Best Operating Practices for Reducing Emissions
From Natural Gas STAR Partners

EPA’s Natural Gas STAR Program,
Pioneer Natural Resources USA, Inc., and
The Gas Processors Association

June 17, 2003
Why Are Company Reported Opportunities Important?

- Many processing facilities have identified practical cost effective methane emissions practices.
- Processing partners have reported saving 1.6 Bcf since 1990, 100% from PRO’s.
Why Are Company Reported Opportunities Important?

- Partners share successes to reduce methane emissions and improve profitability

  - **BMP’s**: the consensus best practices
  - **PRO’s**: Partner Reported Opportunities
  - **Lessons Learned**: expansion on the most advantageous BMP’s and PRO’s
  - All posted on the Gas STAR website: http://www.epa.gov/gasstar
Gathering & Processing Best Management Practices

- BMP 1: Replace Gas Pneumatics with Instrument Air Systems
- BMP 2: Install Flash Tank Separators on Glycol Dehydrators
- BMP 3: Implement Directed Inspection & Maintenance at Gas Plants and Booster Stations
- BMP 4: Partner Reported Opportunities (PRO’s)
Gas STAR PRO Fact Sheets

- PRO Fact Sheets from Annual Reports 1994-2002
  - 54 posted PRO fact sheets
  - 26 PRO’s applicable to Gathering & Processing
    - 16 focused on operating practices
    - 10 focused on technology
  - Several new PRO sheets under development
Lessons Learned

- 14 Lessons Learned on website
- 8 applicable to processing
  - 3 focused on operating practices
  - 5 focused on technology

- New Lessons Learned under development
  - Composite Wrap
Operating Practice Lessons Learned

- Directed Inspection & Maintenance at Compressor Stations
- Reducing Emissions when Taking Compressors Off-line
- Reduce Glycol Circulation Rates on Dehydrators
One of the Best of the Best!

- BMP 3: Implement Directed Inspection & Maintenance at Gas Plants and Booster Stations

Farmington, New Mexico - Gas Booster Station
Source: http://www.surfaceproduction.com/
What is the Problem?

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

- STAR partners find that valves, connectors, compressor seals and open-ended lines (OEL) are major sources
  - 27 Bcf of methane are emitted per year by reciprocating compressors seals and OELs
  - Open ended lines contribute half these emissions

- Gas plant fugitive methane emissions depend on operating practices, equipment age and maintenance
Natural Gas Losses by Source

- Leaking Components: 53.1%
- Flare Systems: 24.4%
- Non-leaking Components: 0.1%
- NRU Vents: 0.3%
- Storage Tanks: 11.8%
- Combustion Equipment: 9.9%
- Amine Vents: 0.5%

Source: Clearstone Engineering, 2002
Natural Gas Losses by Equipment Type

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

Source: Clearstone Engineering, 2002
### How Much Methane is Emitted?

#### Methane Emissions from Leaking Components at Gas Processing Plants

<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>Compressor Seals</td>
<td>23.4 %</td>
<td>81.1 %</td>
<td>372</td>
</tr>
<tr>
<td>Open-ended Lines</td>
<td>11.1 %</td>
<td>10.0 %</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 Leakers¹.

<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><strong>Combined</strong></td>
<td><strong>477.8</strong></td>
<td><strong>892.84</strong></td>
<td><strong>53.5</strong></td>
<td><strong>1.85</strong></td>
</tr>
</tbody>
</table>

¹Excluding leakage into flare system
How Can These Losses Be Reduced?

- Implement a Directed Inspection and Maintenance (DI&M) Program

Source: CLEARSTONE ENGINEERING LTD
What is a DI&M Program?

- Directed Inspection and Maintenance Program
  - Voluntary program to identify and fix leaks that are cost effective to repair
  - Outside of mandatory LDAR program
  - Survey cost pays 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 a PAYBACK criteria
5. Develop a PLAN for future DI&M
6. Record savings/REPORT to Gas Star
### Screening and Measurement

#### 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 Detectors</td>
<td>★</td>
<td>$$</td>
</tr>
<tr>
<td>Acoustic Detection/ Ultrasound Detection</td>
<td>★ ★</td>
<td>$$$</td>
</tr>
<tr>
<td>TVA (FID)</td>
<td>★</td>
<td>$$$</td>
</tr>
<tr>
<td>Bagging</td>
<td>★</td>
<td>$$$</td>
</tr>
<tr>
<td>High Volume Sampler</td>
<td>★ ★ ★</td>
<td>$$$</td>
</tr>
<tr>
<td>Rotameter</td>
<td>★ ★</td>
<td>$</td>
</tr>
</tbody>
</table>

Source: EPA's Lessons Learned Study
# Cost-Effective Repairs

<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
Partner Experience: Dynegy

- Surveyed 30,208 components in two processing plants
- Identified 1,156 leaking components or 3.8%
- Repaired 80 - 90% of the identified leaking components
- Methane Emissions Reductions = 100,000 Mcf/yr
- Savings = $300,000 /yr (at $3/Mcf)
More Operating Practices

- COMPRESSORS & ENGINES
  - Convert Engine Starting to Air
    - SAVES… 1,356 Mcf/yr
    - PAYOUT… < 1 year
  - Convert Engine Starting to Nitrogen
    - SAVES… 1,350 Mcf/yr
    - PAYOUT… < 1yr
  - Reduce Frequency of Starts with Gas
    - SAVES… 132 Mcf/yr
    - PAYOUT… < 1yr
  - Lower Purge Pressure for Shutdown
    - SAVES… 500 Mcf/yr
    - PAYOUT… 3-10 yrs
What is the Problem?

Compressor starts vent methane

- How much methane is emitted?
  - Up to 135 Mcf per start

- How can these losses be reduced?
  - Alternative operating practices
    - Use air
    - Use nitrogen
  - Alternative technology
    - Use electric starters
    - Convert to electric drive
Partners Experience

Compressor starts vent methane

- Partners report 1,350 Mcf/yr savings per compressor using air or nitrogen assuming ten starts per year
  - Availability and cost of air and nitrogen are issues
  - Capital costs for electric starters reduce payout
  - Coordinating starts and shutdowns with maintenance needs
  - Modification of purge procedures to recover gas prior to venting can gain savings with no cost
More Operating Practices

- **OTHER**
  - Eliminate Unnecessary Equipment or Systems
    - SAVES… 2,000 Mcf/yr
    - PAYOUT… < 1yr

- **PIPELINES/PIPING**
  - Use Inert Gases and Pigs for Purges
    - SAVES… 90 Mcf/yr
    - PAYOUT… > 10 yrs
What is the Problem?

Unnecessary equipment or systems provide sources of methane emissions

- How much methane is emitted?
  - One unnecessary process controller vents 1 cfm or 0.5 MMcf/yr
  - Replacing multiple reciprocating compressor engines with one turbine compressor can save >2 MMcf/yr

- Other benefits
  - Increases efficiency
  - Lowers operating & maintenance costs
Partner Experience

Unnecessary equipment or systems provide sources of methane emissions

- One partner reports savings of 7940 Mcf/yr by eliminating 31 dehydrators with an average of 4 controller loops
  - Payback was < 1 year
More Operating Practices

 VALVES

◆ Inspect & Repair Compressor Station Blowdown Valves
  ▪ SAVES…2,000 Mcf/yr
  ▪ PAYOUT… < 1 yr

◆ Test & Repair RV’s
  ▪ SAVES…170 Mcf/yr
  ▪ PAYOUT… < 1 yr

◆ Test & Repair Gate Station RV’s with Nitrogen
  ▪ SAVES… 8 Mcf/yr
  ▪ PAYOUT… >10 yrs
What is the Problem

Leaking valves are another large source

- How much methane is emitted?
  - As RV components wear or foul leakage occurs
  - Estimate 200Mcf/yr per leaker
- How can these losses be reduced?
  - Leak check & repair on a planned schedule
Partner Experience

Leaking valves are another large source

- One partner reports saving 3,907 Mcf/yr by repairing 7 valves. Payback was immediate.
- Another partner reports saving 853 Mcf/yr by repairing compressor RV’s.
Discussion Questions

- To what extent are you implementing these PRO’s?
- Can you suggest other opportunities?
- How could these opportunities be improved upon or altered for use in your operation(s)?
- What are the barriers (technological, economic, lack of information, regulatory, etc.) that are preventing you from implementing this technology?