Best Operating Practices for Reducing Emissions
From Natural Gas STAR Partners

Murphy Exploration & Production,
Gulf Coast Environmental Affairs Group,
American Petroleum Institute, and
EPA’s Natural Gas STAR Program

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Why Are Best Operating Practices Important?

- Many production facilities have identified practical cost effective methane emissions practices
- Production partners report saving 129 Bcf since 1990, 83% from PRO’s
- VRU’s account for 30% of PRO emissions reductions
Why Are Best Operating Practices Important?

- Simple vehicle for sharing successes and continuing program’s future
  - **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](http://www.epa.gov/gasstar)
Production Best Management Practices

- BMP 1: Install and Replace High-Bleed Pneumatics
- BMP 2: Install Flash Tank Separators on Glycol Dehydrators
- BMP 3: Partner Reported Opportunities (PRO’s)
Gas STAR PRO Fact Sheets

- PRO Fact Sheets from Annual Reports 1994-2002
  - 54 posted PRO’s
  - 36 PRO’s applicable to Production
    - 12 focused on operating practices
    - 24 focused on technology
  - Several new PRO sheets under development
Lessons Learned

- 14 Lessons Learned on website
- 7 applicable to production
  - 2 focused on operating practices
  - 5 focused on technology
- New Lessons Learned under development
  - Composite Wrap
  - Desiccant Dehydration
Best Operating Practice
Lessons Learned

- Replacing Gas-Assisted Glycol Pumps with Electric Pumps
- Reducing the Glycol Circulation Rates in Dehydrators
Production Best 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
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 nitrogen
    - Use air
  - Alternative technology
    - Use electric starters
    - Convert to electric drive
Partner 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 schedules are an option
  - Modification of purge procedures to recover gas prior to venting can also gain savings with low costs
More Operating Practices

☐ Other

◆ Eliminate Unnecessary Equipment or Systems
  ▪ SAVES… 2,000 Mcf/yr
  ▪ PAYOUT… < 1yr

◆ Begin Directed Inspection and Maintenance at Remote Facilities
  ▪ SAVES… 362 Mcf/yr
  ▪ PAYOUT… 1-3 yrs

◆ Lower Heater-Treater Temperatures
  ▪ SAVES… 142 Mcf/yr
  ▪ PAYOUT… < 1yr
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

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

Unnecessary equipment or systems provide sources of methane emissions

- One partner reports savings of 7,940 Mcf/yr by eliminating 31 dehydrators with an average of 4 controller loops each
  - Payback was < 1 year
More Operating Practices

- **Tanks**
  - Consolidate Crude Oil Production & Water Tank Storage
    - SAVES… 4,200 Mcf/yr
    - PAYOUT… < 1 yr
  - Convert Water Tank Blanket to Produced CO₂
    - SAVES… 2,000 Mcf/yr
    - PAYOUT… 1-3 years
What is the Problem?

Tankage is a large source of methane emissions

- How much methane is emitted?
  - EPA Guideline 42 or API “E&P TANK” Program provide specific guidance. Partners report up to 1,000 Mcf/yr

- How can these losses be reduced?
  - Tankage consolidation reduces maintenance costs and promotes justification of vapor recovery or alternative blanketing with produced CO$_2$
Partner Experience

Tankage is a large source of methane emissions

- One partner reports 32,600 Mcf/yr by converting water tank blankets on 9 units at a water treatment station from fuel gas to CO2-rich produced gas. Payback was 1-3 years.
- Capital costs are a major factor but gas savings are usually substantial.
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 200 Mcf/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 RV’s. Payback was immediate.
- Another partner reports saving 853 Mcf/yr by repairing compressor RV’s.
- Another Partner reports saving 10 Mcf/yr by using nitrogen to test 120 RV’s versus “popping” off with natural gas.
One of the Newer Operating Practices

- Begin Directed Inspection and Maintenance at Remote Facilities
  - SAVES… 362 Mcf/yr
  - PAYOUT … 1-3 yrs

Bubble test on leaking valve
Source: CLEARSTONE ENGINEERING LTD
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

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

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

Leaking Components: 53.1%

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

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

Source: Clearstone Engineering, 2002

Reducing Emissions, Increasing Efficiency, Maximizing Profits
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>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 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
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 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
- Develop a PLAN for future DI&M
- Record savings/REPORT to Gas Star
### 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
DI&M - Partner Experience

- **Partner A**: A leaking cylinder head was tightened, which reduced the methane emissions from almost 64,000 Mcf/yr per year to 3,300 Mcf/yr
  - The repair required 9 man-hours of labor and the annualized gas savings were approximately 60.7 MMcf/yr. At $3.00/Mcf, the estimated value of the gas saved was $182,100/year

- **Partner B**: A one-inch pressure relief valve emitted almost 36,774 Mcf/yr
  - Five man-hours of labor and $125 of materials eliminated the leak. The annualized value of the gas saved was more than $110,300 at $3.00/Mcf
Reducing Emissions, Increasing Efficiency, Maximizing Profits

DI&M - Partner Experience

- **Partner C**: A blowdown valve leaked almost 14,500 Mcf/yr
  - Rather than replace the expensive valve, the Partner spent just $720 on labor and materials to reduce the emissions to approximately 100 Mcf/yr
  - The gas saved was approximately 14,400 Mcf/year, worth $43,200 at $3.00/Mcf

- **Partner D**: A tube fitting leaked at a rate of 4,121 Mcf/yr
  - A very quick repair requiring only five minutes reduced the leak rate to 10 Mcf/yr
  - At $3.00/Mcf, the annualized value of the gas saved was approximately $12,300
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?