

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

Lessons Learned from
Natural Gas STAR Partners



Processors Technology Transfer Workshop

Pioneer Natural Resources, Inc.,
Gas Processors Association and
EPA's Natural Gas STAR Program

September 23, 2004

DI&M at Gas Processing Plants: Agenda

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



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Methane Losses

- ❑ Estimated 585 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 43 million cubic feet (MMcf) per plant-yr methane emissions
 - ◆ **Worth \$130,000/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
 - ◆ 27 Bcf of methane emitted per year by reciprocating compressors seals and OELs, each contributing equally to the emissions

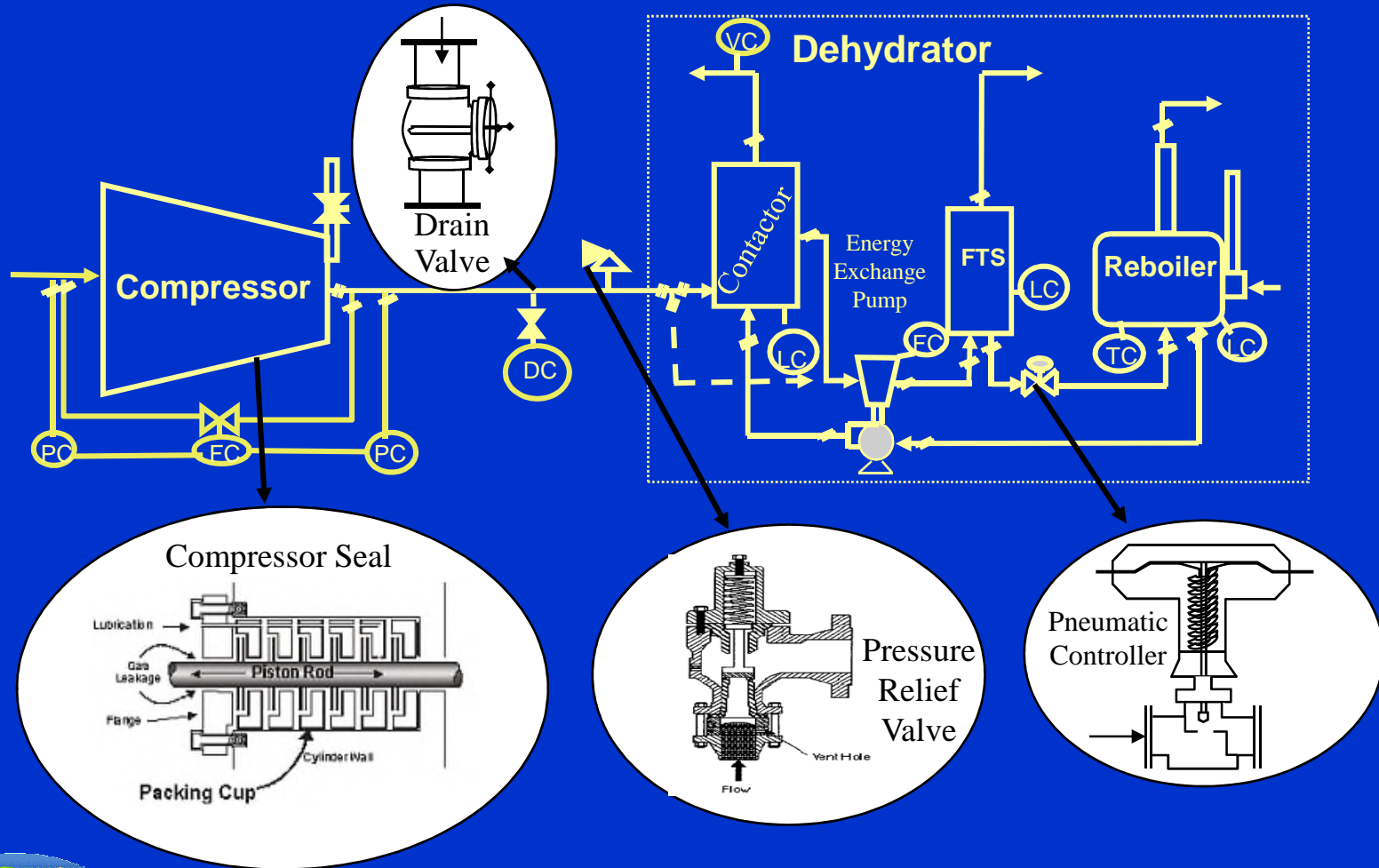
- Gas plant fugitive methane emissions depend on operating practices, equipment age and maintenance



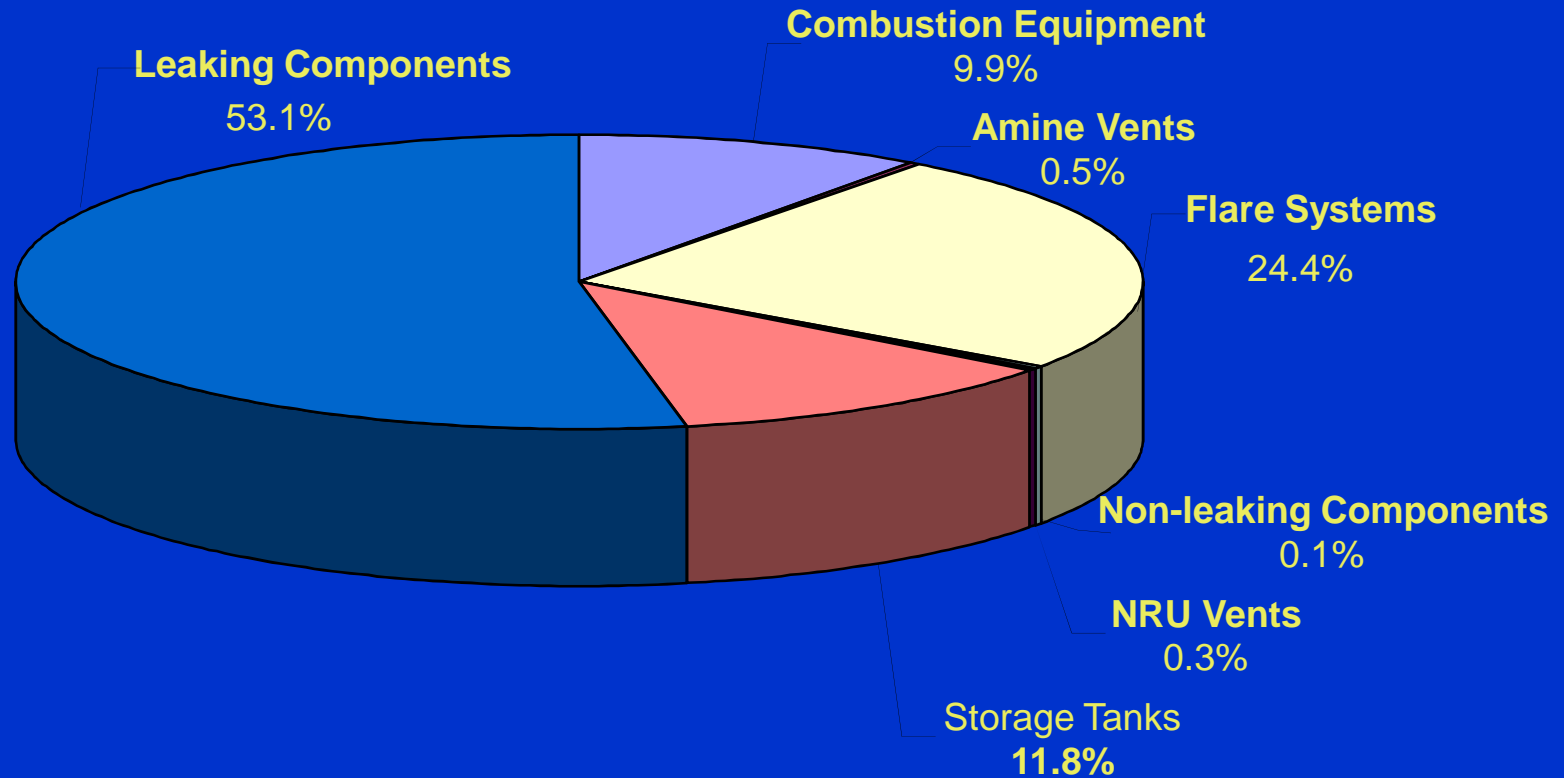
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What are the Sources of Emissions?



Distribution of Losses by Source Category

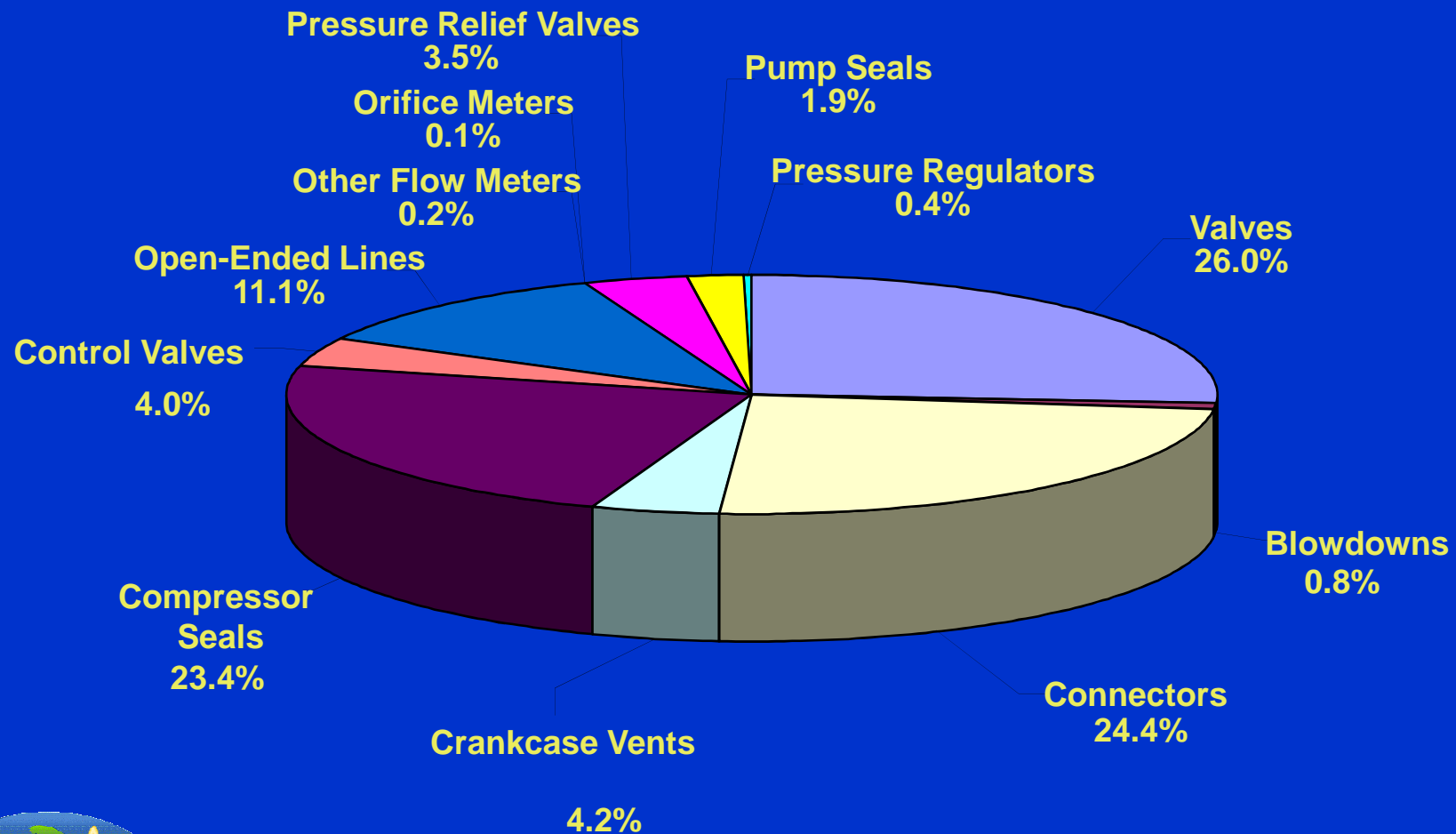


Source: Clearstone Engineering, 2002



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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



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How Much Methane is Emitted?

Summary of Natural Gas Losses from the Top Ten Leakers¹.

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

¹Excluding leakage into flare system



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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



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What is DI&M ?

- Direct Inspection and Maintenance
 - ◆ Cost-effective practice by definition
 - ◆ Find and fix significant leaks
 - ◆ Choice of leak detection technologies
 - ◆ Strictly tailored to company's needs

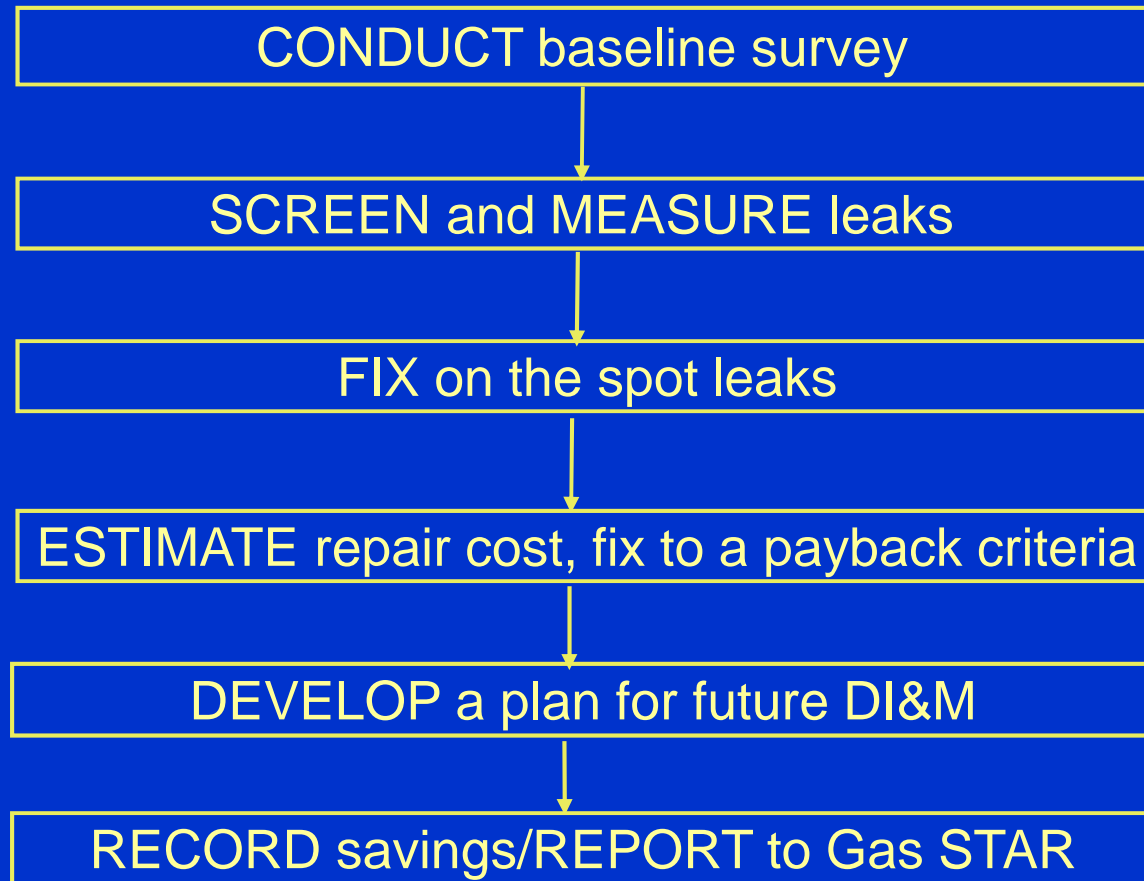
- DI&M is NOT the regulated volatile organic compound leak detection and repair (VOC LDAR) program



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How Do You Implement DI&M?



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



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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

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 ¹
Soap Solution	★ ★	\$
Electronic Gas Detectors	★	\$\$
Acoustic Detection/ Ultrasound Detection	★ ★	\$\$\$
TVA (FID)	★	\$\$\$
Bagging	★	\$\$\$
High Volume Sampler	★ ★ ★	\$\$\$
Rotameter	★ ★	\$\$

Source: EPA's Lessons Learned Study



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



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Cost-Effective Examples

Repair the Cost Effective Components

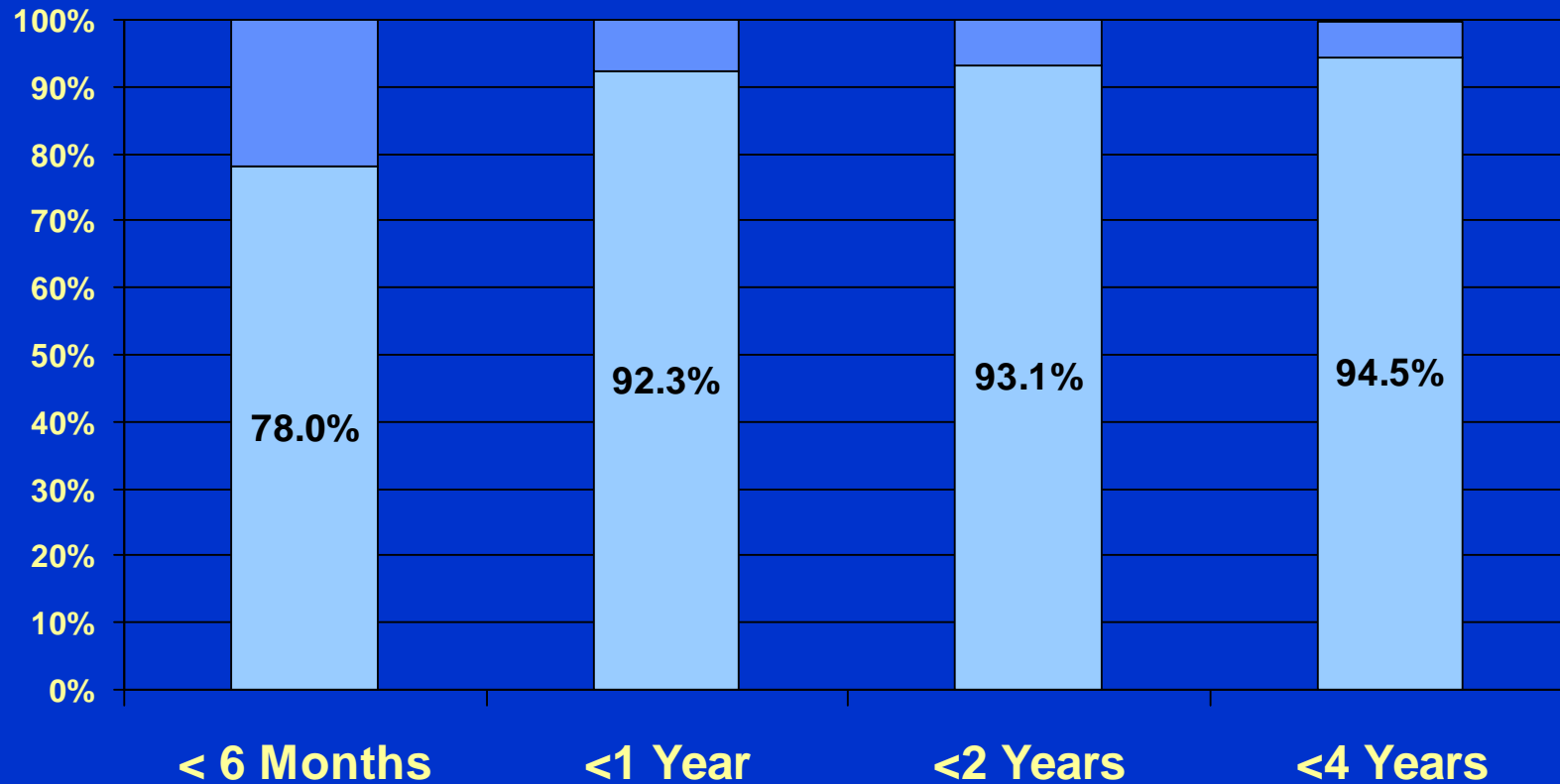
Component	Value of Lost gas ¹ (\$)	Estimated Repair cost (\$)	Payback (Months)
Plug Valve: Valve Body	12,641	200	0.2
Union: Fuel Gas Line	12,155	100	0.1
Threaded Connection	10,446	10	0.0
Distance Piece: Rod Packing	7,649	2,000	3.1
Open-Ended Line	6,959	60	0.1
Compressor Seals	5,783	2,000	4.2
Gate Valve	4,729	60	0.2

Source: Hydrocarbon Processing, May 2002

¹Based on \$3/Mcf gas price



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



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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)	11,064	15,087
Payback (yr)	<1	<1

¹ Assumes two inspections per year

² Gas values based on \$3/Mcf



Case Study: Dynegy

- ❑ Surveyed components in two processing plants: 30,208
- ❑ 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: \$300,000 / year (at \$3/Mcf)



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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



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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 \$182,100/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 \$110,300.



Gas values based on \$3/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 \$43,200.

- **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 \$12,300.



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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 ($> 3\text{cf/hr}$) clearly seen



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Infrared Gas Imaging

- Video recording of fugitive leak found by infrared camera



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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, engine-starter 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



Team available to survey limited number of gas plants at discount cost as part of EPA grant. Call Roger Fernandez at 202-343-9086 for details

Discussion Questions

- ❑ To what extent are you implementing this BMP?
- ❑ How can this BMP be improved upon or altered for use in your operation(s)?
- ❑ What are the barriers (technological, economic, lack of information, regulatory, etc.) that are preventing you from implementing this technology?



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