AST Testing – Integrity and Leak Test Methods

NISTM Pennsylvania
April 14th, 2016
Founded in 1988, Tanknology has grown to become one of the largest testing and inspection service companies in the world.

Our fleet of 150 vehicles provides service in all 50 states domestically, and we have a presence in more than 30 countries with international licensees.

We hold 22 patents covering our test equipment and various leak detection methods.
Headquarters in Austin, TX

8 Strategically Located Regional Offices:

- Southern California
- Northern California
- Georgia
- Illinois
- Minnesota
- Ohio
- Philadelphia
- Texas

Our regional operating structure empowers us to provide clients with the best customer experience.
Integrity Testing and Leak Testing – this terminology is often intermixed in the UST arena, however have dramatically different meanings on ASTs.

- Integrity Testing must be performed by certified personnel to the applicable standard(s) referenced in the SPCC plan.
- Work with your P.E. to establish the most meaningful and cost-effective integrity testing schedule.
- Leak testing may be an important periodic piece to detect leaks at the earliest possible interval.
SPCC rule requires inspection and integrity testing of ASTs per an applicable industry standard. Typically reference API 653 or STI SP001 as the applicable industry standard.
Owner/Operator must conduct integrity testing and routinely inspect:

- Large Field Constructed or Field Erected & small shop built bulk storage containers
- Containers located on, partially in, and off the ground wherever located
- Double-walled containers
Integrity and Leak Testing Methods

- Formal STI SP001 Inspections
- API 653 Inspections
- Leak testing a tank
- Product pipe testing
Tanknology STI SP001 Formal External Inspection

- Review site data
- Assess the site
- Inspect the tanks themselves
- Collect Ultrasonic Thickness Data
Review Site Data

1. Confirm SPCC plan information is up to date.
2. Review any previous inspections & reports.
3. Review site drawings.
4. Verify the tanks that are being inspected.
SPCC Plans are up to date for inspection and testing.

- Verify that the tanks on site are in the SPCC plan
- Review that the tanks contents are what is listed in the plan
- Verify with the site the inspection and testing procedures that are listed in their plan.
Review Inspections and Test reports.

- Review annual & monthly inspections.
- Review any previous formal inspections.
- Review any previous testing, repairs, or other available data on the tank.
Site Drawing

- Verify that the site has an accurate site drawing to include:
  - Quantity
  - Volume
  - Position
  - Labeling
Verify which tanks are to be inspected

• Perform a site walk through with site personnel to identify all tanks.
• Making sure the correct tanks are being inspected.
• Verify the tanks being inspected match up to the SPCC plan schedule.
Assessing the site

Check the Containment

Verify the signage on site and tanks

Categorize the tanks
Assessing the site containment

- Measure it out
- Check for any liquid or debris.
- Check that drains are capped, have a ball valve, and are locked.
- Check for any deformation or cracking.
- Verify it will hold the correct amount of product.
Verify correct signage

- Make sure there are emergency contact signs at the entrance and at tank farm.
- Verify that the tanks are properly labeled with content and capacity.
- Verify that the diamond hazard placards are on the tanks and at the entrance of the facility.
- Verify that no smoking signs are present.
Categorize the tanks

- Check the type of continuous release detection method.
- Check the type of overspill prevention.
- Check type of release prevention barrier.
- Verify if tanks are Shop Fabricated or Field-Erected.
**Release Detection Methods**

**LTM**
Leak Testing Method

- One Time test for leaks
- Effective only at time of test

Examples
- Pressure testing
- Vacuum Testing
- Helium or chemical marker
- Mass or volumetric leak testing
- Inventory reconciliation

**CRDM**
Continuous Release Detection Method

CRDM is inherent in the design and considered one of the most robust of leak detection systems. It is continuous and passive (does not require sensors or power to operate: release detect visual

Examples
- Double Wall Tanks
- Double Bottom Tanks
- Tanks with pans under them
- Tanks with RPBs underneath including under-tank slab foundations
- Elevated tanks
- Horizontal Tanks
- Elevated concrete encases tanks
- Tanks on grillage
Release Prevention Barriers

- Concrete Pad
- Steel Pan
- Liners
## Table 5.4 Example Tank Configuration and AST Category

<table>
<thead>
<tr>
<th>Tank Configuration</th>
<th>Tank has CRDM?</th>
<th>Tank has Spill Control?</th>
<th>AST Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single wall AST in contact with ground</td>
<td>no</td>
<td>no</td>
<td>3</td>
</tr>
<tr>
<td>Single wall AST in contact with ground</td>
<td>no</td>
<td>yes</td>
<td>2</td>
</tr>
<tr>
<td>Elevated tank</td>
<td>yes</td>
<td>yes</td>
<td>1</td>
</tr>
<tr>
<td>AST with RPB</td>
<td>yes</td>
<td>yes</td>
<td>1</td>
</tr>
<tr>
<td>AST with double-bottom</td>
<td>yes</td>
<td>yes</td>
<td>1</td>
</tr>
<tr>
<td>Double-wall AST with overfill prevention</td>
<td>yes</td>
<td>yes</td>
<td>1</td>
</tr>
<tr>
<td>Double-wall AST without overfill prevention</td>
<td>yes</td>
<td>no</td>
<td>3</td>
</tr>
<tr>
<td>Vertical tank resting on concrete (conforms with definition of RPB)</td>
<td>yes</td>
<td>yes</td>
<td>1</td>
</tr>
<tr>
<td>Vertical tank resting on concrete (conforms with definition of RPB)</td>
<td>yes</td>
<td>no</td>
<td>3</td>
</tr>
</tbody>
</table>
Tank Categories:

- **Category 1**
  - Secondary Containment
  - Continuous Release Detection Method (CRDM)
  - (Example - Elevated Tank where all sides of the tanks can be inspected except at the supports)

- **Category 2**
  - Secondary Containment
  - No CRDM – (Example – Vertical DW with Tank shell in contact with soil)

- **Category 3**
  - No Secondary Containment
  - No CRDM
Double-wall tank with overfill prevention

Tanks in concrete dike
Category 2

Single-wall tank in earthen berm
Category 3

Single-wall tank directly on soil and without spill control
### Table 5.5 Table of Inspection Schedules

<table>
<thead>
<tr>
<th>AST Type and Size (U.S. gallons)</th>
<th>Category 1</th>
<th>Category 2</th>
<th>Category 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 1100 (0-4164 liters)</td>
<td>P</td>
<td>P</td>
<td>P, E&amp;L(10)</td>
</tr>
<tr>
<td>1101 - 5,000 (4168-18,927 liters)</td>
<td>P</td>
<td>P, E&amp;L(10)</td>
<td>[P, E&amp;L(5), I(10)] or [P, L(2), E(5)]</td>
</tr>
<tr>
<td>5,001 - 30,000 (18,931-113,562 liters)</td>
<td>P, E(20)</td>
<td>[P, E(10), I(20)] or [P, E(5), L(10)]</td>
<td>[P, E&amp;L(5), I(10)] or [P, L(1), E(5)]</td>
</tr>
</tbody>
</table>

**Portable Containers**

- P
- P
- P

**Owner shall either discontinue use of portable container for storage or have the portable container DOT (Department of Transportation) tested and recertified per the following schedule (refer to Section 9.0):
- Plastic portable container - every 7 years
- Steel portable container - every 12 years
- Stainless Steel portable container - every 17 years

### In Table 5.5 Use the Following Designations:

- **P** – Periodic AST inspection
  - Refer to Section 6
- **E** – Formal External Inspection by Certified Inspector
  - Refer to Section 7
- **I** – Formal Internal Inspection by Certified Inspector
  - Refer to Section 8
- **L** – leak test by owner or owner’s designee
  - Refer to Section 9

5.5.5 ( ) indicates maximum inspection interval in years. For example, E (5) indicates Formal External Inspection every 5 years.
### Table B2.1 Table of Inspection Schedules

<table>
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<tr>
<th>AST Type and Size</th>
<th>Category 1</th>
<th>Category 2</th>
<th>Category 3</th>
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Tank Inspections

• Tank data
• Tank secondary containment
• Tank supports & foundation
• Tank gauges and alarms
• Tank overfill type
• Tanks spill control
• Tank piping and appurtenances
• Tank venting
• Tank platforms and ladders
• Tank external shell
Tank Data

- Tank Nameplate & Number
- Tank Location
  
Tank Layout

- Tank Size
  
  - Tank Content
  - Tank Design

Tank Size

- Tank Construction
- Tank Dimensions
  
Tank Category

- Tanknology
Tank Secondary Containment

• If applicable inspect double wall, double bottom, and tanks with boxes or pans around them.
  • Verify containment area is dry.
  • That it has a drain valve on the container
  • Verify that any gauging system on the secondary is in good condition and reading accurately.
Tank Supports & Foundations

- Type of foundation
- Condition of the foundation
- Type of supports and anchors
- Condition of the supports and anchors
- Tank protection (Bollards, Fencing, & other types)
Tank Gauges and Alarms

• Type of gauge (Manufacture & Model #)
• Gauge for primary and secondary
• The condition of the gauge
• Whether it is electronic or manual
• If it is reading correctly and if it goes into alarm
Type of overfill

- Tanks type of overfill
  - Flapper
  - Overfill alarm
  - Whistle Vent
  - Written filling procedure as overfill prevention on site
Type of Spill Control

• Spill bucket on fill
• Spill bucket at remote fill
• Fill inside the containment area
• Check condition of spill control
  • Does the drain work
  • Is it clean of liquid and debris
• Filling procedure present
Tank piping and appurtenances

- Is piping aboveground or underground
- Does the piping have cathodic protection
- What valves or leak detection are on the piping and tank
- Are the valves operating and sized correctly
- Is the piping supported and secured correctly
- Inspect the piping condition
  - What material is the piping
  - Is the piping corroded
  - Is it painted
Tank Venting

• **Normal Venting**
  – Is it the correct size
  – Is it free and clear
  – Is it 12 feet above grade

• **Emergency Venting**
  – Type of emergency venting
  – Is it the correct size
  – Does move free and clear
  – Is it on both primary and secondary
• **Type of Platforms and Ladders**
  
  – Are they secured properly
  – Are they painted
  – Does the containment entrance have a platform or stairway
Tank External Shell

- The External coating
  - Corrosion
  - Condition of welds
  - Evidence of distortion
  - Evidence of leaks
  - Any changes to the original tank
- Does the tank have Insulation
  - Insulation missing
  - Evidence of moisture
  - Damage to the insulation
  - Corrosion under insulation
- Tank Roof
  - Standing Water (low points)
  - Coating failure
• Ultrasonic thickness readings on single wall tanks or double wall tanks that have product or liquid in them.

• We mark out our readings to make sure we collected them accurately.

• Note what standard we are following if it is a tank manufacture or to UL 142.

• If we get a low reading we evaluate the low reading area to determine the area of the metal thickness loss.

• We evaluate the readings before leaving site to make sure all required data was recorded.
API 653 Tank Inspections

- Foundation
- Shell
- Nozzles
- Roof
- Floor
- Ancillary Equipment
- Additional
- NDT Testing
API Foundation

- Supports of the tank condition
- The concrete footers
- If the tank is level
- The condition of the containment
- The drain of the containment area
API Shell

- Type of welds
- The condition of the shell (Buckling or Distortion)
- The shell coating
- Any re-pads or redesign to the tank.
API Nozzles

- The number of nozzles
- The location of the nozzles
- Any service related issues with nozzles
- Any re-pads or redesign to the tank.
API Roof

- Type of roof
  - Floating, Weak roof to shell, Standard

- If the roof has any distortion or buckling

- The coating of the roof

- Any nozzles on the roof

- Any other fittings on the tank roof
API Floor

- Head of the floor if visible will be looked at.

- If internal inspection will conduct UT or other form of Non-destructive testing

- The coating of the exterior of the floor

- Visual inspect any drain nozzles.
API Ancillary Equipment

- Look at any pumps
- Additional gauges
- Monitor or flow control valves
API Additional

- Look at the ladders connected to the tank
- Platforms or catwalks
- The coatings on the walkway structures.
Nondestructive Testing

- Ultrasonic
- Liquid Penetrant
- Magnetic Particle
- Radiography
- Mag Flux Scan
- Vacuum Box
- Tracer Gas
UT Testing - utilizes high frequency waves to check the internal structure to measure its thickness. Readings are compared to a comparable standard, i.e. UL 142 for shop-built storage tanks.

A-Scan – point reading, commonly used for SP001
B-Scan – point to point reading – measures thickness over linear position
C-Scan - two dimensional imaging of tank walls
Magnetic Flux Leakage

- Magnetic method used to detect corrosion and pitting in steel structures.
- Magnetic detector is placed between two poles to detect the leakage field and determine depth of metal loss.
- Used on carbon steel floor plate in SP001
Short wavelength of electromagnetic radiation is used to penetrate tank wall to find hidden flaws.
Acoustic Emission Testing

- “Stress” test of tank shell
- Structure is subjected to external stimulus (such as a change of load) and the energy released (stress waves) are measured by acoustic sensors
- Dynamic test – only active signals are measured
- Possibly challenging in high noise environment
Liquid Penetrant Testing

- Penetrant used to detect cracks not visible to the naked eye
- Clean surface and apply penetrant
- Remove excess penetrant
- Apply developer and inspect surface – utilize proper lighting based on dye penetrant
Leak Testing Tanks

- STI R912
- Pressure / Vacuum Leak Testing
- Limitations of Pressure testing
STI R912- Leak Testing Guidelines

- Section 3.0 covers leak testing of single walled and double walled aboveground storage tanks
- Test pressures dependent on type of tank, i.e. horizontal cylinder, vertical, or rectangular tanks (wit or without fuel)
- Soap tested – leak test solution applied to surfaces, fittings, welds, etc. to check for leaks
- Single walled tanks – should be pressure tested only, with soap solution
- Double walled tanks –
  - Can vacuum test the tank annular
  - When pressure testing, both the primary and secondary tanks must be under pressure (primary first)
What is pressure?

- Pressure is the Force exerted per unit of Area.
- Pressure = Force ÷ Area.
- Pressure is measured in Pounds per Square Inch (PSI).
- Pneumatic Pressure is exerted by air and other gases like nitrogen and helium.
- Hydrostatic or Hydraulic Pressure is exerted by liquids like water and gasoline.

Pressure is a measure of the linear momentum of the gas molecules. Pressure force acts perpendicular to enclosing surfaces.
What is vacuum?

- Vacuum is a pressure lower than the atmospheric pressure.
- A vacuum is created by removing air from a closed container.
- Outer space is also a vacuum because there’s no air.
- Here’s a simple example of the vacuum inside a suction cup:

In (A), a suction pad is placed against a wall; no vacuum is generated – the atmospheric forces are balanced. In (B), a vacuum is produced by expelling air from between the pad and the wall; the pad clings to the wall because outside pressure is greater than the inside pressure.
Density and Specific Gravity

- **Density** is the ratio of an object’s **weight** for the amount of **volume** it occupies.
- Density of Water = 62.37 **pounds** per **cubic foot**
- **Specific Gravity** is the ratio of the density of a liquid compared to the density of water.

<table>
<thead>
<tr>
<th>Liquid</th>
<th>Density in Pounds per Cubic Inch</th>
<th>Specific Gravity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>0.036</td>
<td>1.0</td>
</tr>
<tr>
<td>Gasoline</td>
<td>0.026</td>
<td>0.72</td>
</tr>
<tr>
<td>Kerosene</td>
<td>0.029</td>
<td>0.80</td>
</tr>
<tr>
<td>Diesel</td>
<td>0.031</td>
<td>0.85</td>
</tr>
</tbody>
</table>

*Actually it's the “mass” but we’ll assume we're in the U.S.*
Hydrostatic “Head” Pressure

• Hydrostatic pressure is created by the weight of liquid above a surface.
• This is sometimes called “Head” Pressure.

The pressure in psi at the bottom of a barrel equals the weight of a column of water directly above an area of one square inch.

P₁ = 1
P₂ = 3
P₃ = 5

http://www.challengers101.com/Pressure.html
Pressure / Vacuum Leak Testing

Why?
Point in time test – used to see if the tank is liquid tight

When?
Post- Installation
Change in service / product
Move the tank one location to another
Unusual operating condition
Post-repair

Leak testing is often requested by the local FD at the time of their inspection.
Limitations of Testing

- Why Soap? Detects small leaks that may be masked due to expansion – pressure flow rate, sun, temperature will impact pressure test results.

- AST – tank surface area is not entirely visible on all tanks.

- If water in interstitial space of double wall tank it automatically fails testing per our protocol.
Product line testing

- **Hydrostatic Pressure Test**
  - “of or relating to fluids at rest or under pressure” according to Webster’s dictionary

- **Constant pressure (TLD-1)**
  - Nitrogen gas required from cylinder stored in truck

- **Measures volume change only**
  - Volume of fluid in cylinder is visually monitored over duration of test. (Remember test pressure is constant and therefore pressure will not change)

- **Consistent pressure with consistent hole size equals consistent leak rate.**
Product line preparation

- In order to set up the product line to test on a pressure system the ball valve to the STP is closed (if there is one).
- The functional element check valve assembly is manually closed.
- All the impact valves for the product being tested are closed including the impact valve from the valve we are testing from.
- Typically the test is started from the impact valve (not the STP).
Line Tester

Gas holding Tank

Hose and valve from holding tank to graduated cylinder

Whip hose that connects tester to the product line

Nitrogen Hose from Truck
Some Specifics

- Minimum Data Collection: 30 minutes for steel & FRP; 60 minutes for flexible pipe
- Maximum Volume: 172 gallons for rigid piping; 119 gallons for flexible piping
- Constant Pressure: Minimum 50 psi or 1 1/2 times operating pressure
- Measure Volume Change (in centimeters)
  - Conversion: 1 cm = 0.00549 gallons
- Ten Minute Readings (60 MINUTES IN 1 HOUR)
- Multiply conversion by 6 to obtain gallon per hour leak rate.
  
  0.3 cm (steel); 0.6 cm (fiberglass); 0.7 cm (suction)
  
  \[
  \begin{align*}
  0.3 \times 0.00549 \times 6 &= 0.009 \text{gph} \\
  0.6 \times 0.00549 \times 6 &= 0.019 \text{gph} \\
  0.7 \times 0.00549 \times 6 &= 0.023 \text{gph}
  \end{align*}
  \]

  (The above are just above the threshold of failing see below for thresholds)

- Passing criteria differs for each pipe material.
- Memorize the following thresholds:
  - The leak rates have to be less than the following values:
    
    0.01 gph (steel);
    0.02 gph (fiberglass/flex);
    0.025 gph (suction)
Summary

• STI SP001 Formal Inspections
  – STI SP001 Inspections look at everything included with the tank
  – UT readings / No reading on double wall tanks

• API 653 Inspections
  – API inspection look more at just the tank
  – API inspections are geared towards large tanks.

• Pressure / Vacuum testing
  – Pressure and Vacuum testing apply to certain types of tanks.
  – Testing tanks with product already in them needs more calculations.

• Product Line Testing
  – How we test them
  – The standards we test them to
Questions ?
Thank You!
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