Reducing the Risk of Aboveground Storage Tank Floor Leaks

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Introduction

- During past 6 years, MN has been engaged in a program to require upgrades of field-erected ASTs to prevent, detect and contain releases
- As with any state regulatory program, when new information or technology becomes available, program improvements can and should be made

Introduction

- Presentation will focus on one constellation of issues related to tank floor leaks that can be called the “Problem”, and how MN is currently evaluating and attempting to address these issues so as to reduce risk of tank floor leaks to an acceptable level

Overview

- The "Problem"
  - Floor upgrades of field-erected ASTs in MN
  - API 653 inspection intervals for upgraded floors
  - Risk of floor leaks--MN data
  - Detecting floor leaks--MN experience

Overview

- A closer look at the risk factors:
  - Substances and environmental sensitivity
  - Internal inspection intervals
  - Floor coating/liner performance
  - Release detection
- 2 recent initiatives
- Conclusions

The "Problem"

--Floor upgrades of field-erect ASTs in MN

- In MN, operation of a single steel-floor field-erected tank storing higher risk substances such as gasoline, hazardous chemicals, distillate fuel oils, or waste oil, with no release prevention, detection or containment safeguards, is not allowed

The "Problem"

--Floor upgrades of field-erect ASTs in MN

- Acceptable floor upgrades include:
  - Elevated tank
  - Concrete pad
  - Impermeable release prevention barrier (RPB) with interstitial monitoring

The "Problem"

--Floor upgrades of field-erect ASTs in MN

- The most common upgrade chosen for big ASTs, due to lower retrofit cost:
  - Coating or lining topside of tank floor PLUS
  - Cathodic protection of underside of tank floor
- Used by all of the largest tank owners (refineries, terminals) representing 2/3 of big ASTs in MN

The "Problem"

--API 653 inspection intervals

- All ASTs of this type must follow the API 653 inspection protocol
- Most important element of API 653 for determining floor condition is the internal inspection

The "Problem"

--API 653 inspection intervals

- Floor scans to fully assess topside and underside floor condition are mandatory in MN
- Condition of floor coating or liner can also be assessed visually and via NDE techniques at this time

The "Problem"

--API 653 inspection intervals

- Internal inspection intervals are normally calculated using corrosion rate data if available
  - Interval set prior to estimated "hole through", including a margin of safety
  - Maximum interval allowed is 20 years

The "Problem"

--API 653 inspection intervals

- If a floor coating/liner and cathodic protection are in place, API 653 normally allows tank owners to assume a zero corrosion rate
- SO, for a tank with an upgraded AST floor, next inspection is not required for 20 years

The "Problem"

--Risk of floor leaks

- No cost-effective method of fully assessing the condition of the floor and floor coating/liner short of emptying, cleaning, and inspecting the tank
  - In-service robotics may work for certain liquids and limited inspection parameters

The "Problem"
--Risk of floor leaks

- Properly installed and maintained cathodic protection mitigates underside corrosion
  - But difficult to fully protect entire surface of a large floor
  - And maintenance can be highly variable

The "Problem"
--Risk of floor leaks

- Properly installed floor coatings and liners virtually eliminate corrosion and weld failure
  - But are they properly installed?
  - And what about performance over time?

The "Problem"

--Risk of floor leaks

- Coatings and liners can and do fail for a variety of reasons:
  - Misapplication (holidays)
  - Process upset leading to incompatible contaminants
  - Floor flex leading to cracking
  - Wear and tear from roof legs, mixers, etc.

The "Problem"

--Risk of floor leaks

- Performance data from one major terminal operator (Williams Pipe Line)
  - Facilities -- 5
  - Tank size range -- 80,000 to 3,300,000 gal.
  - Total tankage -- 93
  - Total capacity -- 140,000,000

The "Problem"

--Risk of floor leaks

- All tank floors coated/lined between 1985 and 1989, most in 87-88, some thin some thick coat
- All tanks are now being API 653 inspected, starting in 1998

The "Problem"

--Risk of floor leaks

- Tanks inspected through 2000 -- 55
- Average inspection interval -- 11.5 years
- Floor coating/liners replaced -- 41

Replacement rate = 75% at 11.5 years

The "Problem"
--Risk of floor leaks

- When coating/liner has failed, the tank floor can fail
  - Marathon Ashland refinery tank #79: in 1999, process upset allows hydrofluoric acid to enter alkylate tank, eating up plascite coating and floor welds and leaking 2000 gallons into containment

The "Problem"
--Detecting floor leaks

- When single floor tank leaks, visual observation will almost never detect the leak, unless:
  - Groundwater is very shallow, or
  - Soil is very tight, or
  - Release protection barrier is in place beneath floor
- In first two, detection still a matter of chance!

The "Problem"
--Detecting floor leaks

- MN AST permits typically require tank gauging and inventory reconciliation as crude method of leak detection
- Due to impact of temperature on measured volume in ASTs, accuracy decreases exponentially with tank size

The "Problem"
--Detecting floor leaks

- No leaks have ever been detected with this method in 5 years of widespread use
- Most ambient leaks/spills actually detected by low-budget "smell test"
- Conclusion: inventory reconciliation is ineffective as release detection method

The Question:

Is MN (and the tank owner) comfortable with a situation where a tank will not be re-inspected for 20 years, the condition of the floor coating will remain unknown, and if the tank should fail, there is no reliable method of release detection in place??

A closer look at the risk factors:

- The MN program, in developing individual permits for major facilities and rules for smaller facilities, has always had a very risk-based, prevention-oriented approach

A closer look at the risk factors:

- Requirements should address the specific risk, go no further than necessary, and allow for alternate methods of mitigating risk

A closer look at the risk factors:

- Toxicity/viscosity of stored substances
- Environmental sensitivity
- Internal inspection intervals
- Floor coating/liner performance
- Release detection

Toxicity/viscosity of stored substance

- Inherent toxicity of the substance (including "out of the tank" characteristics) and its ability to migrate through soil (generally governed by viscosity) should be considered in any risk-based analysis

Toxicity/viscosity of stored substance

- Type A: gasoline, hazardous chemicals
- Type B: diesel, kerosene, #1-2 fuel oil, jet fuel, crude oil, waste oil
- Type C1: #6 fuel oil, low hazard chemicals, wastewater
- Type C2: asphalt, food products, paper pulp

Environmental sensitivity

- Proximity to and characteristics of the protected resources should be considered in any risk-based analysis

Environmental sensitivity

- Obviously, many ways to approach this
- In MN, environmental sensitivity for purposes of AST program defined as:
  - **Groundwater or bedrock less than 10 feet under tank, or surface water within 100 feet of tank**
- Other tank locations are “non-sensitive”

Internal inspection intervals

- Assuming that internal inspection of a tank per API 653 has a very high likelihood of detecting a floor failure, or even more importantly an imminent failure, the general principle is:
  - **The shorter the interval between inspections, the lower the risk of a floor leak**

Internal inspection intervals

- At the risk of getting a bit technical, a few issues in calculating intervals are very relevant:
  - Effect of Release Prevention Barriers
  - Effect of liners
  - "Similar service"
  - Risk Based Inspection
  - 20 year maximum

Internal inspection intervals --RPBs

- API 653 gives "credit" (i.e. longer allowable interval) for having a foundation or floor designed to detect and contain a leak
- For example, release prevention barrier (RPB)
- This makes sense; a leak isn't going anywhere and will be detected

Internal inspection intervals --RPBs

- However, the wording in the standard is vague and non-specific and could extent to designs other than RPBs, or to non-standard RPBs
- Could benefit from revision to avoid misuse

Internal inspection intervals
--Coatings

- API 653 give "credit" for a reinforced (thick) topside liner designed per API 652
- This is good -- properly installed liners virtually eliminate corrosion, so long as they remain intact
- But: how long will a liner last?

Internal inspection intervals
--Coatings

- MN has seen misinterpretation of the use of "Table 4-1" to automatically go to a 20 year interval if a liner is present
- This needs to be clarified by API

Internal inspection intervals
--Risk Based Inspections

- API 653 allows an owner to determining intervals based on risk
- API 581 develops a methodology for estimating risks in various refinery inspections
- We are beginning to see some owners apply this to tanks

Internal inspection intervals
--Risk Based Inspections

- The concept is hard to argue with, but the application must be scrutinized by regulators
- Will it be used to lengthen intervals without proper justification?

Internal inspection intervals
--20 year maximum

- API 653 caps inspection intervals at 20 yrs., "in most cases"
- This is a reasonable approach; 20 years is a long time, well-designed and maintained steel floors can last far longer than this
- The exception for RBI is worrisome--will this be used as a loophole?

Internal inspection intervals

"Similar service"

- API 653 allows owners to base intervals on "experience with other tanks in similar service" rather than on corrosion data on the tank itself
- Yet the design, management, foundation, soil, and corrosion environment from one tank to another can be vastly different

Internal inspection intervals

"Similar service"

- This is perhaps the most worrisome aspect of API 653, and does not fit in with the otherwise rigorous, data-based approach of the document
- MN has encountered abuse of this provision, and is seriously considering limiting the use of "similar service"

Internal inspection intervals

- On these issues mentioned, MN is seeing confusion and occasionally improper advantage taken to delay inspection
  - These factors increase risk of floor leaks
- API 653 is an important document, but API needs to correct deficiencies or lose credibility

Floor coating/liner performance

- Evidence cited above indicates that floor coatings and liners do not have an unlimited lifetime
- Since they cannot be effectively evaluated between inspections, how can risks be managed?

Floor coating/liner performance

- Most practicable indications of performance for regulators probably come from:
  - Materials and design
  - Installation
  - Age

Floor coating/liner performance

- Design factors:
  - Use of API Standard 652
  - Thickness: the thicker the longer lasting, e.g. reinforced, greater than 80 mils best
  - Compatibility of material with stored product

Floor coating/liner performance

- Installation factors:
  - Certification of installers (similar to API 653 Authorized Inspectors)
  - Use of third-party or governmental inspectors
- Age: evidence points to 10 year maximum lifetime for thin coatings; thick liners--?

Release detection

- If a method is in place that can quickly and accurately detect a tank floor release -- or even better, contain the release until it can be stopped -- the potential impact on the environment is greatly reduced or eliminated
  - Prevention is good, but detection / containment is the "gold standard"

Release detection

- Floor design using an RPB an interstitial monitoring--such as an underfloor synthetic or clay liner, or a concrete pad--incorporates both detection and containment
- RPB are extremely cost- and risk- effective for new construction (see API 650, Appendix I)

Release detection

- Older tanks can be retrofitted with RPBs during floor replacement, or the tank can be lifted
- In recent years there have been 2 floor leaks contained and detected by RPBs

Release detection

- In the absence of an RPB, in-service leak testing and leak detection for large ASTs is the primary alternative
- These methods to be effective must at a minimum be temperature-compensated and 3d party certified

Release detection

- The methods recognized in MN are:
  - Mass balance
  - Chemical marker
  - Soil vapor monitoring

Release detection

- 2 parameters directly affect the reliability of leak detection and hence risk:
  - Frequency (is detection continuous or intermittent, and if the latter, how often?)
  - Detection threshold (how small a leak can be detected?)

Two examples of dealing with the "Problem"

- Facility A
- Facility B
- [NOTE: to be addressed only if time permits]

Facility A

Facility B

Conclusions

- As with the general MN approach to AST matters, there is probably no one-size-fits-all answer to the "Problem" of reducing the risk and incidence of tank floor leaks
- MN will address this case-by-case through upcoming facility permit re-issuances

Conclusions

- Some general observations can still be made
- Frequency of internal inspections and need for release prevention, detection, and containment measures should be risk-based rather than fixed

Conclusions

- Key risk factors are:
  - Substance
  - Environmental sensitivity (as defined in some reasonable way)
  - Prevention, detection, and containment measures in place

Conclusions

- MN has chosen not to mandate underfloor release containment (unlike FL, which requires it statewide due to sensitive aquifers)
- Most decisions about tank floor leak prevention have already been made in permits
- So key variables are inspection intervals and release detection

Conclusions

--Inspection intervals

- API 653 is unclear about determining intervals in some cases of upgraded tank floors, and some tank owners take advantage of this
- API's Tanks and Standards Committees should be encouraged to tighten wording and offer incentives for risk reduction

Conclusions
--Inspection intervals

- "Similar service" should be strictly limited or eliminated
- RBI holds promise, but:
  - Protocols should be carefully scrutinized by states
  - Should not be used to delay needed inspections beyond 20 years, especially in environmentally sensitive locations

Conclusions
--Inspection intervals

- Thin topside coatings should not be assumed by API or regulators to function for 20 years
- Voluntary reduction of inspection intervals below API 653 calculations can be credited toward risk reduction

Conclusions
--Release detection

- Release detection should always be required for high-risk substances in environmentally sensitive areas, due to lack of safety margin
- Otherwise, release detection can be optional, or chosen to reduce need for other measures

Conclusions
--Release detection

- Some release detection methods don't work for large ASTs (e.g. inventory control)
- Release detection measures should be third-party certified and/or approved by states to meet their frequency and detection limit requirements

Conclusions

- There are many ways to prevent and detect tank floor leaks
- EPA, the states, industry groups and tank owners can work together to identify reasonable and cost-effective measures to reduce the risk of this most insidious type of tank failure