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Reducing Methane Emissions through Directed Inspection and Maintenance (DI&M)

Oil & Gas Subcommittee Technology Transfer Workshop

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Directed Inspection and Maintenance and Infrared Leak Detection Agenda

- What are fugitive equipment leaks?
- What is DI&M
- Infrared Leak Detection
- Partner Experience
- Discussion

Key Characteristics of Fugitive Equipment Leaks

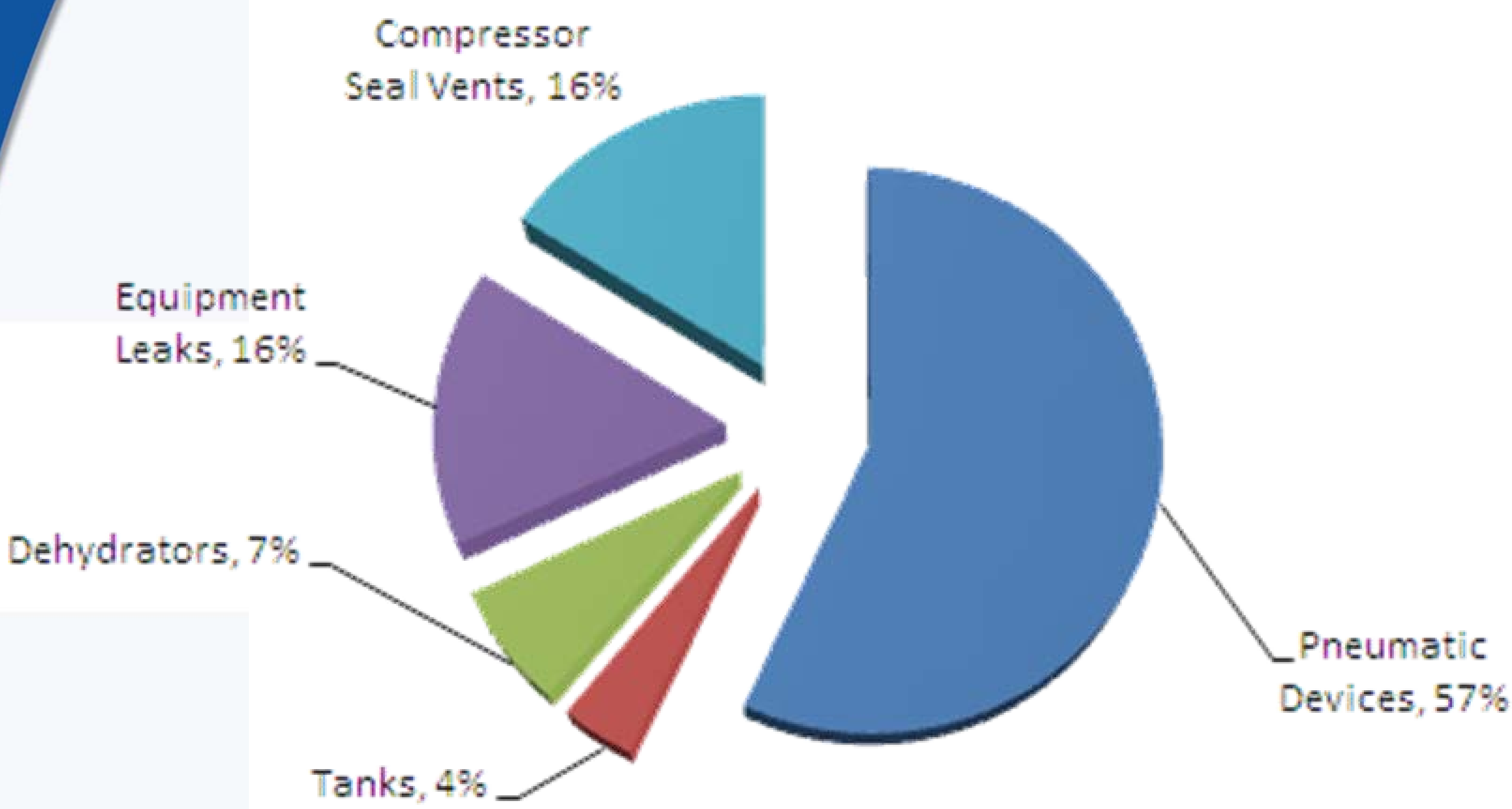
- Fugitive equipment leaks are a major source of CH_4 emissions at oil and gas facilities.
- Most of these emissions are from a few big leaks rather than many small or medium sized leaks.
- 75 to 85% of the emissions from leaks are cost effective to fix (often payback of <6 months).
- Components in gas service leak more than those in liquid service.
- Components in sweet service more likely to leak than those in sour or odorized service.
- Leak potential tends to increase with time and usage.
- Different types of components and service applications have different leak potentials (i.e., leak magnitude and probability).
- Components in vibration, cryogenic or thermal cycling service have an increased leak potential.

Why Do Big Leaks Occur?

- Big leaks often go unnoticed because they occur in difficult-to-access, low-traffic, congested or noisy areas, or the amount of leakage is not fully appreciated.

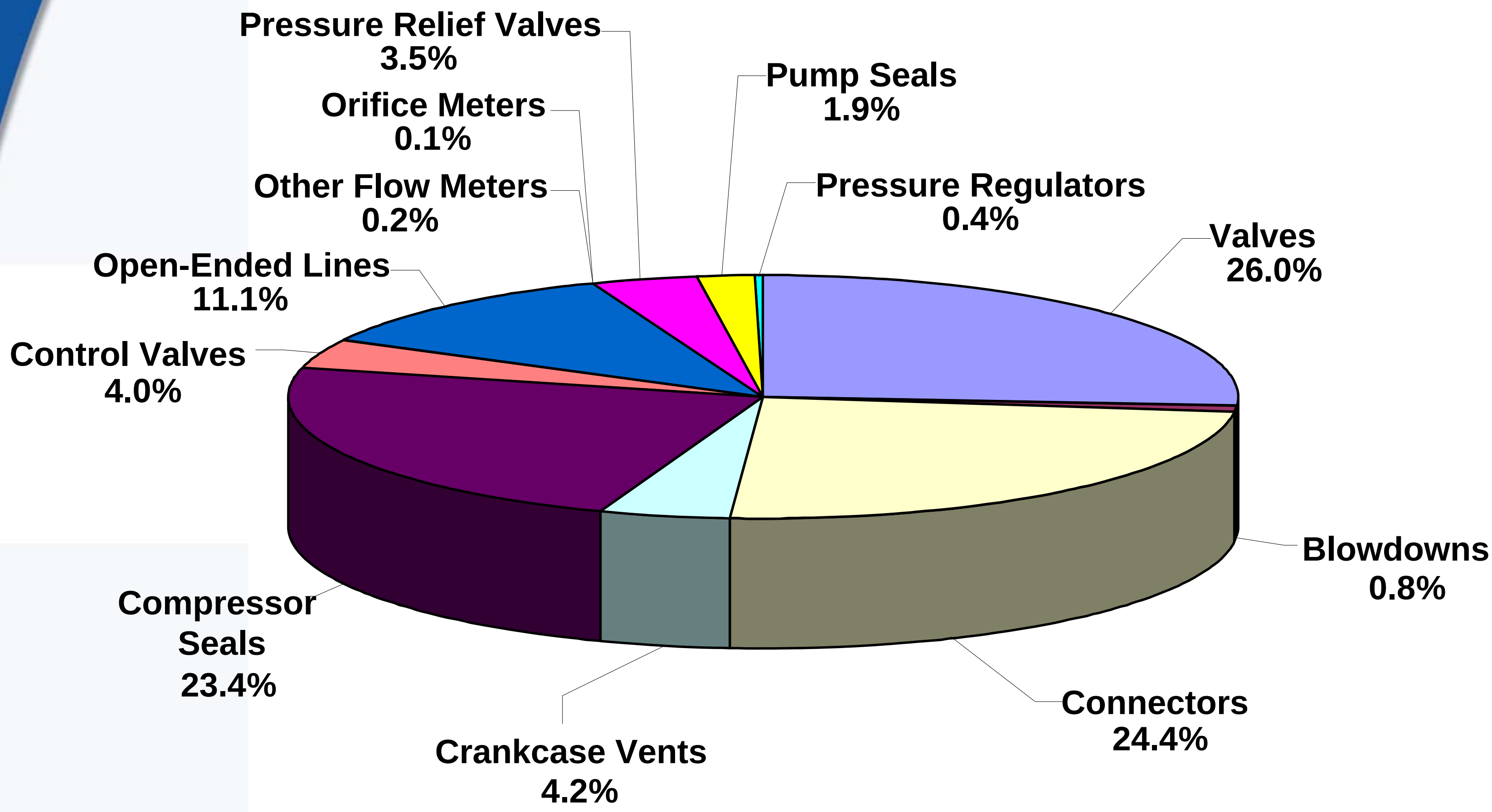
- Big leaks may also occur because of severe/demanding applications or the high cost or difficulty of repairs.

Methane Emissions at 76 Gas Production Facilities



Source: Clearstone Engineering

Distribution of Losses by Type of Component (Processing)



Source: Clearstone Engineering, 2002

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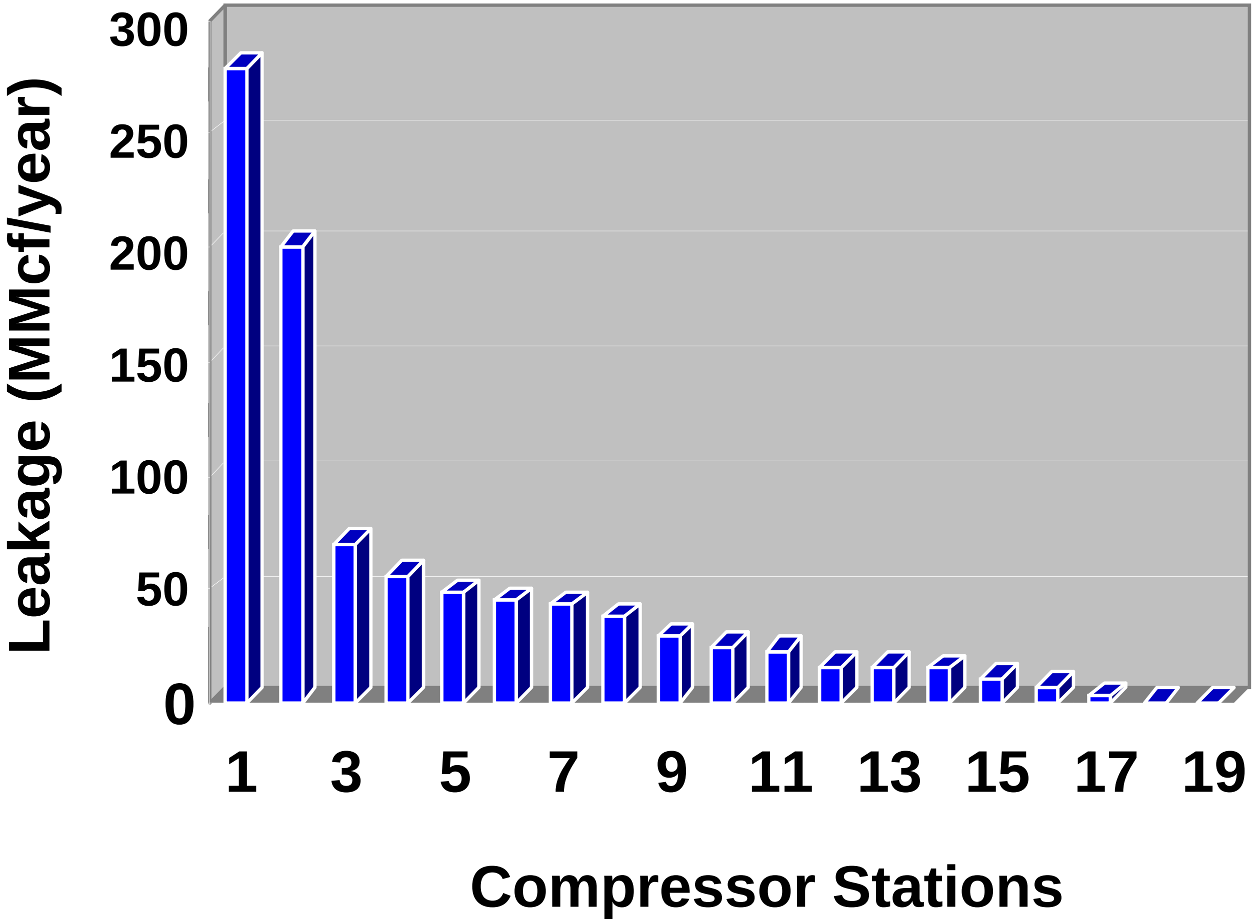
Measured Leakages in Compressor Stations



Source: Clearstone Engineering, 2002

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What is Normal Leak Control Practice?

- Perform a leak check (using a bubble test or hand-held gas sensor) on equipment components when first installed, and after inspection & maintenance.
- Thereafter, leaks are detected by:
  - Area or building monitors.
  - Personal monitors.
  - Olfactory, audible or visual indicators.
- Leaks only fixed if this is easy to do or they pose an obvious safety concern.
- Unmanned facilities get less attention than manned facilities.
- Priority following a facility turnaround is to get it back on line rather than ensure all affected components have been leak checked.

What is Directed Inspection & Maintenance (DI&M)?

It is a practicable ongoing approach to achieving significant cost-effective reductions in fugitive equipment leaks:

- Find the big leaks in an efficient manner:
  - Focus efforts on the most likely sources of big leaks with coarse or less frequent screening of other components.
- Only repair components that are cost-effective to repair or pose a safety or environmental concern.
- Minimize the potential for big leaks and provide early detection and repair of these when they occur.

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What are the benefits of DI&M?

- Attractive payback (often <6 months).
- Reduced maintenance costs.
- Reduced downtime.
- Improved process efficiency.
- Safer work environment.
- Cleaner environment.
- Resource conservation.

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Where Should Leak Monitoring Efforts Be Focused?

Table 1. Sample leak statistics for gas transmission facilities.

Source	Number of Sources	Leak Frequency	Average Emissions (lb/h/source)	Percent of Component Population	Contribution to Total Emissions (%)	Relative Leak Potential
Station or Pressurized Blowdown System	219	59.8	7.50E+00	0.131	53.170	7,616.00
Compressor Seal – Centrifugal	103	64.1	2.79E+00	0.061	9.313	2,838.00
Compressor Seal – Reciprocating	167	40.1	2.35E+00	0.099	12.722	2,400.00
Pressure Relief Valve	612	31.2	3.56E-01	0.366	7.058	362.00
Open-Ended Line	928	58.1	2.02E-01	0.555	6.065	205.00
Orifice Meter	185	22.7	1.07E-01	0.110	0.640	109.00
Control Valve	782	9.0	3.63E-02	0.467	0.918	37.00
Pressure Regulator	816	7.0	1.75E-02	0.488	0.461	18.00
Valve	17,029	2.8	9.09E-03	10.190	5.007	9.00
Connector	145,829	0.9	9.83E-04	87.263	4.641	1.00
Other Flow Meter	443	1.8	2.19E-05	0.265	0.0003	0.02

Source: Clearstone Engineering, 2007

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How Frequently Should Components Be Monitored?

Suggested leak monitoring frequencies for equipment components, presented by component category and type.				
Source Category	**Type of Component**	**Service**	**Application**	**Frequency**
Process Equipment	Connectors and Covers	All		Immediately after any adjustments and once every 5 years thereafter
		All	Thermal Cycling	Bi-annually
		All	Vibration	Annually
	Control Valves	Gas/Vapour/LPG		Annually
		Gas/Vapour/LPG	Thermal Cycling	Bi-annually
	Block Valves – Rising Stem	Gas/Vapour/LPG	All	Annually
	Block Valves – Quarter Turn	Gas/Vapour/LPG	All	Once every 5 years
	Compressor Seals	All	All	Monthly
	Pump Seals	All	All	Quarterly
	Pressure Relief Valves	All	All	Annually
	Open-ended Lines	All	All	Annually
	Emergency Vent and Blowdown Systems[1]	All	All	Quarterly
Vapour Collection Systems	Tank Hatches	All	All	Monthly
	Pressure-Vacuum Safety Valves	All	All	Monthly

Source: Clearstone Engineering, 2006

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How Do You Implement DI&M?

CONDUCT baseline survey

↓

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

↓

DEVELOP a plan for future DI&M

↓

RECORD savings/REPORT to Natural Gas STAR

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

How Do You Implement DI&M?

- Evaluate the leaks detected - measure results
  - High volume sampler
  - End-of-pipe technologies
    - Velocity traverse
    - Rotameters
    - Calibrated bagging
  - Toxic vapor analyzer (correlation factors)

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	★★★	$$$
End-of-pipe Flow Measurement	★★	$$
Infrared Leak Detection	★★★	$$$$
Source: EPA's Lessons Learned		

* - Least effective at screening/measurement

*** - Most effective at screening/measurement

$ - Smallest capital cost

$$$ - Largest capital cost

Estimating Comprehensive Leak Survey Costs

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

DI&M by Infrared Leak Detection

Real-time detection of methane leaks

- Quicker identification 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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Infrared Methane Leak Detection

Video recording of fugitive leaks detected by various infrared devices

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Is Recovery Profitable?

Repair the Cost-Effective Components			
Component	**Value of lost gas[1] (US$)**	**Estimated repair cost (US$)**	**Payback (months)**
Plug Valve: Valve Body	21,070	200	0.11
Union: Fuel Gas Line	20,260	100	0.06
Threaded Connection	17,410	10	0.01
Distance Piece: Rod Packing	12,750	2,000	1.88
Open-Ended Line	11,600	60	0.06
Compressor Seals	9,640	2,000	2.49
Gate Valve	7,880	60	0.09

Source: Hydrocarbon Processing, May 2002 (Repair cost)

1 – Adjusted to US$5/MMBtu 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

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Discussion

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