On Board Condition Sensing

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Thank You for the opportunity ♥
Olin’s North American Position

• Largest shipper of chlorine by rail in North America
• #1 merchant marketer of chlorine
• #1 industrial bleach producer in North America
• #1 producer of on-purpose Hydrochloric Acid
• Widest geographic coverage of any N.A. producer
Olin Chlor Alkali Facilities

<table>
<thead>
<tr>
<th>Plant Location</th>
<th>Chlorine</th>
<th>Caustic</th>
<th>KOH</th>
<th>HCL</th>
<th>Bleach</th>
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Olin’s Responsible Care
Member of Chlorine Institute and American Chemistry Counsel®

• Extends to all aspects of environmental, health, safety and security including Transportation
• Cares about every distribution incident even non-custodial events
• Continuous Improvement required
• Safe transport is a shared responsibility
• Unsafe transport results in higher costs
Multi-K Sensor Equipped GPS Devices

Olin uses 2 GPS Vendors
Location and shape for each

Lat-Lon GPS

Only 1 GPS device per car
No external wires

IONIX GPS

Chlorine Tank-Car
Functional System Diagram

- **Satellite**
- **Cellular**
- **Raw Data Collection Server**
- **Olin Database**
- **Rail CLMs**
- **SAP**
- **RFID AEI Reader**
- **Olin Asset Locator Software**

**Data Sources:**
- **National Weather**
- **NGS - Seismic Data**
- **NOAA - Hurricanes**

**Equipment:**
- **GPS**
- **Condition Sensors**
- **Olin Railcars**
- **NOAA - Hurricanes**
- **RFID AEI Reader**
What can we measure?

SECURITY (Tampering)
• Motion detection image capture
• In-transit valve dome access

RIDE QUALITY
• Impact Accelerations in G’s
• MPH Coupling and Decelerations speed
• Image Capture for high impact events
Olin’s Intent

• Share a RR’s Data with THAT RR

• **Not** share a RRs ride quality data with any other RR!!!

• Hope/belief RR will use data improve ride quality

**As a Rule:**

• Olin will **not** report individual event to RR. This avoids RR costs associated with resolving individual events.

• Share Quarterly about systematic problems
Security Events Reported

17 HCL tank-car tampering since October-09
- Working with TSA, FBI, Rail Police, State police

- Tamper indicator bags
- Inspection Photos post-load
- Motion Detection GPS Cameras
Motion Image Capture

FALSE ALARMS

- Wildlife
- Drastic light changes
  - Locomotive
  - Yard Lights
  - Fast moving clouds

But It works...

- False Alarms can be reduced
- Takes about 2 minutes to review images each day (about 120 images)
2011 No HCL Tampering
Ride Quality

• Multi-thousand Accelerometer GPS units
  – 3 Axis measurements (X,Y,Z)

  ➢ MPH Velocity Change **Accelerometer based**
  ➢ MPH Speed Deceleration **GPS Based**
Delta V can be equal but different characteristics

High Acceleration – Low Displacement – Undampened
Low Acceleration – High Displacement - Dampened

2 Categories:

• **Shock** (Acuteness – Undampened - Fast)
  Localized Damage to equipment. Energy dissipates quickly. Higher frequency energy needs higher sampling rate. Filter chosen to avoid equipment resonance (vibrations, natural System)

• **Longitudinal Displacement** (Dampened or Slow)
  Little damage but possible NAR if resonance of system enhances amplitude. Difficult to predict. Empty/Full – Outage - Material
Shock is characterized by **High G short duration event**. 100Hz data
- 100 Hz value >>> 10 Hz value -> high shock little dampening
- 10 Hz value ~ 100 Hz value -> long duration (dampened non-shock event)
- High Delta-V with low 10 Hz value -> high shock w little dampening
- High Delta-V with high 10 Hz value -> less shock w more dampening
- **Big Difference between 100 Hz Value - 10 Hz Value indicates Shock Pulse**
Abnormal Events

- Short duration high impact events < 50 ms
- Over-Speed events (7 mph) GPS based
- Undamped or vertical or side events
- **Olin marks these for inspection**

**Basis:**

- 13 out of 15 damaged cars had Shock Pulse characteristics
- 2 out of 15 damaged cars side impacts
Coupling (Niagara - Plant)

Trackmobile delivered – loaded released at 5 mph into 6 cars on cushioned anchor

10 Hz = 100 Hz -> Semi-dampened (Non-shock) ~ Expected Hump Yard condition
Derailed Skin Damage

Delta-V: 5.6 mph
100 Hz g’s: 2.7 g Longitudinal
10 Hz g’s: 1.7 g Longitudinal
Diff 100-10: 1 g Longitudinal

9.5 mph
9.0 g Lateral
4.5 g Lateral
5.5 g Lateral
Longitudinal Impact 6.4 G 6.6 mph

Dislodged Spring
3 G Lateral Impact
Average Impact 3.2 G (2011)

% Chance of Impact = \#Impacts / \#Trips
System Impact profile Top 10 Yards (2011)

Shows Normal Distribution (3.2G Avg)
GPS Based Decelerations MPH

- Speed checked in motion over 3 mph (GPS)
- Deceleration is reported as Speed-Drop
- Original Speed = Final Speed + Speed Drop
- Excellent Correlation between Delta-V from accelerometer alarms and Speed Drop from GPS data
Average Speed Drop 4.7 MPH for 10,058 events >= 4mph (2 sec.)

Yard 3 – 12% chance a car will experience a 4+ mph deceleration
Selecting Yard yields details

This track appears to have Higher Speed couplings then do the others!!!
Olin Monitors:

• Impacts and characterizes the potential for damaged equipment – Flags equipment for inspection
• Deceleration and Coupling Speeds
• Images while in transit based upon Impact alerts, Opening dome, motion detection for tampering
Olin ORC Focus

• Work with carrier partners to help improve ride quality (Share Data)
• Continue to explore techniques to help reduce and mitigate tampering
• Ensure that **ZERO** Olin rail equipment leaves Olin with any defects
• Strengthen relationships with industry partners and carriers to improve everyone’s safety and security

Thank You ♥