Directed Inspection and Maintenance and Infrared Leak Detection

Lessons Learned from the
Natural Gas STAR Program

Shell Exploration & Production Company,
Chevron Corporation,
Offshore Operations Committee, and
Gulf Coast Environmental Affairs Group

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epa.gov/gasstar

EPA

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?
- Discussion

Methane Losses

- Over 3,900 offshore facilities nationally
- Emissions from offshore production facilities are estimated to be 34 billion cubic feet per year (Bcf/year)

Source: Spring 2004 Partner Update

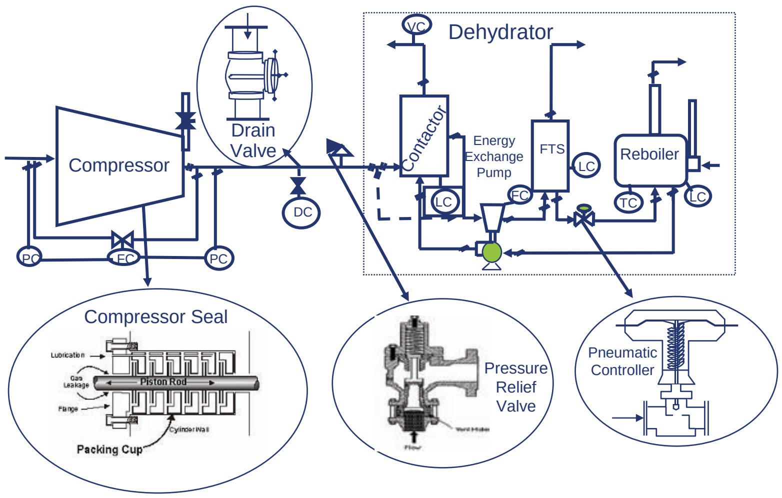
2

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 emission sources
  - In 2005, 25.5 Bcf of methane was emitted as fugitives by compressor related components in the production and processing sectors
  - Production fugitive methane emissions depend on operating practices, equipment age, and maintenance

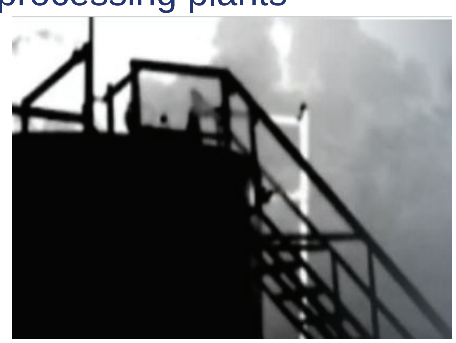
3

Sources of Methane Emissions

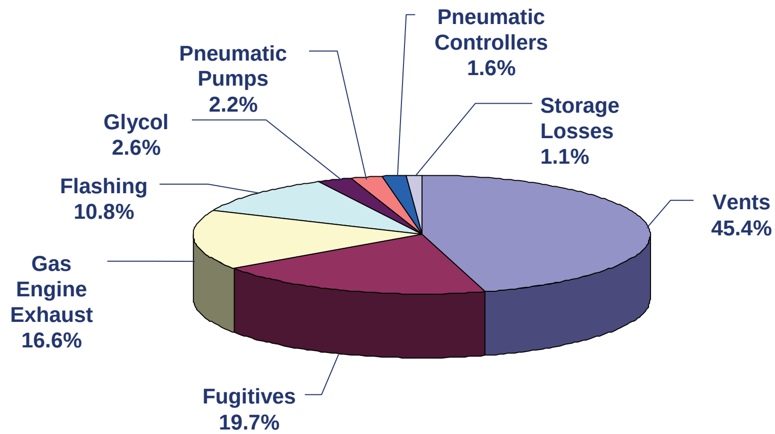


What are the losses? – GOADS and Clearstone

- GOADS 2000 quantified leaks from offshore components
- 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



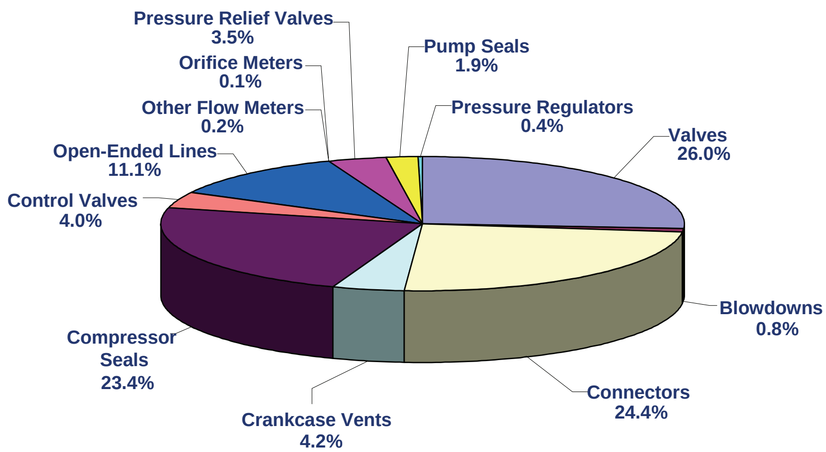
Distribution of Losses by Source Category



Source: MMS GOADS 2000

6

Distribution of Losses from Equipment Leaks by Type of Component



Source: Clearstone Engineering, 2002

7

How Much Methane is Emitted?

Methane Emissions from Leaking Components at Gas Processing Plants			
Component Type	% of Total Methane Emissions	% Leak Sources	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

8

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)	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

9

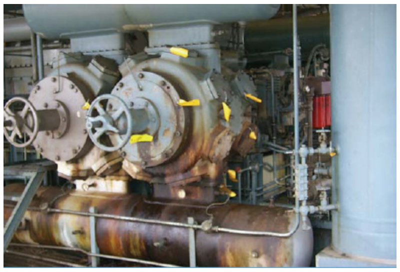
Methane Recovery

- 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"

10

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

11

How Do You Implement DI&M?

CONDUCT baseline survey

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SCREEN and MEASURE leaks

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FIX on the spot leaks

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ESTIMATE repair cost, fix to a payback criteria

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DEVELOP a plan for future DI&M

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RECORD savings/REPORT to Natural Gas STAR

12

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

13

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

Source: Heath Consultants

14

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

15

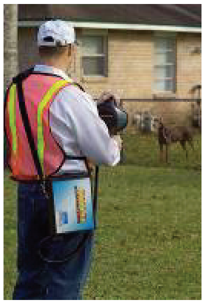
Estimating Comprehensive Survey Cost

- Cost of complete screening survey using high volume sampler
  - Ranges $15,000 to $20,000 per medium size plant
  - Rule of Thumb: $1 per component for an average plant environment (based on processing plants)
  - Cost per component for remote small 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)

16

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.

17

Infrared Methane Leak Detection

- Video recording of fugitive leaks detected by various infrared devices

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

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

20

Discussion

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

21