Methane to Markets

Methane to Markets Experience with Methane Leak Detection and Measurement Technologies

Gazprom – EPA Technical Seminar on Methane Emission Mitigation

28 – 30 October, 2008

Methane Leak Detection and Measurement Technologies

- Systematic Leak Inspection and Repair Program (Directed Inspection and Maintenance)
  - Methane Emission Sources
  - Methane Recovery: Directed Inspection and Maintenance (DI&M)
  - DI&M with Infrared Leak Detection
  - Industry Experience
  - Summary: Lessons Learned
- Other Innovative Leak Detection Approaches
- Discussion

Source: TransCanada

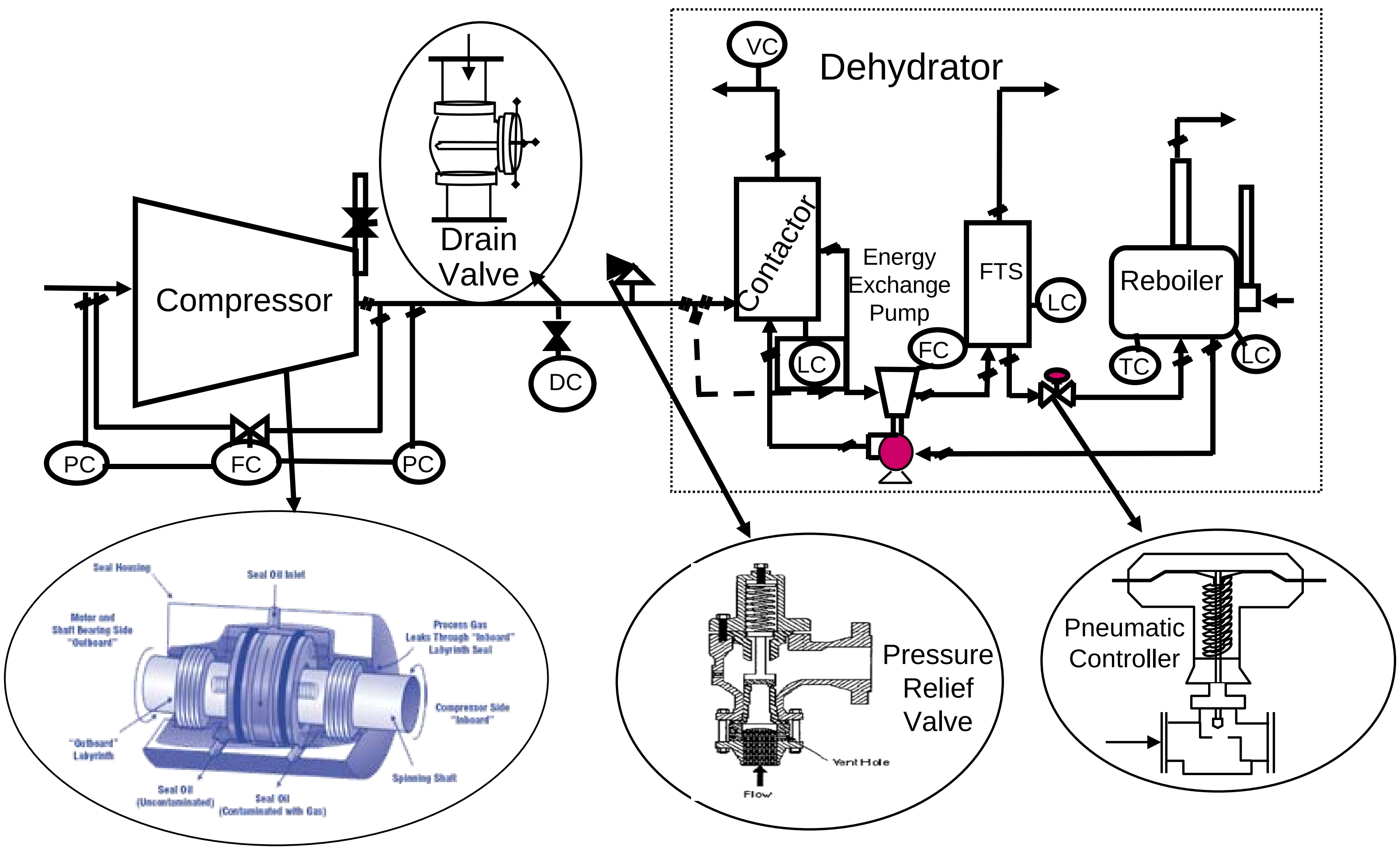
Basis of Recommended Technologies and Practices

- All technologies and practices promoted by Methane to Markets and Natural Gas STAR are proven based on successful field implementation by Partner companies
- Examples represented in the following presentation are based on company specific data collected from actual projects in the U.S. and other countries; economic information is presented according to U.S. costs and gas prices

What is the Problem?

- Transmission methane gas leaks are *invisible*, *odorless*, and *go unnoticed*
- Natural Gas STAR transmission and processing companies find that valves, connectors, compressor seals, and open-ended lines (OELs) are major methane fugitive emission sources
  - Transmission fugitive methane emissions depend on operating practices, equipment age, and maintenance practices

Overview: Methane Emission Sources



Leak Detection Study: Key Methane Emission Sources

- Study of 4 natural gas facilities provides insight into key methane sources[1]
  - Screened for all leaks, measured larger leak rates
- Principles of study are relevant to all sectors
  - A relatively small number of large leaks cause most fugitive emissions
  - Fugitive leaks from valves, connectors, compressor seals, and open-ended lines are a large source of revenue loss for all sectors
  - Solution is the same

Source: Hy-bon

[1] Clearstone Engineering, 2002, *Identification and Evaluation of Opportunities to Reduce Methane Losses at Four Gas Processing Plants*. Report detailing results of a methane emission leak detection survey at four gas processing plants in Wyoming and Texas.

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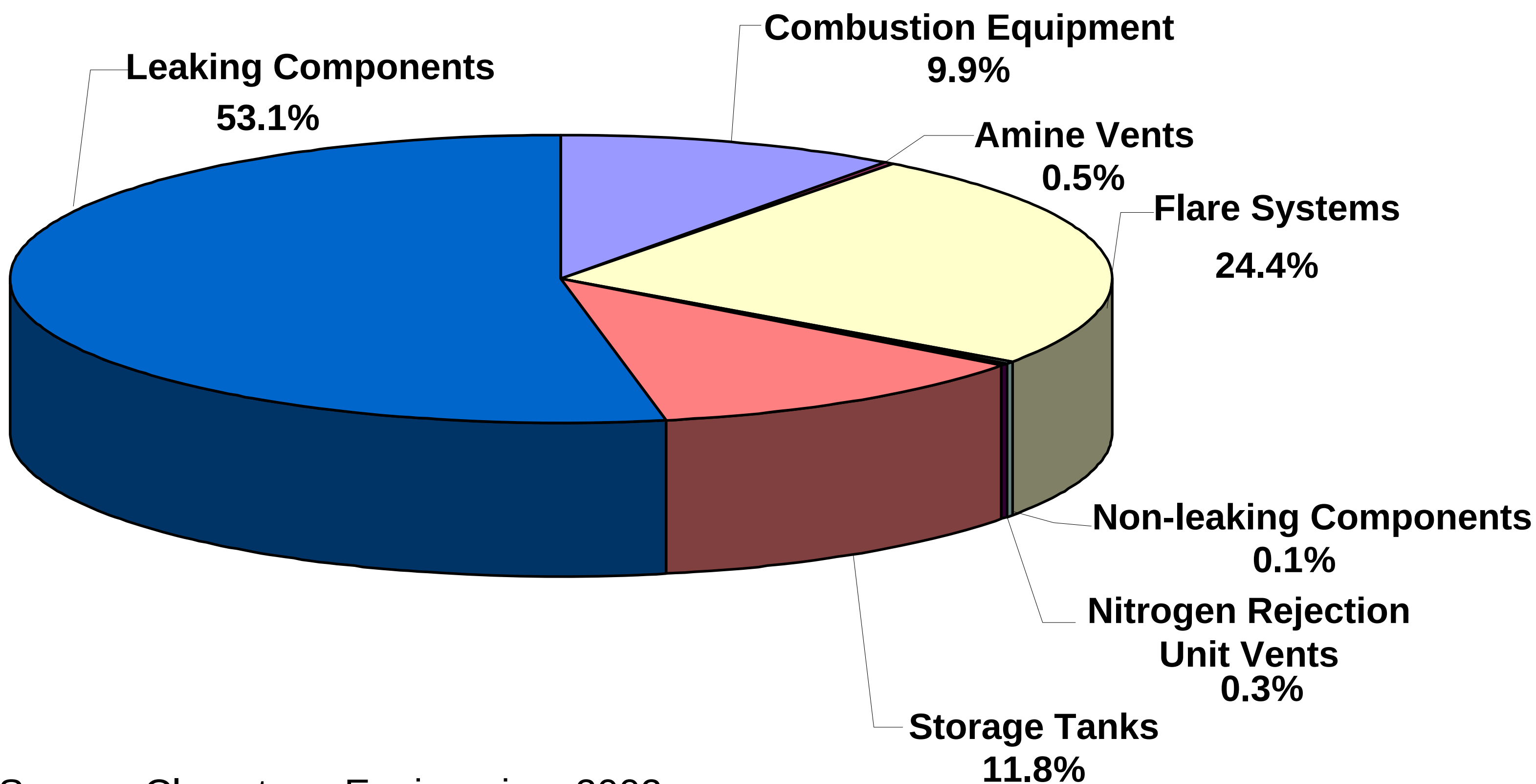
Study Findings: Distribution of Methane Emissions by Source Category

- Equipment leaks are the largest emissions
  - Production & processing share some similar sources



Source: Clearstone Engineering, 2002

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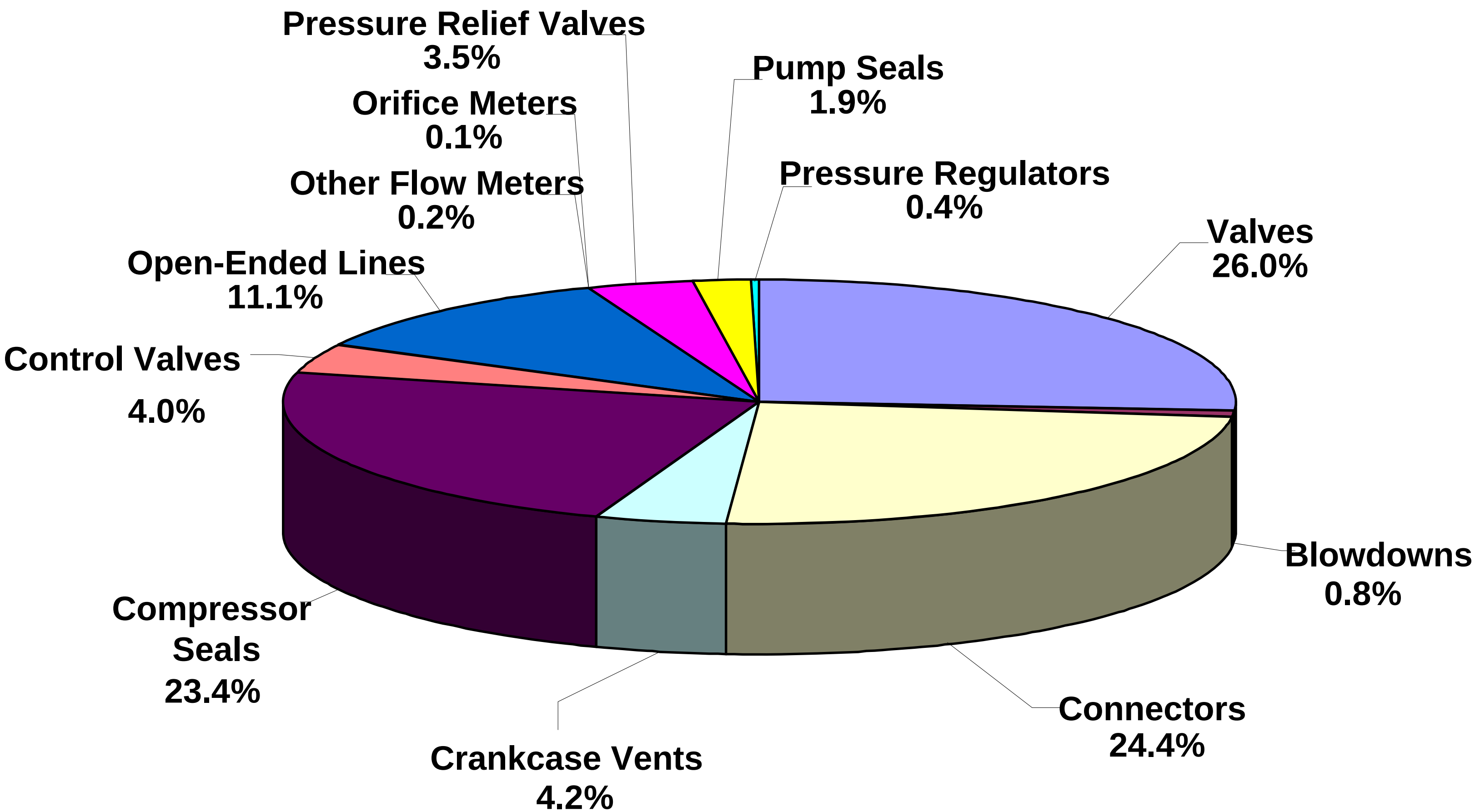
Study Findings: Distribution of Methane Emissions by Type of Component

- Distribution of leak sources similar in processing and transmission



Source: Clearstone Engineering, 2002

Study Findings: Quantity of Methane Emitted

Methane Emissions from Leaking Components at Gas Facilities			
Component Type	**% of Total Methane Emissions**	**% Leak Sources**	**Estimated Average Methane Emissions per Leaking Component (m^3/year)**
Valves (Block & Control)	26.0%	7.4%	1,869
Connectors	24.4%	1.2%	2,265
Compressor Seals	23.4%	81.1%	10,534
Open-ended Lines	11.1%	10.0%	5,267
Pressure Relief Valves	3.5%	2.9%	23,899
Source: Clearstone Engineering, 2002			

Study Findings: Quantity of Methane Emitted

Facility	Gas Losses From Top 10 Leak Sources (m^3/day)	Gas Losses From All Leak Sources[2] (m^3/day)	Contribution By Top 10 Leak Sources (%)	Contribution By Total Leak Sources (%)
A	1,240	3,469	35.7	1.78
B	3,777	5,847	64.6	2.32
C	6,346	9,982	63.6	1.66
D	2,166	5,983	36.2	1.75
Combined	13,530	25,281	53.5	1.85

Source: Clearstone Engineering, 2002

1 – Excluding leakage into flare system
2 – Approximately 10,000 components tested in each facility

Methane Recovery: Directed Inspection & Maintenance (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)
  - Program to identify and fix leaks that are cost effective to repair
  - Many options for leak detection technologies
  - Provides valuable data on sources of leaks with information on where to look
  - Strictly adapted to company's needs
  - Cost-effective practice, by definition

Infrared Leak Imaging Camera

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

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

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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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NaturalGas EPA POLLUTION PREVENTER

Additional Gas Vent Measurement Tools

- GRI-GLYCalc
  - Software tool that uses field conditions and compositional data to simulate hydrocarbon emissions from glycol dehydrators
  - Factors in flash gas control technologies into emissions estimate
- Vasquez-Beggs
  - Estimate methane emissions from oil and condensate tanks

Vasquez-Beggs Equation

$$GOR = A \times (G_{flash\ gas}) \times (P_{sep} + 14.7)^{B} \times \exp\left(\frac{C \times G_{oil}}{T_{sep} + 460}\right)$$

where,

GOR	=	Ratio of flash gas production to standard stock tank barrels of oil produced, in scf/bbl oil (barrels of oil corrected to 60°F)
$G_{flash\ gas}$	=	Specific gravity of the tank flash gas, where air = 1. A suggested default value for $G_{flash\ gas}$ is 1.22 (TNRCC; Vasquez, 1980)
G_{oil}	=	API gravity of stock tank oil at 60°F
P_{sep}	=	Pressure in separator, in psig
T_{sep}	=	Temperature in separator, °F

For $G_{oil} \leq 30°$API: A = 0.0362; B = 1.0937; and C = 25.724

For $G_{oil} > 30°$API: A = 0.0178; B = 1.187; and C = 23.931

psig – pounds per square inch, gauge

scf – standard cubic feet

bbl – barrels

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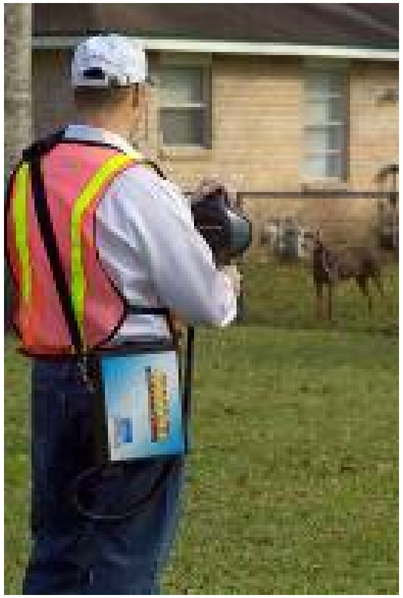
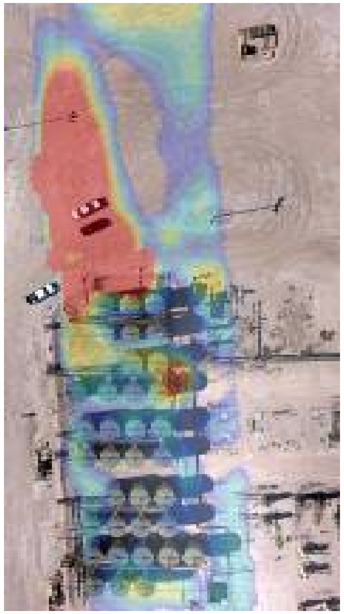
DI&M with Infrared Leak Detection

- The challenge has always been finding those few large leaks among the hundreds of components
- Real-time detection of gas leaks
  - Quicker identification and repair of leaks
  - Screen hundreds of components an hour
  - Easily screen inaccessible areas





Remote Sensing and Leak Detection Video

- Techniques to find fugitive leaks with new technology and equipment

5 minutes

Available for download at www.epa.gov/gasstar

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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

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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

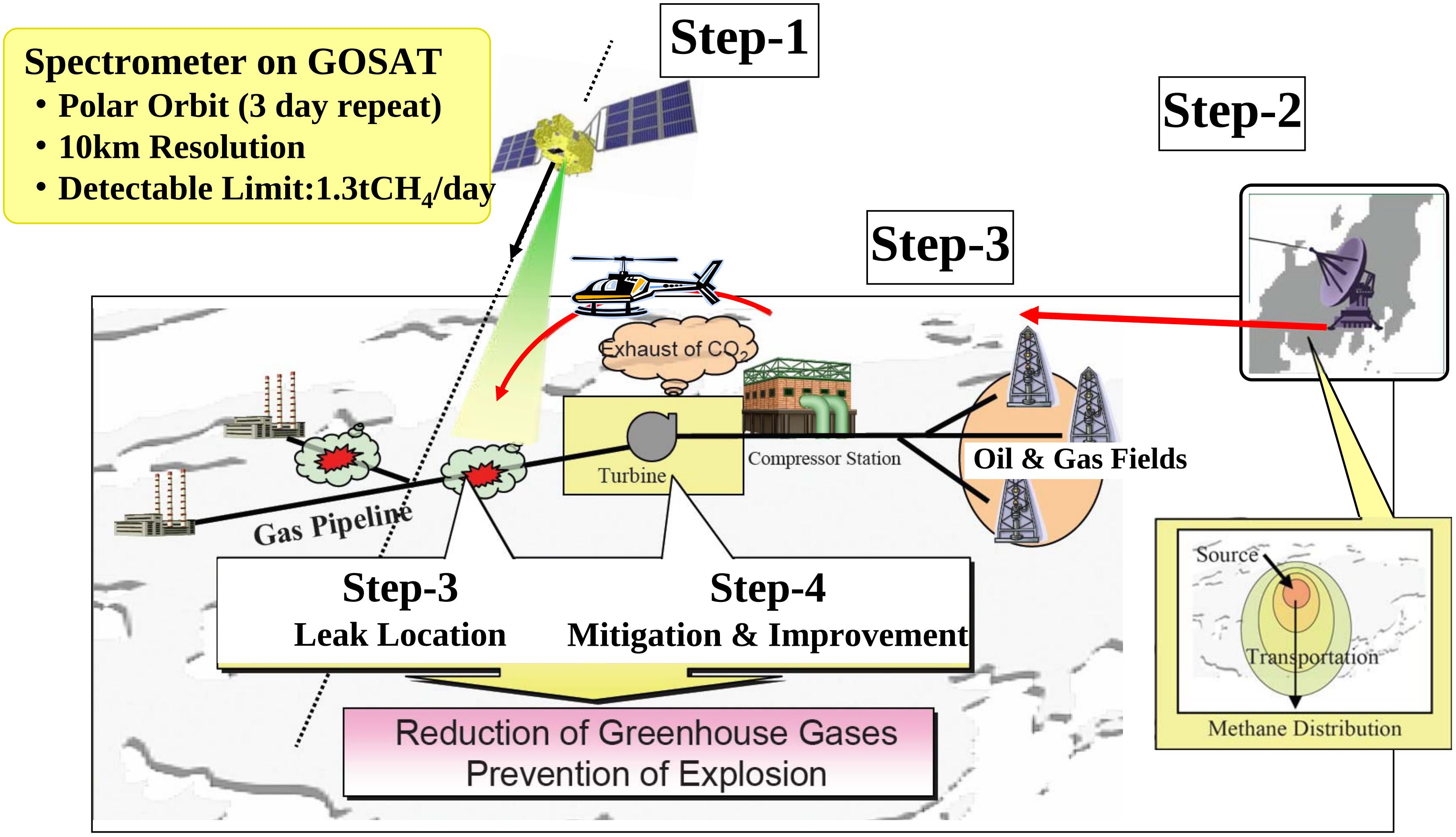
- A successful, cost-effective DI&M program requires measurement of the leaks
- A high volume sampler is an effective tool for quantifying leaks and identifying cost-effective repairs
- A relatively small number of large leaks cause most fugitive emissions
- The business of leak detection is changing 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



Discussion Questions

- To what extent are you implementing these opportunities?
- How could these opportunities be improved upon or altered for use in your operation?
- Do you use any additional methods?
- What are the barriers (technological, economic, lack of information, labor, etc.) that are preventing you from implementing these practices?