Directed Inspection and Maintenance and Infrared Leak Detection

Lessons Learned from the
Natural Gas STAR Program

Producers Technology Transfer Workshop

Newfield Exploration Company,
Anadarko Petroleum Corporation,
Utah Petroleum Association,
Interstate Oil & Gas Compact Commission,
Independent Petroleum Association of Mountain States

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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

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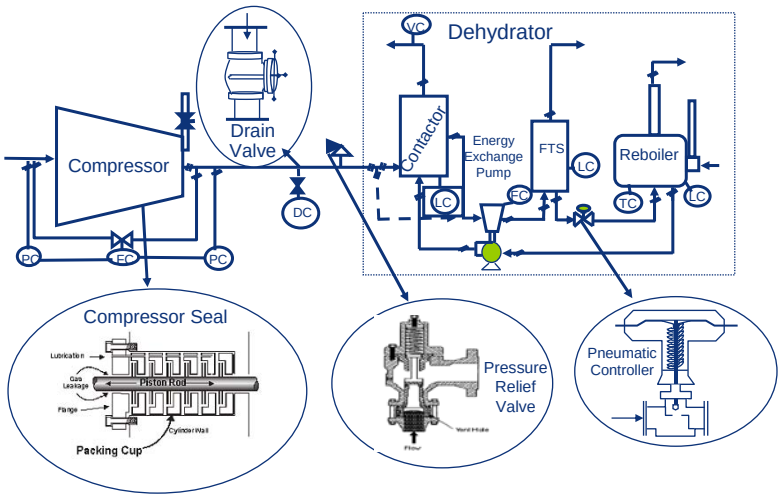
Sources of Methane Emissions



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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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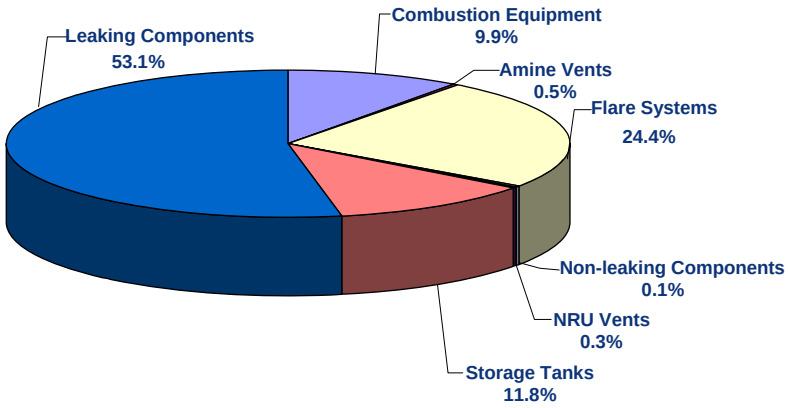
Distribution of Losses by Source Category



Source: Clearstone Engineering, 2002

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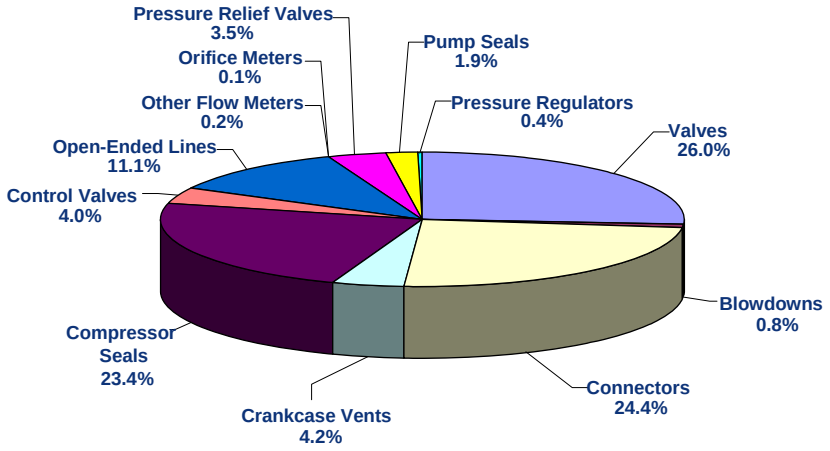
Distribution of Losses from Equipment Leaks by Type of Component



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[1]				
Plant Number	**Gas Losses From Top 10 Leak Sources (Mcf/day)[2]**	**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

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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 Natural Gas STAR

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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

Toxic Vapor Analyzer

Acoustic 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

*** - Most effective at screening/measurement

$ - Smallest capital cost

$$$ - 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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Is Recovery Profitable?

Repair the Cost-Effective Components			
Component	**Value of lost gas[1] ($)**	**Estimated repair cost ($)**	**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
1 – Based on $7/Mcf gas price

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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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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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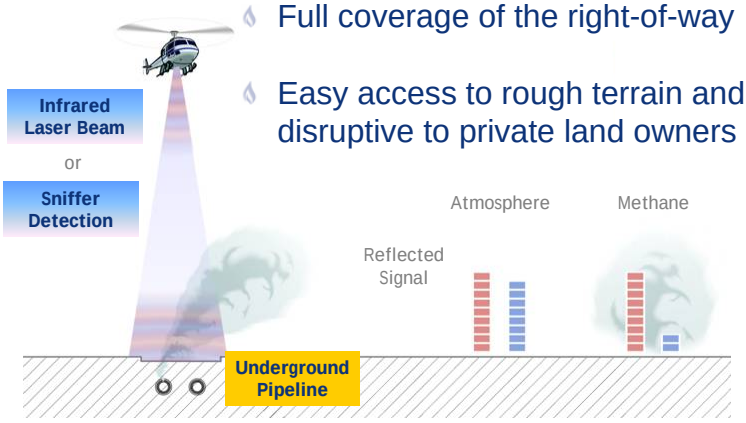
Aerial Pipeline Surveys

- 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

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