Rules of Thumb and Best Practices for Conducting Directed Inspection and Maintenance

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What is the Problem?

- Production, processing and transmission methane gas leaks are *invisible*, *odorless*, and *go unnoticed*.
- Natural Gas STAR companies find that valves, connectors, compressor seals, and open-ended lines (OELs) are major methane fugitive emission sources.
  - Fugitive methane emissions depend on operating practices, equipment age, and maintenance practices.

Where is the leak?
How Do You Implement DI&M?

1. CONDUCT baseline survey
2. SCREEN and MEASURE leaks
3. FIX on the spot leaks
4. ESTIMATE repair cost, fix to a payback criteria
5. DEVELOP a plan for future DI&M
6. RECORD savings
## Summary of Screening and Measurement Techniques

<table>
<thead>
<tr>
<th>Instrument/ Technique</th>
<th>Effectiveness</th>
<th>Approximate Capital Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soap Solution</td>
<td>★★</td>
<td>$</td>
</tr>
<tr>
<td>Electronic Gas Detector</td>
<td>★</td>
<td>$$</td>
</tr>
<tr>
<td>Acoustic Detector/ Ultrasound Detector</td>
<td>★★</td>
<td>$$$</td>
</tr>
<tr>
<td>TVA (Flame Ionization Detector)</td>
<td>★</td>
<td>$$$</td>
</tr>
<tr>
<td>Calibrated Bagging</td>
<td>★</td>
<td>$$</td>
</tr>
<tr>
<td>High Volume Sampler</td>
<td>★★★</td>
<td>$$$</td>
</tr>
<tr>
<td>Rotameter</td>
<td>★★</td>
<td>$$</td>
</tr>
<tr>
<td>Infrared Leak Detection</td>
<td>★★★</td>
<td>$$$</td>
</tr>
</tbody>
</table>

* Least effective at screening/measurement

** Least effective at screening/measurement

*** Most effective at screening/measurement

$ Smallest capital cost

$$ Largest capital cost
Leak Detection Study: Key Methane Emission Sources

- Study of 5 natural gas facilities provides insight into key methane sources\(^1\)
  - Screened for all leaks, measured larger leak rates

- Principles of study are relevant to all sectors
  - A relatively small number of large leaks cause most fugitive emissions
  - Fugitive leaks from **valves, connectors, compressor seals, and open-ended lines** are a large source of revenue loss for all sectors
  - Solution is the same – prioritizing and repairing largest leaks is efficient and cost-effective

\(^1\) Clearstone Engineering, 2006, *Cost-Effective Directed Inspection and Maintenance Control Opportunities at Five Gas Processing Plants and Upstream Gathering Compressor Stations and Well Sites.*
### Study Findings: Quantity of Methane Emitted

#### Summary of Natural Gas Losses from the Top Ten Leak Sources

<table>
<thead>
<tr>
<th>Facility</th>
<th>Total Number of Components</th>
<th>Gas Losses From Top 10 Leak Sources (m³/day)</th>
<th>Gas Losses From All Leak Sources (m³/day)</th>
<th>Contribution By Top 10 Leak Sources (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>22,290</td>
<td>2,200</td>
<td>7,700</td>
<td>29</td>
</tr>
<tr>
<td>2</td>
<td>12,330</td>
<td>370</td>
<td>650</td>
<td>56</td>
</tr>
<tr>
<td>3</td>
<td>18,353</td>
<td>1,500</td>
<td>3,300</td>
<td>45</td>
</tr>
<tr>
<td>4</td>
<td>16,687</td>
<td>1,700</td>
<td>1,950</td>
<td>87</td>
</tr>
<tr>
<td>5</td>
<td>4,478</td>
<td>9,000</td>
<td>12,000</td>
<td>75</td>
</tr>
<tr>
<td>Combined 2</td>
<td>74,438</td>
<td>14,770</td>
<td>25,600</td>
<td>58</td>
</tr>
</tbody>
</table>

Source: Clearstone Engineering, 2006

1 – Excluding leakage into flare system
2 – Combined data includes top 10 leak sources from each plant (50 total)
Estimating Comprehensive Survey Cost

- Cost of complete screening survey (processing plant)
  - Ranges $15,000 to $20,000 per medium size plant
  - Rule of Thumb: $1 per component for an average processing plant
  - Cost per component for remote production sites would be higher than $1
  - Using Infrared camera and high volume sampler as primary tools for survey

- 25 to 40% cost reduction for follow-up survey
  - Focus on higher probability leak sources (e.g. compressors)

- Numerous companies have indicated that surveys conducted with purchased equipment or service providers payback immediately from gas savings
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