Partner Reported Opportunities for Small and Medium Sized Producers

Lessons Learned from Natural Gas STAR

Small and Medium Sized Producer Technology Transfer Workshop

Bill Barrett Corporation, Evergreen Resources Inc, Southern Gas Association and EPA’s Natural Gas STAR Program

June 29, 2004
Producer PROs: Agenda

- Introduction to Partner Reported Opportunities (PROs) and Lessons Learned
- Selected PRO Overviews
- DI&M
- DI&M Industry Experience
- Discussion Questions
Why Are Partner Reported Opportunities Important?

- Partner Annual Reports document Program accomplishments
  - Best Management Practices (BMPs): the consensus best practices
  - PROs: Partner Reported Opportunities
- Simple vehicles for sharing successes and continuing Program’s future
  - Lessons Learned: expansion on the most advantageous BMPs and PROs
  - PRO Fact Sheets
  - Technology Transfer Workshops
  - Posted on www.epa.gov/gasstar
Why Are Partner Reported Opportunities Important?

- Many production facilities have identified practical, cost effective reduction practices
- Production partners report saving 187 Bcf since 1990, 80% from PROs
  - Vapor recover units (VRUs) account for 30% of PRO emissions reductions
  - Plunger lift installations account for 16%
  - Flare installations account for 13%
Production Best Management Practices

- BMP 1: Install and replace high-bleed pneumatics
- BMP 2: Install flash tank separators (FTS) on glycol dehydrators
- BMP 3: Partner Reported Opportunities
Lessons Learned

- 11 applicable to small and medium sized producers
  - 2 focused on operating practices
  - 9 focused on technology

- All 16 Lessons Learned studies on the EPA web site
  - www.epa.gov/gasstar/lessons.htm
Technology Focused Lessons Learned for Small and Medium Producers

- Installing Vapor Recovery Units on Crude Oil Storage Tanks
- Optimize Glycol Circulation and Installation of Flash Tank Separators in Dehydrators
- Options for Reducing Methane Emissions from Pneumatic Devices in the Natural Gas Industry
- Convert Gas Pneumatic Controls to Instrument Air
- Reducing Methane Emissions from Compressor Rod Packing Systems
- Replacing Gas-Assisted Glycol Pumps with Electric Pumps
- Installing Plunger Lift Systems in Gas Wells
- Composite Wrap for Non-Leaking Pipeline Defects
- Replace Glycol Dehydrators with Desiccant Dehydrators
Gas STAR PRO Fact Sheets

- 16 applicable to small and medium sized producers
  - 38 PROs applicable to production
    - 12 focused on operating practices
    - 26 focused on technology
- PRO Fact Sheets from Annual Reports 1994-2002
  - Total 56 posted PROs at epa.gov/gasstar/pro/index.htm
PROs

- Replace Gas Starters with Air
- Replace Ignition – Reduce False Starts
- Install Electric Starters
- Rerouting of Glycol Skimmer Gas
- Convert Gas-Driven Chemical Pumps to Instrument Air
- Pipe Glycol Dehydrator to Vapor Recovery Unit
- Convert Pneumatics to Mechanical Controls
- Install Electronic Flare Ignition Devices
- Use ClockSpring® Repair
More PROs

- Inspect Flowlines Annually
- Install BASO® Valves
- Use Ultrasound to Identify Leaks
- Connect casing to VRU
- Lower Heater-Treater Temperature
- Begin DI&M at Remote Facilities
- Install Compressors to Capture Casinghead Gas
- Install Pumpjacks on Low Water Production Gas Wells
- Replace Glycol Dehydration Units with Methanol Injection
Examples of PROs Applicable to Small/Medium Producers

- PROs enabled by instrument air
  - Replace Gas Starters with Instrument Air
  - Convert Gas-Driven Chemical Pumps to Instrument Air
- PROs enabled by glycol dehydrators
  - Reroute Glycol Skimmer Gas
  - Reroute Glycol Dehydrator to Vapor Recovery
- PROs enabled by electric power
  - Install Electric Starters
  - Install Compressors to Capture Casinghead Gas
Replace Gas Starters with Air

What is the Problem?
- Pressurized gas used to start engines is exhausted to atmosphere

Partner Solution
- Replace gas with compressed air

Methane Savings
- Based on one 3,000 HP reciprocating compressor with 10 start-ups per year

Applicability
- Natural gas pneumatic starter motors
- Needs electric power to run air compressor

Methane Savings
- 1,356 Mcf/yr

Project Economics

<table>
<thead>
<tr>
<th>Project Cost</th>
<th>$1,000 or less</th>
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</thead>
<tbody>
<tr>
<td>Annual O&amp;M Costs</td>
<td>$100 - $1,000</td>
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<tr>
<td>Payback</td>
<td>&lt; 1 yr</td>
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</tbody>
</table>
Convert Gas-Driven Chemical Pumps to Instrument Air

- What is the Problem?
  - Chemical pumps powered by pressurized natural gas vent methane

- Partner Solution
  - Replace natural gas with instrument air to power pumps

- Methane Savings
  - Based on glycol unit pump

- Applicability
  - Use excess capacity of existing instrument air
  - Needs electric power to run air compressor

Methane Savings
2,500 Mcf/yr

Project Economics

<table>
<thead>
<tr>
<th>Project Cost</th>
<th>$1,000 - $10,000</th>
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<tr>
<td>Annual O&amp;M Costs</td>
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Reducing Emissions, Increasing Efficiency, Maximizing Profits
PROs Enabled by Glycol Dehydrators

Dehydrators present an excellent place to reduce emissions

- How much methane is emitted?
  - A 1 MMcf/d dehydrator with vent condenser, no flash tank separator and gas pump can produce 460 Mcf/yr of losses

- How can these losses be reduced?
  - BMP 2: install flash tank separator
  - Many PROs
Reroute Glycol Skimmer Gas

- **What is the Problem?**
  - Gas from condensate separator vented to atmosphere

- **Partner Solution**
  - Reroute condensate separator gas for fuel use

- **Methane Savings**
  - Based on 20 MMcf/d dehydrator w/o FTS, circulating 300 gph

- **Applicability**
  - All dehydrators with vent condensers
  - Condensate separator must operate at higher pressure than gas destination

### Methane Savings

<table>
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<tr>
<th>Project Cost</th>
<th>7,600 Mcf/yr</th>
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### Project Economics

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<tr>
<td>Annual O&amp;M Costs</td>
<td>$100 - $1,000</td>
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<tr>
<td>Payback</td>
<td>&lt; 1 yr</td>
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Pipe Glycol Dehydrator to Vapor Recovery

- What is the Problem?
  - High pressure gas used to drive gas pumps in dehydrators are vented

- Partner Solution
  - Reroute gas vent to VRU

- Methane Savings
  - Based on a 10 MMcf/d gas dehydration unit with FTS and gas assist pump

- Applicability
  - Sufficient spare capacity in existing VRU
  - Capacity of VRU outlet

Methane Savings
3,300 Mcf/yr

Project Economics

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<thead>
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<tbody>
<tr>
<td>Project Cost</td>
<td>$1,000 - $10,000</td>
</tr>
<tr>
<td>Annual O&amp;M Costs</td>
<td>&gt; $1,000</td>
</tr>
<tr>
<td>Payback</td>
<td>&lt; 1 yr</td>
</tr>
</tbody>
</table>
Install Electric Starters

- What is the Problem?
  - Pressurized gas used to start engines is exhausted to atmosphere

- Partner Solution
  - Replacing starter expansion turbine with electric motor starter

- Methane Savings
  - Based on one engine starter, ten start-ups per year and methane leakage through gas shut-off valve

- Applicability
  - All sectors of the gas industry
  - Requires access to power supply

Methane Savings
1,350 Mcf/yr

Project Economics

<table>
<thead>
<tr>
<th>Project Cost</th>
<th>$1,000 - $10,000</th>
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<tbody>
<tr>
<td>Annual O&amp;M Costs</td>
<td>&lt; $100</td>
</tr>
<tr>
<td>Payback</td>
<td>1-3 yrs</td>
</tr>
</tbody>
</table>
Install Compressors to Capture Casinghead Gas

- What is the Problem?
  - Casinghead gas vented to atmosphere
- Partner Solution
  - Install compressor to capture casinghead gas and pump to sales line
- Methane Savings
  - Based on 180 Mcf/d associated gas containing 50% methane, 30 HP electric rotary compressor, 100 psig sales line
- Applicability
  - Oil wells that produce significant volume of casinghead gas
  - Access to electricity for compressor

**Methane Savings**
- 32,850 Mcf/yr

**Project Economics**
- Project Cost: > $10,000
- Annual O&M Costs: > $1,000
- Payback: < 1 yrs
Directed Inspection & Maintenance
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
  - OELs contribute half these emissions
- Fugitive methane emissions depend on operating practices, equipment age and maintenance
How Can These Losses Be Reduced?

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

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

- Implementing a Directed Inspection and Maintenance Program
  - **Voluntary program to identify and fix leaks that are cost-effective to repair**
  - **Outside of mandatory Leak Detection and Repair (LDAR)**
  - **Survey cost will pay out in the first year**
  - **Provides valuable data on leakers**
How Do You Implement A DI&M Program?

- CONDUCT Baseline survey
- SCREEN and MEASURE leaks
- FIX on the spot leaks
- ESTIMATE repair cost, fix to a payback criteria
- PLAN for future DI&M
- Record savings/REPORT to Gas Star
One of the New PROs

- **Begin Directed Inspection and Maintenance at Remote Facilities**
  - **SAVES**: 362 Mcf/yr
  - **PAYOUT**: < 1 yr

- **Enables several PROs**
  - Inspect and Repair Compressor Station Blowdown Valve
  - Use Ultrasound to Identify Leaks
  - Test and Repair Pressure Safety Valves

*Source: CLEARSTONE ENGINEERING LTD*
Natural Gas Losses by Source

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

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

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

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

<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>8.1%</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?

<table>
<thead>
<tr>
<th>Plant No.</th>
<th>Gas Losses From Top 10 Leakers (Mcf/d)</th>
<th>Gas Losses From All Equipment Leakers (Mcf/d)</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>

1Excluding leakage into flare system
**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

### 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
DI&M - Partner Experience

- **Partner A**: leaking cylinder head tightened, which reduced methane emissions from almost 64,000 Mcf/yr to 3,300 Mcf/yr
  - Repair required 9 man-hours labor and annualized gas savings were approximately 60,700 Mcf/yr. At $3/Mcf, the estimated value of gas saved was $182,100/yr

- **Partner B**: one-inch pressure relief valve emitted almost 36,774 Mcf/yr
  - Five man-hours labor and $125 materials eliminated leak. The annualized value of gas saved was more than $110,300 at $3/Mcf
DI&M - Partner Experience

- Partner C: blowdown valve leaked almost 14,500 Mcf/yr
  - Rather than replace expensive valve, the Partner spent just $720 on labor and materials to reduce emissions to ~100 Mcf/yr
  - Gas saved was approximately 14,400 Mcf/yr, worth $43,200 at $3/Mcf

- Partner D: tube fitting leaked 4,121 Mcf/yr
  - Very quick repair requiring only five minutes reduced leak rate to 10 Mcf/yr
  - Annualized value of gas saved was ~ $12,300 at $3/Mcf
Discussion Questions

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