Facility Optimization
And
Directed Inspection & Maintenance Programs

An EPA Best Management Practice

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Agenda

1. Industry Research Findings
2. DI & M Programs
3. 7 Step Process
4. Partner / Client Experiences
5. Reporting Objectives
6. Rallying Company Support (Your Battle Cry)
Industry Research on Leakage From Compressor Stations

Extensive research conducted by Indaco and sponsored by AGA’s Pipeline Research Committee *International (PRCI)*, the Gas Research Institute (GRI) and the U.S. Environmental Protection Agency (EPA) Gas STAR Program

Program Goals: Refine component emission factors for compressor stations to determine most effective ways to detect and quantify leaks, and to evaluate cost effective options for leak mitigation.
What is the Problem?

Gas leaks are invisible, unregulated and go unnoticed.

STAR Partners find that valves, connectors, compressor seals and open-ended lines (OELs) are major sources.

- 27 Bcf methane emitted per year by reciprocating compressor seals and OELs.
- Open ended lines contribute half these emissions.

Facility fugitive methane emissions depend on operating practices, equipment age and maintenance.
Industry Research on Leakage From Compressor Stations

- Indicates gas losses at compressor stations average 35,000 Mcf/station/year
- Equivalent to a loss of $140,000/year at $4/Mcf.
- Cost of Service + Repairs = $30,000
- Payback Period = 2.5 months
- Profits Increase with Time
Approach to Reducing Leakage

Institute a measurement program that accurately measures all leaks.

Station personnel then have the information necessary to weigh the cost of the leak repair versus the value of the lost gas for each leak.
How Can These Losses Be Reduced?

Implementing a Directed Inspection and Maintenance (DI&M) Program

Reducing Emissions, Increasing Efficiency, Maximizing Profits
What is a DI&M Program?

- Voluntary program to identify and fix leaks that are cost-effective to repair
- Survey cost will pay out in the first year
- Provides valuable data on leakers
How Do You Implement a DI&M Program?

1. **CONDUCT** baseline survey
2. **SCREEN** and **MEASURE** leaks
3. **FIX** on the spot leaks
4. Estimate repair cost, **FIX** to Payback criteria
5. **PLAN** for future DI&M
6. Record savings/REPORT to Gas STAR
Step 1
Familiarize & Strategize

- Walk Through Facility and Determine Plan Of Attack
- Focus your attention on all Vented Components (I.e., Packing Vents, Distance Piece “dog-house” Vents, Blowdown Vents, Pressure Relief Vents, Starter Gas Vents, ESD Vents & even Crankcase vents).
- Determine safe approach to access vents with the use of ladders, man-lifts and OSHA Certified Fall Protection.
Step 2
Screening & Tagging

Recommend the use of a reliable pump-driven combustible gas indicator that can see down to 50 PPM.

For Vented Components, recommend measuring as you go.

For Standardized Components, recommend screening and tagging.
### Partial List of Potential Leak Sources

<table>
<thead>
<tr>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressor Unit</td>
</tr>
<tr>
<td>Valves</td>
</tr>
<tr>
<td>Relief Valves</td>
</tr>
<tr>
<td>Unit Blowdowns</td>
</tr>
<tr>
<td>Compressor Packing</td>
</tr>
<tr>
<td>Meter Tubes</td>
</tr>
<tr>
<td>Valve Stems</td>
</tr>
<tr>
<td>Fuel Valves</td>
</tr>
<tr>
<td>Various Piping &amp; Vessel Flanges</td>
</tr>
<tr>
<td>Online Gas Analyzers</td>
</tr>
<tr>
<td>Centrif. Comp. Seals</td>
</tr>
<tr>
<td>Pipeline Damage</td>
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</tbody>
</table>
Top 4 Typical Fugitive Sources

- Reciprocating Compressor Packing
- Blow Down Valves
- Unit Valves
- Condensate Tank

“Find The Needle In The Haystack”
Leak Survey Methods

Leak Detection

- Soap solution
- Flame Ionization
- Catalytic oxidation/thermal conductivity
- Ultrasonic
- Visual

Tag and number leaks on standard components
Step 3
Measuring Leakage or Emissions

Leak Measurement
- Hi Flow Samplers
- Vent-Bag™
- Hot Wire Anemometer
Measurement Methods

- For leaks up to 10 cfm – Hi Flow Sampler
  10 cfm @ $5/Mcf = $26,280

- For leaks 10 – 240 cfm – Vent-Bag Method
  50 cfm @ $5/Mcf = $131,400
  100 cfm @ $5/Mcf = $262,800

- For leaks >180 cfm - Anamometer
Hi-Flow Sampler Applications

- Originally developed as a research tool for determining emissions
- Now used to help reduce the greater than $200 million of gas lost yearly from natural gas facilities
- Allows repair decisions to be made based on the cost of the gas lost from each leak
Hi Flow Sampler Applications

Advantages:
- Total Leak Capture
- Measures Leak Rate Directly
- Can Measure 30 components per hour
- Repair Decision Based on Leak Rate & Repair Costs
Hi Flow Sampler Technology

- Captures Entire Leak
- Measures Flow Rate (F) and Concentration (sample)
- Subtracts the background (back) Concentration
- Leak Rate = F x (sample – back)
Condensate Tank Leakage Identified Loses/Savings

Estimated Annual Loss
$54,061/yr
Or
13,515 Mcf/yr
Step 4
Fix On The Spot Leaks
DI&M – Partner Experience

**Example 1:** Leaking cylinder head was tightened, which reduced the methane emissions from almost 64,000 Mcf/yr to 3,300 Mcf/yr
- Repair required 9 man-hours of labor
- Gas savings were approximately 60,700 Mcf/yr
- Value of gas saved was $182,100/year at $3/Mcf

**Example 2:** One-inch pressure relief valve emitted almost 36,774 Mcf/yr
- Required five man-hours of labor and $125 of materials
- Value of the gas saved was $110,300 at $3/Mcf
DI&M – Partner Experience

**Example 3:** Blowdown valve leaked almost 14,500 Mcf/yr
- Rather than replace the expensive valve, Partner spent just $720 on labor and materials to reduce the emissions to approximately 100 Mcf/yr
- Value of gas saved was $43,200 at $3/Mcf

**Example 4:** Tube fitting leaked 4,121 Mcf/yr
- Very quick repair requiring only five minutes reduced leak rate to 10 Mcf/yr
- Value of the gas saved was $12,300 at $3/Mcf
Largest leaks measured across rod packings of running compressors.

Total leak rate at site was 18,200 scfh. Unit 3 had largest leak at 11,800 scfh, accounting for 64.6% of the total leak rate from packings.

Operated 5 months of the year, leak rate is equivalent to $179,600/year @ $2.7/Mcf (Enough gas to heat 374 homes with an average monthly gas bill of $40).

This figure works out to be $327,600 at $5/Mcf.
## Appendix I: Leak Rates at Company Compressor Station, Louisiana

<table>
<thead>
<tr>
<th>Leak Tag Number</th>
<th>Engine ID, Model, Compressor #</th>
<th>Status</th>
<th>Check At</th>
<th>Source of Leak/Component</th>
<th>Leak Rate (scfm)</th>
<th>Activity factor</th>
<th>Yearly Leak Rate (Mcf/yr)</th>
<th>Cost ($/Yr) @ $3/Mcf</th>
<th>Comments on Replacement/Repair</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eng. 3, BA6, Total</td>
<td>Running</td>
<td>Rod Packing Vent</td>
<td>Rod Packing</td>
<td>53.25</td>
<td>0.80</td>
<td>22392.4</td>
<td>$67,177</td>
<td>All Packing changed in the last 10 years. Distance Piece Vent combined with Rod packing vent. Unit Valves on schedule for replacement. Two engines each year according to supervisor.</td>
<td></td>
</tr>
<tr>
<td>Eng. 7, BA6, Total</td>
<td>Running</td>
<td>Rod Packing Vent</td>
<td>Rod Packing</td>
<td>39.30</td>
<td>0.76</td>
<td>15899.1</td>
<td>$47,097</td>
<td>All Packing changed in the last 10 years. Distance Piece combined with Rod Packing Vent. Unit Valves on Engines 7-10 were replaced after 2000.</td>
<td></td>
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<tr>
<td>Eng. 7, BA6, Total</td>
<td>Idle and Pressurized</td>
<td>Rod Packing Vent</td>
<td>Rod Packing</td>
<td>43.27</td>
<td>0.24</td>
<td>5458.2</td>
<td>$16,374</td>
<td>All Packing changed in the last 10 years. Distance Piece combined with Rod Packing Vent. Unit Valves on Engines 7-10 were replaced after 2000.</td>
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<tr>
<td>Eng. 3, BA6, Total</td>
<td>Idle and Pressurized</td>
<td>Rod Packing Vent</td>
<td>Rod Packing</td>
<td>32.37</td>
<td>0.20</td>
<td>3403.2</td>
<td>$10,209</td>
<td>All Packing changed in the last 10 years. Distance Piece combined with Rod packing vent. Unit Valves on schedule for replacement. Two engines each year according to supervisor.</td>
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<tr>
<td>Eng. 10, HBA5, Total</td>
<td>Running</td>
<td>Rod Packing Vent</td>
<td>Rod Packing</td>
<td>7.60</td>
<td>0.80</td>
<td>3194.5</td>
<td>$9,584</td>
<td>All Packing changed in the last 10 years. Distance Piece combined with Rod Packing Vent. Unit Valves on Engines 7-10 were replaced after 2000.</td>
<td></td>
</tr>
<tr>
<td>Station Blow Down Valve 1-6</td>
<td>Pressurized</td>
<td>Blow Down Vent outside gate</td>
<td>Valve, Blow Down</td>
<td>5.75</td>
<td>1.00</td>
<td>3021.8</td>
<td>$9,066</td>
<td>Blow Down Valves for units 1-6 are all originals. They were installed in 1950. Common Blow Down Vent is located on the far West side.</td>
<td></td>
</tr>
<tr>
<td>Outside, Unit Valve Area</td>
<td>Pressurized</td>
<td>Discharge Unit Valve, #C</td>
<td>Valve, Stem</td>
<td>4.88</td>
<td>1.00</td>
<td>2566.5</td>
<td>$7,700</td>
<td># C Unit Valve on Discharge line in back of Eng 8</td>
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<tr>
<td>Eng. 4, BA6, Total</td>
<td>Running</td>
<td>Rod Packing Vent</td>
<td>Rod Packing</td>
<td>6.42</td>
<td>0.89</td>
<td>2327.1</td>
<td>$6,981</td>
<td>All Packing changed in the last 10 years. Distance Piece Vent combined with Rod packing vent. Unit Valves on schedule for replacement. Two engines each year according to supervisor.</td>
<td></td>
</tr>
</tbody>
</table>
Step 6
Perform Maintenance and or Repair and Conduct Post Measurement

- Determine true savings achieved
- Determine accurate emission reductions achieved for EPA Gas Star report
Typical Company Profile of Methane Emissions on a Station to Station Survey

Assumes a cost of $3/Mcf
Primary Objectives of a Leak Rate Measurement Survey

- Identify & Measure all leaks
- Rank Order Leaks ($$/Mcf)
- Prioritize Maintenance & Repair
- Target Largest Leaks at Each Station and Repair As Soon As Possible
- Improve Profit Margins
- Provide Baseline Emission Factors Per Station
Secondary Objectives of Leak Rate Measurement Program

- Identify Unsafe Conditions and Lower the Risk of Accidents
- Audit of Facility/Reality Check
- Provide Hard Data On Emission Reductions to EPA Gas STAR Program
- Demonstrate Environmental Awareness to Public and Shareholders
- Data to Support Future Credits
Questions?