WELCOME!

Topic Lecturer:
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Discussion Scope

LT Method and BLT Technique application for those employees that are not needing certification to a code and standard.
(d) Examination before shipping. (1) No person may offer for transportation a tank car containing a hazardous material or a residue of a hazardous material unless that person determines that the tank car is in proper condition and safe for transportation. As a minimum, each person offering a tank car for transportation must perform an external visual inspection that includes: …
Divided into three main categories by American Society of Non-Destructive Testing.

- Leak Detection,
- Leak Location,
- Leak Measurement

Bubble Leak Testing is an example of both Leak Detection, and Leak Location.
Three common LT techniques for tank car inspection:

- Bubble leak testing – liquid film (BLT)
- Chemical Reactivity (CRLT)
- Pressure change or Pressure Decay
LT is a form of NDT that uses either a pressurized or evacuated system to detect the location of leak and possibly measure the leakage through the leak.

LT when compared to other methods, either surface (MT, PT) or Volumetric (UT, RT), has a higher degree of sensitivity to locate the leak or measure leakage.
Leak Testing Definitions

**Leak:**
- Physical hole that exists and not the quantity of fluid passing through.

**Leakage:**
- The flow of fluid through a leak without regard to physical size of the hole through which flow occurs.

Term *leak tight* is relative. Nothing is truly *leak tight* and different terms should be used.

Terms *no detectable leakage, no leakage, or zero leakage* truly represent the desired condition before shipping a tank car.

Everything leaks, absolute tightness is only theoretical in practice. Nothing made by humans can truly be absolute leak tight.
Leak Path

Diagram showing the flow of high pressure fluid transitioning to low pressure fluid through a leak path.
LT techniques are measured in leak rates. The smaller the leak rate detected, the higher the sensitivity.

Examples of minimum detectable leak rates:

<table>
<thead>
<tr>
<th>Method</th>
<th>Leak Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultrasonic Leak Detector</td>
<td>$10^{-1}$ std cm$^3$ per second</td>
</tr>
<tr>
<td>Bubble Leak</td>
<td>$10^{-3}$ std cm$^3$ per second</td>
</tr>
<tr>
<td>Mass Spectrometer detector probe</td>
<td>$10^{-5}$ std cm$^3$ per second</td>
</tr>
<tr>
<td>Radioactive Isotope</td>
<td>$10^{-8}$ std cm$^3$ per second</td>
</tr>
</tbody>
</table>

Quantity (mass) of a gas leaking in one second.

- Volume equal to three dimes stacked vertically.

<table>
<thead>
<tr>
<th>Value</th>
<th>Time Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$10^{-2}$</td>
<td>10 seconds</td>
</tr>
<tr>
<td>$10^{-3}$</td>
<td>100 seconds</td>
</tr>
<tr>
<td>$10^{-5}$</td>
<td>3 hours</td>
</tr>
<tr>
<td>$10^{-8}$</td>
<td>1 year</td>
</tr>
<tr>
<td>$10^{-12}$</td>
<td>3000 years</td>
</tr>
</tbody>
</table>

Reasons for Leak Testing

- **(Economic)** To prevent material loss that interferes with system operation.

- **(Safety)** Prevent fire, explosion, and environmental contamination.

- **(Reliability)** Detect unreliable components, and those with leakage rates that exceed standards.
LT is an important process to measure the reliability of the system under test. LT can show a fundamental fault of the system. High leakage rates in specific areas may determine:

- Gasket improperly aligned
- Valve connections misaligned or improperly threaded
LT is not a direct measurement of continuing system reliability, only a measurement of the reliability at the time of testing.

Primary use of LT for railroad tank car industry is to detect installation errors.
LT sensitivity depends heavily on the skill level and alertness of the LT operator.

LT operators must be trained in the fundamentals of LT to ensure they are performing a LT correctly each time.

Common errors:
- Operators do not look at test joint for an acceptable period of time
- not identify all possible leak paths
Training plans for LT operator personnel should include:

- Disadvantages and advantages of LT methods
- Identify hazards with LT
- Enhancing testing environments
- Techniques for improving inspection skills
- Factors affecting LT measurement accuracy
- Proper ways to carry out and conduct LT methods
Leak Testing technique must be of proper sensitivity for scope of test, and also be economical value for the technique to be desirable for application.

Bubble Leak testing accomplishes both of these criteria, and represents most of the LT performed in the RR Tank Car Tank industry.
Three techniques classified by the how the liquid used for detection is applied:

- Liquid Immersion
- Liquid Film
- Foam application

Simple to use, rapid application, and inexpensive
Sensitivity is acceptable for use with tank car tanks
Enables the observer to locate the exit point of leaks very accurately (compared to Pressure Change Test)
Very large leaks and small leaks can be detected, offers a wide range of detection unlike some other techniques.
BLT Advantages

- BLT allows observer to distinguish real leaks from “virtual” leaks.

- “Virtual” Leaks are those in which trapped gases are escaped during a test and are observed.

- Safe to apply BLT with proper inert gases, and testing liquids, in combustible areas.

When performing BLT, or any LT technique beyond its limitations, it renders the test inaccurate and the results dangerously false.
Certain conditions interfere with BLT, and must be corrected prior to testing.

- Contamination of test specimen
- Improper test temperatures
- Contaminated Leak Test solutions
- Prior contaminates that clog leaks or leak paths
- Air dissolved in test liquids, or out gassing from connections. “Virtual Leaks”
Importance of cleaning test surface

Cleaning a tank car connection prior to performing a LT should include as a guideline:

- Remove by safe means any signs of rust, grease, oxide films, or other visible surface contaminants.
Non-technical applications of LT can cause ordinary soap and water combination to be used.

While economical, these testing solutions diminish the sensitivity of the test, possibly causing them to be lower than $10^1 \text{ std cm}^3$ per second.

Example: Dishwashing soap and water
Limitations of Common Soap for BLT

- Soaps form sticky, gummy deposits that can clog leaks. “Bath tub ring”
- Soaps are alkaline; pH values of 10.5 to 11.5. Can cause severe corrosion to Aluminum Alloys.
- Soaps contain chlorides and borates. These can cause stress corrosion cracking on stainless steels or titanium alloys. Many valves are SS or 22Ti.

Commercial BLT solutions are favorable over “soap and water” when compared:

- Have pH between 6-8
- Do not form deposits when mixed with “hard water”
- Viscosity allows low surface tension, allows BLT solution to spread over surface
- Stabilized solutions are resistant to bacteria and maintain sensitivity over long periods of time
- Allow BLT solution to dry to a clean state
- Temperature range -30°F to over 150°F

Commercial vs “Homemade”
BLT Solutions
Commercial vs “Homemade”
BLT Solutions
Commercial vs “Homemade”

BLT Solutions

SHERLOCK

GAS and AIR LEAK DETECTOR

LOW-TEMP BELOW AND ABOVE FREEZING

Apply to test surface and watch for bubbles. Large leaks form large bubbles instantly. Small leaks form white foam in 5 to 10 seconds. Dries clean. Non-Corrosive.

Caution: Contains Ethylene Glycol and Isopropanol Alcohol which are hazardous if taken internally. Keep out of the reach of children. Use of safety glasses is recommended.

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BIG BLU

MICRO LEAK DETECTOR SOLUTION

This Out of Reach of Children
First and foremost, safety is key in working with loaded tank cars or any pressurized vessel.

Along with tank car shipping location safety standards, LT safety briefings should include these topics:

- Working with pressurized vessels
- Hazards with going on top of, or below tank car.
Clean areas of interest to BLT. Remove dirt, slag, rust, or any foreign debris.

Consideration of the cleaning chemical must be taken in consideration for compatibility with BLT solution.
Create pressure differential. Creating a high pressure side, and lower pressure side will start leakage to flow.

General guidelines state that a minimum of 15 psig (210 kpa) be used as a starting pressure.

Temperature should be checked prior to applying the BLT solution.

Use IR or contact thermometers. Must be between temp limits of BLT solution.
Apply BLT solution.

- Flow solution over test area, not creating bubbles in the process
- Do not brush or spray unless LT solution is designed for such application!
- Gently flowing solution over area will allow complete coverage. Care should be taken to observe the solution as it is applied.
Process Steps for BLT

- Allow BLT solution to Dwell on the test area for a specific amount of time.
  - Usual Dwell times are 5min - 10min

- After Dwell time has elapsed, inspect area for bubble formation
Inspection should be done in an adequate environment to get the best results for the test.

Improve the environment to increase the sensitivity of the test:

- Increase lighting
- Better position to keep view angle at 0°-15°
- If possible, improve temperature, wind, humidity
- Use BLT solutions that have higher visibility
Test joint must show no bubble formation to be considered to pass the leak test

BLT will show bubbles collapsing and reforming to indicate a leak
LT Procedure

- LT procedure should be written by an ASNT Level III
- Allows for uniform application by all LT operators
- Specifies the minimum requirements for conducting a test
- A procedure should list all aspects of the LT that are essential to be met
- Can provide reasonable certainty that a specific sensitivity is being met
LT Procedures

Procedures should include:
- Cleaning requirements
- LT solution
- Temperature limits
- Test Pressure
- Acceptable leak rates (Acceptance Criteria)
- Reporting of a leak
- Cleaning practice

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