DI&M: Agenda

- Methane Losses
- Methane Recovery
- Is Recovery Profitable?
- Industry Experience
- Discussion Questions
Natural Gas Industry Emissions

- Production sector responsible for largest portion of emissions

**Emissions**
- Transmission & Storage: 101 Bcf
- Production: 148 Bcf
- Processing: 36 Bcf
- Distribution: 68 Bcf
- Oil Downstream: 2 Bcf
- Transmission & Storage: 1 Bcf
- Oil Downstream: 2 Bcf

**Reductions**
- Oil Downstream: 7 Bcf
- Production: 24 Bcf
- Processing: 18 Bcf
- Distribution: 68 Bcf


Reducing Emissions, Increasing Efficiency, Maximizing Profits
The production sector has several large methane emission sources that can be targeted for reductions:

- Storage Tank Venting: 9 Bcf
- Meters and Pipeline Leaks: 10 Bcf
- Gas Engine Exhaust: 12 Bcf
- Dehydrators and Pumps: 17 Bcf
- Well Venting and Flaring: 18 Bcf
- Pneumatic Devices: 61 Bcf
- Other Sources: 21 Bcf


Reducing Emissions, Increasing Efficiency, Maximizing Profits
Methane Losses by Equipment Type

- Valves: 26.0%
- Connectors: 24.4%
- Crankcase Vents: 4.2%
- Compressor Seals: 23.4%
- Open-Ended Lines: 11.1%
- Control Valves: 4.0%
- Pressure Relief Valves: 3.5%
- Orifice Meters: 0.1%
- Other Flow Meters: 0.2%
- Pump Seals: 1.9%
- Pressure Regulators: 0.4%
- Blowdowns: 0.8%

Source: Clearstone Engineering, 2002

Reducing Emissions, Increasing Efficiency, Maximizing Profits
What is the Problem?

★ Gas leaks are **invisible, unregulated** and **go unnoticed**

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

◆ 27 Bcf of methane emitted per year by reciprocating compressors seals and OELs, each contributing equally to the emissions
What are the Sources of Emissions?
# How Much Methane is Emitted?

## Methane Emissions from Leaking Components

<table>
<thead>
<tr>
<th>Component Type</th>
<th>% of Total Methane Emissions</th>
<th>% Leaks</th>
<th>Estimated Average Methane Emissions per Leaking Component (Mcf/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valves (Block &amp; Control)</td>
<td>26.0%</td>
<td>7.4%</td>
<td>66</td>
</tr>
<tr>
<td>Connectors</td>
<td>24.4%</td>
<td>1.2%</td>
<td>80</td>
</tr>
<tr>
<td>Open-Ended Lines</td>
<td>11.1%</td>
<td>8.1%</td>
<td>186</td>
</tr>
<tr>
<td>Pressure Relief Valves</td>
<td>3.5%</td>
<td>2.9%</td>
<td>844</td>
</tr>
</tbody>
</table>

## How Much Methane is Emitted?

### Summary of Natural Gas Losses from the Top Ten Leakers

<table>
<thead>
<tr>
<th>Plant No.</th>
<th>Gas Losses From Top 10 Leakers (Mcfd)</th>
<th>Gas Losses From All Equipment Leakers (Mcfd)</th>
<th>Contribution By Top 10 Leakers (%)</th>
<th>Contribution By Total Leakers (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>43.8</td>
<td>122.5</td>
<td>35.7</td>
<td>1.78</td>
</tr>
<tr>
<td>2</td>
<td>133.4</td>
<td>206.5</td>
<td>64.6</td>
<td>2.32</td>
</tr>
<tr>
<td>3</td>
<td>224.1</td>
<td>352.5</td>
<td>63.6</td>
<td>1.66</td>
</tr>
<tr>
<td>4</td>
<td>76.5</td>
<td>211.3</td>
<td>36.2</td>
<td>1.75</td>
</tr>
<tr>
<td>Combined</td>
<td>477.8</td>
<td>892.84</td>
<td>53.5</td>
<td>1.85</td>
</tr>
</tbody>
</table>

1. Excluding leakage into flare system
Fugitive losses can be dramatically reduced by implementing 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 with information of where to look
What is DI&M?

Direct Inspection and Maintenance
- Cost-effective practice by definition
- Find and fix significant leaks
- Choice of leak detection technologies
- Strictly tailored to company’s needs

DI&M is NOT the regulated volatile organic compound (VOC) leak detection and repair program (LDAR)
How Do You Implement DI&M?

- CONDUCT baseline survey
- SCREEN and MEASURE leaks
- FIX on the spot leaks
- ESTIMATE repair cost, fix to a payback criteria
- DEVELOP a plan for future DI&M
- RECORD savings/REPORT to Gas STAR

Reducing Emissions, Increasing Efficiency, Maximizing Profits
How Do You Implement DI&M?

★ Screening - finding leaks
  - Soap bubble screening
  - Electronic screening (sniffer)
  - Toxic Vapor Analyzer (TVA)
  - Organic Vapor Analyzer (OVA)
  - Ultrasound Leak Detection
  - Acoustic Leak Detection
  - Optical Leak Imaging
How Do You Implement DI&M?

☆ Evaluate the leaks detected - measure results

♦ High Volume Sampler

♦ Toxic Vapor Analyzer (correlation factors)

♦ Rotameters
DI&M by Leak Imaging

- Real-time visual image of gas leaks
  - Quicker identification & repair of leaks
  - Screen hundreds of components an hour
  - Screen inaccessible areas simply by viewing them
## Is Recovery Profitable?

### Repair the Cost Effective Components

<table>
<thead>
<tr>
<th>Component</th>
<th>Value of Lost gas (^1) ($)</th>
<th>Estimated Repair cost ($)</th>
<th>Payback (Months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plug Valve: Valve Body</td>
<td>12,641</td>
<td>200</td>
<td>0.2</td>
</tr>
<tr>
<td>Union: Fuel Gas Line</td>
<td>12,155</td>
<td>100</td>
<td>0.1</td>
</tr>
<tr>
<td>Threaded Connection</td>
<td>10,446</td>
<td>10</td>
<td>0.0</td>
</tr>
<tr>
<td>Distance Piece: Rod Packing</td>
<td>7,649</td>
<td>2,000</td>
<td>3.1</td>
</tr>
<tr>
<td>Open-Ended Line</td>
<td>6,959</td>
<td>60</td>
<td>0.1</td>
</tr>
<tr>
<td>Compressor Seals</td>
<td>5,783</td>
<td>2,000</td>
<td>4.2</td>
</tr>
<tr>
<td>Gate Valve</td>
<td>4,729</td>
<td>60</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Source: Hydrocarbon Processing, May 2002

\(^1\) Based on $3/Mcf gas price
A successful, cost-effective DI&M program requires measurement of the leaks.

A high volume sampler is an effective tool for quantifying leaks and identifying cost-effective repairs.

Open-ended lines, compressor seals, blowdown, engine-starter and pressure relief valves represent <3% of components but >60% of methane emissions.

The business of leak detection is about to change dramatically with new technology.
DI&M - Partner Experience

★ Partner A: 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

★ Partner B: 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