Overview

- Statement of the problem
- Technology
- Benefits
- Field results
- Discussion
Conventional Inspection Methods

- Hand-held or truck mounted "sniffers":
  - Allow maximum coverage of only 8-10 miles a day
  - Scan the swath of one bumper width at best
  - Are ineffective over rough terrain and unwelcome over private land

- Aerial patrols only look for secondary signs of leaks and right-of-way encroachments
What is ALPIS

ALPIS (Airborne Lidar Pipeline Inspection Service) is a revolutionary new way to find leaks in natural gas transmission and gathering lines.
ALPIS Evolution
How ALPIS Works
How Technology Works
How It Looks

Sensor unit

Helicopter mounting bracket

Cooler

Package weight: 250 lbs.
ALPIS at Work
ALPIS Benefits to Customers

- Over ten times faster than ground surveys
- Highest sensitivity in remote gas detection
- Easy access to rough terrain
- Non-disruptive to private landowners
- GPS accuracy of results
- Full coverage of the right-of-way
- Digital photography of the entire survey route
- Full reports delivered within 24 hours of inspection
- 1-hour emergency response available
- Multimedia and Internet based reporting and archiving
Survey Results

- **Printed reports**
  - Conventional, easy to use format
  - Convenient for field follow ups
  - Available within an hour after survey

- **Interactive DVDs**
  - Combine maps and high-resolution digital imaging in one easy to use software package
  - Allow to replay the entire inspection for visual verification

- **Secure online GIS - database**
  - Aids in maintenance and repair planning
  - Improves long-distance collaboration
  - Enhances field feedback
Printed Report

Inspection overview

Inspection results in a tabular format

Inspection results overlaid on a map
Complete Results on DVD

Map of the inspected area

Digital imaging

Detailed inspection information
Secure On-line Database

![Secure On-line Database]

**Disclaimer:** All information featured herein is for demonstration purposes only. Measuring coordinates and leak locations used in this sample database are fictitious and do not correspond to any real pipelines.

<table>
<thead>
<tr>
<th>Marker</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Size</th>
<th>Visual</th>
<th>Wind</th>
<th>Confirmed</th>
<th>Source</th>
<th>Distance to Site</th>
<th>Concentr.</th>
<th>Leaktage</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-4231</td>
<td>32.027855</td>
<td>-167.46449</td>
<td>Small</td>
<td>Meter House</td>
<td>Yes</td>
<td>Meter</td>
<td>7 m NW</td>
<td>40 ppm-v</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>A-300005</td>
<td>32.240155</td>
<td>-167.20682</td>
<td>Large</td>
<td>Meter House</td>
<td>Yes</td>
<td>Meter</td>
<td>exact</td>
<td>30000 ppm-v</td>
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<td>E-541729</td>
<td>32.118066</td>
<td>-167.209169</td>
<td>Medium</td>
<td>Yes</td>
<td>Underground</td>
<td>16 m WV</td>
<td>120 ppm-v</td>
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<tr>
<td>E-1403065</td>
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<td>-167.240324</td>
<td>Large</td>
<td>Yes</td>
<td>Underground</td>
<td>exact</td>
<td>300 ppm-v</td>
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<tr>
<td>D-0479</td>
<td>32.209434</td>
<td>-167.206439</td>
<td>Small</td>
<td>S at 0 mph</td>
<td>Yes</td>
<td>Underground</td>
<td>exact</td>
<td>40 ppm-v</td>
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<td>Medium</td>
<td>S at 8 mph</td>
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<td>16 m E</td>
<td>150 ppm-v</td>
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<td>D-1151156</td>
<td>32.134504</td>
<td>-167.415225</td>
<td>Medium</td>
<td>S at 0 mph</td>
<td>Yes</td>
<td>Underground</td>
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<td>170 ppm-v</td>
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<td>D-222392</td>
<td>32.214322</td>
<td>-167.205167</td>
<td>Small</td>
<td>S at 0 mph</td>
<td>Yes</td>
<td>Underground</td>
<td>exact</td>
<td>90 ppm-v</td>
<td></td>
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<td>D-285238</td>
<td>32.280685</td>
<td>-167.305869</td>
<td>Large</td>
<td>Valve Stem</td>
<td>Yes</td>
<td>Underground</td>
<td>exact</td>
<td>2000 ppm-v</td>
<td></td>
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<tr>
<td>D-2365</td>
<td>32.151012</td>
<td>-167.305438</td>
<td>Small</td>
<td>Tank Battery</td>
<td>Yes</td>
<td>Tank Hatch</td>
<td>26 m S</td>
<td>20 ppm-v</td>
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<td>D-334239</td>
<td>32.149223</td>
<td>-167.396968</td>
<td>Small</td>
<td>SSE at 19 mph</td>
<td>Yes</td>
<td>Underground</td>
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<td>100 ppm-v</td>
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<td>D-534265</td>
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<td>-167.351860</td>
<td>Medium</td>
<td>SSE at 19 mph</td>
<td>Yes</td>
<td>Underground</td>
<td>exact</td>
<td>140 ppm-v</td>
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<td>D-064032</td>
<td>32.146024</td>
<td>-167.251184</td>
<td>Large</td>
<td>SSE at 19 mph</td>
<td>Yes</td>
<td>Underground</td>
<td>exact</td>
<td>300 ppm-v</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**End**
Survey Results Overlay on Map
Survey Results Overlay on Satellite Imagery
High-resolution Image of Leak Location
Right-of-Way High-Resolution Digital Imagery
Survey - Repair - Survey - ... Cycle

- November 2006 survey: 86 indications
- February 2007 survey: 39 indications
Field Results Summary

- Commercial application started: in 2004
- Total miles inspected in 2006: 4,719
- Total leak indications reported: 1,283 (approx. 1 leak every 3.5 miles)
- Customers served: 7
Effectiveness of Inspection

15 miles of transmission line inspected on April 13, 2006

<table>
<thead>
<tr>
<th>LASEN Marker</th>
<th>Indication size</th>
<th>As-Found Daily Leakage Rate (mcf)</th>
<th>Annual Leakage Rate (mcf) m=1,000</th>
<th>Annual BTU Loss</th>
<th>Annual product loss ($)</th>
<th>Description of leak and repair</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-210994</td>
<td>medium</td>
<td>0.1776</td>
<td>64.82</td>
<td>64,824,000</td>
<td>583.42</td>
<td>Leak found on fuel tap valve operator (booster station). Lubricated stem and operated valve to stop leak.</td>
</tr>
<tr>
<td>A-216681</td>
<td>small</td>
<td>0.4181</td>
<td>152.61</td>
<td>152,606,500</td>
<td>1,373.46</td>
<td>Leak found from plug in top of drip valve. Removed, cleaned, taped and replaced plug to stop leak.</td>
</tr>
<tr>
<td>A-231599</td>
<td>medium</td>
<td>0.1672</td>
<td>61.03</td>
<td>61,028,000</td>
<td>549.25</td>
<td>Leak found from plug in top of drip valve. Removed, cleaned, taped and replaced plug to stop leak.</td>
</tr>
<tr>
<td>A-316434</td>
<td>medium</td>
<td>0.5017</td>
<td>183.12</td>
<td>183,120,500</td>
<td>1,648.08</td>
<td>Leak found within booster station yard (piping). Will have to hand excavate to perform repair(s).</td>
</tr>
<tr>
<td>A-357112</td>
<td>large</td>
<td>1.5840</td>
<td>578.16</td>
<td>578,160,000</td>
<td>5,203.44</td>
<td>Leaking dresser coupling repaired with full encirclement sleeve.</td>
</tr>
<tr>
<td>A-357584</td>
<td>small</td>
<td>1.7280</td>
<td>630.72</td>
<td>630,720,000</td>
<td>5,676.48</td>
<td>Leaking dresser coupling repaired with full encirclement sleeve.</td>
</tr>
<tr>
<td>A-387233</td>
<td>small</td>
<td>0.4181</td>
<td>152.61</td>
<td>152,606,500</td>
<td>1,373.46</td>
<td>Leak was from a thermocouple in meter tube. Will isolate meter tube and replace leaking thermocouple.</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>4.9947</td>
<td><strong>1,823.07</strong></td>
<td><strong>1,823,065,500</strong></td>
<td><strong>16,407.59</strong></td>
<td></td>
</tr>
</tbody>
</table>

* Cost of inspection does not include setup fee

** Calculations are made based on the price of $9 for 100000 BTU
Results of grid-pattern survey of a partially abandoned oil field. Areas marked as A, B, C and D represent identified plumes.
ALPIS Facts

- Developed with the support of the U.S. Air Force and the U.S. Department of Transportation.
- Demonstrated and proven in numerous government and commercially funded tests of various leak detection technologies.
- The only helicopter-based system of its kind commercially used in the U.S. today.
- The service is priced competitively with ground surveys.