

Emerging Solutions for Biofuel-Induced Corrosion for ASTs & USTs



Real world problems caused by the use of Ethanol, Bio-diesel, and Ultra-Low Sulfur Diesel, and a look at possible solutions

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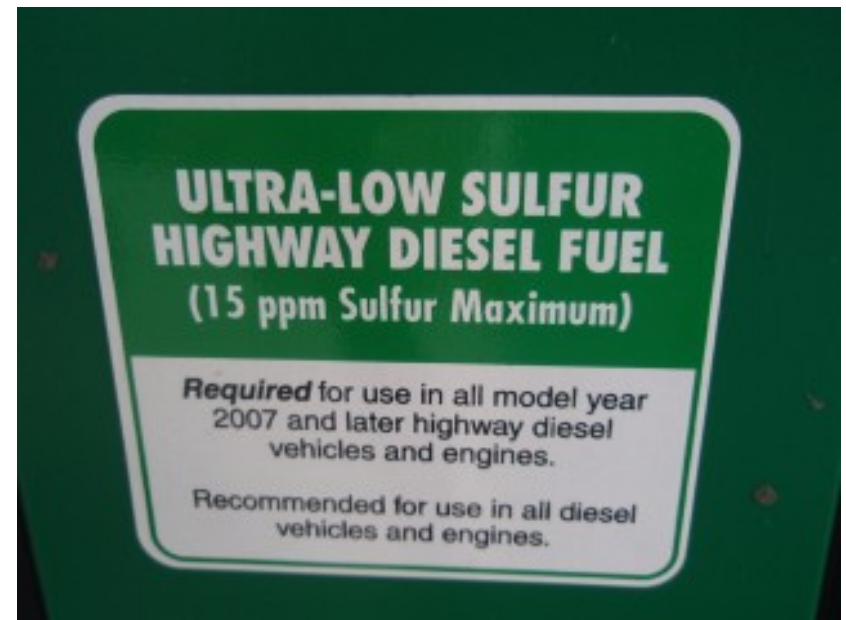
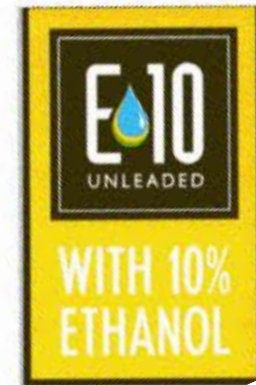
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Alternative Fuels



- E-10 Ethanol
- E-15 Ethanol
- E-85 Ethanol
- B-20 Bio-diesel
- ULSD – Ultra-Low Sulfur Diesel





ETHANOL TK 17

Why are we using Ethanol?

(from government sources)

- Air pollution – as an oxygenate to make fuel burn cleaner and reduce air pollution
- Augment the nations fuel supply and reduce reliance on foreign fuels
- Stimulate the economy
- It's a “Green” Fuel



Problems with Ethanol...

1. Ethanol does not burn that much cleaner than regular gasoline
2. Using Ethanol leads to an energy drop-off
3. Using Ethanol competes with food crops and increases food costs
4. Chemically-speaking, Ethanol wants to become water
5. Phase Separation
6. Some older fiberglass systems are not compatible
7. Ethanol loves to eat soft metals, rubber, and plastics
8. More frequent dispenser filter changes
9. Ethanol has a scouring effect on tank systems
10. Ethanol is destroying our petroleum pumping infrastructure

Alternative fuels (ULSD, Ethanol and Bio-diesel)



- Have only been in widespread use nationally for about five to six years
- Growing number of problems with the integrity of storage tank system equipment

Evidence of problems discovered from facility monthly visual inspections and State UST regulatory and fuel quality inspections



Ethanol – E-10 & E-85



Problems



Diesel sump, same facility, Georgetown,
South Carolina, November 2011



Regular Unleaded gasoline sump, same facility,
Georgetown, South Carolina, November 2011



Mississippi (e10)

Photo 12-09



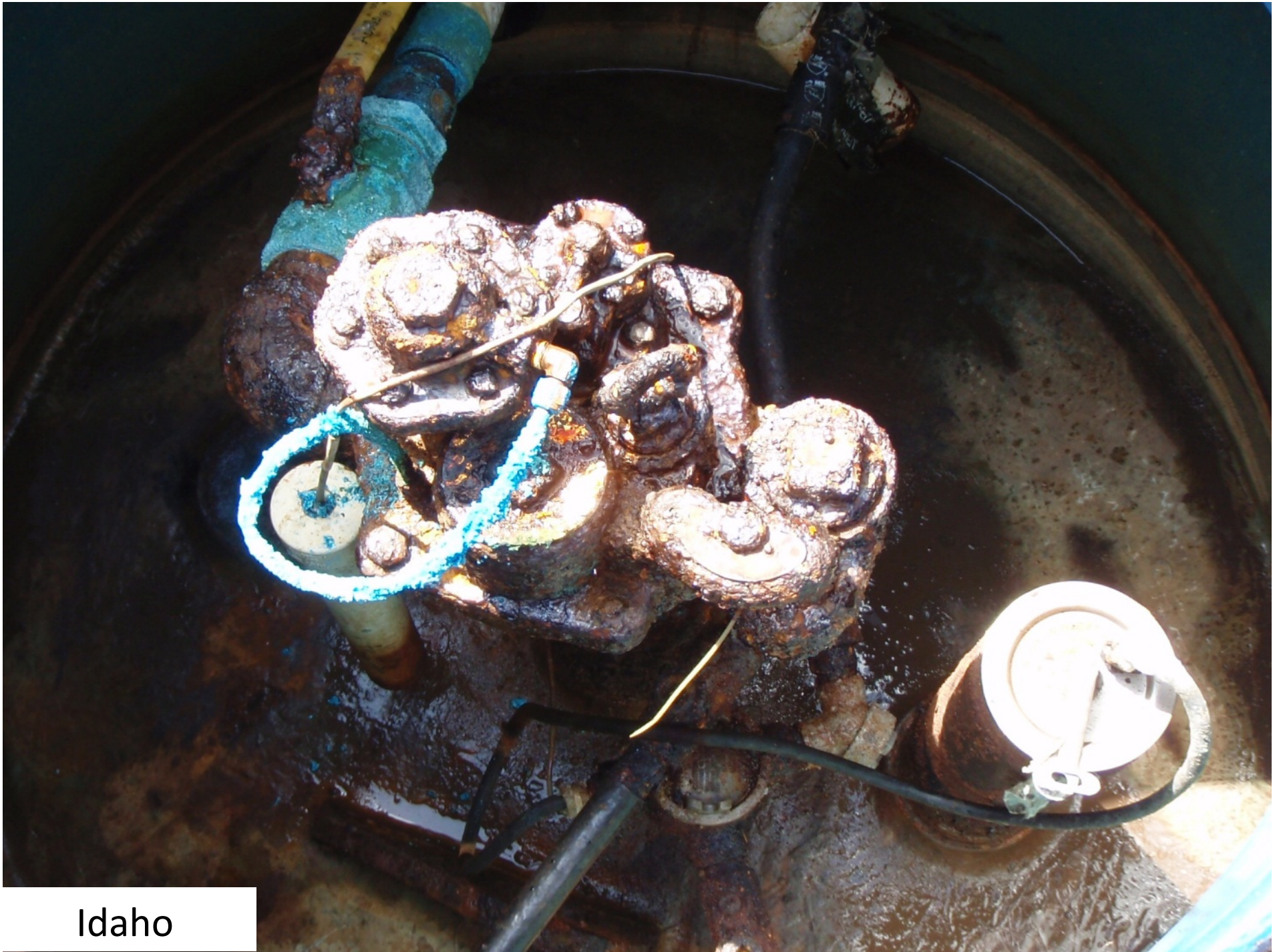
South Carolina (e85)



Kentucky (e10)



Ohio



Idaho



Delaware (e85)

Installed 3-07 – Photo 3-08



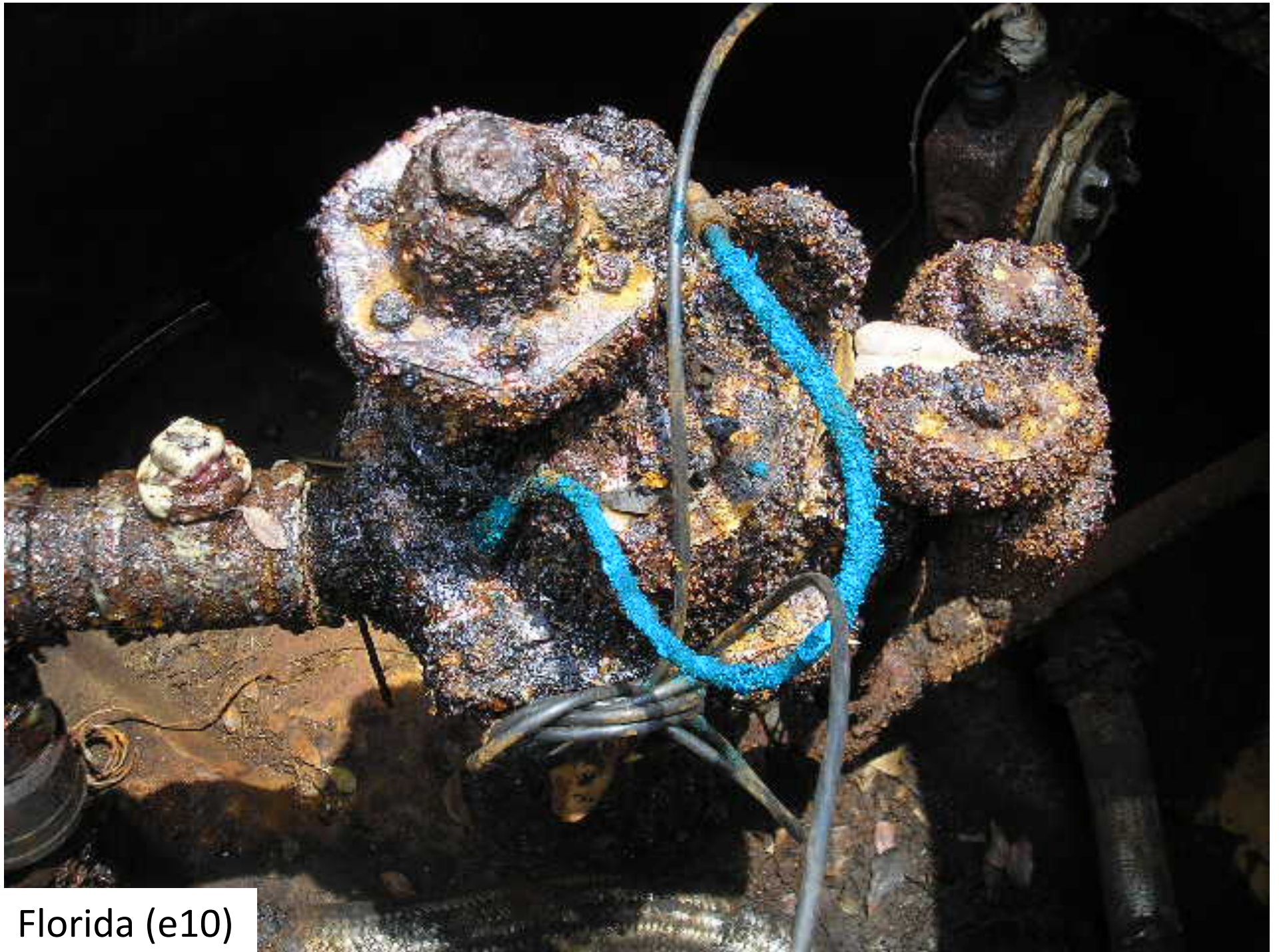
Minnesota (e85)



Washington



California





Florida (e10)



Florida (e10)

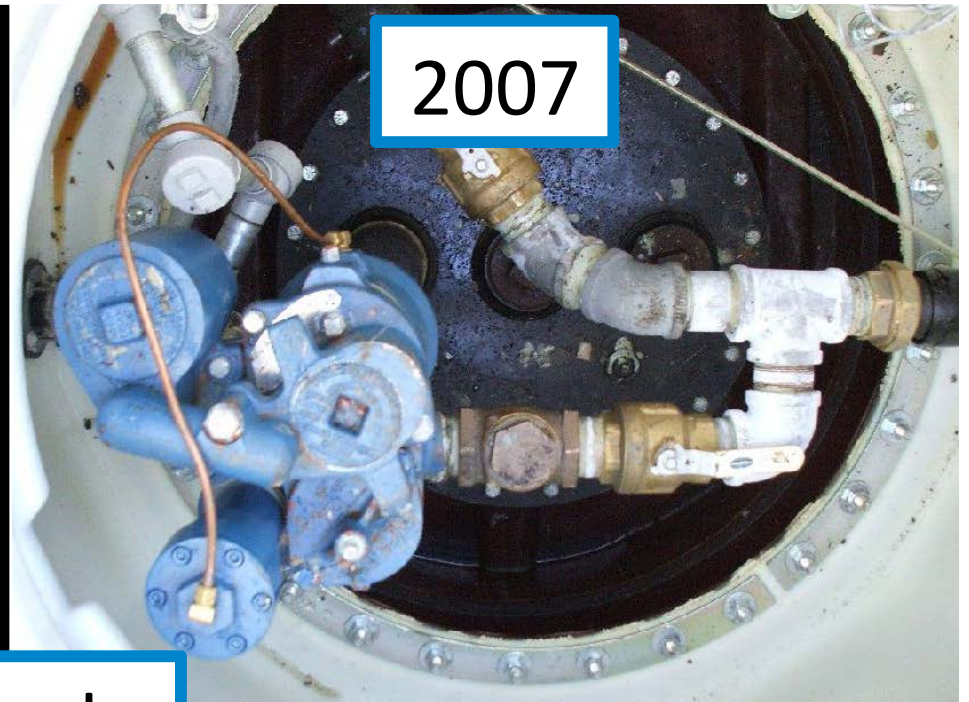
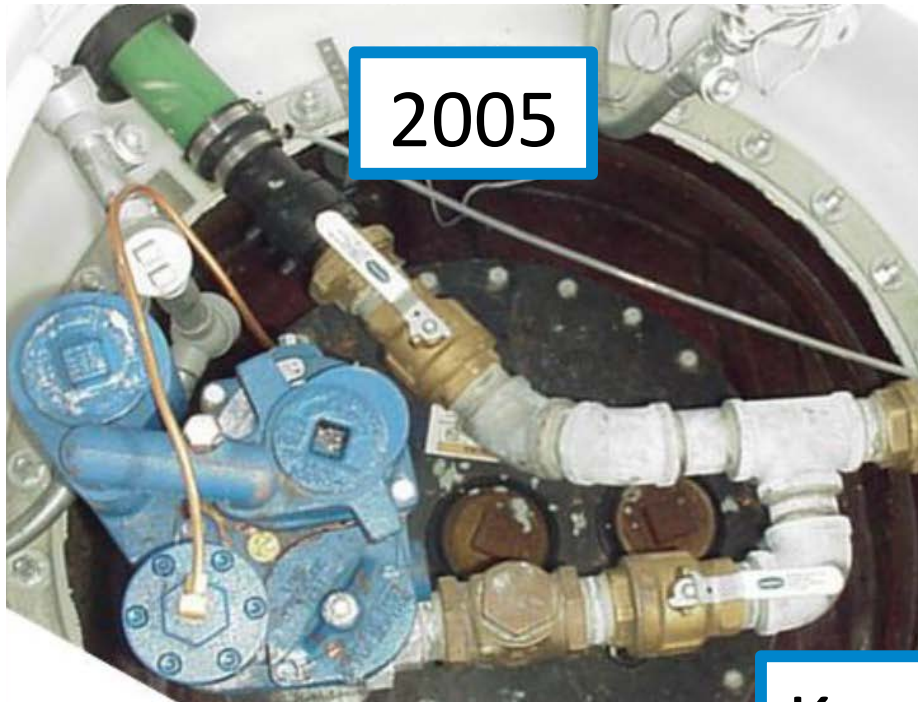
How Long Does It Take For This Severe Corrosion To Occur?



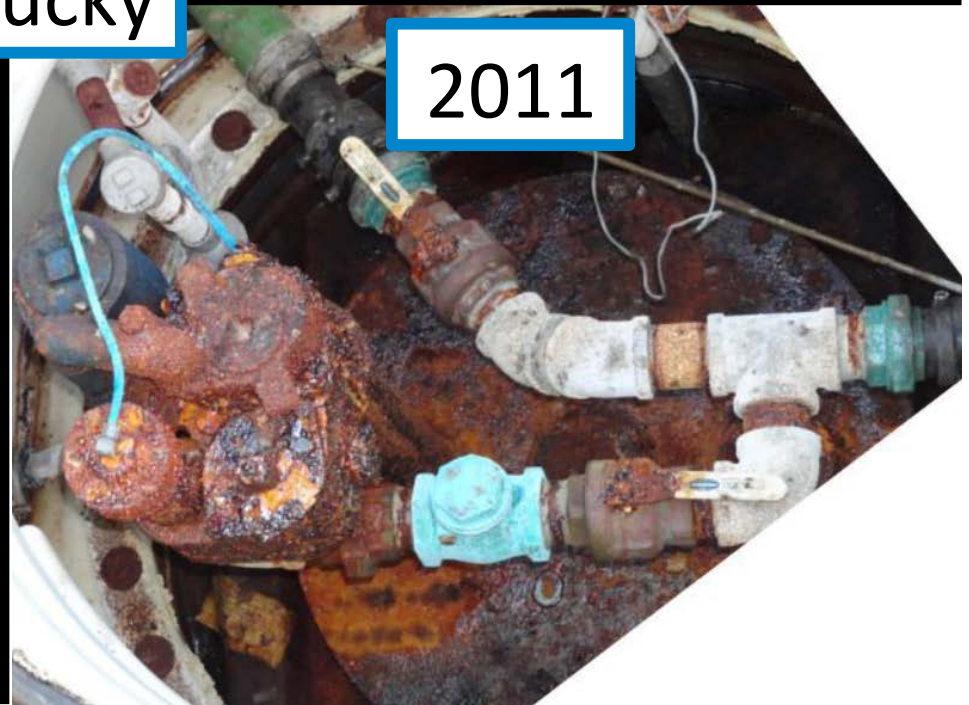
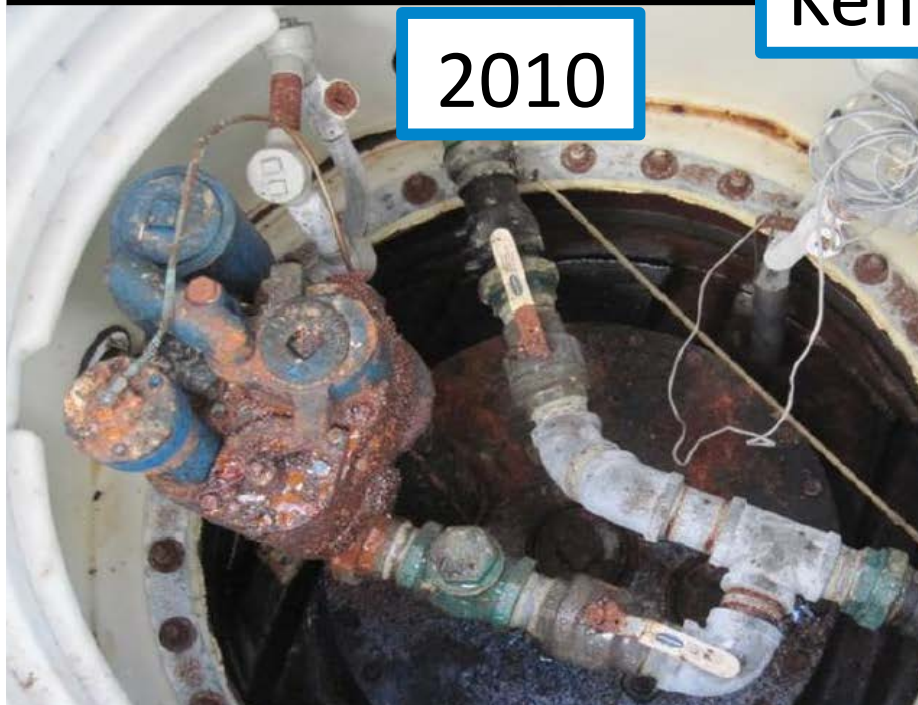
Tennessee - March 2010



Tennessee - August 2010



Kentucky



Diesel vs. Gasoline

Mississippi



Diesel



E10

Installed 8-07 - Photos 3-12

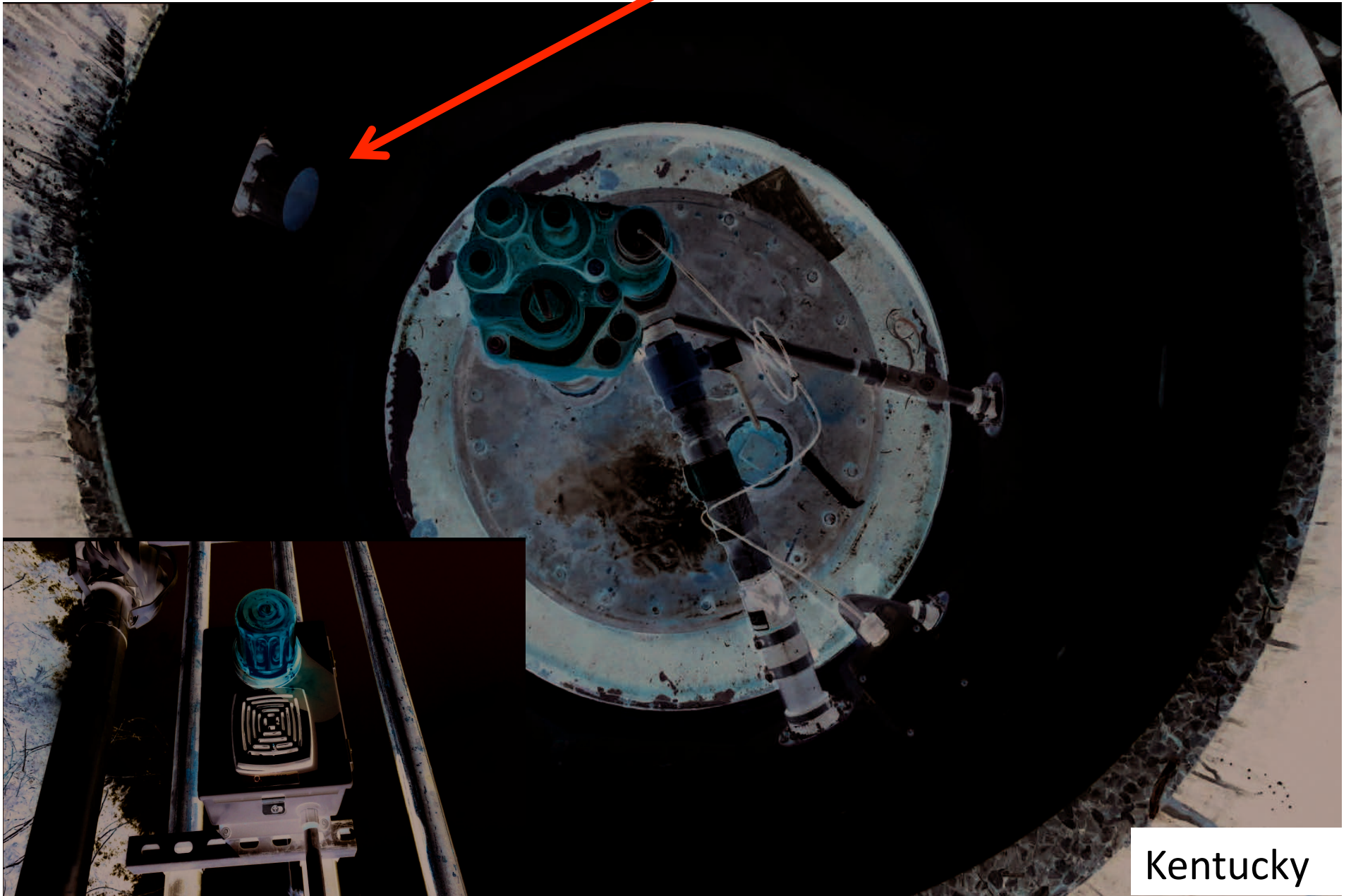
Same Facility - Same Equipment – Same Day- Different Sumps

What's this “whirlybird” doing here with the tank vents?



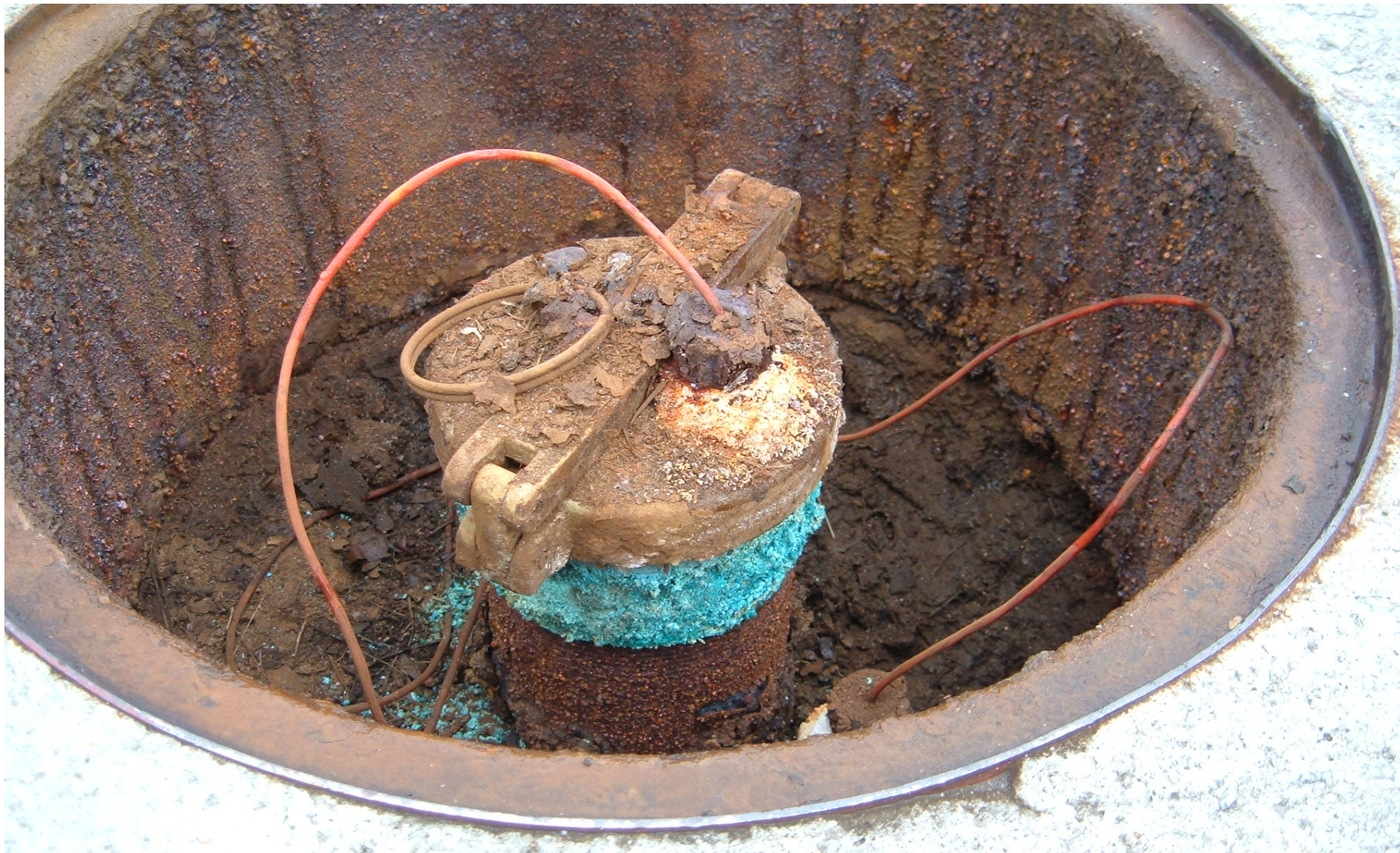
Kentucky

What's this open pipe doing here?



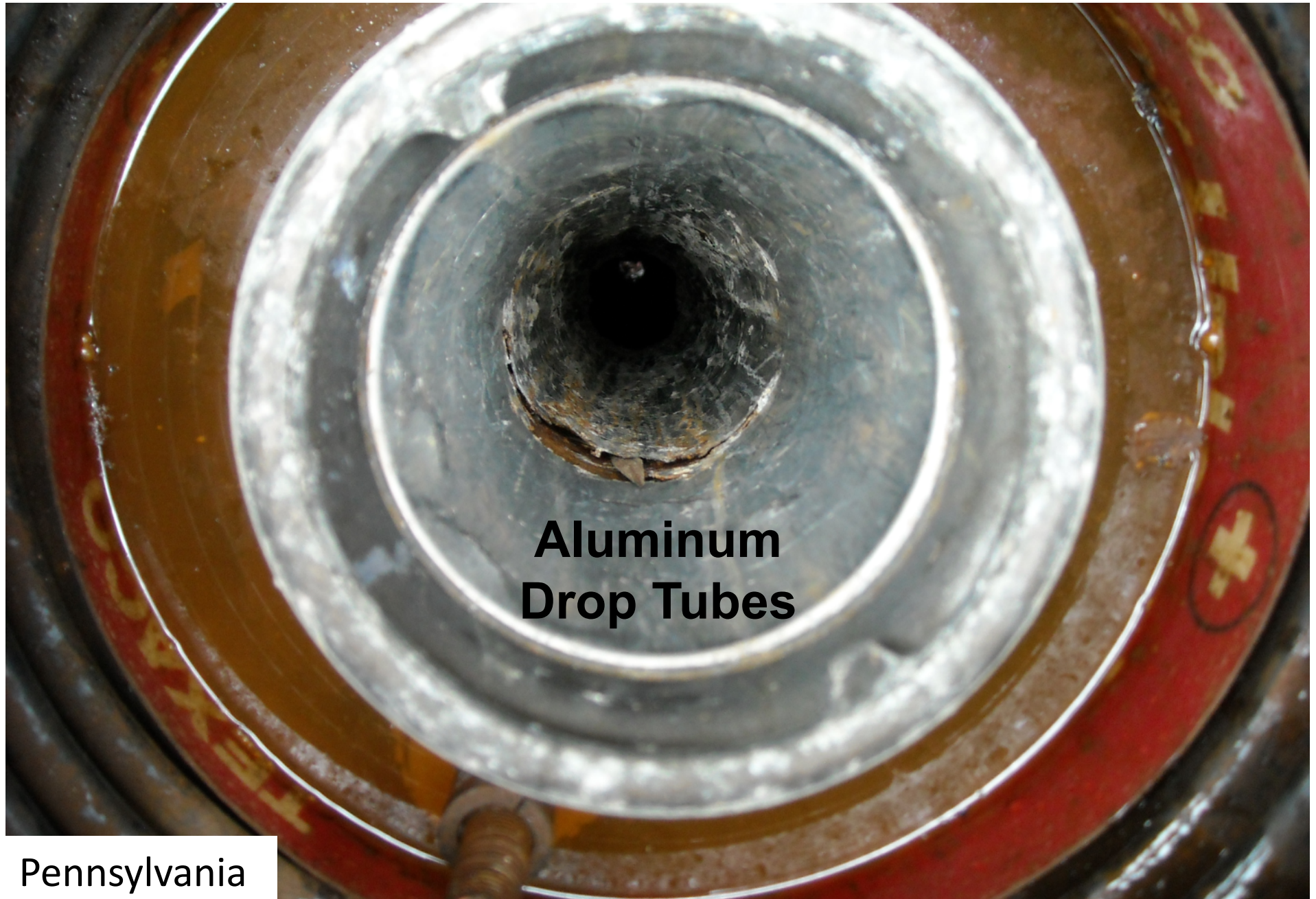
Kentucky

Other Problem Areas – ATG Equipment

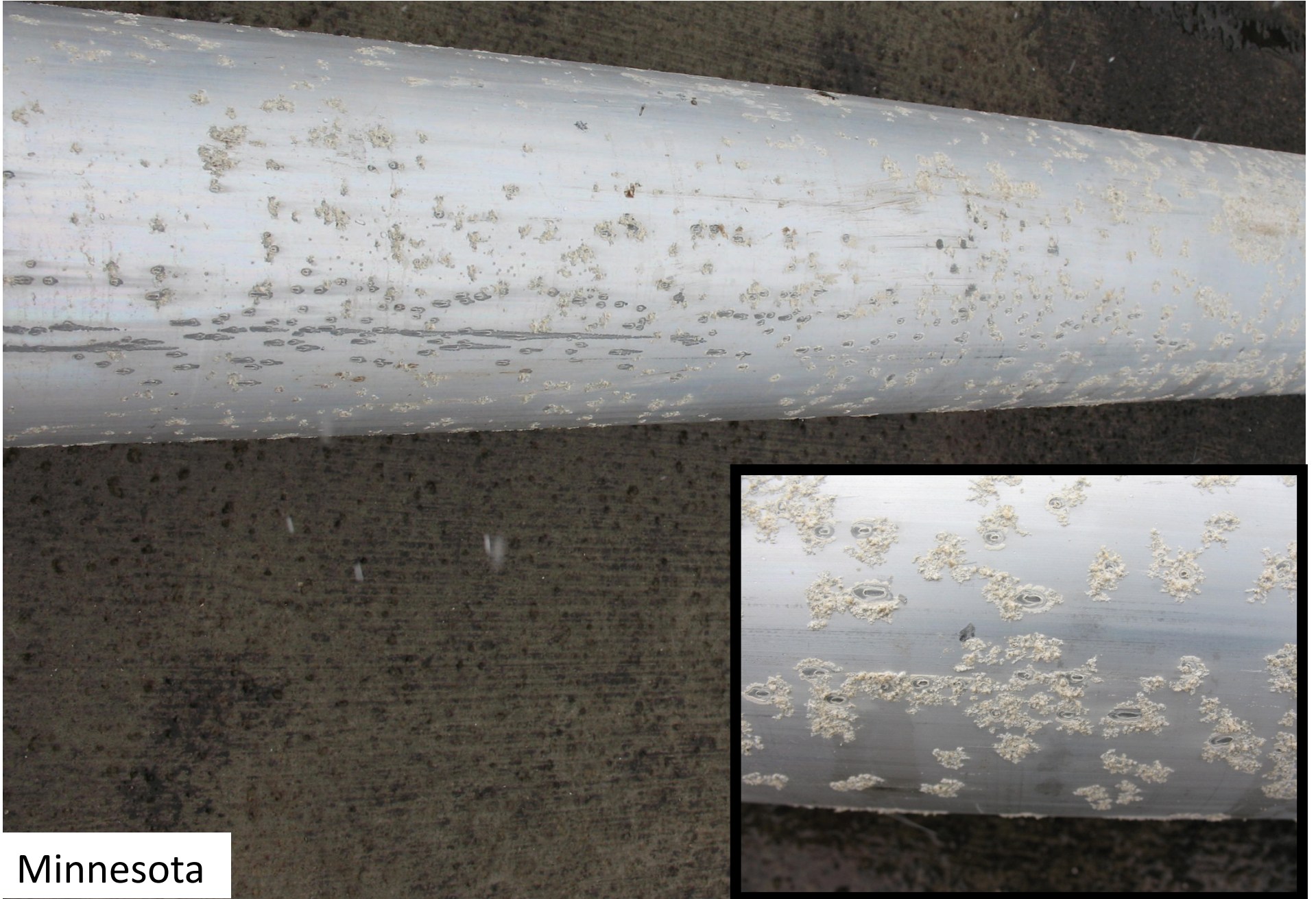


Evidence of vapor leaks

What other components could be affected by corrosion?



Corrosion on Aluminum Drop Tubes



Minnesota



Corrosion on Ball Float Valve Equipment

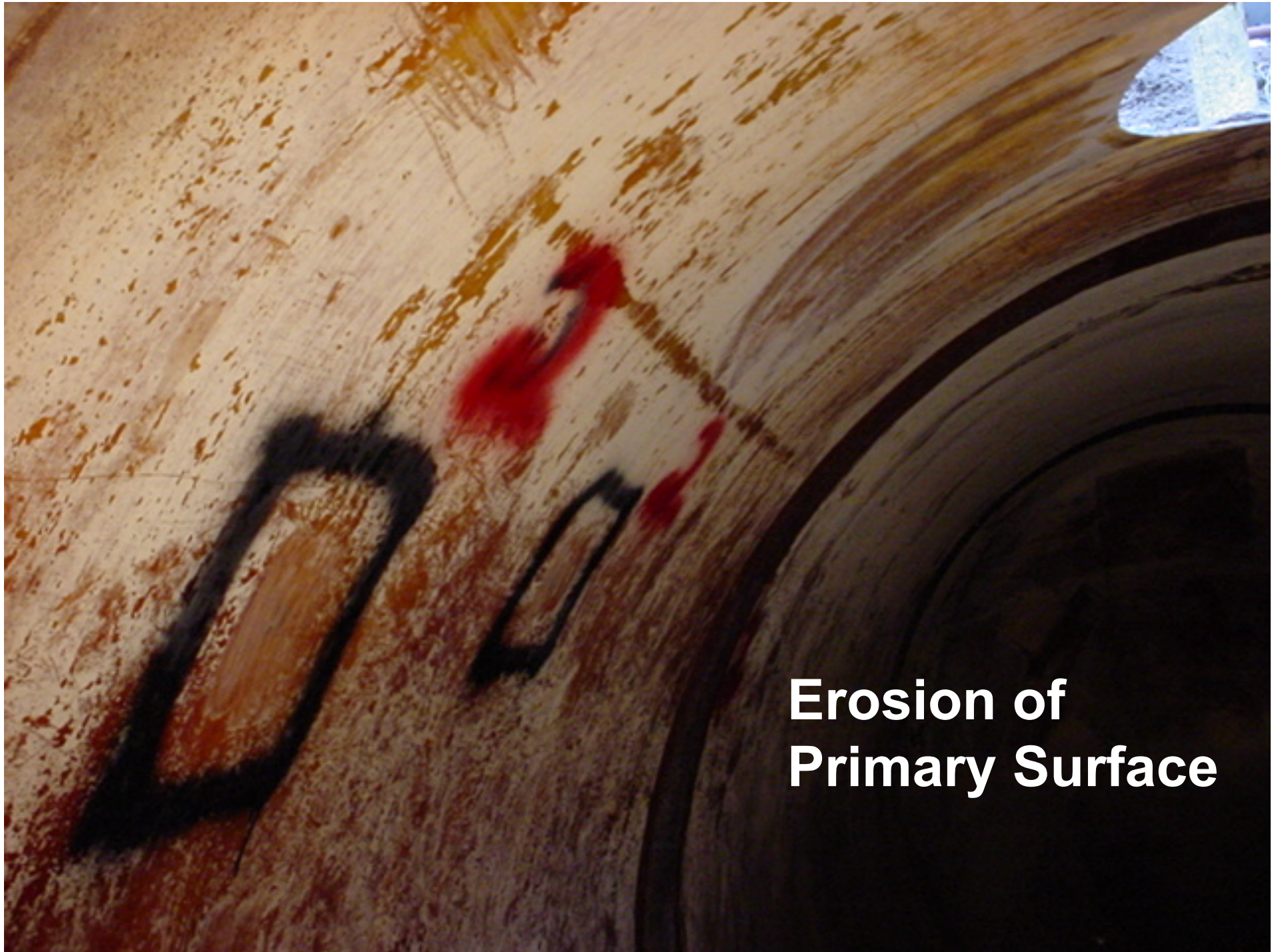
Overfill Protection



Mississippi



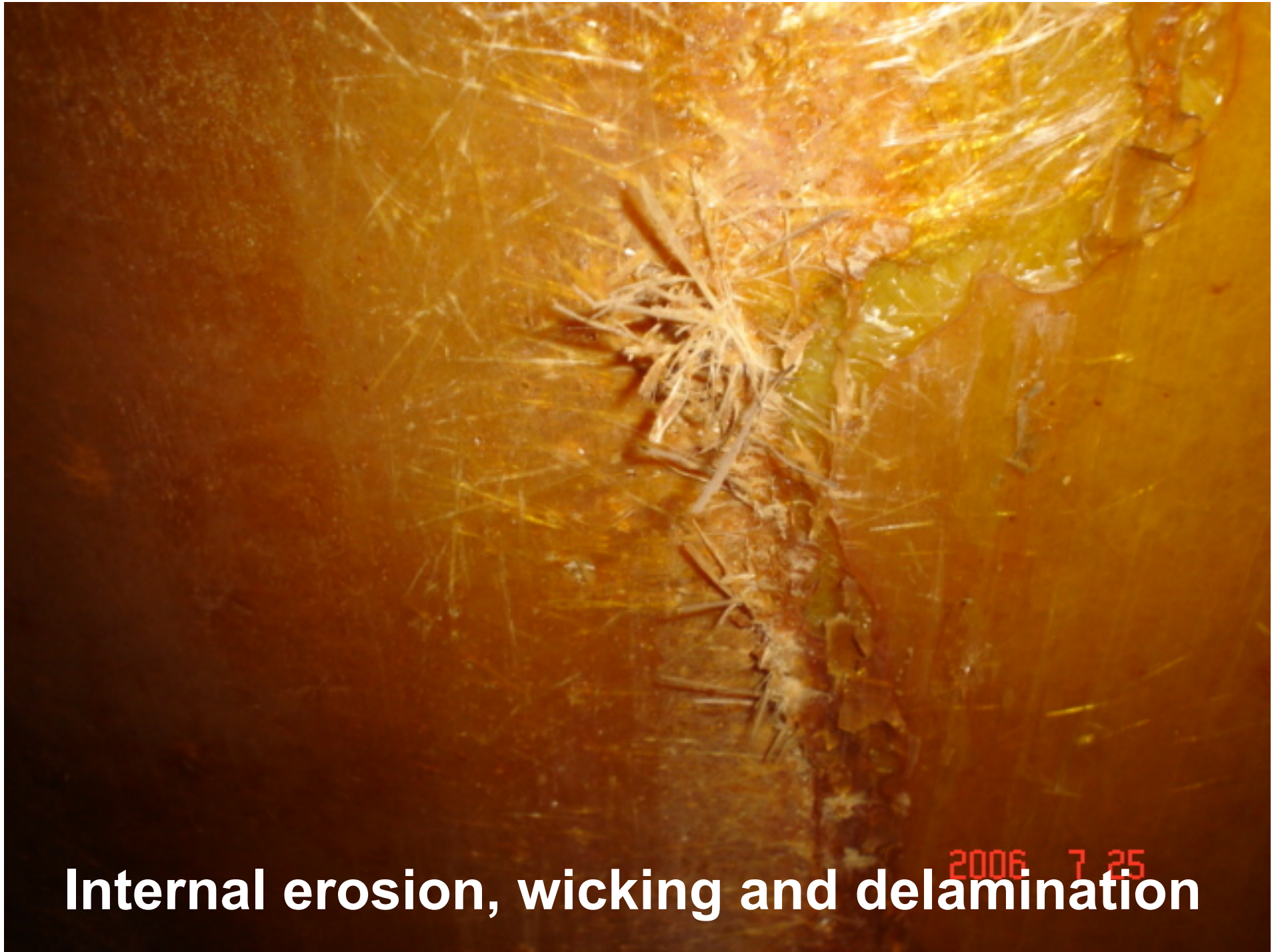
**Observations with Older Single-wall
Fiberglass Tanks in E-10 Service for
less than Two Years**



**Erosion of
Primary Surface**

Cracking





2006 7 25
Internal erosion, wicking and delamination

A close-up photograph of a composite material surface, likely a boat hull, showing significant delamination of the gel coat. The surface is a mottled brown color with a dense network of fine scratches. A vertical strip of material in the center is peeling and flaking away, revealing a lighter, fibrous substrate underneath. The damage is most pronounced in the middle of the frame, where the gel coat has completely detached in several places.

Delamination of gel coat

2006 7 25

BLISTERS
↓
T-3

Blisters on sidewall

Ethanol-Free Gasoline Has Become a Marketing Tool



Advertising Ethanol-Free Fuels



CONTAINS
NO ETHANOL

Reg-90 Octane Marine Fuel

PUSH TO
SPEAK
WITH
ATTENDANT

WARNING
Improper use may cause a
hazardous condition:
• Avoid flame hazard
• Return all nozzles
• In case of fire do not
remove nozzle
• No smoking! extinguish
all flames
• Licensed drivers only
• Do not top off
Refer to product
warnings
Ready

Marine Fuel

Shell
Marine Fuel

\$ Per Gallon (including tax)

4.759

REGULATED OCTANE RATING
90
PUSH HERE

Recent National EPA/State Regulator Field Study with Ethanol Corrosion

- EPA provided sampling kits
- Passive diffusion samplers were placed in piping sumps to measure the concentrations of ethanol and acetic acid
- Data came from Florida (35), Tennessee (13), Illinois (6), Wisconsin (4), California (2), and Iowa (1)
- 27 RUL, 2 MUL, 26 PUL, 5 E-85, and One Diesel



Findings

- Many sumps had high concentrations of Ethanol or Acetic Acid
- No significant difference between RUL & PUL
- Corrosion worse in sumps with high concentrations
- Corrosion worse in sumps with water
- For Ethanol to cause corrosion in a sump, there must be ethanol, bacteria, and water
- Eliminating one of these could prevent corrosion?



Other Problems

- Warranties for UST and AST Fuel System Components
- Vehicle Warranties
- Concerns with traditional problems from ethanol fuel use such phase separation, degradation of soft metals, increased filter replacement, and the scouring effect on fuel tanks
- UST & AST owner acceptance
- Consumer confidence



Recent Field Studies for Remedies



Zerust Vapor Corrosion Inhibitors



Ethanol Vapor Saturation...



Vapor Corrosion Inhibitor Testing and Ethanol Corrosion Prevention Efforts...

- More Field Trials
- Invite Participation
- Future considerations:
 1. VCI media and levels
 2. Tightness of sumps
 3. Tightness of piping connectons
 4. Existing rust, manual removal of corrosion
 5. Surface penetrants and coatings
 6. Venting of vapors
 7. Combinations of the above

Ultra-Low Sulfur Diesel

**ULTRA-LOW SULFUR
HIGHWAY DIESEL FUEL**
(15 ppm Sulfur Maximum)

Required for use in all model year
2007 and later highway diesel
vehicles and engines.

Recommended for use in all diesel
vehicles and engines.

Ultra Low Sulfur Diesel



Submersible Pump & Riser
(Left hand side is aluminum;
Right hand side is steel)



Submersible Pump Head
(in vapor space -- never
contacts fuel)

Problems with Ultra Low Sulfur Diesel and Steel Components



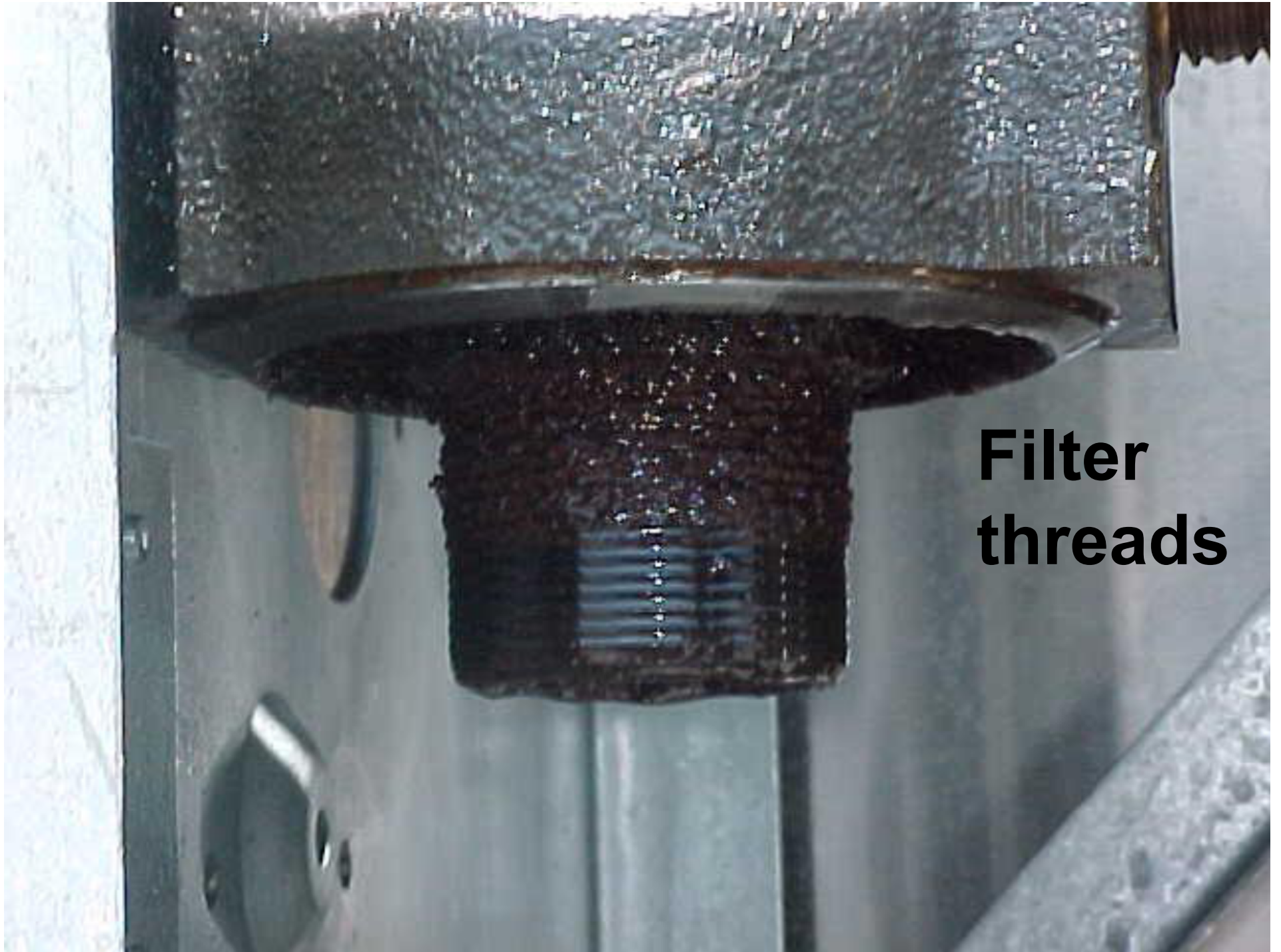
FE Petro Equipment



Old vs New
Corrosion, Pitting

Leak detection equipment not functioning





**Filter
threads**

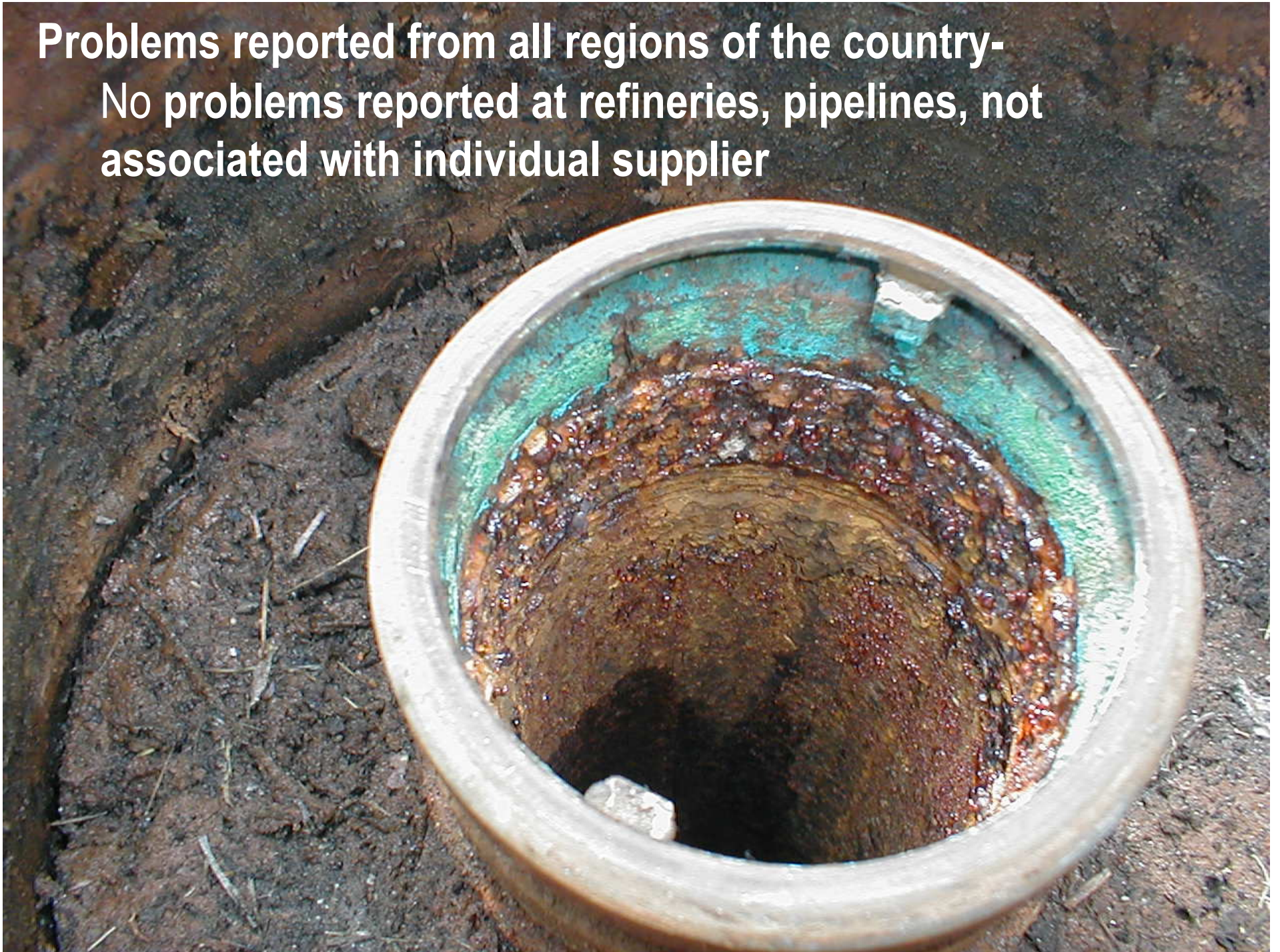
Strainer



“Coffee Grounds”



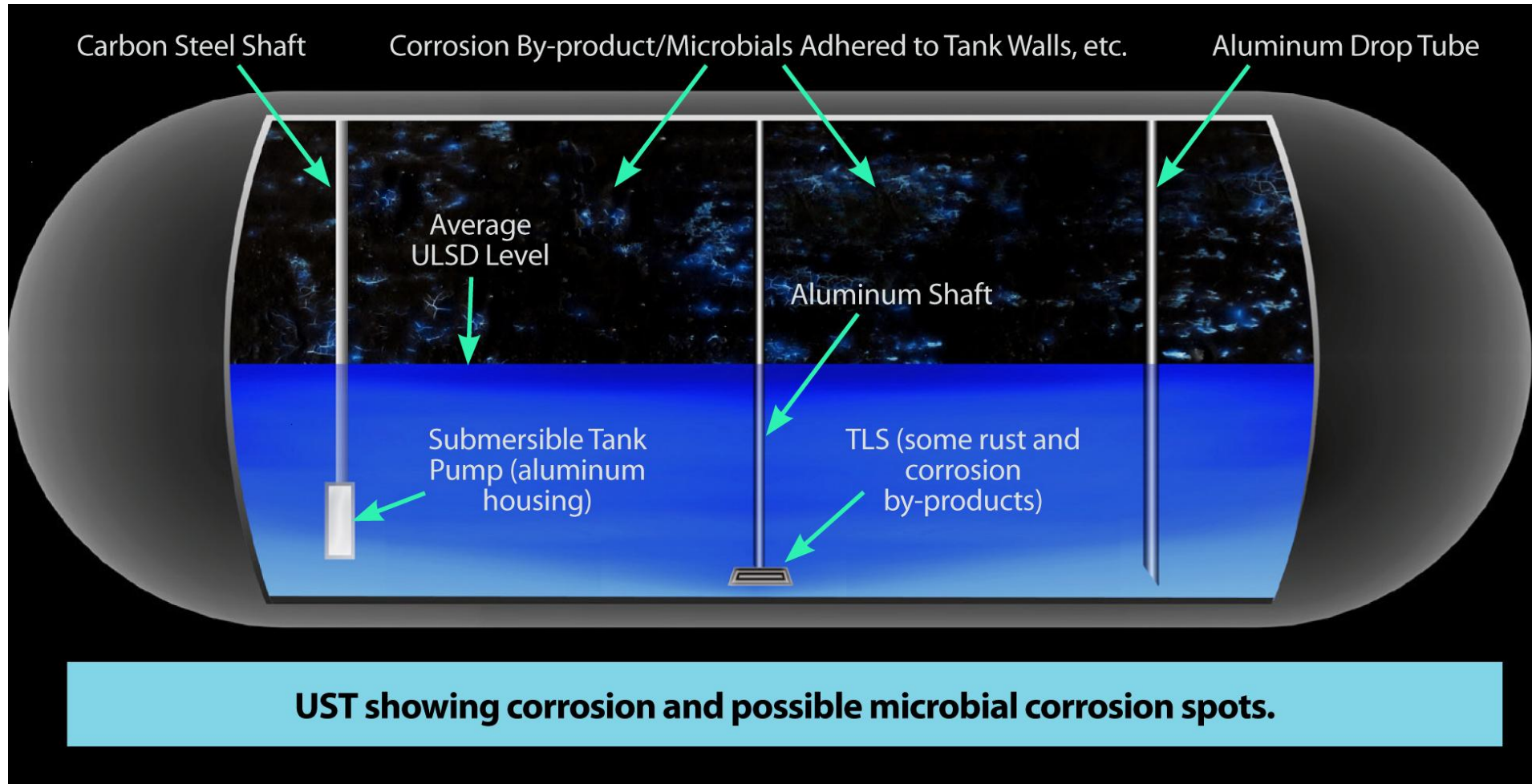
**Problems reported from all regions of the country-
No problems reported at refineries, pipelines, not
associated with individual supplier**



Problems Observed

- Filters clogging/requiring more frequent replacement
- Seal/Gasket/O-ring deterioration
- STP replacement/Column pipe wear/ Motor problems
- Tanks rusting/leaking (includes tanks of vehicles)
- Meter Failure
- Line leak detectors damaged or broken
- Automatic nozzle shutoff failure/ shorter lifespan
- Tank probes malfunctioning
- Check valves not seating
- Shear valves not sealing/failing tests
- Swivels failing/shorter lifespan
- Dispenser leaks/failures/ premature replacement
- Solenoid valves clogged/failing
- Corrosion on the riser pipe
- Pipe failure

ULSD Corrosion – UST Detail



Likely Causes

- No one cause, but rather a mixture.....
- Microbial influence getting a lot of attention:
- Salt and other contaminants also a contributing factor?
- Corrosion inhibitor depletion (aka “soap”) theory – acidic additives form soaps if contacted with excessive tank water cations from salts or caustic:
- Poor housekeeping, no biological monitoring, improper application of biocides exacerbates problem

The Clean Diesel Fuel Alliance

- Created in early 2006
- Participants include:
 1. Government
 2. Engine Manufacturers
 3. Marketers
 4. Refiners
 5. Marketers
 6. Equipment Producers

Government - Industry - Consumers
Clean Diesel Fuel Alliance
INFORMATION CENTER

> Skip Navigation > About ULSD > EPA Standards > EIA > ULSD Compliance > Media Room > Contact Us

> Highway ULSD Fuel
> Non-Road ULSD Fuel
> Vehicle Performance
> Environment & Health
> Frequently Asked Questions
> Quicklinks to Member Web Sites

Ultra Low Sulfur Diesel (ULSD) fuel and new engines and vehicles with advanced emissions control systems offer significant air quality improvement.

Highway ULSD Fuel
EPA standards have led to a major reduction in the sulfur content of diesel fuels.
[Highway Diesel](#)

New Diesel Technology
Ultra Low Sulfur Diesel (ULSD) is a cleaner-burning diesel fuel containing a maximum 15 parts-per-million (ppm) sulfur.
[Vehicle Performance](#)

Non-Road ULSD Fuel
New EPA fuel standards for diesel fuel also apply to locomotive, marine and non-road engines and equipment, such as farm or construction equipment.
[Non-Road Diesel](#)

Environmental Benefits
ULSD fuel along with new engine and emission control system technologies have an important role in improving air quality and providing human health benefits by significantly reducing current emissions.
[Environment and Health](#)

[Para leer en español el folleto sobre diesel ultra bajo en azufre](#)

[Energy Tomorrow Radio Podcast on ULSD](#)

ULTRA-LOW SULFUR HIGHWAY DIESEL FUEL (15 ppm Sulfur Maximum)
Recommended for use in all diesel vehicles and engines.
Remembered for use in all diesel vehicles and engines.

Service Station Owners/Operators
Remember to keep all pumps properly labeled (especially when refueling or replacing pumps).

Website: www.clean-diesel.org

Members of the Clean Diesel Fuel Alliance

- AAA
- Alliance of Automobile Manufacturers
- American Petroleum Institute
- American Trucking Associations
- Association of American Railroads
- Association of International Automobile Manufacturers
- Association of Oil Pipe Lines
- Diesel Technology Forum
- Engine Manufacturers Association
- Independent Liquid Terminals Association
- Manufacturers of Emission Controls Association
- National Automobile Dealers Association
- National Association of Convenience Stores
- National Association of Fleet Admins.
- NATSO, Inc., representing Truck Stops & Travel Plazas
- National Petrochemical & Refiners Association
- National Tank Truck Carriers, Inc.
- Petroleum Equipment Institute
- Petroleum Marketers Association of America
- Society of Independent Gasoline Marketers of America
- Steel Tank Institute
- Truck Renting and Leasing Association
- U.S. Environmental Protection Agency
- U.S. Department of Energy
- U.S. Energy Information Administration
- Western States Petroleum Association

Clean Diesel Alliance Study

The Battelle/Tanknology proposal was chosen and funded by API, PEI, STI, NACS, PMAA, NATSO, AAR, and Ford

Theories Investigated

- **Aerobic and anaerobic microbes** are producing byproducts that are establishing a corrosive environment in ULSD systems
- **Aggressive chemical species (e.g., acetic acid)** present in ULSD systems are facilitating aggressive corrosion; and
- **Additives** in the fuel are contributing to the corrosive environment in ULSD systems

Test Sites

- **Chose 6 sites with similar throughput and history of issue:**
 - 1 site that does not show symptoms of corrosion
 - 5 sites with history of severe, rapidly induced corrosive symptoms
- **Sites in three states**
 - 2 in California
 - 3 in NY (including no symptoms site)
 - 1 in NC



Site Inspections

- Feb 8-23: Inspected 6 sites
- Report Completed Late Summer 2012



Inspection Process Disassembled System



Inspection Process Fuel Sampling



Inspection Process Water Bottom Sampling



Inspection Process Video Inside Tank and Vapor Sampling



Biological Analysis to Extract DNA



ULSD Corrosion – Assessment



New steel
corrosion coupon



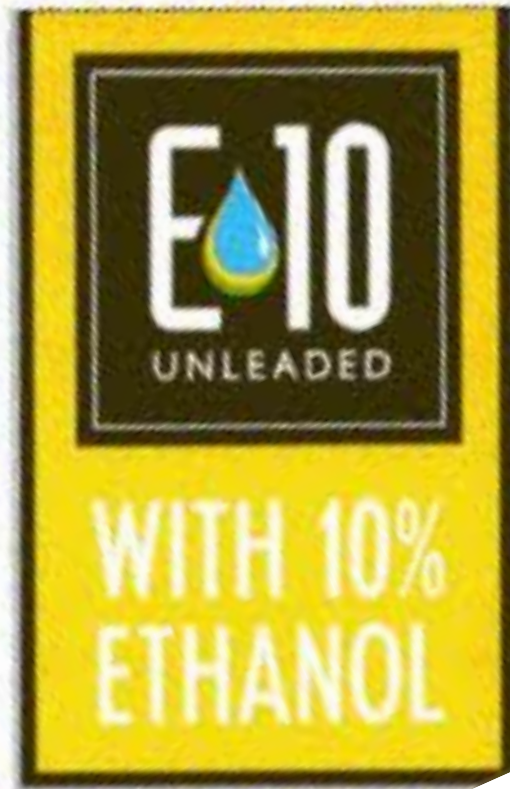
After 3 months

So what did the Study Conclude?

- More studies are needed, but one of the causes of corrosion with ULSD systems is...



Conclusion- The Source of the Problem...Ethanol!



Solutions, and What's Next?

- Clean Diesel Alliance may be funding another study
- ASTM and other industry professionals constantly in search of solutions
- Work with reputable fuel quality companies to provide biocides and other fuel treatment services and remedies to maintain fuel quality

Bio-Diesel

- Many Bio-diesel plants shut down when the price dropped
- Problems with feedstocks and maintaining quality
- Problems with cold-flow and scouring effects on tanks
- Problems with “shelf-life”
- Expensive to refine
- Prone to microbial growth



Questions?

