# DI&M (Directed Inspection & Maintenance), A Gas STAR International Best Practice

**1st Asia Pacific Global Methane Initiative Oil & Gas Sector Workshop**

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Don Robinson
ICF International

Global Methane Initiative

# Agenda

- What is the Problem?
- Methane Losses
  - Sources of methane emissions
  - What are the losses?—Clearstone
- Methane Recovery
  - What is Directed Inspection and Maintenance (DI&M)?
  - How do you implement DI&M?
- Estimating Comprehensive Survey Cost
- Is Recovery Profitable?
- Contacts and Further Information

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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, 104.5 million cubic meters (MMcm) 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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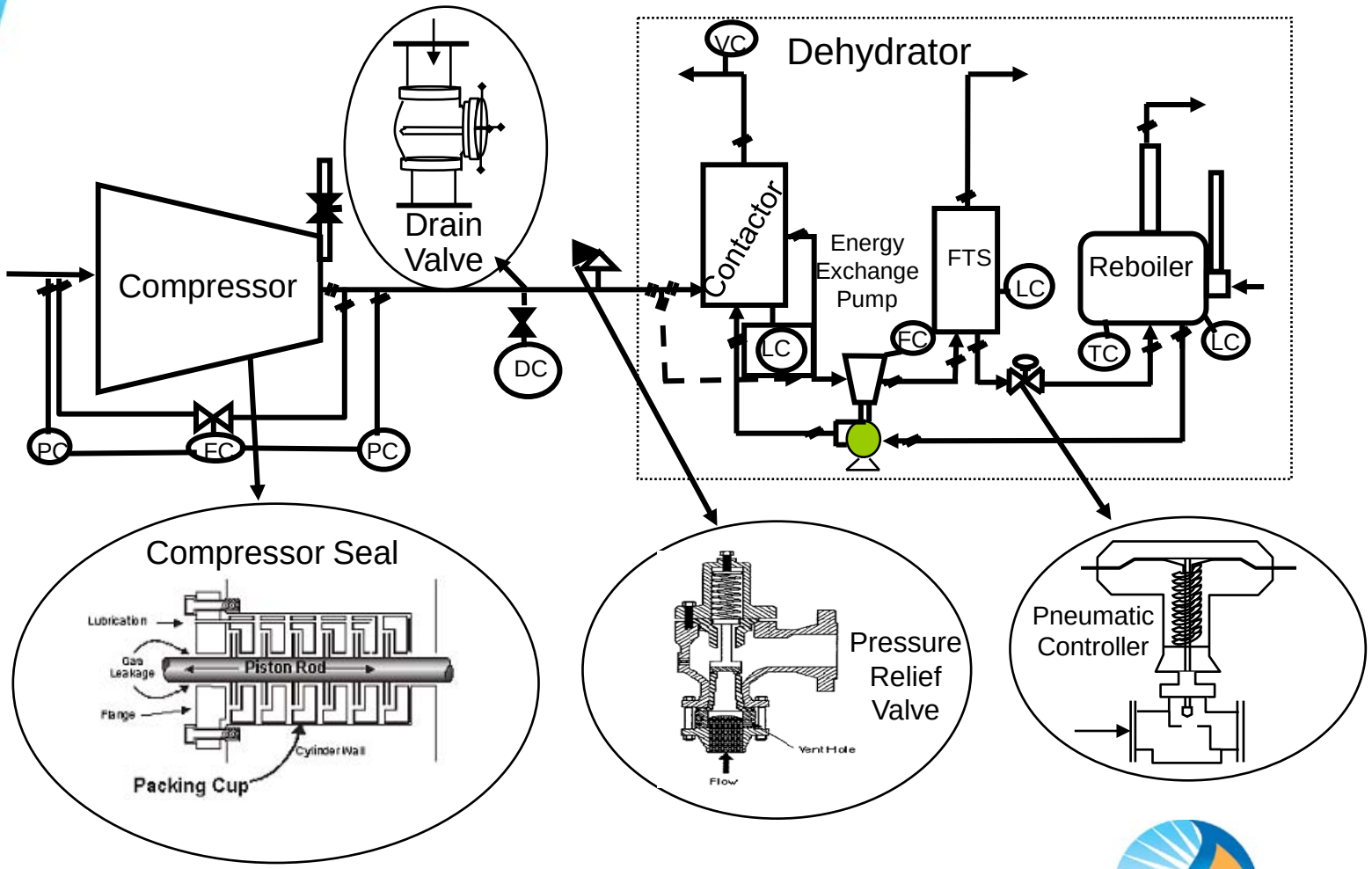
# Sources of Methane Emissions

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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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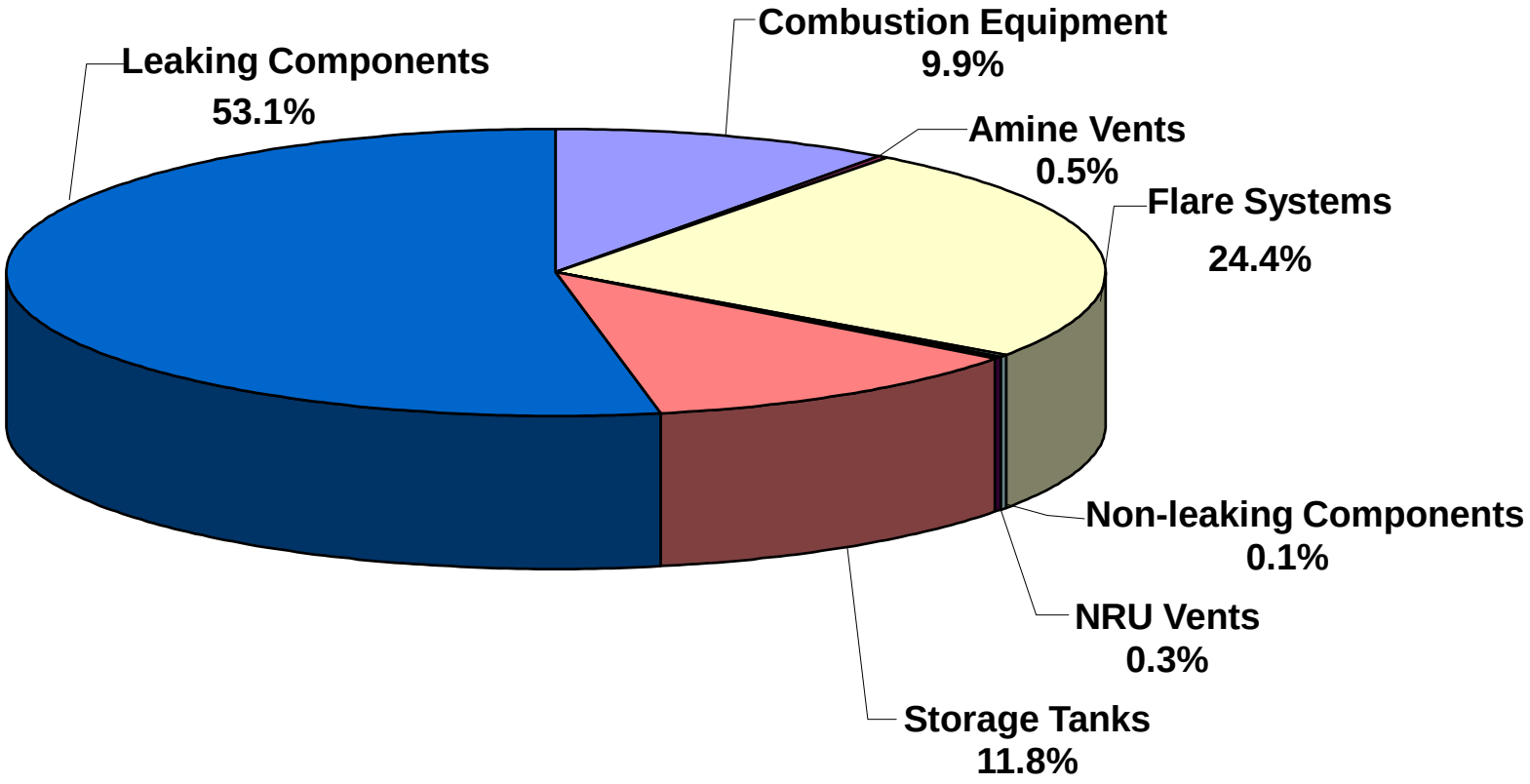
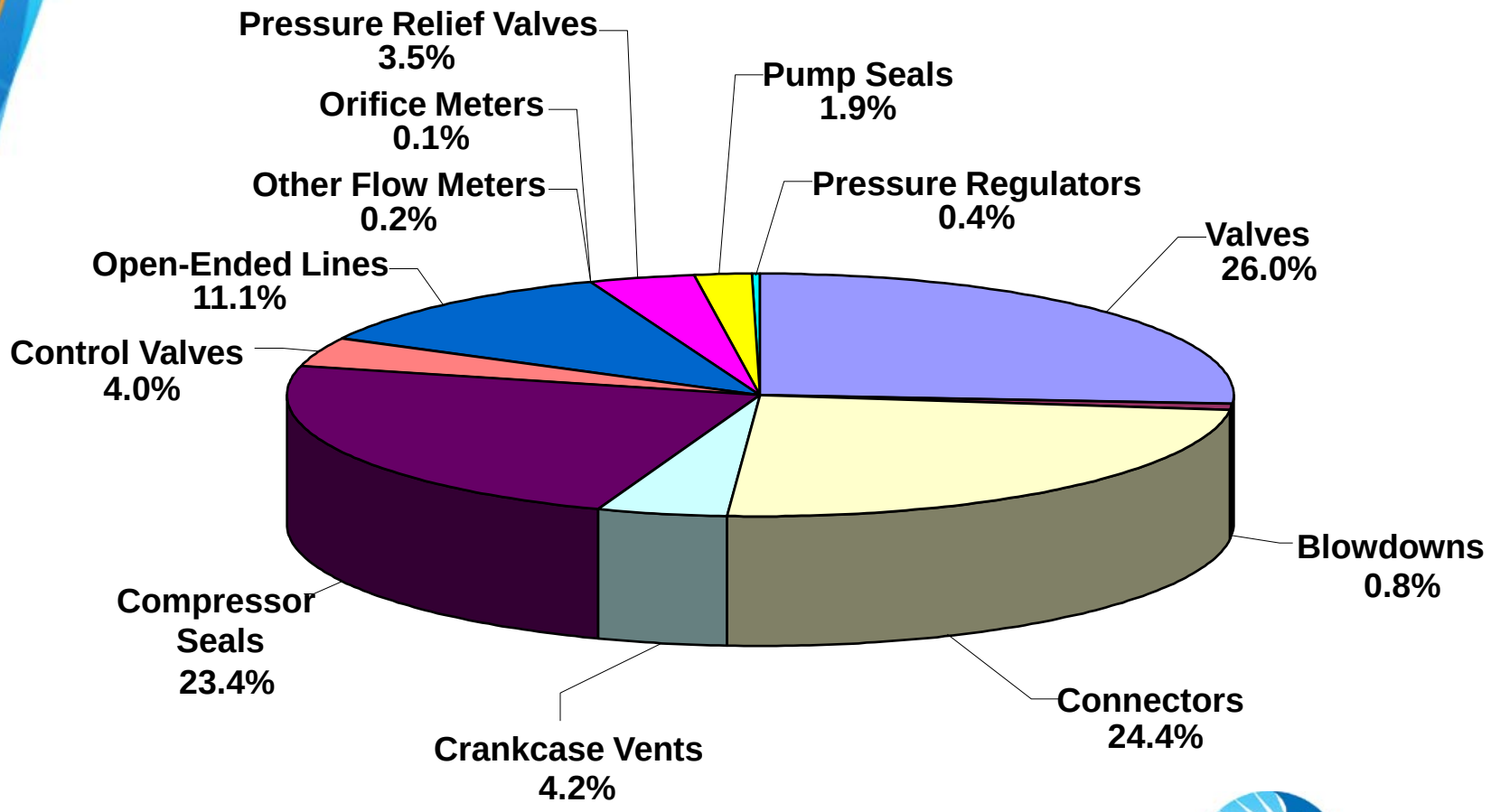
# Distribution of Losses by Source Category




Source: Clearstone Engineering, 2002

# Distribution of Losses from Equipment Leaks by Type of Component




Source: Clearstone Engineering, 2002

# Fugitive Equipment Leaks

| Facility Type | Number of Components surveyed Per Site | Leak Frequency (%) | Emissions From All Leaking Sources | | Combustion to THC Emissions |
|---|---|---|---|---|---|
| | | | Methane | Value | Top 10 Sources |
| | | | (tonnes/year) | ($/year) | (%) |
| Gas Plants | 56461 | 1.7 | 997 | 500253 | 35 |
| | 16050 | 3.5 | 471 | 320608 | 36 |
| | 14424 | 3.0 | 1412 | 558665 | 64 |
| | 14174 | 4.0 | 1376 | 553248 | 36 |
| | 11556 | 3.3 | 1215 | 621061 | 33 |
| | 13133 | 2.5 | 186 | 386538 | 57 |
| | 13471 | 1.2 | 299 | 178744 | 93 |
| | 3672 | 10.3 | 2334 | 1262874 | 77 |
| | 5979 | 0.6 | 29 | 11863 | 93 |
| TOTAL | **148920** | | **8320** | **4393854** | |
| AVERAGE | **16547** | **2.5** | **924** | **488206** | **54** |
| Compressor Stations | 608 | 5.1 | 110 | 61572 | 90 |
| | 4626 | 1.1 | 98 | 49184 | 83 |
| | 3084 | 0.7 | 169 | 98802 | 95 |
| | 6168 | 1.0 | 194 | 103508 | 64 |
| | 1568 | 4.2 | 80 | 33552 | 80 |
| | 224 | 1.3 | 0 | 189 | 100 |
| | 1391 | 1.9 | 4 | 2367 | 88 |
| | 2115 | 1.8 | 67 | 27855 | 89 |
| | 2516 | 1.1 | 45 | 18901 | 91 |
| TOTAL | **22300** | | **767** | **395928** | |
| AVERAGE | **2478** | **1.5** | **85** | **43992** | **83** |
| Well Sites | 1474 | 0.2 | 1 | 501 | 100 |
| | 1617 | 1.5 | 1 | 351 | 88 |
| | 1797 | 0.4 | 1 | 585 | 100 |
| TOTAL | **4888** | | **3** | **1437** | |
| AVERAGE | **407** | **0.7** | **0** | **120** | **97** |

- Value of emissions based on natural gas price of $6.78/GJ

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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

Source: Targa Resources

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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 (kg/h/source) | Percent of Component Population | Contribution to Total Emissions (%) | Relative Leak Potential |
| Station or Pressurized Blowdown System[6] | 219 | 59,8 | 3,41E+00 | 0,131 | 53,116 | 7616 |
| Compressor Seal – Centrifugal [2] | 103 | 64,1 | 1,27E+00 | 0,062 | 9,310 | 2838 |
| Compressor Seal – Reciprocating [2] | 167 | 40,1 | 1,07E+00 | 0,100 | 12,764 | 2400 |
| Pressure Relief Valve | 612 | 31,2 | 1,62E-01 | 0,366 | 7,062 | 362 |
| Open-Ended Line | 928 | 58,1 | 9,18E-02 | 0,555 | 6,070 | 205 |
| Orifice Meter [7] | 185 | 22,7 | 4,86E-02 | 0,111 | 0,641 | 109 |
| Control Valve [4] | 782 | 9 | 1,65E-02 | 0,468 | 0,919 | 37 |
| Pressure Regulator | 816 | 7 | 7,95E-03 | 0,488 | 0,462 | 18 |
| Valve [9] | 17029 | 2,8 | 4,13E-03 | 10,190 | 5,011 | 9 |
| Connector [3] | 145829 | 0,9 | 4,47E-04 | 87,264 | 4,644 | 1 |
| Other Flow Meter [8] | 443 | 1,8 | 9,94E-06 | 0,265 | 0,000 | 0,02 |

Source: Clearstone Engineering, 2007

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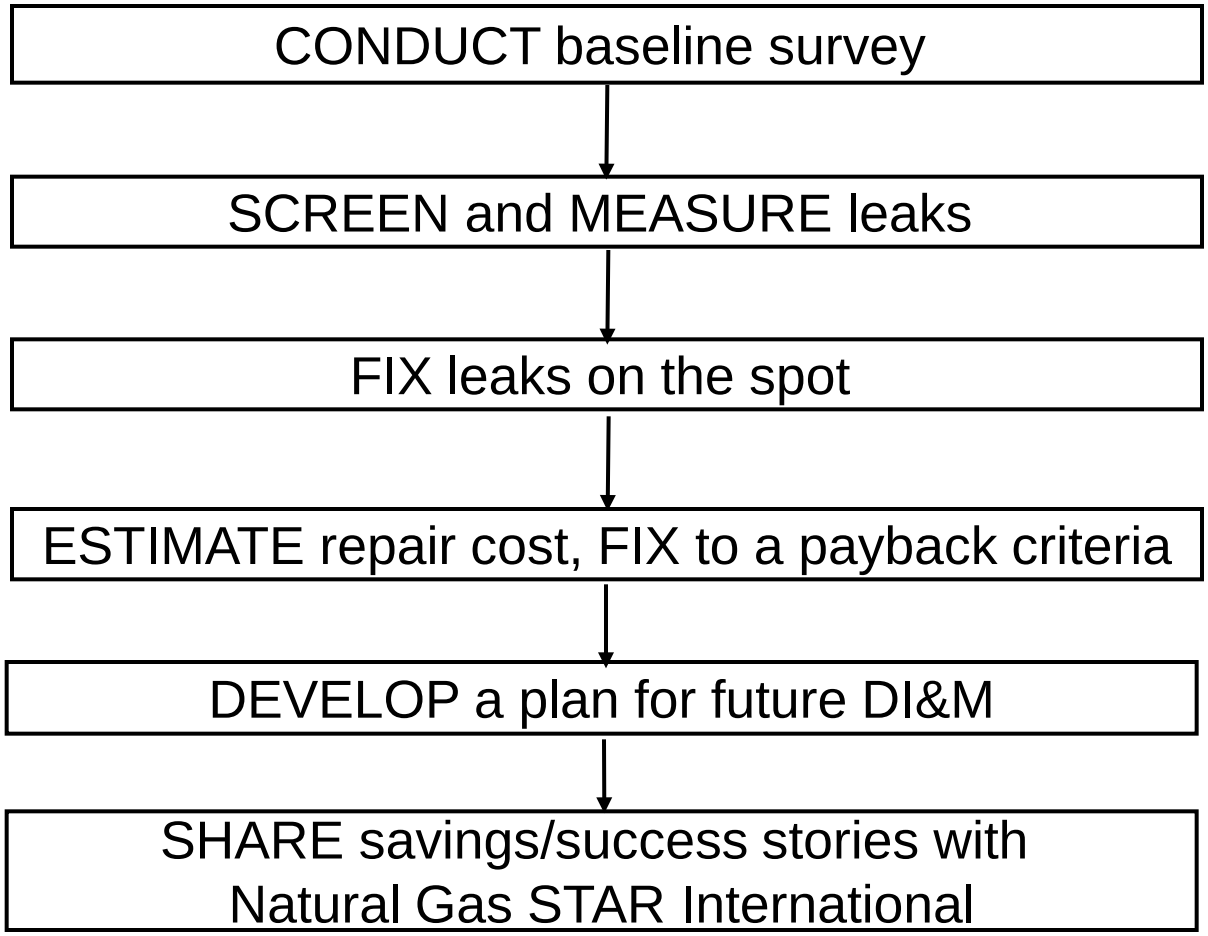
# How Do You Implement DI&M?

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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?—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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# 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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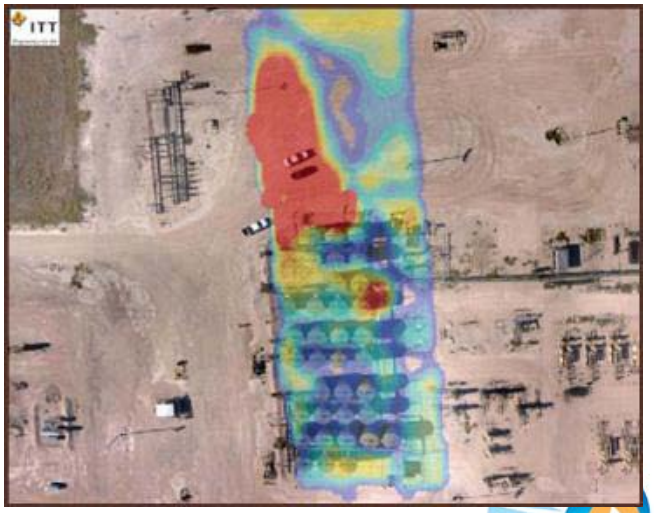
# DI&M - Aerial Leak Surveys

- 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.




Source: ANGEL, Aerial image

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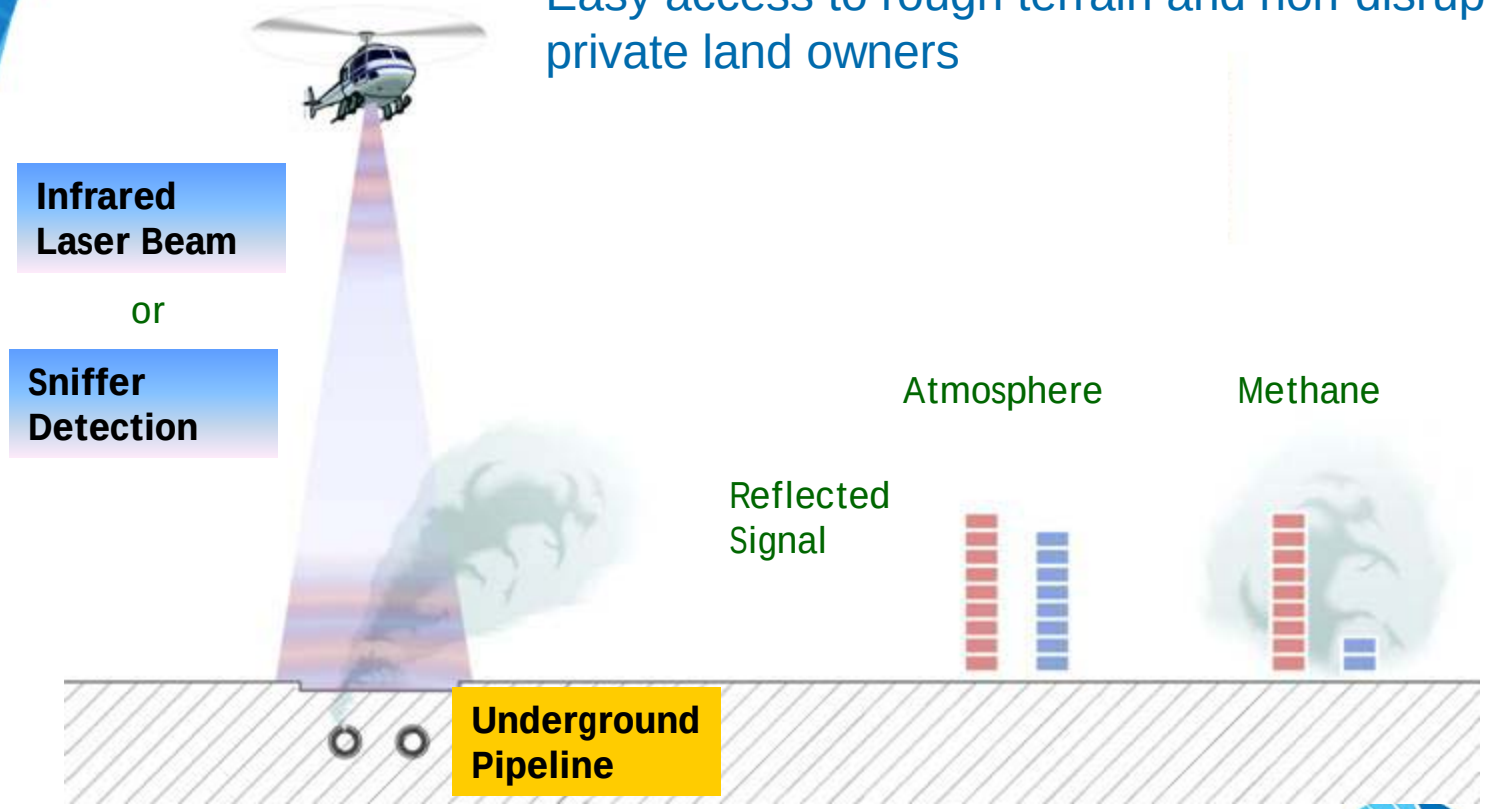
# Aerial Pipeline Surveys

- 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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# 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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# Contacts and Further Information

- More detail is available on these practices and over 80 others online at: epa.gov/gasstar/tools/recommended.html
- For further assistance, direct questions to:


*Scott Bartos*
*EPA Natural Gas STAR Program*
*bartos.scott@epa.gov*
*+1 (202) 343-9167*

*Don Robinson*
*ICF International*
*drobinson@icfi.com*
*+1 (703) 218-2512*



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# Following Presentations on Leak Detection

- "Leak Detection Practices & Demonstration of Optical Imaging"

  *Milton Heath III*

  *Heath Consultants*

  *Manager Professional Services Division*

- "Leak Detection Practices via FLIR Optical Imaging"

  *Raymond Lau*

  *FLIR Systems Co. Ltd.*

  *Area Manager – ASEA*

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