Above Ground Liquid Fertilizer Storage Tanks

TFI Guidelines for Mechanical Integrity

National Agronomic Environmental Health & Safety School
August 17 - 18, 2010
Bloomington, IL
Mechanical Integrity Practices

The Why and The How
The Why
Tank Failure History

► Storage tank failure is not a new phenomenon in fact...

- **January 15, 1919:** A molasses tank in Boston ruptured, emptying its 2.5 million gallon contents in a few seconds. Soon a 15-foot high wave of molasses moving about 35 miles per hour swallowed the streets of Boston's North End. Almost 150 people were injured with a final death toll of 21. A Massachusetts court determined that insufficient safety inspections had played a part in the accident. After a year of hearings, the courts found the company liable, concluding shoddy construction and overfilling of the tank was to blame. The company paid almost $1 million to settle the claims.....in 1919
Tank Failure History (Cont.)

- **3/1997** – Iowa, a 1M gallon amm phosphate tank ruptures and in turn damages two other liquid fertilizer tanks.

- **7/1999** – Michigan, a 1M gallon APP ruptures and damages 3 adjacent tanks.

- **1/2000** – Ohio, a 1M gallon fertilizer tank ruptures and damages 4 adjacent tanks and 5 tractor trailer rigs. More than 800k gallons spills into the Ohio River.

- **3/2000** – Ohio, a 1.5M gallon amm phosphate tank ruptures and damages 2 adjacent tanks. Some of the released liquid flows into nearby creeks.

- **11/2008** – Virginia, catastrophic failure of a UAN tank. Updating TFI guidelines as well as a proposed fertilizer tank law in Virginia are direct results (note: passed API inspection 23 months prior).
So Why Do Tanks Fail?

- Corrosion
- Improper Construction/Modifications
- Specific Gravity of fluid incompatible with tank wall
- Internal/External forces or events (fire, flood, impact, etc.)
How Do Tanks Fail?

► Catastrophically – Happens very quickly, can cause damage or loss in adjacent equipment and dangerous to personnel.
  - Wall blowout
  - Explosion/Vacuum
  - Total roof collapse

► Non-catastrophically – Slow, general corrosion type failures, can often be repaired while still insignificant
  - Pinhole leaks
  - General corrosion
Where Can Tanks Fail?

- Roof
- Weld
- Wall plate
- Internal Floor
- External Floor
Floor Failures - Internal

Solids create stagnant voids where accelerated corrosion can take place - pitting
Floor Failures – External (Soil Side)

Non-uniform tank base can allow moisture to collect underneath tank
Other Causes of Failure

► Sulfur Reducing Bacteria (SRB). This occurs on tank floors sitting on soil or sand. Moisture, nutrients, and ideal temperatures for bacteria growth (40 F – 120 F) are required for this type of corrosion to occur.

► Chloride cracking – stainless steels are susceptible to chloride attacks. Insulation can often be the source of chlorides. If the insulation gets wet cracking can occur. “Halide – Free” insulation is the answer for all stainless tanks.
In 2009 TFI set up a task force to update the TFI document:

Above Ground Storage Tanks of Liquid Fertilizer - Recommended Inspection Guidelines (April 2001).

The result was renamed to:

Above Ground Storage Tanks of Liquid Fertilizer – Recommended Mechanical Integrity Practices (Dec 2009)
Overview of the Mechanical Integrity Practice Guidelines

**The Guidelines apply to:**

- Tanks of 100,000 gallons or more.
- Tanks constructed of stainless, aluminum, or carbon steel.

**The Guidelines recommend:**

- New tanks constructed to API Std 650
- Tanks be modified and inspected according to API Std 653
- Inspections performed by API certified personnel familiar with ASTs

**The Guidelines represent the minimum recommended practices for inspection and maintenance. More stringent state/local regulations may apply.**
Section Review

• Section 1 – Purpose
• Section 2 – Definitions
• Section 3 – Scope
• Section 4 – Construction, Repair, Maintenance, and Inspection
• Section 5 – Bladders/Coatings
• Section 6 – Flammability
• Section 7 – Specific Gravity
• Section 8 – Inspections
• Section 9 – Record Keeping
• Section 10 – References
• Appendices A & B – Bladder & Coating Inspection Criteria
Section 4
Construction, Repair, Maintenance, & Inspection
Exterior & Interior Considerations Highlights

▸ Paint tanks a light color to reduce heat input and corrosion
▸ Tanks should be on a proper foundation, minimize moisture at base
▸ Repairs should be done by qualified API 653 welders to API 653 procedures or original tank standard if known
▸ Weld zones should be inspected thoroughly
▸ “Soil side” of tank bottoms should be inspected
▸ Roof rafters and joints should be inspected
▸ Avoid certain material of construction/fertilizer combinations:
  ▪ Copper and Brass with liquid fertilizers of any type
  ▪ Aluminum with phosphates or potassium chloride
  ▪ Carbon steel with acidic materials, dilute thiosulfates
Section 5
Bladders/Coatings Highlights

- Keep records of bladder or coating – manufacturer, installation date, properties, installation contractor, inspection data
- Inspect bladder within two years of adoption of this guideline by authorized inspector
- Tanks with bladders should have leak detection system
- Inspect bladders every 5 years after establishing baseline
- Repairs to bladder should have bladder manufacturer providing guidance
- Tanks with coatings or liners should be inspected every 5 years after establishing baseline
- Tanks should be inspected by API inspector prior to having coating applied
Consideration should be given in tank design to the specific gravity of the material being stored and the rating of the walls.
Section 8
Inspection Highlights

- Establish API Baseline Inspection
- Establish monthly in-house, walk around inspections
- External API inspections 5 year interval or sooner if corrosion rate warrants
- Internal API Inspections not to exceed 10 year interval unless RBI evaluation states different timeline
- Tanks should be evaluated for suitability for service based on:
  - Inspection reports
  - Shell thickness
  - Joint efficiencies
  - SG of product stored
Section 9
Recordkeeping Highlights

► Owner/Operator should keep detailed records of each tank including:
  - Tank Calculations
  - Construction and repair drawings
  - Inspection reports
  - Materials test reports
  - Original tank construction data
  - Description of the tank (Ht., dia., service)
  - Design conditions (liquid level, SG)
  - Shell thickness by course
  - Hydro tests
  - Foundation type
  - Leak detection systems and testing/maintenance of such
Tank Mechanical Integrity Measures

- Inspection Program
- Code/Procedure Based Construction & Repair
- Proper Metallurgy
- External roof supports/self supporting roofs
- Concrete or engineered foundations
- Linings/Coatings/Bladders
- Tank thickness meets SG guidelines
- Solids removal/minimization
- Vapor barriers
- Cathodic Protection
Testing Methods

- X-Ray (New tank welds)
- Hydrostatic - holes
- Ultrasonic Thickness (UT) - pitting
- Vacuum (floors/floor joints)
- Dye Penetrant - Cracks
- Magnetic Particle - Cracks
- Magnetic Flux Leakage - pits on tank floor
- Eddy Current - flaws in structure
- Visual Examination
Tank Guidelines

- API STD 650 - Welded Steel Tanks for Oil Storage
- API RP 651 – Cathodic Protection of Aboveground Petroleum Storage Tanks
- API RP 652 – Lining of Aboveground Petroleum Storage Tank Bottoms
- API STD 653 - Tank Inspection, Repair, Alteration, and Reconstruction

American Petroleum Institute
1220 L St. NW
Washington DC 20005
http://www.api.org
(202) 682-8000
Tank Guidelines - continued

► The Fertilizer Institute (TFI) Publication

Aboveground Storage Tanks of Liquid Fertilizer
Recommended Inspection Guidelines

The Fertilizer Institute
820 First St., NE
Washington, DC 20002
http://www.tfi.org
(202) 962-0490
Tank Guidelines - continued

► The Canadian Fertilizer Institute Publication

Canadian Fertilizer Industry Storage and Handling Guidelines 2001

Canadian Fertilizer Institute
350 Sparks Street, Suite 802
Ottawa, ON  K1R 7S8

(613) 230-2600

http://www.cfi.ca
CHEMICAL COMPATIBILITY FOR LIQUIDS FERTILIZERS

Table Key:
- A - Acceptable if compatible with container or appurtenances
- N - Not acceptable because of chemical compatibility
- 1 - Acceptable if product is treated with corrosion inhibitor
- 2 - Acceptable if warranted by equipment manufacturer for the intended use
- 3 - Acceptable if cleaned after seasonal use and is used to store materials less than three months (cumulative) annually

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<th>Product</th>
<th>Urea Ammonia Nitrate</th>
<th>Ammonium Thiosulfate</th>
<th>Ammonium Polyphosphate</th>
<th>Potassium Phosphate</th>
<th>Potassium Hydroxide</th>
<th>Potash Solutions</th>
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Source: Wisconsin Department of Agriculture, Trade and Consumer Protection