



## **Directed Inspection and Maintenance and Infrared Leak Detection**

Lessons Learned from the Natural Gas STAR Program

Montana Petroleum Association  
Producers and Processors  
Technology Transfer Workshop

Billings, Montana  
August 31, 2009

[epa.gov/gasstar](http://epa.gov/gasstar)



## **Directed Inspection and Maintenance and Infrared Leak Detection Agenda**

- 🔥 Methane Losses
  - 🔥 What are the sources of emissions?
  - 🔥 How much methane is emitted?
- 🔥 Methane Recovery
  - 🔥 Directed Inspection and Maintenance (DI&M)
  - 🔥 DI&M by Infrared Leak Detection
- 🔥 Is Recovery Profitable?
- 🔥 Partner Experience
- 🔥 Discussion

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## What is the Problem?

- ⦿ Methane gas leaks are invisible, unregulated, and go unnoticed
- ⦿ Natural Gas STAR Partners find that valves, connectors, compressor seals, and open-ended lines (OELs) are major methane fugitive emission sources
  - ⦿ In 2007, 3.69 Bcf of methane was emitted as fugitives by reciprocating compressor related components alone
  - ⦿ Production and processing fugitive methane emissions depend on operating practices, equipment age, and maintenance

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## Methane Losses - Production

- ⦿ Over 550,000 producing gas wells nationally
- ⦿ Fugitive emissions from gas production and gathering/boosting facilities are estimated to be 19 billion cubic feet per year (Bcf/year)
  - ⦿ Estimated 35 thousand cubic feet emissions (Mcf) per well-year
  - ⦿ Worth \$245/well-year



Source: Anadarko (Formerly Western Gas Resources)

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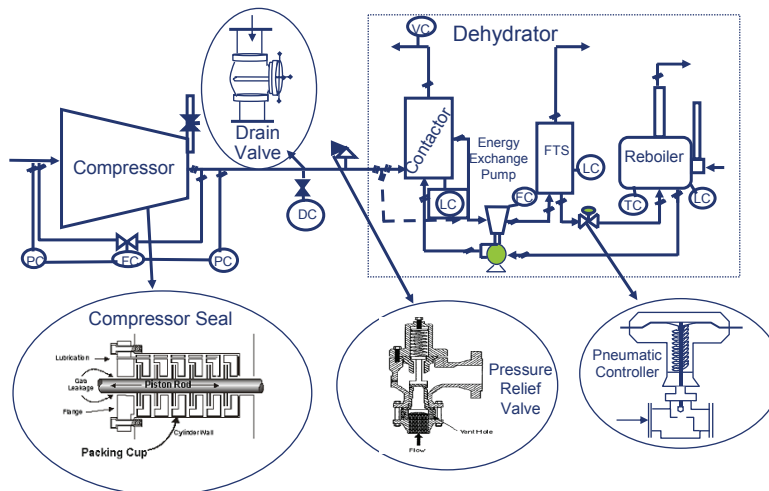
## Methane Losses - Processing

- ♦ 732 natural gas processing plants nationally
  - ♦ Operating nearly 5,000 compressors
- ♦ Fugitive emissions from gas processing facilities are estimated to be 24 billion cubic feet per year (Bcf/year)
  - ♦ Estimated 33 million cubic feet emissions (MMcf) per plant-year
  - ♦ Worth over \$230,000/plant-yr



Source: Chevron/Unocal

## Sources of Methane Emissions



## What are the losses? - Clearstone

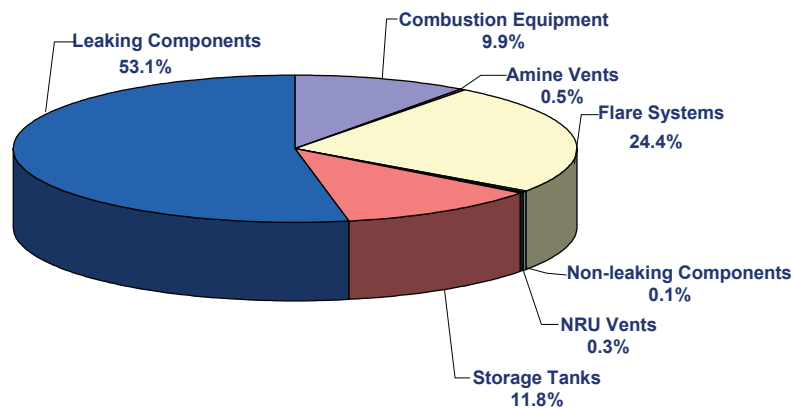
- ♠ Clearstone studied 4 gas processing plants
  - ♠ Screened for all leaks
  - ♠ Measured larger leak rates
  - ♠ Analyzed data
- ♠ Principles are relevant to all sectors
  - ♠ Fugitive leaks from valves, connectors, compressor seals, and lines still a problem in production
  - ♠ Solution is the same



Source: Hy-bon Engineering

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## Distribution of Losses by Source Category

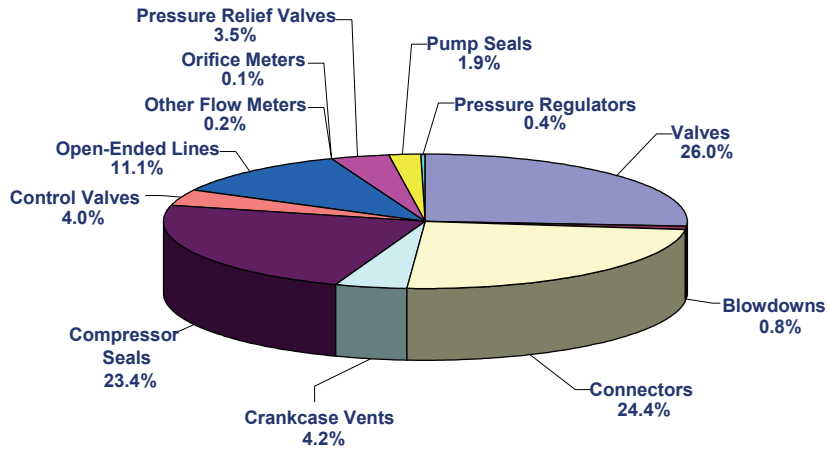


Source: Clearstone Engineering, 2002

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## Distribution of Losses from Equipment Leaks by Type of Component



Source: Clearstone Engineering, 2002

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## How Much Methane is Emitted?

Methane Emissions from Leaking Components at Gas Processing Plants			
Component Type	% of Total Methane Emissions	% of Components Found Leaking	Estimated Average Methane Emissions per Leaking Component (Mcf/year)
Valves (Block & Control)	26.0%	7.4%	66
Connectors	24.4%	1.2%	80
Compressor Seals	23.4%	81.1%	372
Open-ended Lines	11.1%	10.0%	186
Pressure Relief Valves	3.5%	2.9%	844

Source: Clearstone Engineering, 2002. *Identification and Evaluation of Opportunities to Reduce Methane Losses at Four Gas Processing Plants*. Report of results from field study of four gas processing plants in Wyoming and Texas to evaluate opportunities to economically reduce methane emissions.

Mcf = Thousand cubic feet

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## How Much Methane is Emitted?

Summary of Natural Gas Losses from the Top Ten Leak Sources<sup>1</sup>

Plant Number	Gas Losses From Top 10 Leak Sources (Mcf/day) <sup>2</sup>	Gas Losses From All Leak Sources (Mcf/day)	Contribution By Top 10 Leak Sources (%)	Contribution By Total Leak Sources (%)
1	43.8	122.5	35.7	1.78
2	133.4	206.5	64.6	2.32
3	224.1	352.5	63.6	1.66
4	76.5	211.3	36.2	1.75
Combined	477.8	892.8	53.5	1.85

1 – Excluding leakage into flare system

2 – Approximately 10,000 components surveyed per plant

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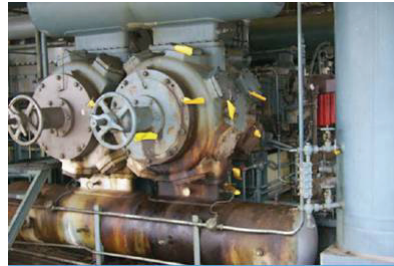
## Methane Recovery

- ❖ Fugitive losses can be dramatically reduced by implementing a directed inspection and maintenance 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 leak sources with information on where to look “next time”

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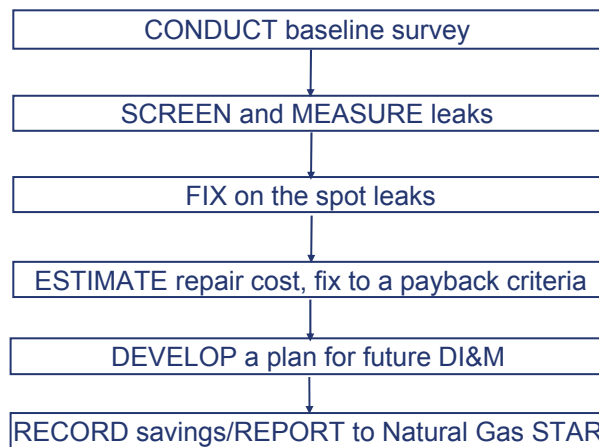
## What is Directed Inspection and Maintenance?

- ⚡ Directed Inspection and Maintenance (DI&M)
  - ⚡ 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 leak detection and repair (VOC LDAR) program



Source: Targa Resources

## How Do You Implement DI&M?



## How Do You Implement DI&M?

- 🔦 Screening - find the leaks
  - 🔦 Soap bubble screening
  - 🔦 Electronic screening (“sniffer”)
  - 🔦 Toxic vapor analyzer (TVA)
  - 🔦 Organic vapor analyzer (OVA)
  - 🔦 Ultrasound leak detection
  - 🔦 Acoustic leak detection
  - 🔦 Infrared leak detection



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## How Do You Implement DI&M?

- 🔦 Evaluate the leaks detected - measure results
  - 🔦 High volume sampler
  - 🔦 Toxic vapor analyzer (correlation factors)
  - 🔦 Rotameters
  - 🔦 Calibrated bagging

Leak Measurement Using High Volume Sampler



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## How Do You Implement DI&M?

Summary of Screening and Measurement Techniques		
Instrument/ Technique	Effectiveness	Approximate Capital Cost
Soap Solution	★ ★	\$
Electronic Gas Detector	★	\$\$
Acoustic Detector/ Ultrasound Detector	★ ★	\$\$\$
TVA (Flame Ionization Detector)	★	\$\$\$
Calibrated Bagging	★	\$\$
High Volume Sampler	★ ★ ★	\$\$\$
Rotameter	★ ★	\$\$
Infrared Leak Detection	★ ★ ★	\$\$\$

Source: EPA's Lessons Learned

\* - Least effective at screening/measurement

\$ - Smallest capital cost

\*\*\* - Most effective at screening/measurement

\$\$\$ - Largest capital cost

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## Estimating Comprehensive Survey Cost

- 💧 Cost of complete screening survey using high volume sampler (processing plant)
  - 💧 Ranges \$15,000 to \$20,000 per medium size plant
  - 💧 Rule of Thumb: \$1 per component for an average processing plant
  - 💧 Cost per component for remote production sites would be higher than \$1
- 💧 25 to 40% cost reduction for follow-up survey
  - 💧 Focus on higher probability leak sources (e.g. compressors)

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## Infrared Methane Leak Detection

- Video recording of fugitive leaks detected by various infrared devices



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## DI&M by Infrared Leak Detection

- Real-time detection of methane leaks
  - Quicker identification & repair of leaks
  - Screen hundreds of components an hour
  - Screen inaccessible areas simply by viewing them

Infrared Leak Detection



Source: Leak Surveys Inc.

Remote Methane Leak Detector



Source: Heath Consultants

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## Is Recovery Profitable?

Repair the Cost-Effective Components			
Component	Value of lost gas <sup>1</sup> (\$)	Estimated repair cost (\$)	Payback (months)
Plug Valve: Valve Body	29,498	200	0.1
Union: Fuel Gas Line	28,364	100	0.1
Threaded Connection	24,374	10	0.0
Distance Piece: Rod Packing	17,850	2,000	1.4
Open-Ended Line	16,240	60	0.1
Compressor Seals	13,496	2,000	1.8
Gate Valve	11,032	60	0.1

Source: Hydrocarbon Processing, May 2002  
<sup>1</sup> – Based on \$7/Mcf gas price

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## Partner Experience - EnCana

- ⚡ DI&M implemented as part of EnCana's energy efficiency initiative in all US production and midstream facilities in 2007
- ⚡ Surveyed components in 1,860 production sites and 35 compressor stations using FLIR camera and Hi Flow Sampler
- ⚡ Identified leaking rates as high as 17 Mcf/day/station
- ⚡ Annual methane emissions reduction of 358,000 Mcf/year
- ⚡ Annual savings: \$2,506,000/year (at \$7/Mcf)



Source: EnCana

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## Partner Experience - Targa Resources (formerly Dynegy)

- 🔥 Surveyed components in two processing plants: 23,169 components
- 🔥 Identified leaking components: 857 about 3.6%
- 🔥 Repaired components: 80 to 90% of the identified leaking components
- 🔥 Annual methane emissions reductions: 198,000 Mcf/year
- 🔥 Annual savings: \$1,386,000/year (at \$7/Mcf)



Source: Targa Resources

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## DI&M - Aerial Leak Surveys

- 🔥 Aerial leak surveys with infrared leak detection devices can aid in leak identification over large sections of pipelines
- 🔥 Aerial surveys can be conducted in helicopters or fixed wing aircrafts using both active and passive IR detection devices

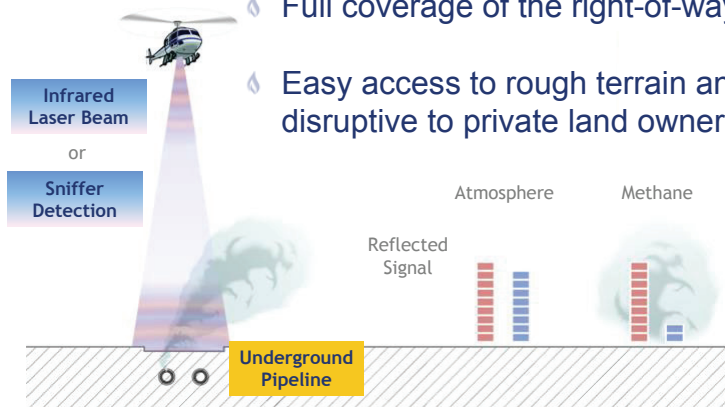


Source: LaSen Inc.

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## Aerial Pipeline Surveys

- ⦿ Over 10 times faster than ground surveys
- ⦿ Full coverage of the right-of-way
- ⦿ Easy access to rough terrain and non-disruptive to private land owners



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## Partner Experience - Chesapeake Energy

- ⦿ Sept. 2008 flight covered 616 miles
- ⦿ To cover the same area with ground patrol:
  - ⦿ 4 men: 2 men on 2 crews 2 vehicles and fuel
  - ⦿ 6 hours / day
  - ⦿ 6 miles / day
  - ⦿ Result: 100 days, 3,200 man hours, 5 months of detection
- ⦿ Flight time was 65 hours
- ⦿ Real savings in man hours, time, and vehicle fuel

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## Partner Experience - DCP Midstream

- ⚡ DCP Midstream faced with surveying their 66,000 mile “spaghetti” like pipelines
- ⚡ Contacted LaSen Inc. to use their laser remote sensing application on DCP’s gathering lines.
- ⚡ DCP reported LaSen’s surveys cover 50 to 100 miles per day
- ⚡ Since working with LaSen, DCP has reduced it’s unaccounted emissions by 50 %

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## DI&M - Lessons Learned

- ⚡ 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 valves, engine-starters, and pressure relief valves represent <3% of components but >60% of methane emissions
- ⚡ The business of leak detection has changed dramatically with new technology



Source: Chevron

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## Discussion

- ⚡ Industry experience applying these technologies and practices
- ⚡ Limitations on application of these technologies and practices
- ⚡ Actual costs and benefits