In past years, 15-20 tank fires per year was the norm globally.

3 tank fires in less than 2 weeks in the Gulf Coast region.
Houston, TX

April 24, 2013

Houston, TX | Southwest Mineral Oil Terminal
Mineral Oil
April 27, 2013

Harris County, TX  |  Ft. Worth Natural Gas Crude Oil
May 2, 2013
Denham Springs, LA | Denbury Resources, Inc
Crude Oil
Fact
In 41 years LEC and our associates have not seen this many tank fires cause by lightning in such a short period of time in the Gulf Coast

Conclusion:
Oil & Gas needs to take proactive measures to be taken to prepare
Electrostatic Shadow

Electrostatic Field 5 to 30 kV/m
Electrostatic Field

ELECTROSTATIC FIELD
5 to 30 kV/m

ELECTROSTATIC SHADOW
$10^8 \text{ V } \pm \text{10\%}$
Storm Generated Upward Streamers
Earth Current Transients

Nearby Strike

Buried Data & Phone Lines
Atmospheric Transients

Field Strength: 5 to 30 kV/m

Nearby Strike
Atmospheric Transients

Overhead Power & Comm Lines
Atmospheric Transients

Overhead Power & Communication Lines
Ground Potential Rise

A 5 ohm ground develops 150 kV during a 50 percentile strike
Stroke Channel EMP

\[ \frac{di}{dt} = \frac{100 \text{ kA}}{\mu \text{s}} \]

- EMP Field
- Computer Systems
- Power Distribution
- Data & Comm
Summary of Secondary Effects

- Earth Current Transients
- Atmospheric Transients
- Electromagnetic Pulse
- Ground Potential Rise
Industry Standards

- Over 250 years with no significant changes
- Based on “historical precedent”
- Intended to **collect strikes!**
Petroleum Tank Fire - Engulfed
Petroleum Tank Fire - Aftermath
1. Direct Strike
2. Atmospheric Transients
3. EMP
4. Earth Transients
5. GPR

Strike Collectors: Increase Risk!
Direct Strike Protection
THE DISSIPATION ARRAY™ SYSTEM (DAS™)
DAS™: PROVEN PERFORMANCE

- In use since 1971
- > 99.87% success rate
- Over 37,000 system years
- Exclusive No-Strike warranty
Foundational Definitions

- Lightning is a discharge
- Discharge transfers charge (Ampere-Seconds)
- DAS is a Charge Transfer System (CTS)
  - CTS: Generic name
  - DAS: LEC’s patented Dissipation Array System
The DAS Objective

- Use points to transfer charge slowly and continuously
- Use the storm’s electric field as the motivating force (Passive system)
Maximum ionization is achieved by optimizing design parameters:

- Point Spacing
- Point Length
- Number and geometry of points
Point Discharge Current in a Strong Electric Field
Captured by Exxon Mobil security camera
Mobile Bay, Alabama
Isolating the Site

Grounding System

Ionizer

Protected Area

www.LightningProtection.com
Isolating the Site

www.LightningProtection.com
Test Site Data - 2007

Proving Reduction of the Atmospheric Electric Field
Test Site EFM Comparison
(07-25-2007)

Atmospheric Electric Field (kV/m)

Field EFM, Blue

Roof EFM, Orange

Time

16:00 16:30 17:00 17:30 18:00 18:30 19:00 19:30 20:00
Test Site EFM Comparison

(08-17-2007)

Field EFM, Blue

Roof EFM, Orange

Atmospheric Electric Field (kV/m)

Time

12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00 0:00
Test Site Data

Location: Browns Ferry, Alabama

Location Type: Nuclear Power Plant

Methodology: U.S. National Lightning Detection Network Database (NLDN) & CTS current monitor

Differentiator(s): Charge Transfer technology
  - Dissipation Array System (DAS®)
    - Stack Array > Off-gas stack
    - Spline Ball Terminal (SBT®) > surrounding area
Test Overview/TVA Internal Review

Time Line: 6 year Study 1995-2001
- 3 years before installation of DAS
- 3 years after installation of DAS

Testing Radii:
- 500 meters
- 3 miles
- 6 miles
- 10 Miles

Area of Protection:
- Off-gas Stack (600 Ft. tall/6 ft. Diameter on top)
- Area around base of Off-gas Stack
Historical strike analysis (Mark Bowman)
Top row is 3 years prior, bottom row is 3 years post installation of DAS

80% reduced within 500m when normalized to strikes in 10 mile circle.
## 6 Year Review Analysis

<table>
<thead>
<tr>
<th>Distance From Array</th>
<th>Strikes 3 Years Before Installation</th>
<th>Strikes 3 Years After Installation</th>
<th>Change in Strike Number</th>
<th>Expected Strikes</th>
<th>Actual Normalized</th>
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<tr>
<td>5 00 meters</td>
<td>40</td>
<td>13</td>
<td>0.325</td>
<td>65.54728</td>
<td>0.19833013</td>
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<td>4327</td>
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<td>55199</td>
<td>1.638681906</td>
<td>55199</td>
<td>1</td>
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</tbody>
</table>
FedEx Super Hub, Memphis, TN, USA

Total Facility = 3 Sq. Km with over 1 billion Sq. Ft. of buildings and space protected
Oil Storage Facility
Floating Roof Tanks

Lagoven - Venezuela
Alltel Corporate Campus, Tampa, Florida

Alltel’s Corporate Campus
Space Vehicle Tracking Station
Prevents Ignition Of H₂ Gas

PPG Chemical

USA
Off-Shore Platform

Papua, New Guinea
The End

DISCUSSION & QUESTIONS

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