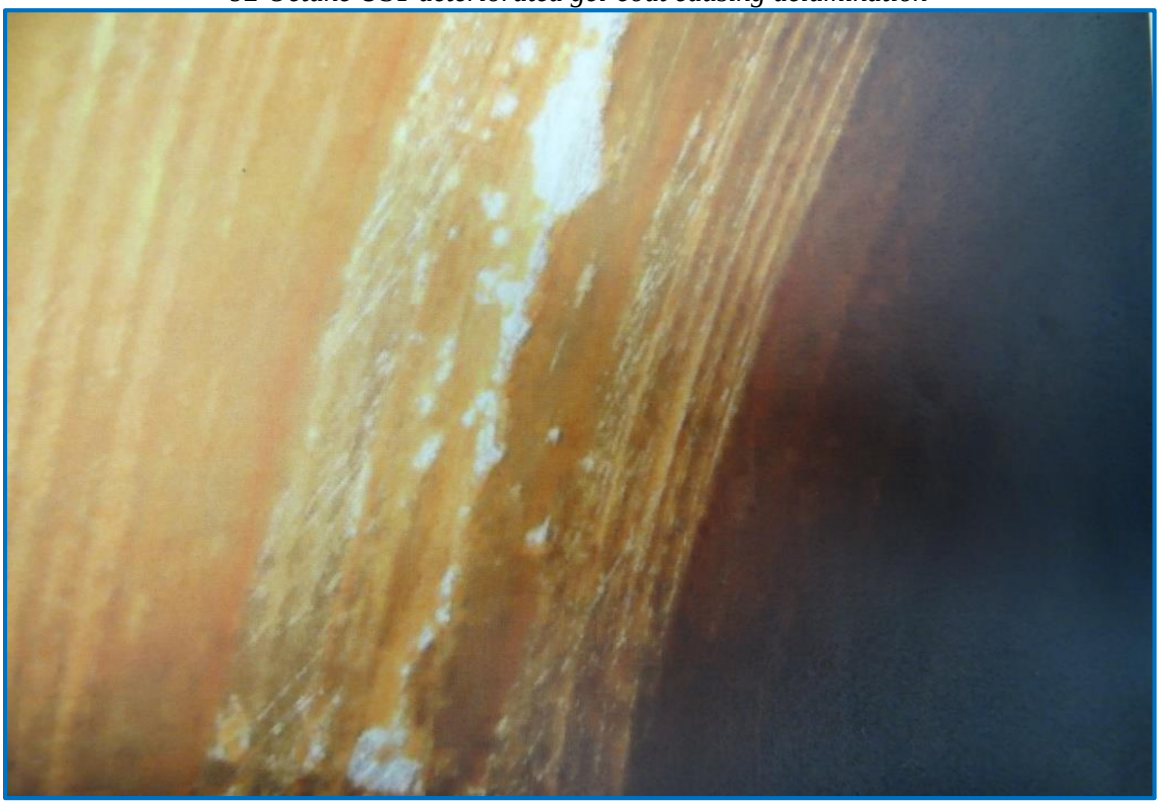
Tank Construction: Double Walled Tank Material: FRP

Tank Capacity: 12,000 gallons Installation Date: 1989 Current Tank Age: 23 yrs

Description of Issue:
Prior to storing blended fuel, UST stored unleaded 92 octane. It was believed that the tank was interior cleaned prior to switching product. Tank was placed on a TOU status on 9/23/2009 for relining and brought back in service on 3/24/2010. Tank was again TOU on 7/16/2011 because product was found in the interstice. The tank was lined for a second time and then was brought back in service on 12/16/2011. Currently, tank is TOU since 8/6/2012 due to breach in the inner shell

Supporting Pictures
UST fibers exposed due to chemical exposure

92 Octane UST deteriorated gel-coat causing delamination



Findings and Resolution:
Tank was lined twice and is currently TOU

Case Summary 21

Site Location: Honolulu (Lawehana), HI

Fuel Type: E10 Product Type: Gasoline (Regular, Plus and Premium)

Issue Type: Tank

For Tank Issues:

Tank Construction: Single Walled Tank Material: FRP

Tank Capacity: 10,000 gallons Installation Date: 1986 Current Tank Age: 26 yrs

Description of Issue:
Prior to the storing of blended fuels, the USTs stored unleaded 87, 89 and 92 octane. It was believed that the tanks had had been properly cleaned prior to the switching of products. The premium UST failed several CSLD and static tests and was therefore placed in TOU status on 8/14/2009. All three tanks were internally inspected and consequently the remaining two tanks were placed in TOU status. Free product was also found in two groundwater wells connected to the tank catchment pit.

Supporting Pictures:
UST 87 Octane internal view: gel deterioration

UST 89 Octane internal view: crack

Findings and Resolution:
All three USTs showed severe deterioration of internal Gel coat with exposure of fiberglass fibers. There were visible cracks as well as a 2.5 feet long crack on the bottom center and at both ends of the premium UST. There was one (1) large area of crazing in the plus tank. All tanks were eventually lined and returned to service on 10/21/2009.

Case Summary 22

Site Location: Kihei, HI

Fuel Type: E10 Product Type: Gasoline (Regular, Plus and Premium)

Issue Type: Tank (master and slave)

For Tank Issues:

Tank Construction: Single Walled Tank Material: FRP

Tank Capacity: 10,000 gallons Installation Date: 1985 Current Tank Age: 27 yrs

Description of Issue:
Prior to the storing of blended fuels, the USTs stored unleaded 87 and 92 octane. It was believed that the tanks had had been properly cleaned prior to the switching of products. The premium tank was placed in TOU status on 8/17/2010. Water was found in the UST and "spider web" cracking was also noted. The ATG probe, however, did not note any possible loss/leak of product. Further investigation eventually confirmed a release. All tanks were internally inspected.

Supporting Pictures:
UST 87 Octane (master) - Gel-coat breakdown exposing fibers

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UST 92 Octane interior – cracked shell

Findings and Resolution:
After the internal inspection the following was noted:

- Super Tank: was in unsatisfactory condition. The gel coat exhibited breakdown and laminate layers contained creases that resulted in buckles between the stiffening ribs. Chemical attack was observed throughout the tank shell and the bulkheads. On 3/29/2011, the tank was permanently closed in place.
- Regular Tank: Master and slave tanks both exhibited some early signs of breakdown within the gel coat and laminate layers of fiberglass on the shell and bulkheads. The USTs were eventually lined

Case Summary 23

Site Location: Miles City, MT

Fuel Type: E10 Product Type: Gasoline (E10)

Issue Type: Tank

Tank Issue:

Tank Construction: STIP-3 Tank Material: Steel

Tank Capacity: 4,000 gallons Installation Date: est. 1987 Current Tank Age: 23 yrs

Description of Issue:
Explosive vapors in building adjacent to site (required evacuation of building). Release was confirmed, LNAPL identified in monitoring well (depth to water: 10-13 feet), estimated volume of loss 9,700 gallons, actual gasoline recovered >14,000 gallons.

Supporting Pictures:
Exterior Photo

Interior Photo

Findings and Resolution:
Release from perforation in tank caused by internal corrosion. Tank was removed. Total cleanup costs estimated at over $900,000. Tank owner is in litigation with tank manufacturer.

APPENDIX D: CASE SUMMARY TEMPLATE

The ASTSWMO Emerging Fuels Task Force is still gathering documentation on fuel material incompatibility cases, and if you have any, we would appreciate it if you could use the template below to share this information with us. Pictures supporting the issues observed are encouraged.

Mini Case Summary –Fuel and Equipment/Material Issues

Site Name/Location: _____

Fuel Type: E10__ E15__ E20__ E85__ E100__ B20__ B100__ Other: _____

Product Type: Gasoline (Regular___ or Premium ___) Gasohol ___ Biodiesel ___

Issue Type: Tank __ Piping __ Other (STP, dispenser, spill bucket, tank probe, etc) __

For Tank Issues:

Tank Construction: Single Walled ___ Double Walled ___

Tank Material: Steel ___ Composite ___ FRP ____

Tank Capacity: _____

Installation Date: _____ Current Tank Age: _____

Additional Details:
If known – manufacturer, make, model number, etc. *(we will not be reporting this information; however, it may be useful for putting together a confidential spreadsheet to look for possible trends)*

Description of Issue (Background info and field observations):
Provide a brief history of tank (product stored prior to the alternative fuel, was tank interior cleaned prior to switching product, was equipment evaluated/replaced for compatibility, timing on the appearance of incompatibility issues after switching products, etc.)

Describe field observations and/or other observations that prompted further investigation (evidence of corrosion, product leaks or seepage, failed component, etc).

Supporting Pictures:
Please attach photo documentation of the issue described above if available.

Findings and Resolution:
Describe findings and evidence that caused you to conclude that the issue described above was directly related to material incompatibility with the alternative fuel.

Describe consequences of the incompatibility and how the issue was resolved (resulted in a release to environment, replaced incompatible materials, removal of tank, enforcement action, etc)

For Piping Issues:

Piping Construction: Single Walled ___ Double Walled ___

Piping Material: Steel ___ Composite ___ FRP ____ Flex _____

Date of Installation: _____

Additional Details:

If known – manufacturer, make, model number, etc. *(we will not be reporting this information; however, it may be useful for putting together a confidential spreadsheet to look for possible trends)*

Description of Issue (Background info and field observations):

Supporting Pictures:

Findings and Resolution:

For Other Issues (STP, dispenser, spill bucket, tank probe, etc):

Equipment involved:

Additional Details:
If known – manufacturer, make, model number, etc. *(we will not be reporting this information; however, it may be useful for putting together a confidential spreadsheet to look for possible trends)*

Description of Issue (Background info and field observations):

Supporting Pictures:

Findings and Resolution: