Methane to Markets

NaturalGas
EPA POLLUTION PREVENTER

Directed Inspection & Maintenance

Methane to Markets Partnership Workshop
Technology Transfer Workshop

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David Picard

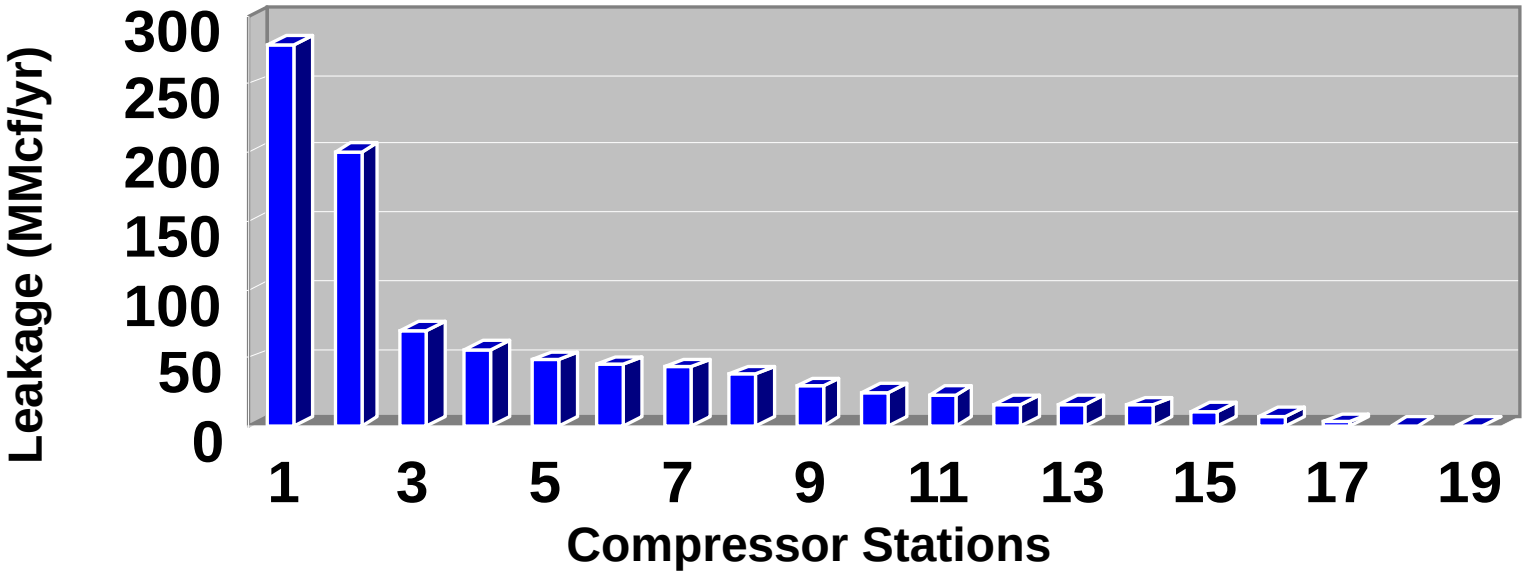
CLEARSTONE ENGINEERING

Leak Characteristics

- Contribute significantly to total CH_4 emissions at natural gas facilities.
- Only a few percent of the components actually leak.
- Most of the leakage is usually from just a few big leakers.
- Different types of components have different leak potentials and wear out at different rates.
- Components in sour or odorized service tend to leak less than those in sweet or unodorized service.

Fugitive Emissions

- Distribution of opportunities is skewed
- Few sources are responsible for majority of emissions-focus efforts on these sources first



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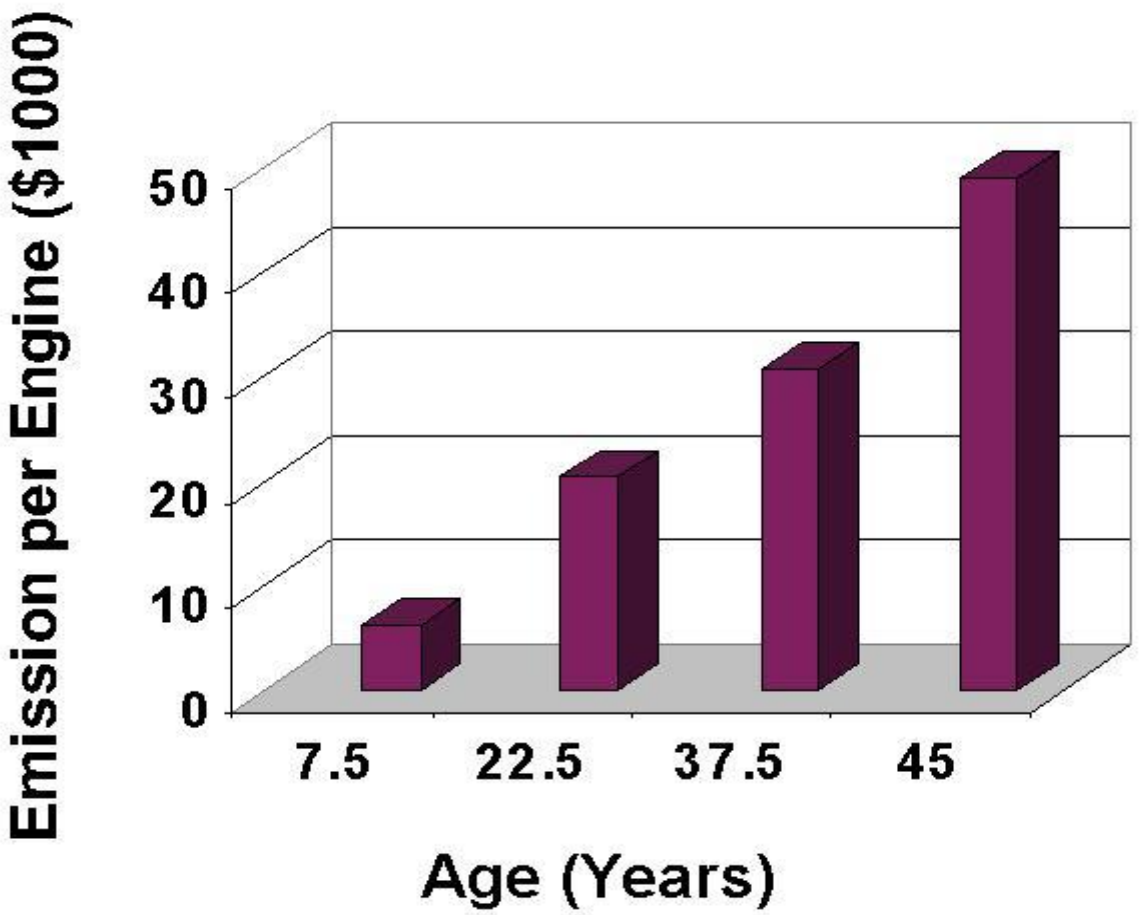
Opportunities are Greatest at Older Facilities: Average Emissions vs Age



Reasons for Big Leaks

- Flaws, improper installation, damage, and progressive deterioration.
- Severe/demanding applications coupled with high cost or difficulty of repairs.
- Lack of leak checks after maintenance activities.
- Unnoticed leaks because they occur in difficult-to-access, low-traffic, crowded or noisy areas.
- Lack of measurement data to build a business case.

What is Normal Practice?

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

What is Directed Inspection & Maintenance or DI&M?

- Fugitive losses can be reduced dramatically by implementing a systematic leak detection and repair program
- Natural Gas STAR refers to this practice as Directed Inspection and Maintenance (DI&M) :
  - Practicable ongoing program to identify & fix leaks.
  - Focus efforts on the areas that offer the greatest opportunities.
  - Use the DI&M results to determine where best to look.
  - Only fix leaks that are cost-effective to repair or pose a safety, health or environmental risk.
  - Adapt to each company's and facility's needs and circumstances.
  - Utilizes various options for leak detection & quantification.

Infrared Leak Imaging Camera

What are the Benefits?

- Resource conservation.
- Increased revenue.
- Cost-effective
- Improved system reliability.
  - Reduced downtime.
  - Potentially reduced maintenance costs through early detection of problems.
- Safer work place.
- Improved environmental performance.
- Best-in-Class recognition.

Where Should Efforts be Focused?

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**
Pressurized Station or Unit Blowdown System	219	59.8	3.41E+00	0.131	53.116	7616
Compressor Seal – Centrifugal	103	64.1	1.27E+00	0.062	9.310	2838
Compressor Seal – Reciprocating	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	185	22.7	4.86E-02	0.111	0.641	109
Control Valve	782	9	1.65E-02	0.468	0.919	37
Pressure Regulator	816	7	7.95E-03	0.488	0.462	18
Valve	17029	2.8	4.13E-03	10.190	5.011	9
Connector	145829	0.9	4.47E-04	87.264	4.644	1
Other Flow Meter	443	1.8	9.94E-06	0.265	0.000	0.02

Suggested Monitoring Frequencies

Component Specific Suggested Leak Monitoring Frequencies				
Source Category	**Type of Component**	**Service**	**Application**	**Frequency**
Process Equipment	Connectors and Covers	All		Immediately after any adjustments and once every 5 years thereafter.
	Control Valves	Gas/Vapour/LPG		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	Quarterly.
	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	Quarterly.
	Pressure-Vacuum Safety Valves	All	All	Quarterly.

How Do You Detect the Leaks?

- 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/Imaging

Acoustic Leak Detection

Toxic Vapor Analyzer

How Do You Measure the Leaks?

- Evaluate the leaks detected - measure results
  - High Volume Sampler
  - TVA (correlation factors)
  - Rotameters
  - Calibrated Bag
  - Engineering Method

Leak Measurement Using High Volume Sampler

Summary of Screening and Measurement Techniques

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	★★★	$$$

* - Least effective at screening/measurement

*** - Most effective at screening/measurement

$ - Smallest capital cost

$$$ - Largest capital cost

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Example: Economic Analysis of DI&M at Compressor Stations

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

1 – Based on $7 per thousand cubic feet gas price
Source: "Cost-effective emissions reductions through leak detection, repair". Hydrocarbon Processing, May 2002

Industry Experience – Targa Resources (U.S. Processing Company)

- Surveyed components in two processing plants: 23,169 components
- Identified leaking components: 857 (about 3.6%)
- Repaired 80 to 90% of the identified leaking components
- Annual methane emissions reductions: 5.6 million m^3/year
- Annual savings: $1,386,000/year (at $250/thousand m^3 or $7/Mcf)

Source: Targa Resources

Industry Experience – Kursk Natural Gas Distribution Company (Russian)

- Hired Heath Consultants to survey 47 regulator stations in November 2005
  - Surveyed 1,007 components
  - Found 94 leaks
- Using Hi Flow Sampler, quantified leaks as 900,000 m^3 per year
  - Initial investment of $30,000
  - Produced revenue from verified carbon credits
- So successful, Kurskgas expanded study beyond initial 47 stations and covered over 3,300 components

Summary: 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
- A relatively small number of large leaks cause most fugitive emissions
- The business of leak detection is changing dramatically with new technology like infrared cameras that make DI&M faster and easier

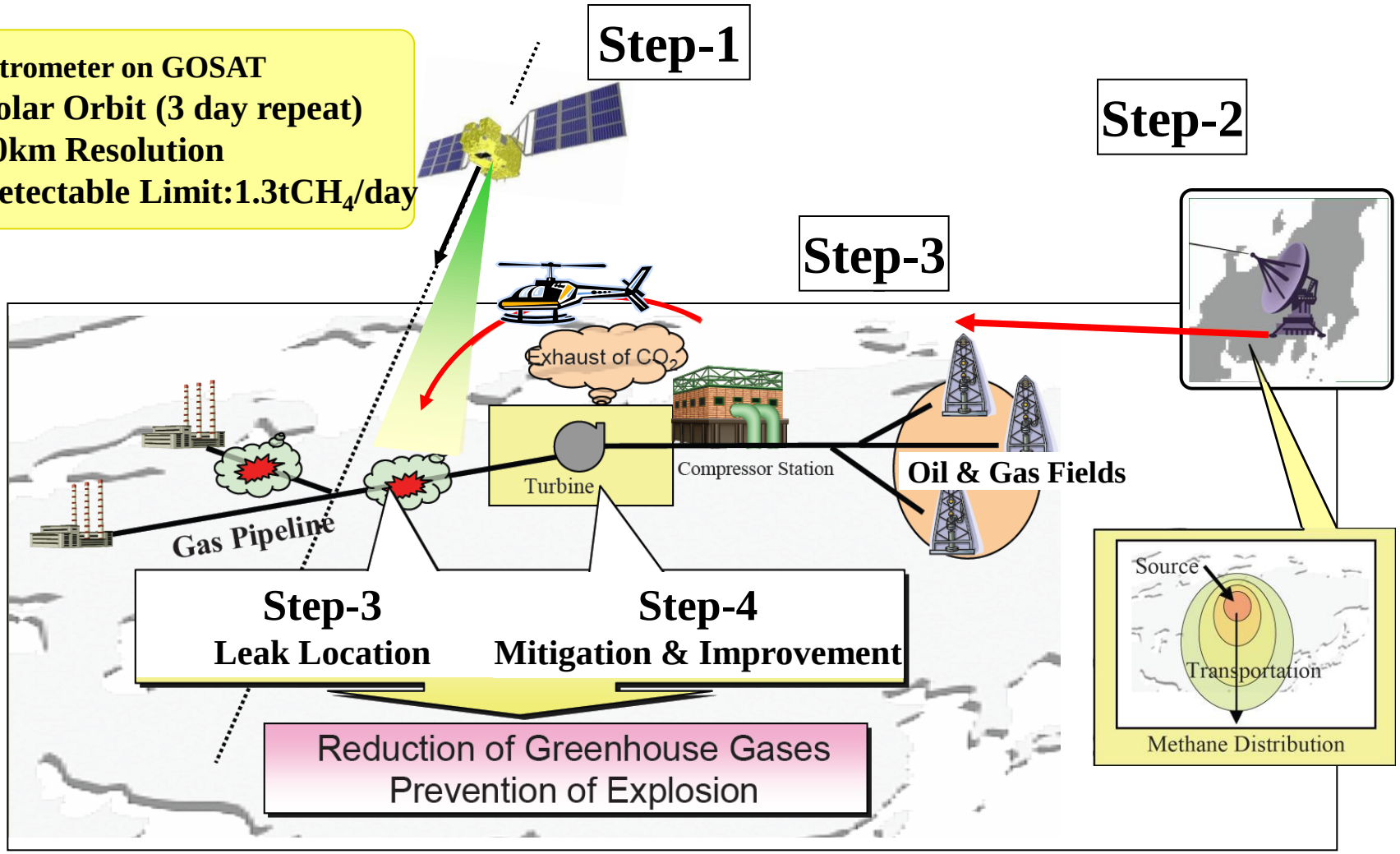
Other Innovative Leak Detection Approaches

- Greenhouse Gas Observing Satellite (GOSAT)
  - Joint project of JAXA (Japan Aerospace Exploration Agency), MOE (Ministry of the Environment) and NIES (National Institute for Environmental Studies)
- Observes concentrations of GHGs from orbit
  - Passive observation system
    - Calculates gas concentration using reflected light radiated by the sun that is absorbed by GHGs
    - Wide range of wavelengths (near infrared to thermal infrared)
  - Projected launch: early 2009

The concept of the natural gas pipeline leak detection system using GOSAT

Step-1:Satelite Pipeline leak observation
Step-2:Data transmission and analysis
Step-3:Ground exploration based on results of analysis
Step-4:Mitigation of problems

Spectrometer on GOSAT
- **Polar Orbit (3 day repeat)**
- **10km Resolution**
- **Detectable Limit:1.3tCH_4/day**



Wrap up

- Questions?
- Additional Information
  - http://www.epa.gov/gasstar/tools/recommended.html
  - http://www.capp.ca/getdoc.aspx?DocId=116116&DT=PDF
- Thank you
- David Picard, Clearstone Engineering, Ltd
- dave.picard@clearstone.ca