Directed Inspection and Maintenance (DI&M) at Gas Processing Plants

Innovative Technologies for the Oil & Gas Industry: Product Capture, Process Optimization, and Pollution Prevention

Targa Resources and the Gas Processors Association

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Hobbs, NM

epa.gov/gasstar

DI&M at Gas Processing Plants Outline

- Methane Losses
- Methane Recovery
- Is Recovery Profitable?
- Industry Experience
- Discussion

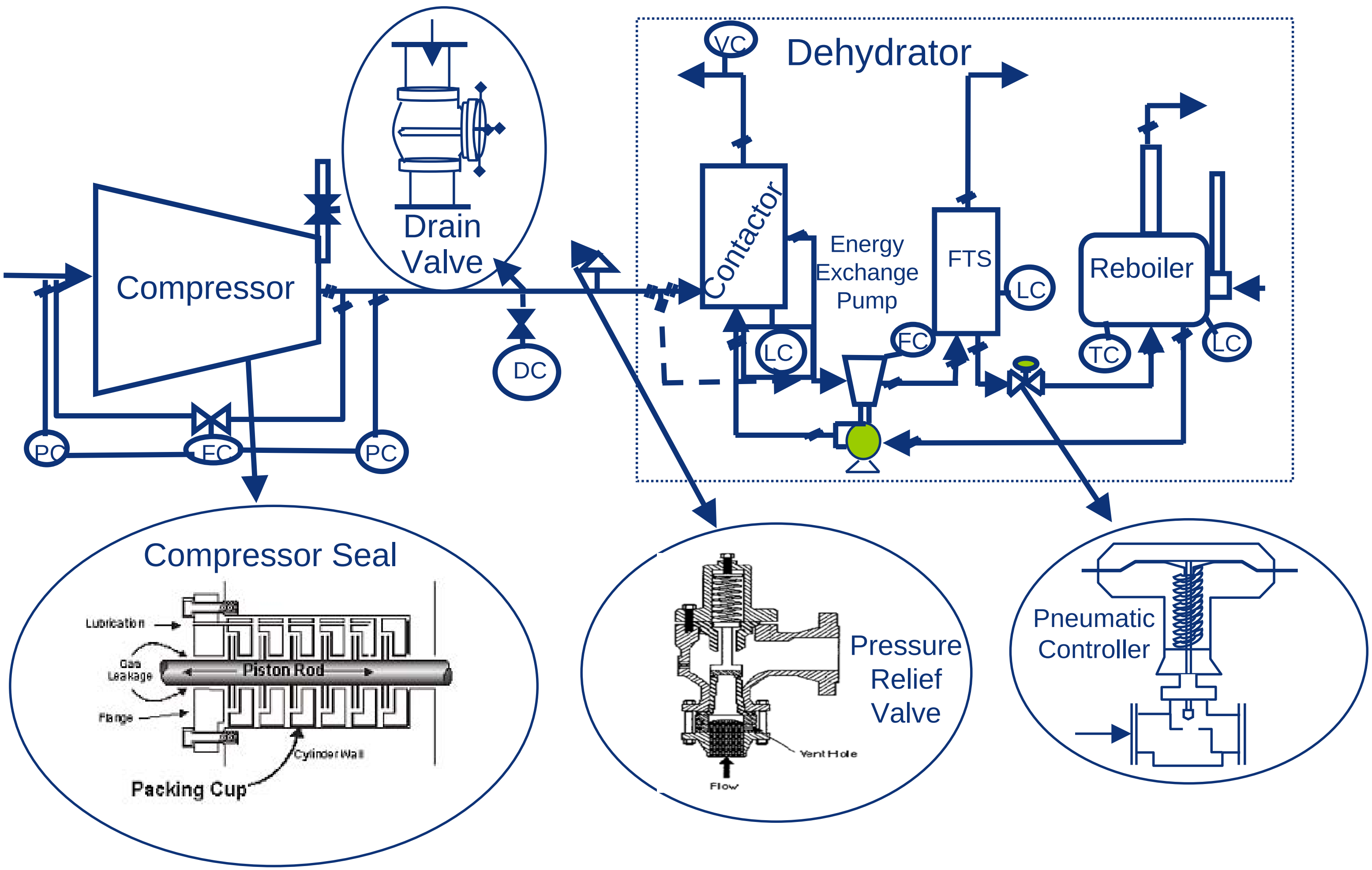
Methane Losses

- Estimated 567 processing plants nationally
- Estimated 5,000 compressors in processing sector
- National fugitive and compressor seal methane emissions from processing plants is estimated to be 25 billion cubic feet per year (Bcf/yr)
- Estimated 44 million cubic feet (MMcf) per plant-yr methane emissions
  - Worth $308,000/plant-yr

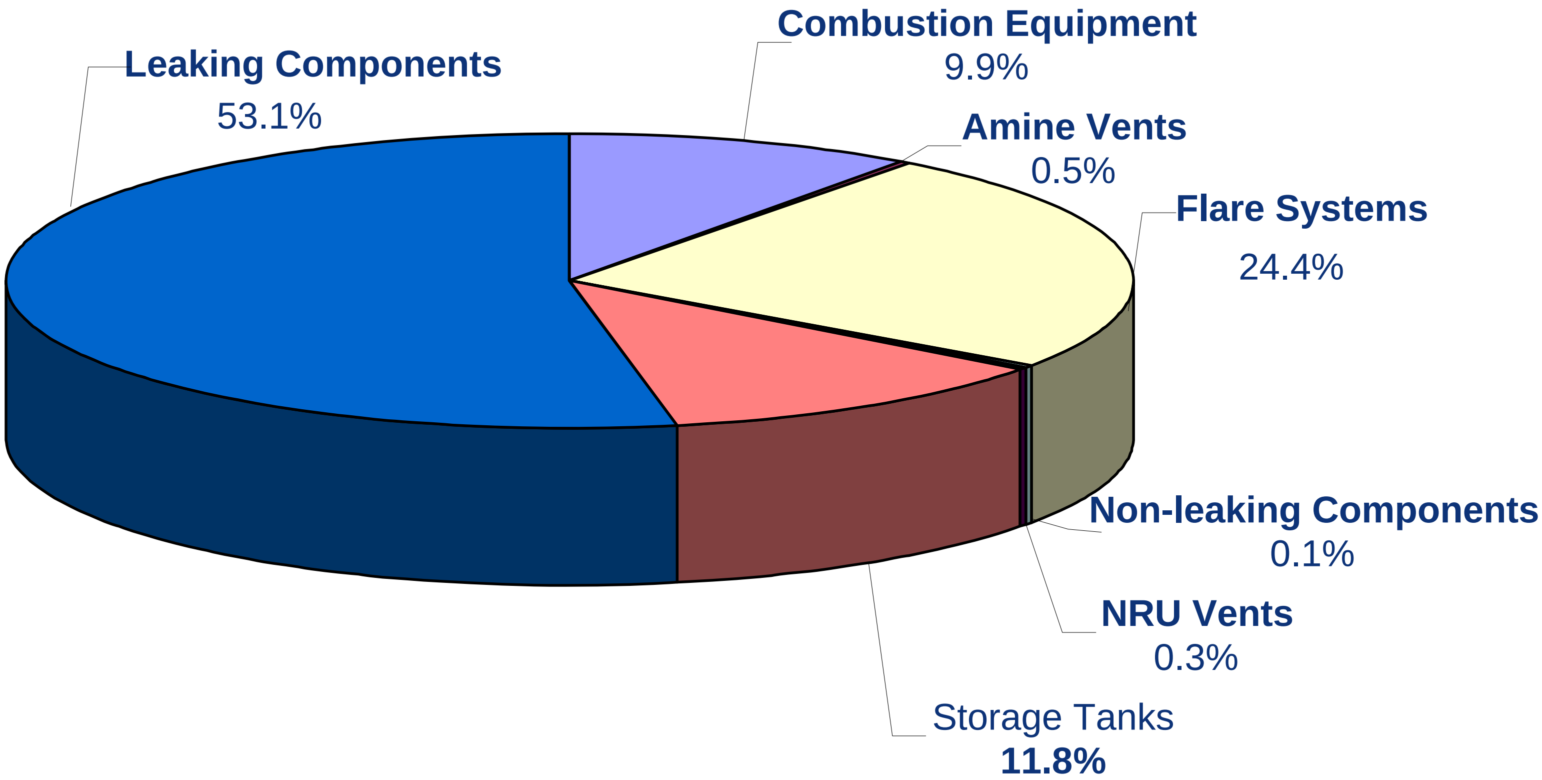
What is the Problem?

- Gas leaks are *invisible*, *unregulated* and *go unnoticed*
- Gas STAR Partners find that valves, connectors, compressor seals and open-ended lines (OELs) are major sources
  - 25 Bcf of methane emitted per year by reciprocating compressors seals and OELs, each contributing equally to the emissions
- Gas plant fugitive methane emissions depend on operating practices, equipment age and maintenance

What are the Sources of Emissions?

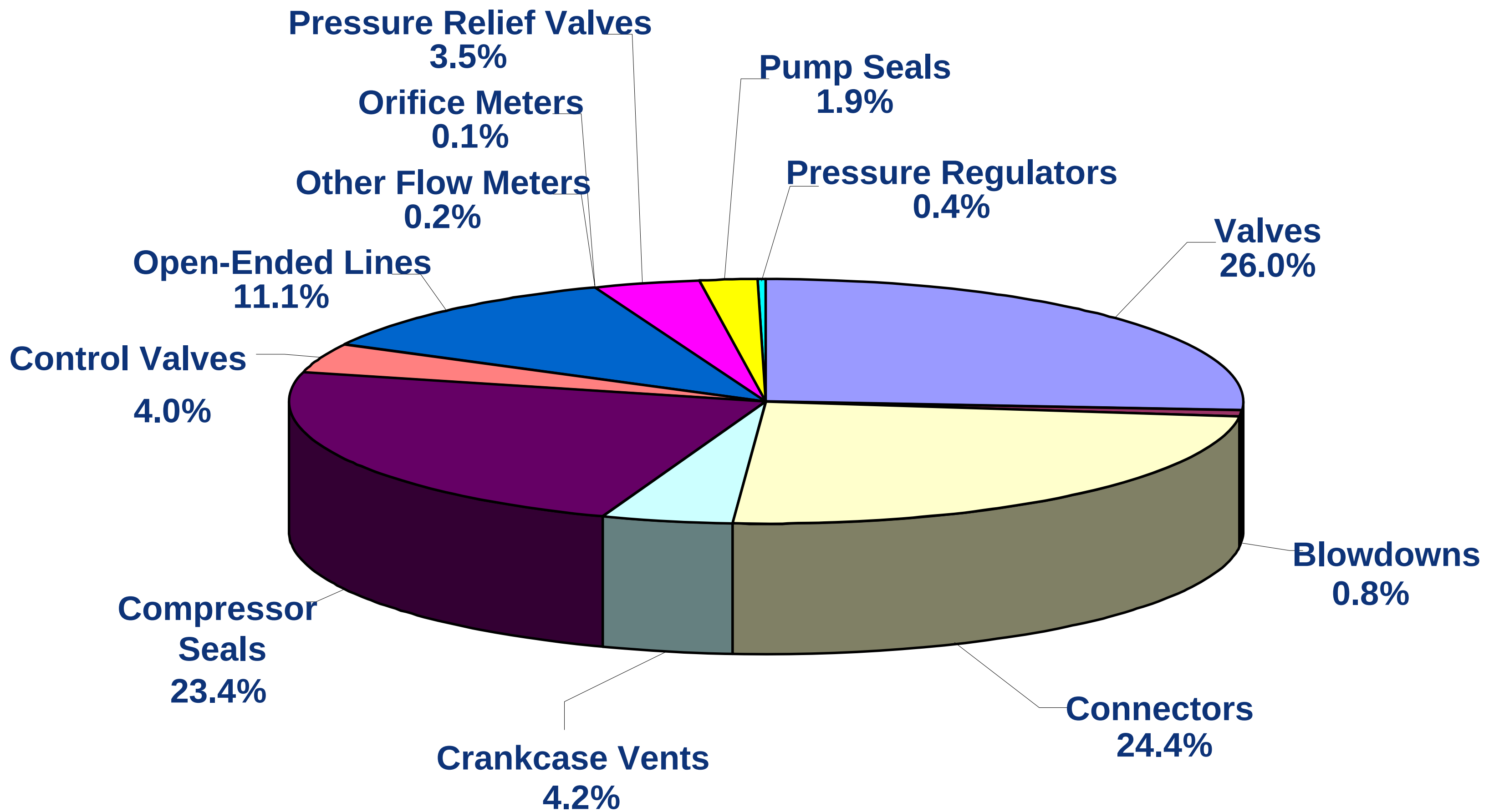


Distribution of Losses by Source Category



Source: Clearstone Engineering, 2002

Distribution of Losses from Equipment Leaks by Type of Component



Source: Clearstone Engineering, 2002

How Much Methane is Emitted?

Methane Emissions from Leaking Components at Gas Processing Plants			
Component Type	**% of Total Methane Emissions**	**% Leakers**	**Estimated Average Methane Emissions per Leaking Component (Mcf/Yr)**
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 4 gas processing plants in WY and TX to evaluate opportunities to economically reduce methane emissions.			

DI&M - Partner Experience

- Four gas processing plants were selected for joint EPA/GTI study of DI&M using high volume sampler
- Initial estimates have been shown to be 40% lower than actual component count during baseline study
- Final component count
  - Plant 1 - 16,050 components
  - Plant 2 - 14,424 components
  - Plant 3 - 56,463 components
  - Plant 4 - 14,168 components

How Much Methane is Emitted?

Summary of Natural Gas Losses from the Top Ten Leakers[1]				
Plant No.	Gas Losses From Top 10 Leakers (Mcf/d)	Gas Losses From All Equipment Leakers (Mcf/d)	Contribution By Top 10 Leakers (%)	Contribution By Total Leakers (%)
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	892.84	53.5	1.85

[1]Excluding leakage into flare system

Methane Recovery

- Fugitive losses can be dramatically reduced by implementing a DI&M 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 leakers with information of where to look

What is DI&M?

- Directed Inspection and Maintenance
  - Cost-effective practice by definition
  - Find and fix significant leaks
  - Choice of leak detection technologies
  - Strictly tailored to company’s needs
- DI&M is <u>NOT</u> the regulated volatile organic compound leak detection and repair (VOC LDAR) program

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

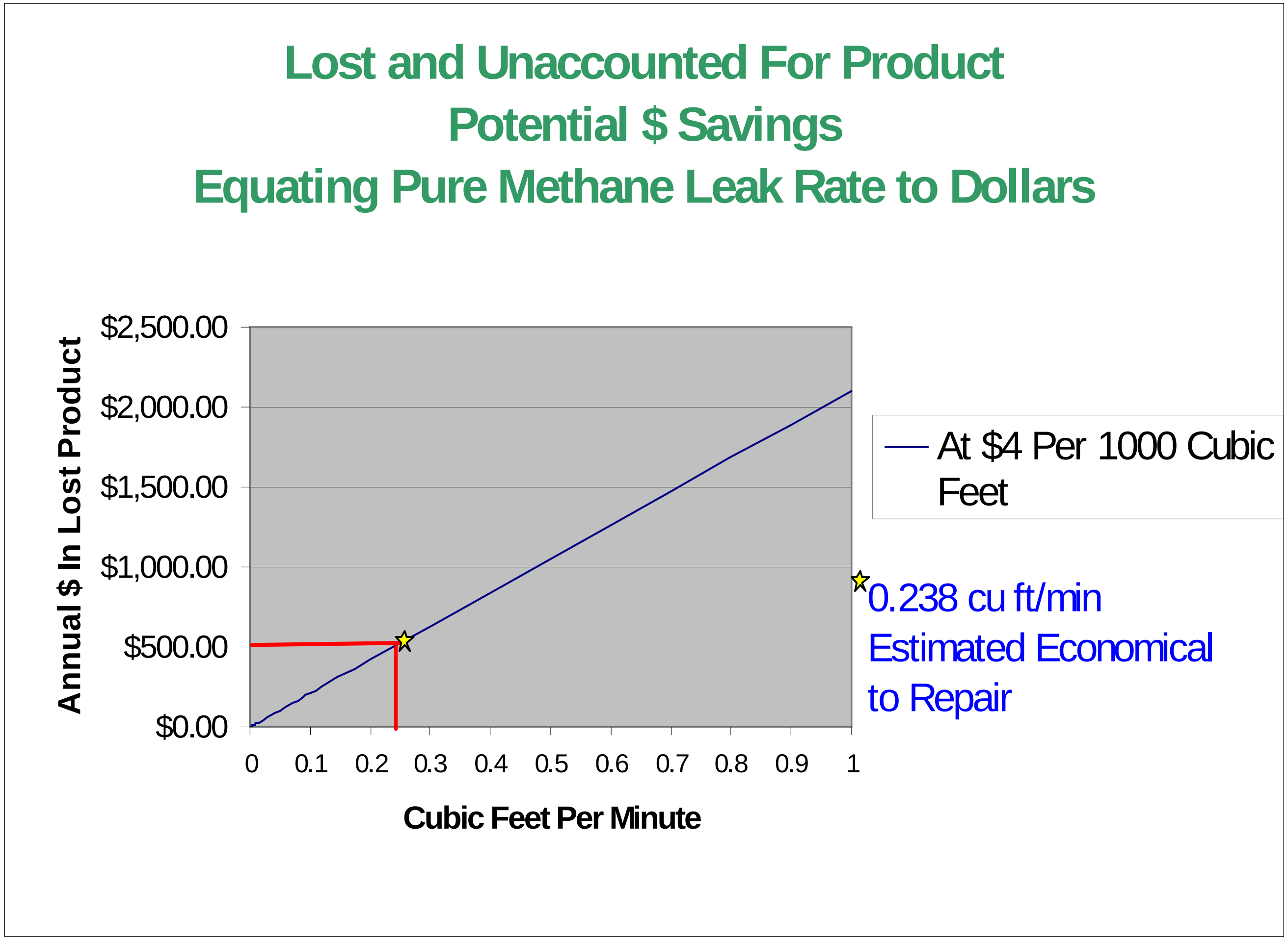
↓

DEVELOP a plan for future DI&M

↓

RECORD savings/REPORT to Gas STAR

Economics of LAUF



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
  - Optical Leak Imaging

Toxic Vapor Analyzer

Acoustic Leak Detection

How Do You Implement DI&M?

- Evaluate the leaks detected - measure results
  - High Volume Sampler
  - Toxic Vapor Analyzer (correlation factors)
  - Rotameters

Leak Measurement Using a High Volume Sampler

How Do You Implement DI&M?

Summary of Screening and Measurement Techniques		
Instrument/ Technique	**Effectiveness**	**Approximate Capital Cost**
Soap Solution	★★	$
Electronic Gas Detectors	★	$$
Acoustic Detection/ Ultrasound Detection	★★	$$$
TVA (FID)	★	$$$
Bagging	★	$$$
High Volume Sampler	★★★	$$$
Rotameter	★★	$$
Source: EPA's Lessons Learned Study		

*** - Least effective at screening/measurement**

***** - Most effective at screening/measurement**

$ - Smallest capital cost

$$$ - Largest capital cost

Estimating Comprehensive Survey Cost

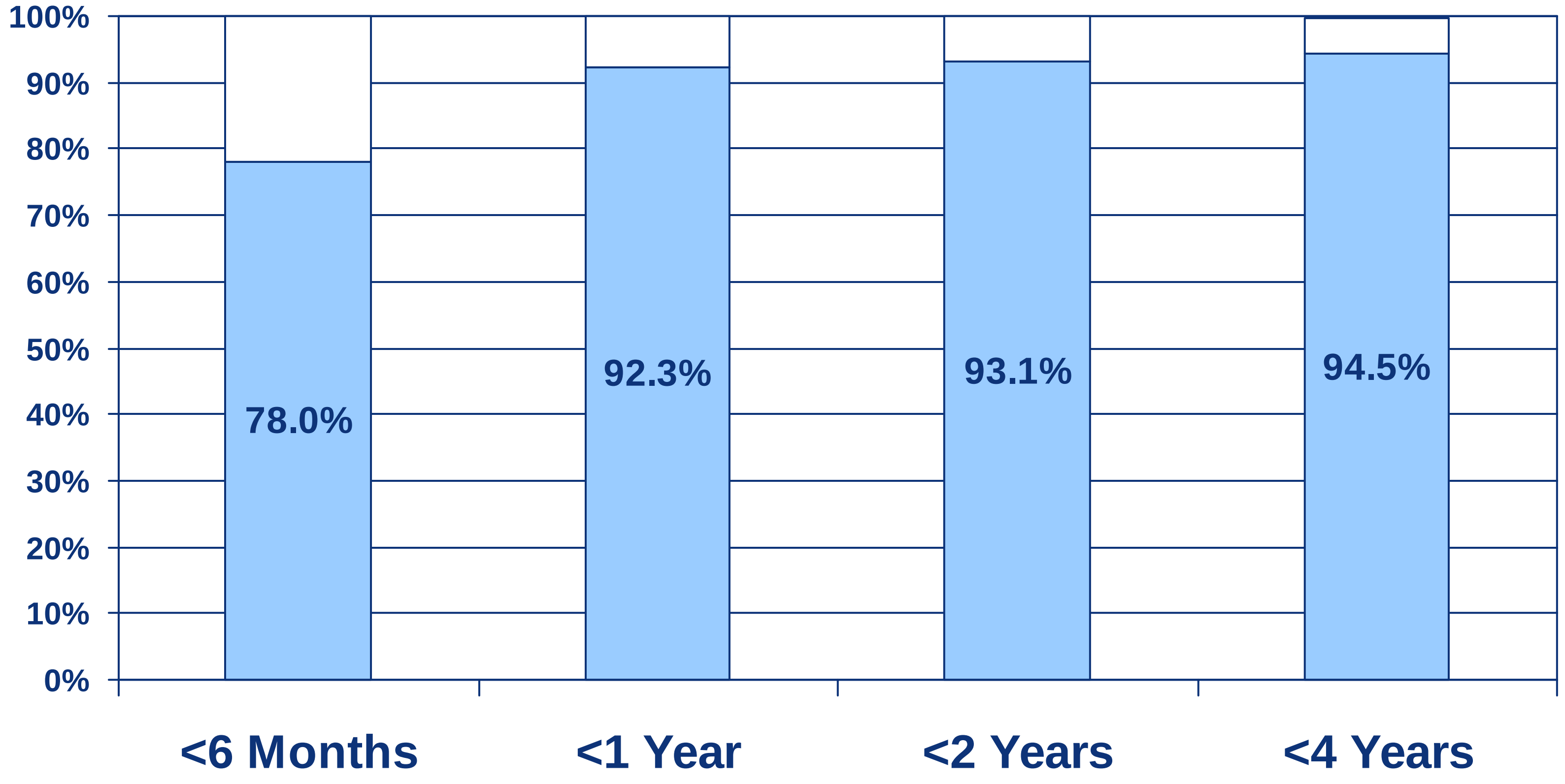
- Cost of complete screening using High Volume Sampler
  - Ranges $15,000 -$20,000 per medium size plant
  - Rule of Thumb: $1 per component for an average plant
- 25 - 40% cost reduction for follow-up survey

Cost-Effective Examples

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

Total Loss Reductions that are Cost-Effective to Find and Fix for Gas Plants



Economic Analysis of DI&M of OELs

Economics Analysis of DI&M of Open-Ended Lines at Large and Small Gas Plants[1]		
	Large	**Small**
Inspection of Plants OELs (Man-day/yr)	**1**	**1**
Inspection of Booster OELs (Man-day/yr)	**2**	**3**
Inspection Prep and Record (Man-day/yr)	**NA**	**3**
Repairs & Maintenance (Man-days)	**1**	**2**
Labor Cost ($/day)	**500**	**500**
Total Labor Cost ($/yr)	**2,000**	**4,500**
Methane Savings (Mcf/yr)	**3,319**	**4,526**
Gas Savings (Mcf/yr)[2]	**3,688**	**5,029**
Gas Saving Value ($/yr)	**25,816**	**35,203**
Payback (yr)	**<1**	**<1**

[1] Assumes two inspections per year

[2] Gas values based on $7/Mcf

Case Study: Targa Resources (formerly Dynegy)

- Surveyed components in two processing plants: 30,208 components
- Identified leaking components: 1,156 ~ 3.8%
- Repaired components: 80-90% of the identified leaking components
- Annual methane emissions reductions: 100,000 thousand cubic feet per year (Mcf/yr)
- Annual savings: $700,000 / year (at $7/Mcf)

Case Study 2: Targa Resources (formerly Dynegy)

- Surveyed components in two processing plants: 23,169 components
- Identified leaking components: 857 ~ 3.6%
- Repaired components: 80-90% of the identified leaking components
- Annual methane emissions reductions: 198,000 thousand cubic feet per year (Mcf/yr)
- Annual savings: $1,386,000 / year (at $7/Mcf)

DI&M Partner Experience: BP

- One large gas plant to date - 40,000 components
- Results
  - 938 equipment leaks identified – 37 MMcf/yr
    - 50% of volume from top 31 leaks
    - 75% of the volume from top 83 leaks
  - 48 compressor seals checked – 20 MMcf/yr
    - 16 leaks
    - 50% of volume from top 2 seals
    - 80% of volume from top 6 seals
  - One “water” tank issue found – 66 MMcf/yr
- Ten-year net present value is $2.4 MM; Payout is 2 months

DI&M - Partner Experience

- **Success #1:** A leaking cylinder head was tightened, which reduced methane emissions from almost 64,000 Mcf/yr to 3,300 Mcf/yr. The repair required 9 man-hours of labor, and the annualized gas savings were approximately 60,700 Mscf/yr. The estimated value of the gas saved was $424,900/yr.

- **Success #2:** A one-inch pressure relief valve emitted almost 36,774 Mcf/yr. Five man-hours of labor and $125 of materials eliminated the leak. The annualized value of the gas saved was more than $257,400.

Gas values based on $7/Mcf

DI&M - Partner Experience

- **Success #3:** A blowdown valve leaked almost 14,500 Mcf/yr. Rather than replace the expensive valve, the Partner spent just $720 on labor and materials to reduce the emissions to approximately 100 Mscf/yr. The gas saved was approximately 14,400 Mcf/yr, worth $100,800.

- **Success #4:** A tube fitting leaked 4,121 Mcf/yr. A very quick repair requiring only five minutes reduced the leak rate to 10 Mcf/yr. The annualized value of the gas saved was approximately $28,847.

Infrared Gas Imaging

- Video recording of fugitive leak found by infrared camera

Optical Remote Leak Detection

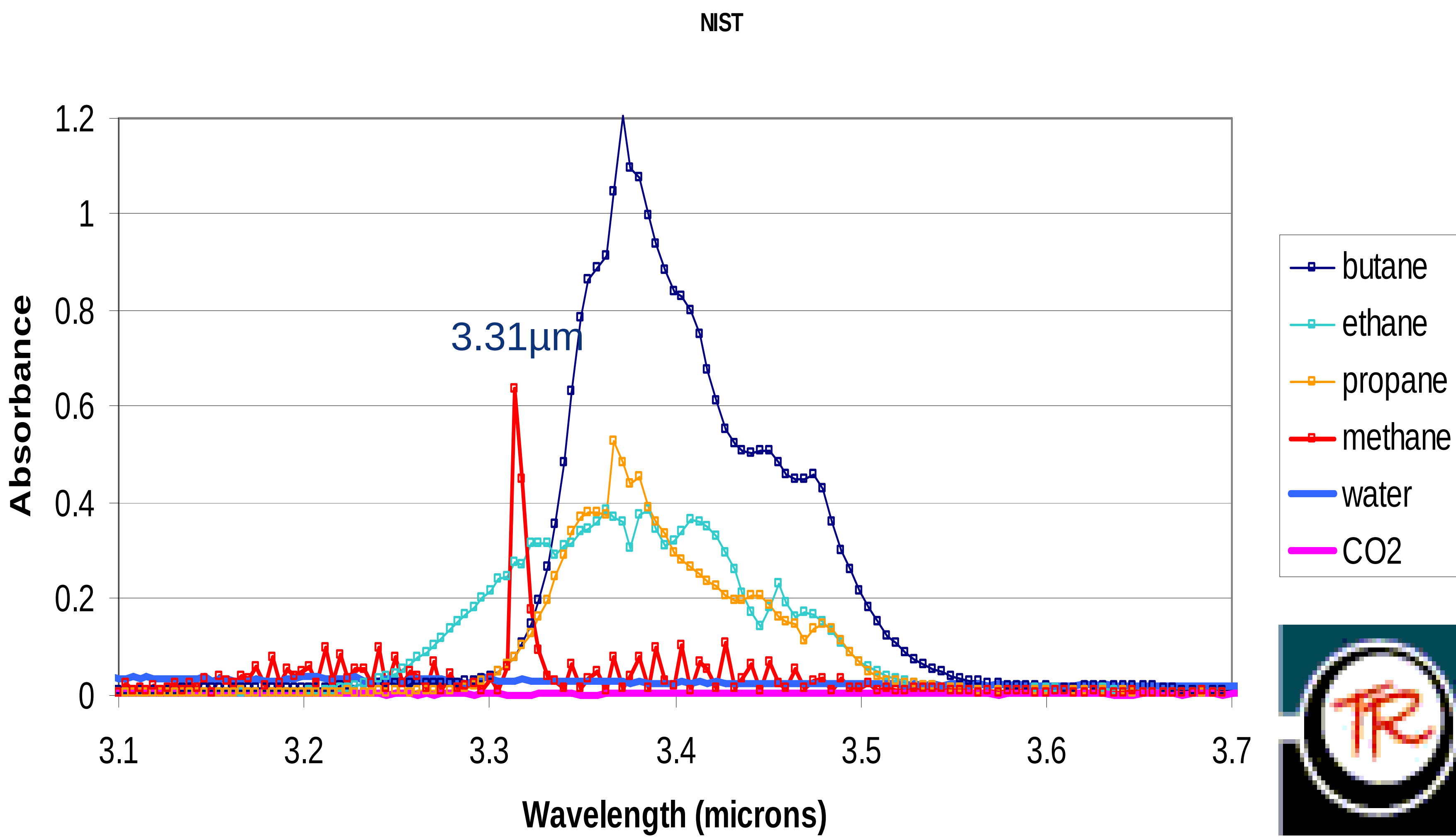
Infrared Differential Absorption

- Mid wave Infrared - 3 to 5 µm
- Long wave Infrared - 8 to 11 µm
- Visible - 0.4 to 1.0 Microns
- Near IR -0.9 to 1.6 Microns

Remote sensing is the science and art of obtaining information about an object, area, or phenomenon through the analysis of data acquired by a device that is not in contact with the object, area, or phenomenon under investigation.

From Remote Sensing and Image Interpretation, Lilles and and Kiefer, 1987

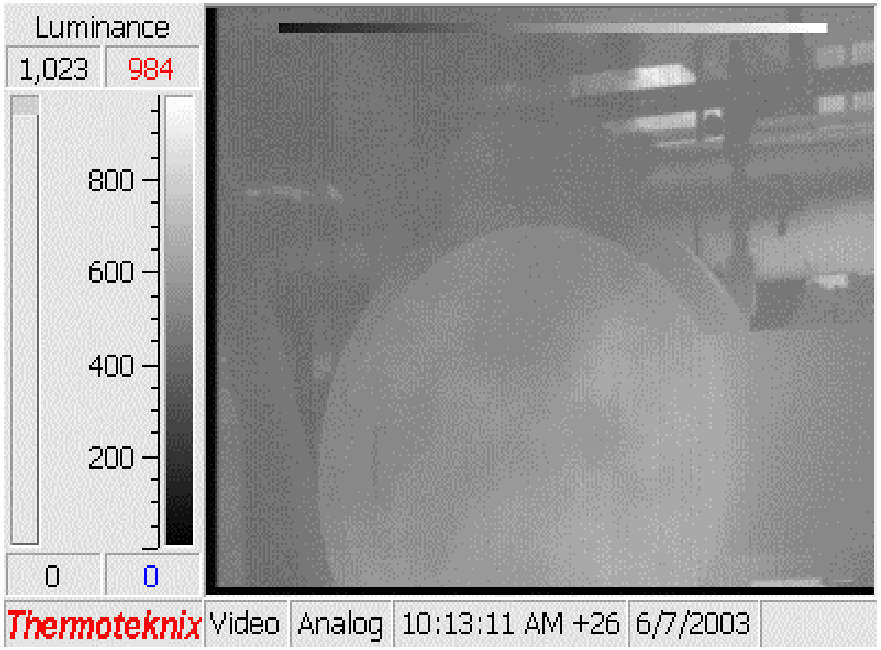
Similar to Gas Chromatography



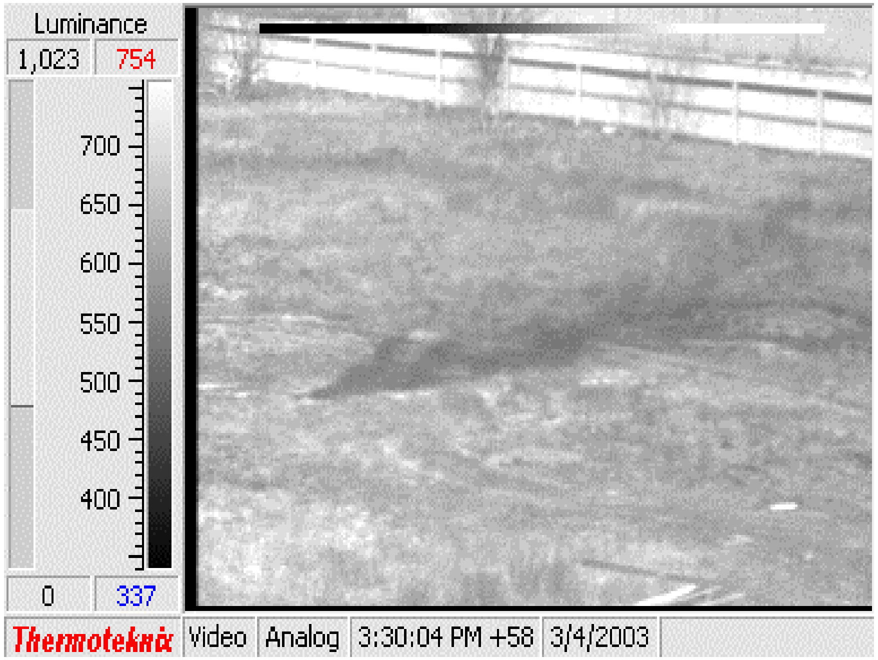
LSI Camera Visualizes Gasoline Vapor

- Field Portable
- Rugged
- Reliable
- Repeatable
- Sensitivity
- Ease of Use - Doesn’t Require Frequent Adjustment
- Capable of Identifying “Inaccessible” Leaks

LSI Leak Surveys Video Imagery



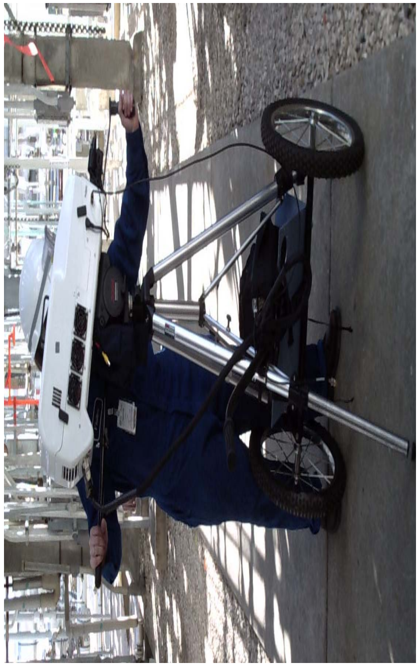
Flange Leak



Buried Pipeline Leak

DI&M by Leak Imaging

- Real-time visual image of gas leaks
  - Quicker identification & repair of leaks
  - Screen hundreds of components an hour
  - Screen inaccessible areas simply by viewing them


Infrared Gas Imaging Technology

- Shoulder- and/or tripod-mounted
  - Hand-held prototype
- Aerial surveillance applications
- Require battery and/or power cord
- Most very large leaks (> 3cf/hr) clearly seen

Conventional vs Remote Sensing

Speed:	2,400 comp./day	2,300 comp./hr
Mobility:	most areas	difficult in congested
Elevated:	difficult	easy
Cost :	$1200/ day	$ 4000/ day
Safety:	less	more
	proximity	distance

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, blowdowns, engine-starters and pressure relief valves represent <3% of components but >60% of methane emissions
- The business of leak detection is about to change dramatically with new technology

Discussion

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