



STI/SPFA 2017 Annual Meeting
January 28-31

The Naples Beach Hotel & Golf Club
851 Gulf Shore Boulevard North
Naples FL 34102



Fuel Quality Services, Inc.

Microbial Contamination Detection and Remediation

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Fuel Quality Services, Inc.

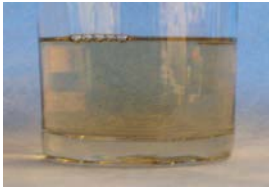
- Manufacture & sell performance chemicals including microbicides for the upstream and downstream markets
- Actively participate with various industry peer groups, task forces, and ad hoc technical groups.
- Consulting in the areas of fuel storage and maintenance.
- Legal & litigation support, expert witness.

Overview of Presentation

- Overview
- Issues
- Potential Causes
- Detection Methods
- Remediation
- Q&A

Industries Impacted By Microbially Influenced Corrosion

Finished Fuel



Bulk Fuel Transmission



Bulk Fuel Storage



Local Terminals



Retail Fueling



Utilities



Emergency Systems



Aviation / Military



Ground



Industrial



Rail



Marine



The damaging effects associated with Microbially Influenced Corrosion (MIC) are well known and are experienced across the entire spectrum of industries that store, distribute and utilize petroleum based energy and biomass based energy.

Telecommunications



Agriculture





Clean Air Act

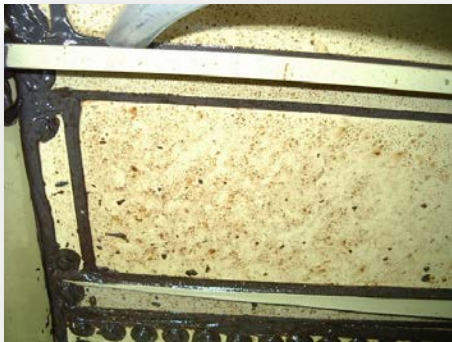
.... however, the introduction of alternative fuels into a well established industry has resulted in some unanticipated & costly outcomes.

Changing Fuel Supply 1993 to Current

Items	High Sulfur Diesel Pre 1993	Low Sulfur Diesel 1993	EtOH in Gasoline 2005	Ultra Low Sulfur Diesel 2006	Biodiesel 2008	
Sulfur	3000 ppm	500 ppm	—————→		<15 ppm	0 ppm
Stability	Stability Issues			Very Stable	Variable	
Aromatics, %	Decrease in aromatics reduces ability of fuel to retain water - increases water present in tank bottom				0%	
Saturates, %	Increase in concentration leads to increased energy microbial food source				Varies based on blend stock	
Water, ppm	Increasing volume in fuel tank bottoms				Absorbs much more water	
Microbial Activity	>120 days due to presence of aromatics		<180 days due to more in saturates		<30 days Enhances MIC	

Typical Fuel System Corrosion From MIC

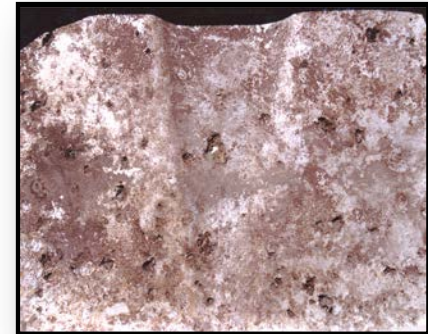
Aircraft Wing Tank



Ship Hull



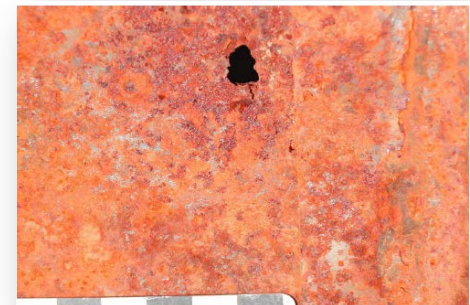
Truck Fuel Tank



Diesel AST



Gasoline UST



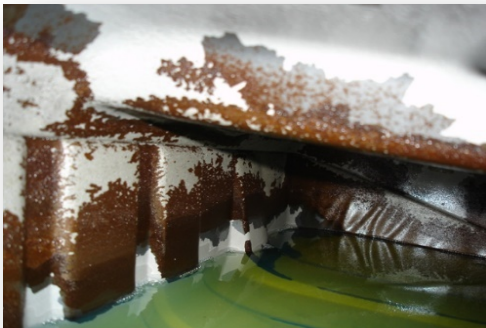
Home Heating Oil Tank

Atypical ULSD Fuel System Corrosion

Fuel System
Components



Diesel
Automobile



Atypical E10 Gasoline System Corrosion

- Accelerate Corrosion of Sump Pump by Acetobacter
- Dryness or saturation of sump effects corrosion rates



Premium/E10 STP (Tennessee) – March 2010

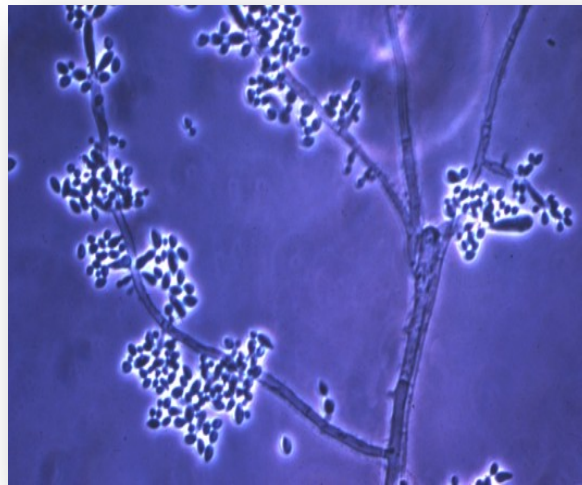


Premium/E10 STP (Tennessee) – August 2010

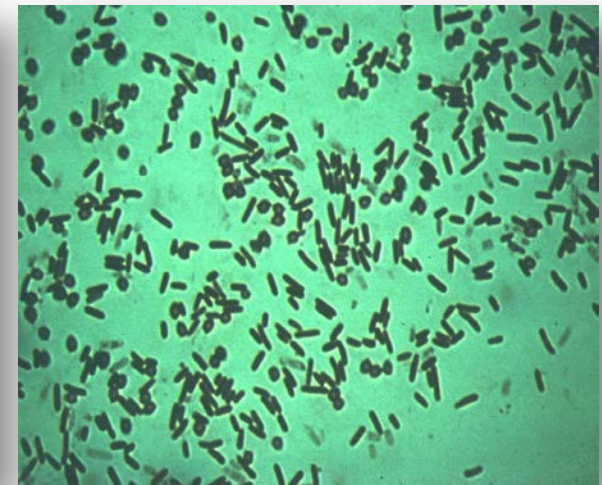
Microorganisms



Algae
Not Associated
with Fuels

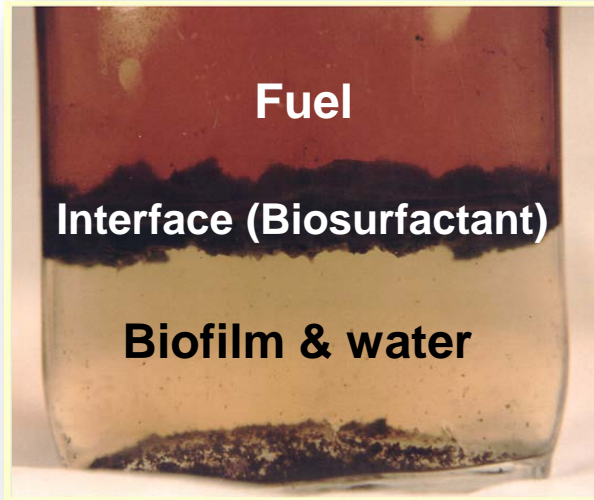


Fungi
Not Involved
with the current
problem

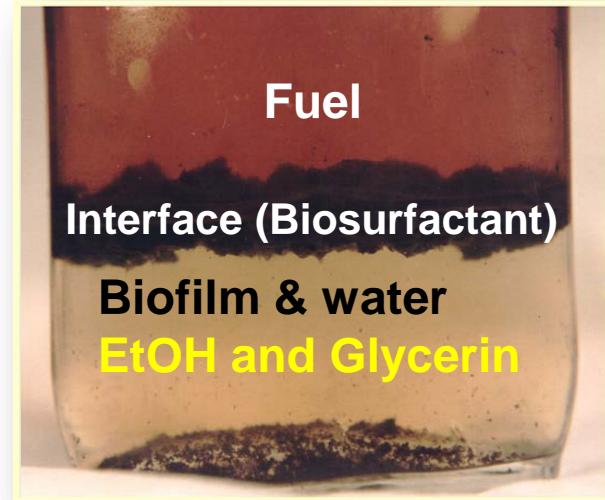


Bacteria
Acetobacter

Factors That Promote Microbial Growth In Fuel Systems Before and After



Before 2005



After 2005

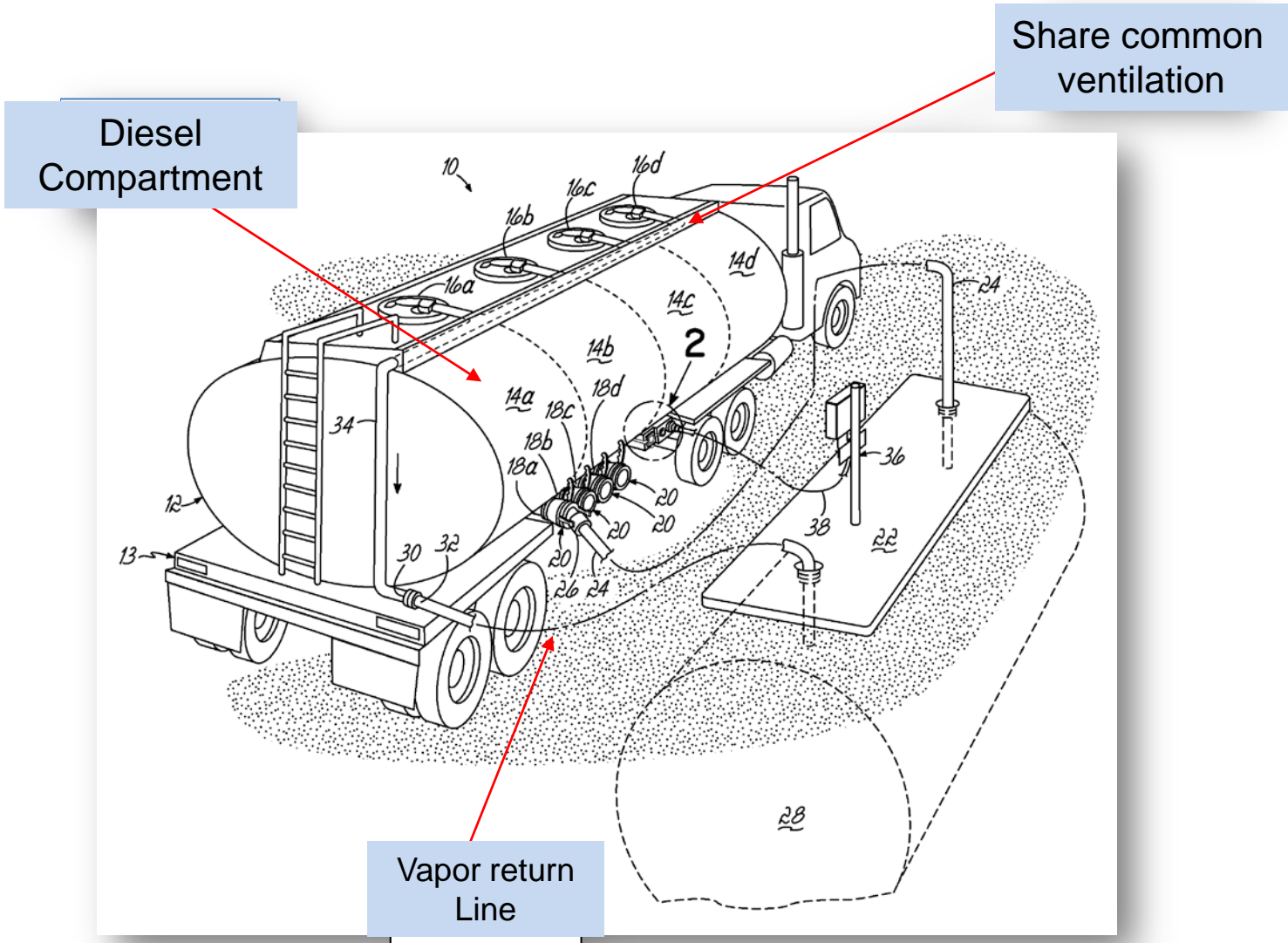
Potential Sources of Fuel Cross Contamination

Switch Loading

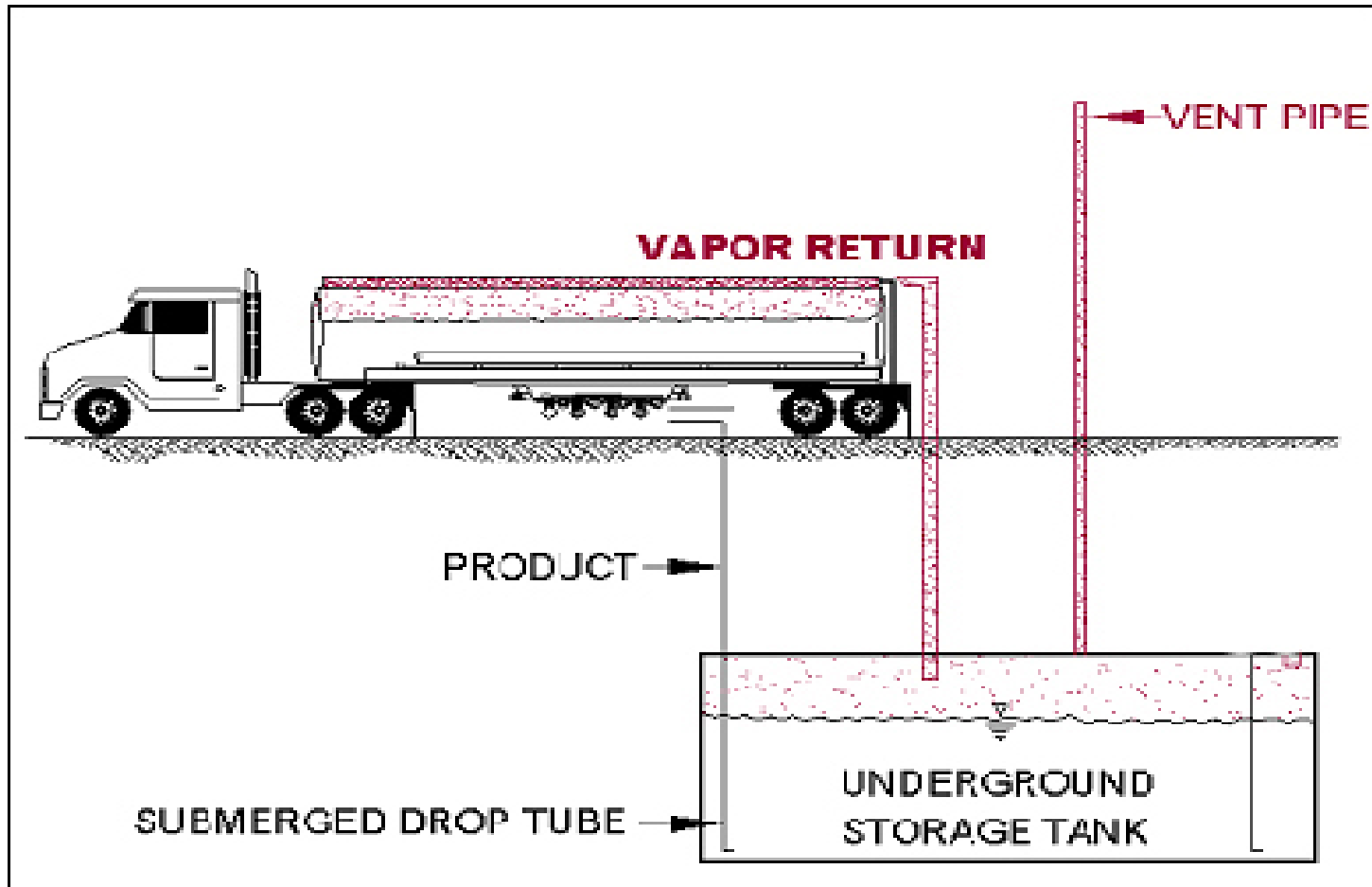
Split Loading

Stage 1 Vapor Recovery

What is Split Loading?

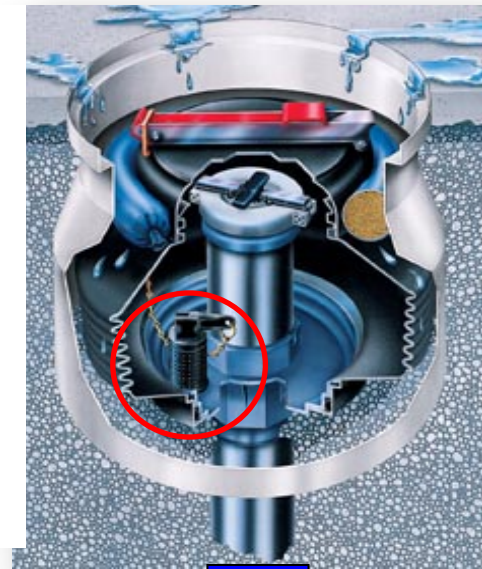
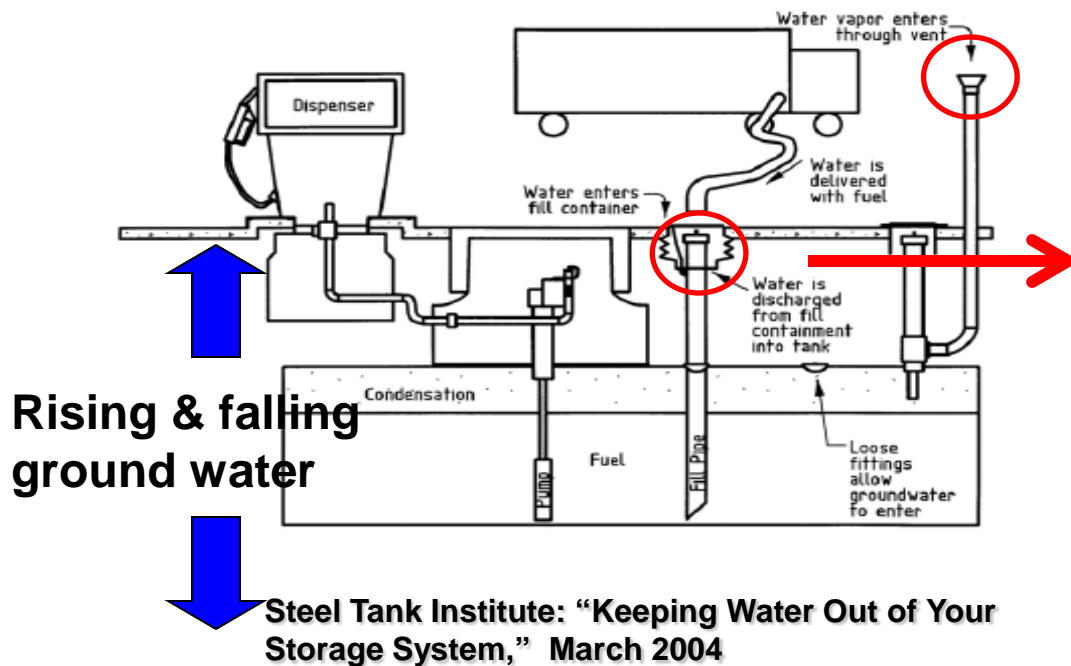


EPA Stage 1 Vapor Recovery System



Potential Sources of Microbial Contamination

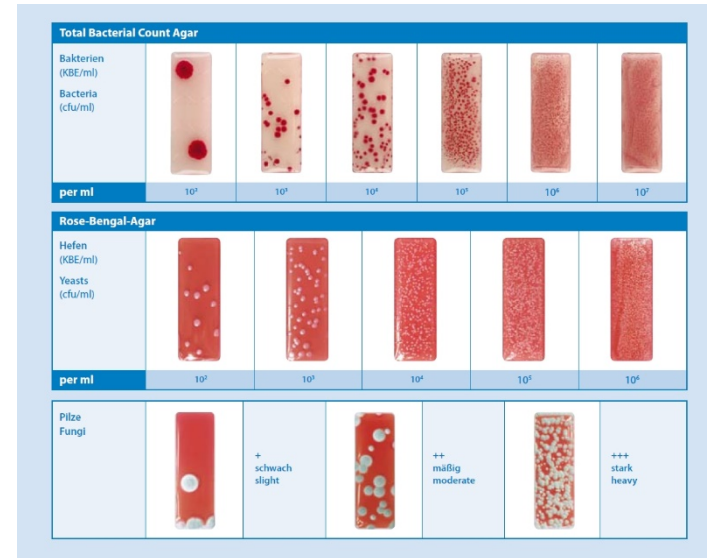
Water and Microbial Contamination



H₂O
contaminants into tank

Nutrient Growth Media

- Nutrient Growth Media Kits
- Dip slide effective only with water samples
- Injectable kit effective with fuel and water
- Incubate in a range of 1-4 days for bacteria and fungi.
- Semi-Quantitative results



Bioluminescence Assay

- Merck - HY-LiTE® 2
- Quantitative detection of total ATP in fuel, fuel/water mixture and water.
- Test time < 10 minutes
- ATP only from metabolically active microbes produces photons.
- Spores not metabolically active.
- **ASTM D7463-16 with a precision statement**



Courtesy: IATA - Guidance Material on Microbiological Contamination in Aircraft Fuel Tanks, **Edition 5th**, Effective 1 Dec 2015
Contact: Michel Baljet, Phone: (514)874-0202, Email: BaljetM@iata.org .

Remediation

Product	Solubility	Dose Rate	Contact Time
FQS 1.5 Microbicide®	Primarily Water Soluble	100 ppm	<12-24hrs
Hammonds Biobor JF ¹	Fuel Soluble Only	270 ppm	36-72hrs
Power Services Bio Kleen ²	Primarily Fuel Soluble Partitions to Water Phase to Kill Microbes	400 ppm	36-168hrs
Gold Eagle Stabil Diesel Biocide ²	Primarily Fuel Soluble Partitions to Water Phase to Kill Microbes	400 ppm	36-168hrs
FPPF Killem	Primarily Fuel Soluble Partitions to Water Phase to Kill Microbes	195 ppm	Unk.

1. Rapid hydrolysis in the presence of water to boric acid and glycols., Ref: EPA RED 738-R-93-004, June 1993.

2. These products can crystallize at 10°C (50°F). Avoid temperatures above 35°C (95°F). Potentially violent decomposition can occur above 100°C (212°F). Ref: Product Safety Assessment BIOBAN™ P-1487 Antimicrobial Agent FUELSAVER™ Antimicrobial Agent Select a, 2009.

Biocide Overview

Product Named	Active EPA Reg	On Road Application	Off Road Application
FQS 1.5 Microbicide®	Isothiazolinone 65597-1-66596	Yes ¹ , G&D	Yes ² , G&D
Hammonds Biobor JF	Dioxiboranes 65217-1-AA	No	Yes ² , G&D
Power Services Bio Kleen	Nitromorpholines 464-659-AA- 35559	Yes ³ , G&D	Yes ² , G&D
Gold Eagle Diesel Biocide		Not Listed ⁴	Yes ² , G&D
FPPF Killem	MBT / TCMBT ¹ 1448-171-AA-55737	Yes ³ , D	Yes ² , G&D

Notes:

1. Registration As a Fuel Additive Not Required .
2. Fuel Additive Registration not required for Non Road Application.
3. Registered as On Road Additive, List Current as of December 1, 2016. (G-Gas / D-Diesel)
4. Product not registered with EPA Office Transportation and Air Quality (OTAQ) "List of Registered Diesel Additives" , as of December 1, 2016.

Conclusion

- Current situation, environmental policy and regulation are at the cross roads with transportation fuel needs.
- Root cause potentially due to cross contamination of ULSD with E10 gasoline and contaminants from biodiesel.
- Perform detection with a system that provides fast and reliable results.
- Remediate fuel systems with a biocide that is cost effective and in line federal and state requirements.

Q & A

FOR A COPY OF TODAY'S
PRESENTATION VISIT:

www.fqsinc.com/blog