

Corrosion in Fuel Systems

ULSD Issues

NORA Research Technical Workshop
September 15, 2016 Newport, RI

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Steel Tank Institute



Outline

1. History
2. Research Conducted
3. How does this affect you?
4. Moving Forward

Who and What is STI/SPFA?

- Association of 180 fabricating and affiliate companies of steel construction products – shop-fab tanks, field erect tanks, pipe, pressure vessels and other special fabricated products
- STI members build a significant majority of shop-fabricated underground and aboveground fuel storage tanks



What does Steel Tank Institute do?

- UST and AST tank technologies
- Industry standards, RP's
- Quality control of tank fabricators who build tanks to STI specifications
- Information resource
 - TankTalk, Tank Mishaps
- Certification



History

- 2006- ULSD
- 2007 – PEI forum
- 2008 – 2009 ASTM committees
- 2010 – Clean Diesel Fuel Alliance



History

- 2012 – Battelle Report
- 2015/2016 – EPA study and report



Problem exists!

STP column pipe inside FRP tank





In service less than one year
STP Column Pipe

Pump connection corroded thru



CDFA hires Battelle - 2012

- API
- Ford Motor Co.
- Railroads
- PEI
- NATSO
- PMAA and others

Contract No. CON00008697
Study No 10001550
Final Report

Corrosion in Systems Storing and Dispensing Ultra Low Sulfur Diesel (ULSD), Hypotheses Investigation

Battelle Memorial Institute
505 King Avenue
Columbus, OH 43201

To
Clean Diesel Fuel Alliance
C/O Mr. Prentiss Searles
American Petroleum Institute
1220 L Street, NW
Washington, DC 20005-4070

September 5, 2012



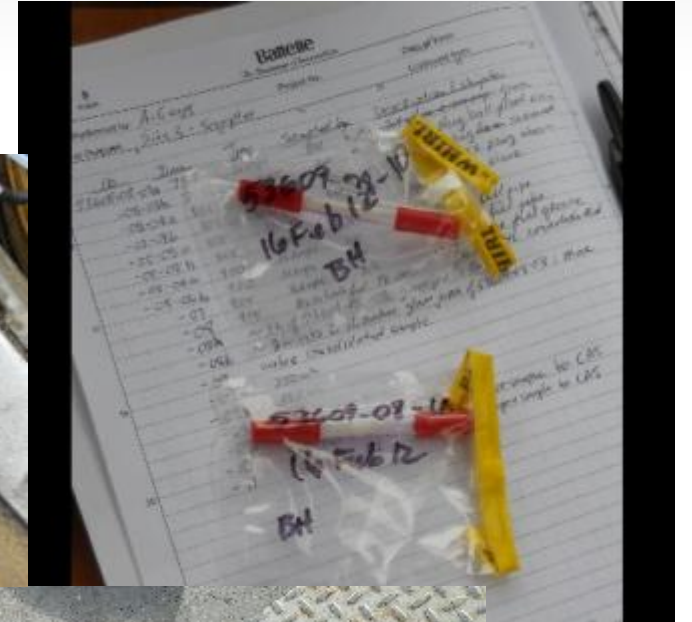
Battelle Investigation - 2012

- 6 FRP tanks
- Tank age: 4 - 14 years old
- Throughput: 6,500 gallons – 26,000 gallons
- Capacity: 6000 gallons to 17,265 gallons

Inspection Process

Vapor Sampling: SKC Tubes

- Tested for carboxylic acids and formic acid analysis by GC-MS (CAS Method 102)



Water Bottom Sampling

- ~1-2 Liters of water bottom sample/site
- Bottom sediment
- Consolidated from multiple risers
- Bacon Bomb triggered by bottom of tank



Inspection Process Fuel Sampling

- 1 gallon of diesel sample/site
- Consolidated from multiple risers
- Bacon Bomb with string to trigger collection within fuel column



Inspection Process Disassembled System

- Collected scrape, wipe, o-rings, and other corrosion samples
- Fouling investigation process by 2 labs



Site NY-2 (Feb 18)



Site CA-3 (Feb 23)



Liquids and Vapor Summary

- Low biodiesel levels
- 3 fuels failing NACE ratings
- Sulfur content 5.9 – 7.7 ppm
- pH 3.5 to 5.3
 - 3 NACE failures had pH of 3.5 – 3.8

Liquids and Vapor Summary

- Trace amounts of ethanol at 4 sites
- Acetate (dominant acid) and formic acid detected in all water and vapor samples
- Glycolic and other acids found
- Acetobacter dominant organism found at 3 sites

Other elements found

- Significant levels of sodium and chlorides (4 of 6)
- Significant level of potassium (3 of 6)
- Significant level of magnesium (4 of 6)
- Others:
 - Methyl vinyl ketone, phthalate, glycol and dioxane

Conclusions of Battelle Report

Battelle hypothesize: Acetic acid was created by Acetobacter microorganisms and ethanol, thus causing the corrosion.



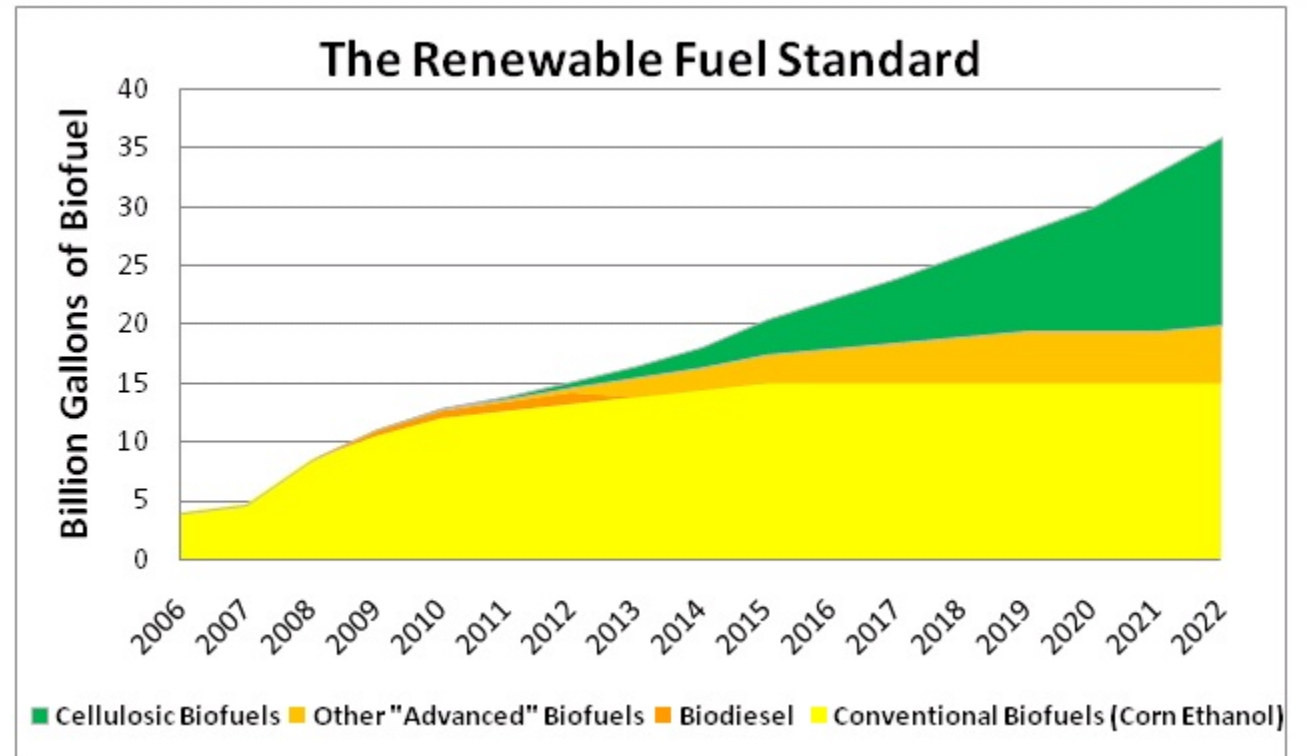
EPA Research - 2015

- Concern about possible releases
- Overfill limiters, automatic shut-offs and other
- Worked with CRC members to develop test plan
- Similar approach to first Battelle study



Changes from Battelle R&D

- 2007, RFS expanded
- EPA considered both in study, while not eliminating other possibilities



42 sites- 24 FRP, 18 STEEL



Diverse population

- AGE: 1 to 29 years
- CAPACITY: 5,000 – 20,000 gallons
- OWNERS: Gov't, retail and fleet
- NUMBER SITES OWNED: One to multiple

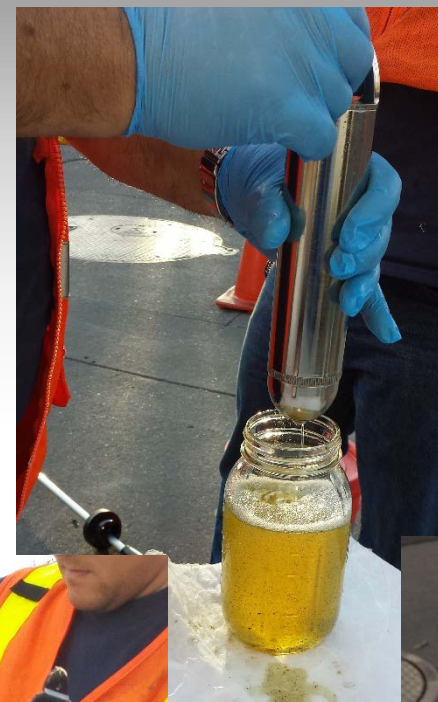
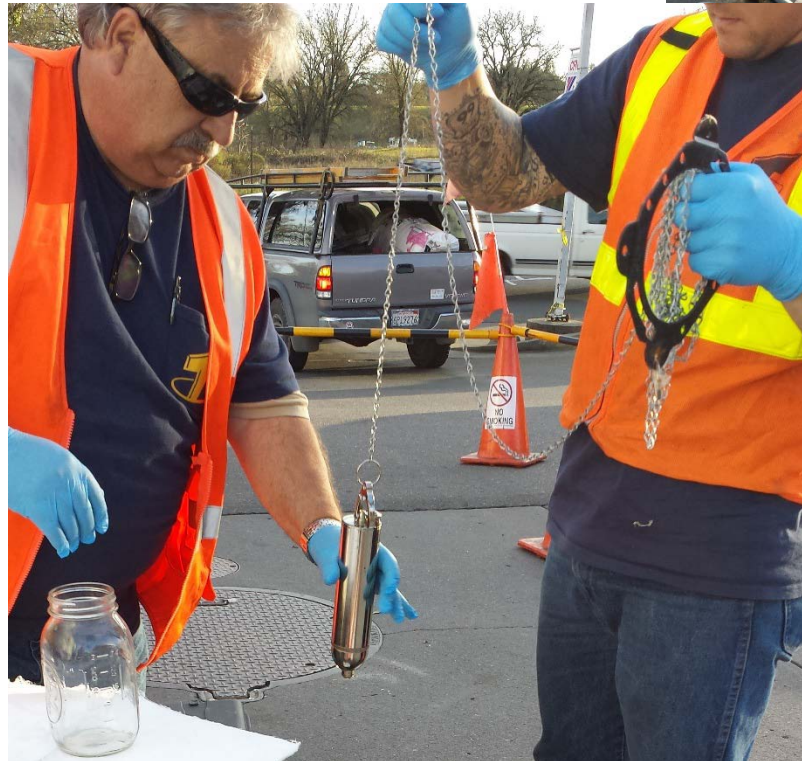
Vapor Testing

- Acids, humidity



Fuel Testing

- Water content
- Acids
- Particulates
- Biofuel
- Conductivity
- Corrosion Rating
- Chromatography



Water Bottom Testing



- Water bottoms tested for:
 - ethanol,
 - methanol,
 - glycerin
 - acids,
 - cations
 - pH level

Equipment Analysis

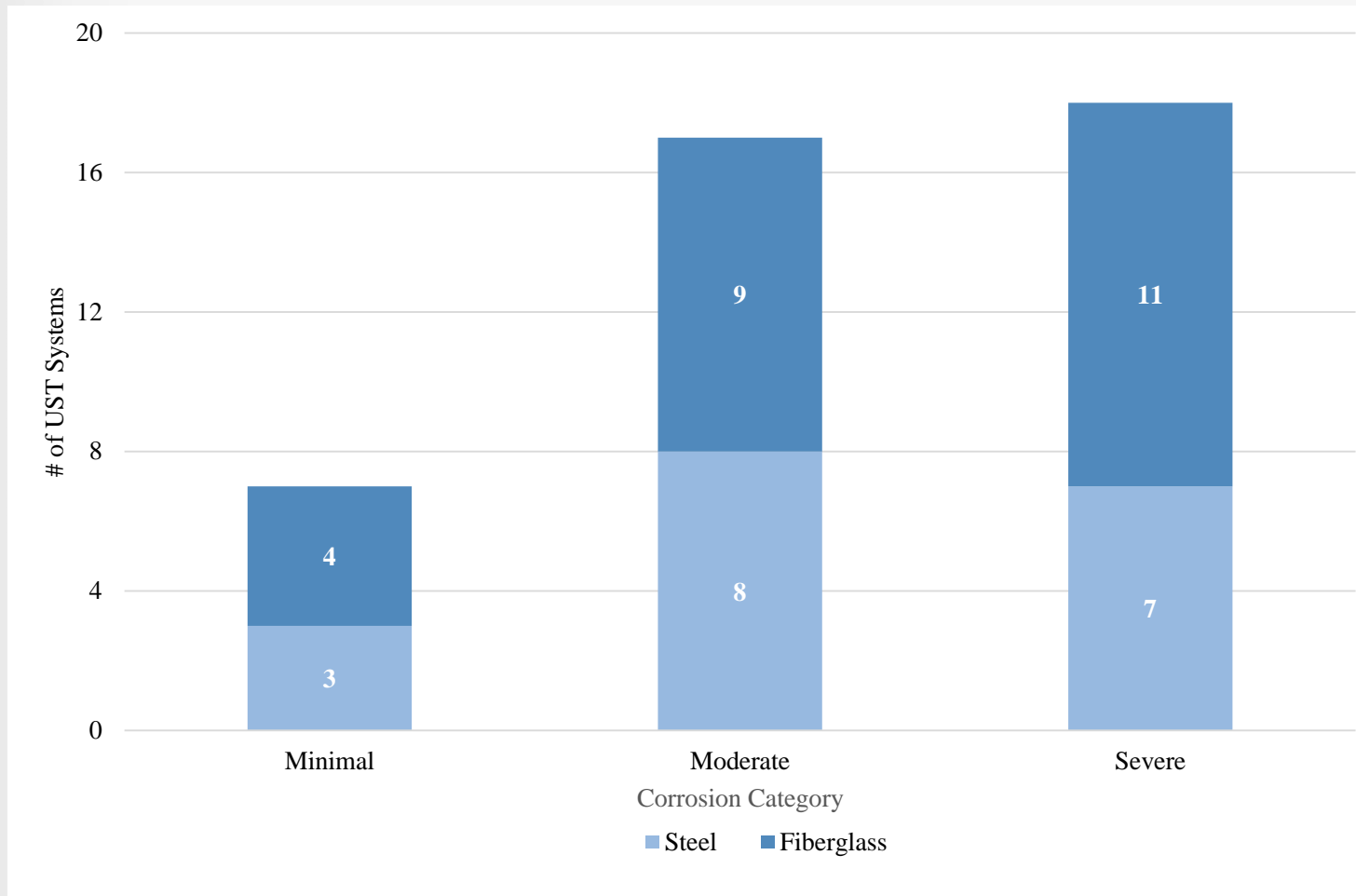
- If equipment was removed, it was visually examined and photographed
- Pristine condition!



What did they find?

- EPA Report issued, June 2016
- Acids: formic, acetic, propionic and lactic
- Methanol, ethanol and glycerol
- Humidity levels relatively high – average 68%
- Failed NACE ratings on percentage of fuels
- Gasoline

What did they find?



What did they find?

	Age unknown	1-3	4-7	8-11	12-15	16-19	20+	Totals
FG - minimal	1	2			1			4
FG - moderate	1	1	1	5			1	9
FG - severe	1		2	3	3	1	1	11
FG -Subtotal	3	3	3	8	4	1	2	24
ST - minimal		1				1	1	3
ST - moderate			1			1	6	8
ST - severe	1					1	5	7
ST - Subtotal	1	1	1	0	0	3	12	18
Total	4	4	4	8	4	4	14	42

Fiberglass tank photos



How Does This Affect You?

- Documented cases have only occurred in USTs dispensing fuel
- Few stories of cases involving shop-fab ASTs
- A few concerns in terminal tanks

Heating Oil Tanks?

Biggest known problem in heating oil tanks is microbiologically influenced corrosion in tank bottoms, which is treatable

Steps Forward



- CRC – Coordinating Research Council
- A research group composed mainly of major oils and automotive industry.
- Instead of more field tests, CRC is planning to conduct lab tests to help eliminate variables.

Lab Test – Isolate Variables

- Corrosion inhibitors
- Oxygen levels
- Humidity
- Water absorption
- Temperature
- Fungi
- Bacteria
- Biocides

Corrosion Continues...



2015 Photos



Preventive Maintenance Guide for Diesel Storage and Dispensing Systems

This guide provides practical tips for maintaining underground storage tanks (USTs), minimizing fuel contamination and maximizing fuel system cleanliness necessary for diesel equipment. Adopting these guidelines can help improve fuel quality, prolong equipment life, reduce corrosion and owner's operating expenses. All suggestions below should be performed in a safe, legal and environmentally sensitive manner.



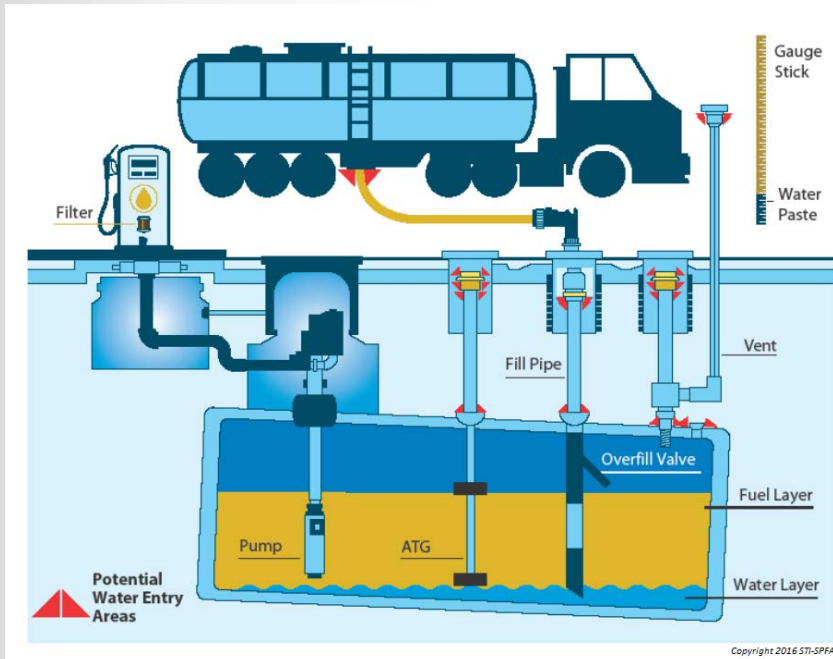
Good water management eliminates most fuel quality problems:

Keep water from entering tanks to minimize tank water bottoms:

No detectable water is desirable and if found should be removed as soon as possible. Test removed water for microbes. If detected, take appropriate corrective action. If biocide is used, expect more frequent filter changes for a brief period.

Inspection and Maintenance

STI R111, Storage
Tank Maintenance
&
PEI RP 900



Check Fuel Quality



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