

Directed Inspection and Maintenance (DI&M)

Lessons Learned from
Natural Gas STAR Partners



Producers Technology Transfer Workshop

Devon Energy and
EPA's Natural Gas STAR Program
Casper, Wyoming
August 30, 2005

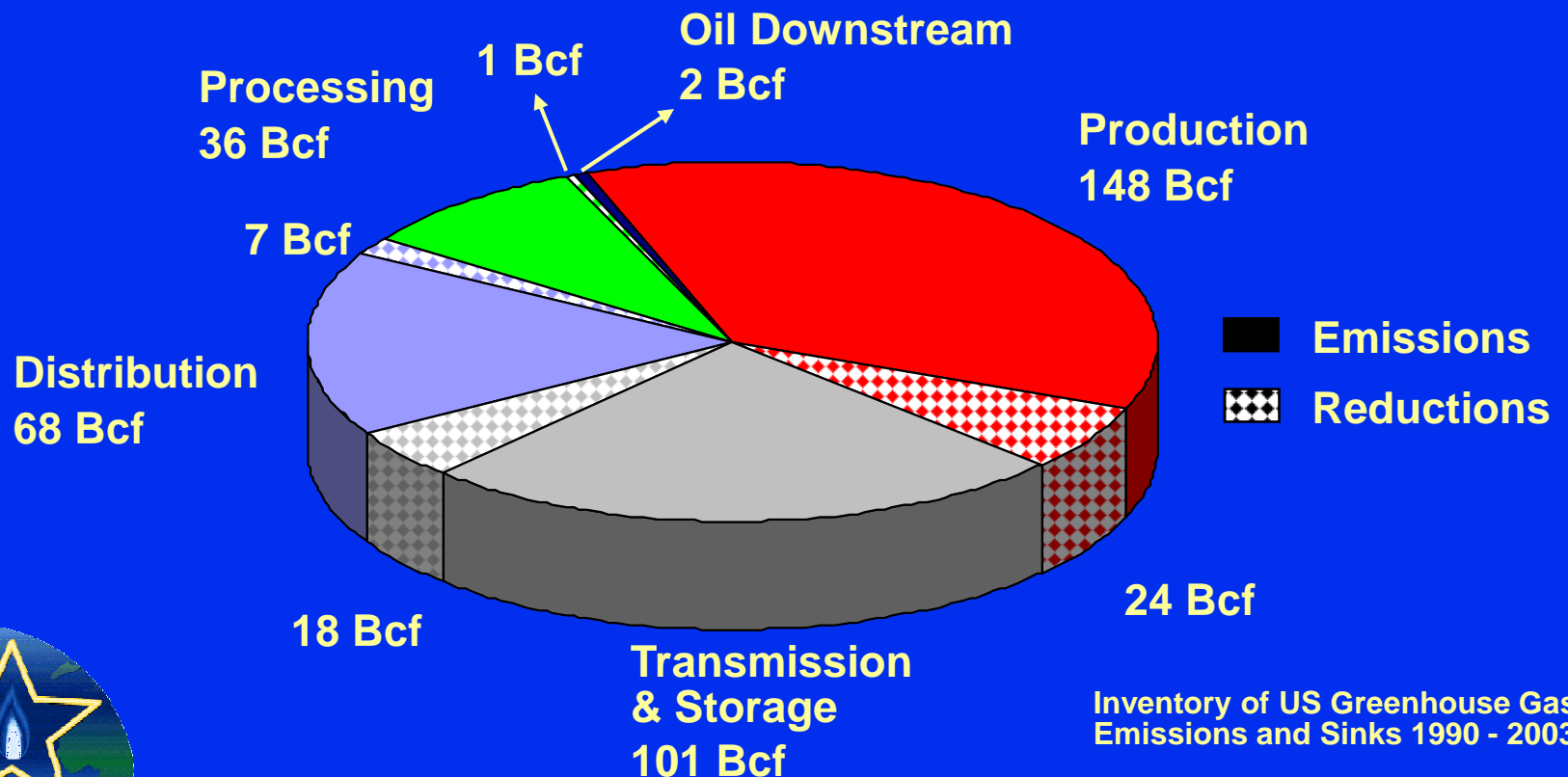
DI&M: Agenda

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



Natural Gas Industry Emissions

- ★ Production sector responsible for largest portion of emissions

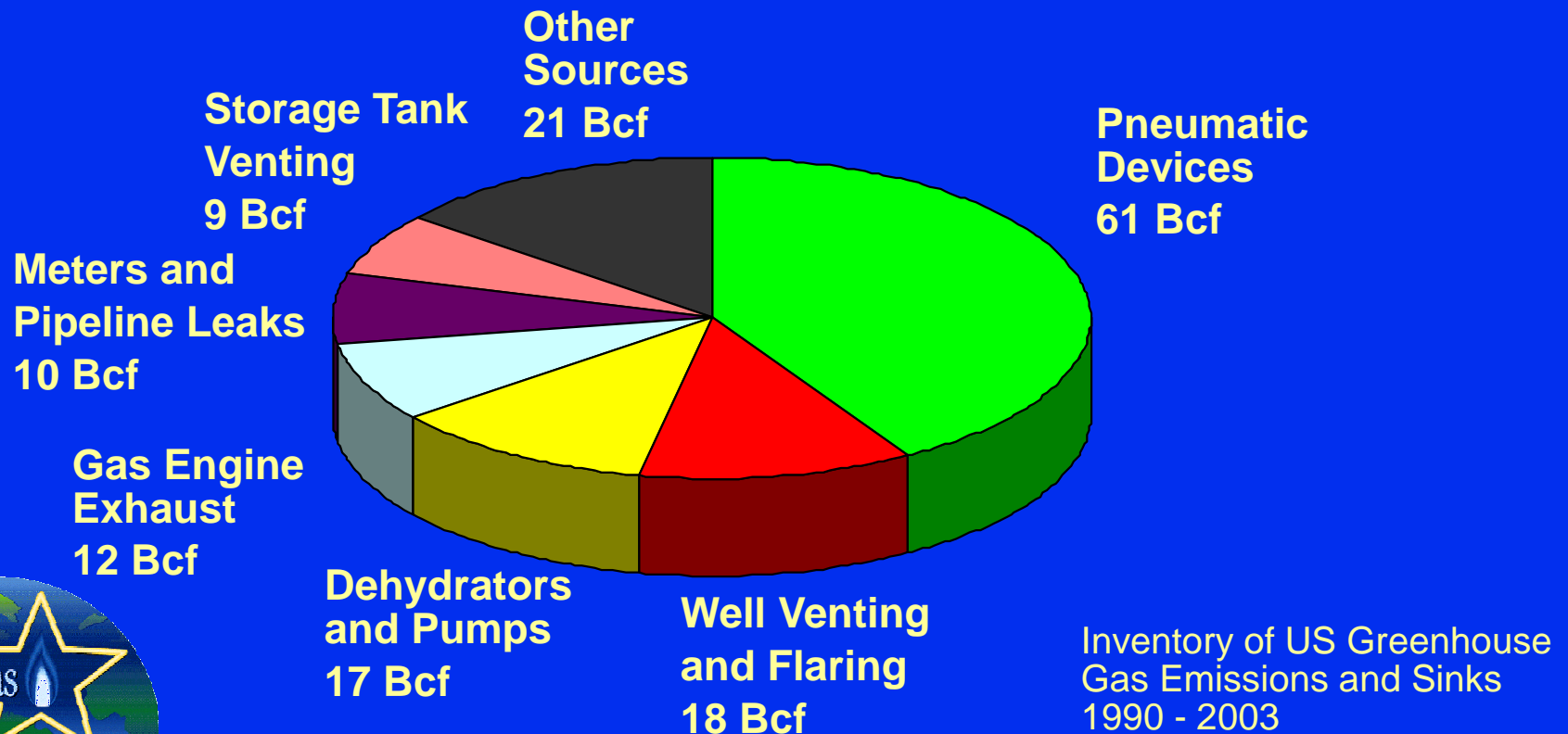


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Inventory of US Greenhouse Gas Emissions and Sinks 1990 - 2003

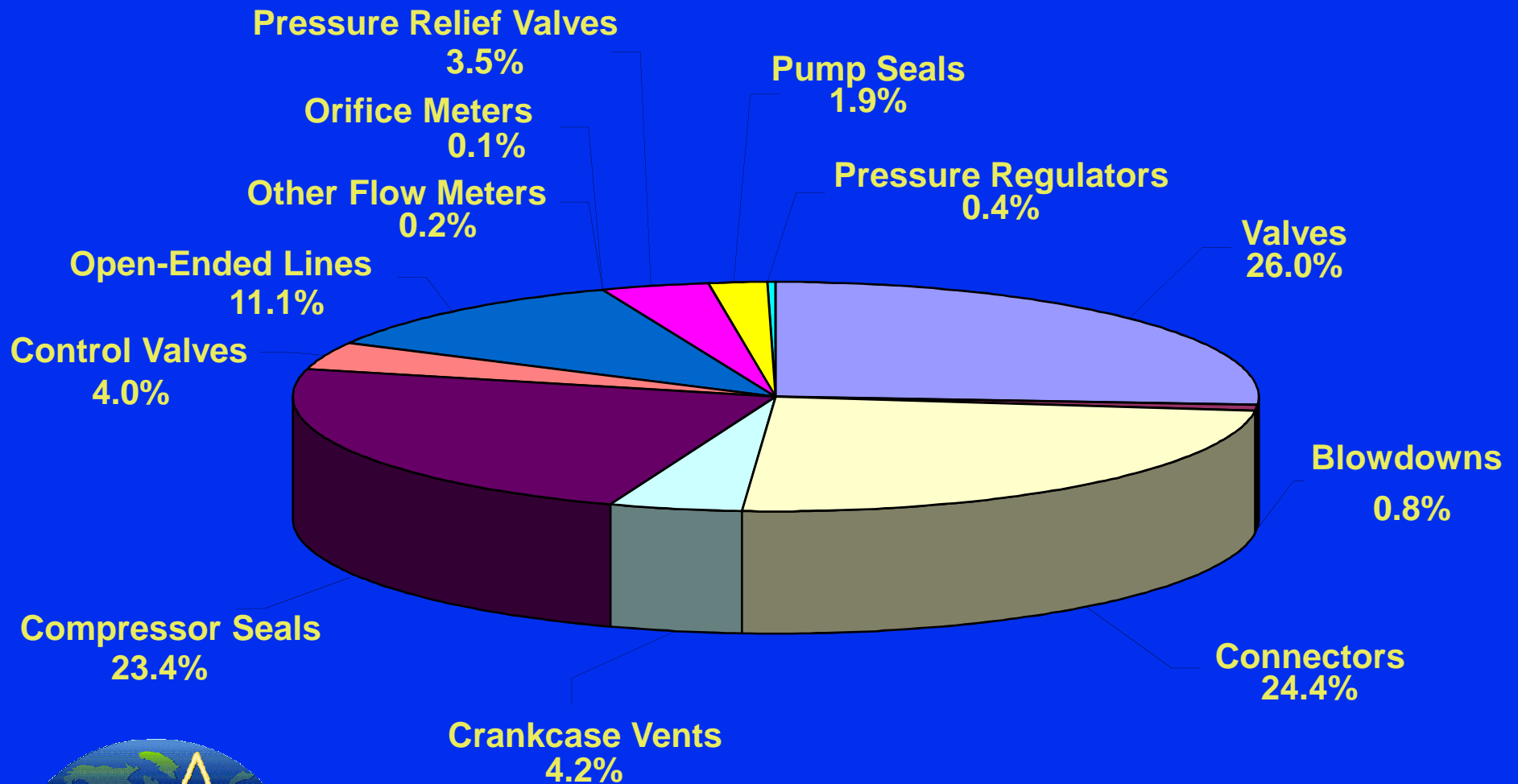
Oil and Gas Production Sector Methane Emissions

- ★ The production sector has several large methane emission sources that can be targeted for reductions



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Methane Losses by Equipment Type



Source: Clearstone Engineering, 2002

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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**

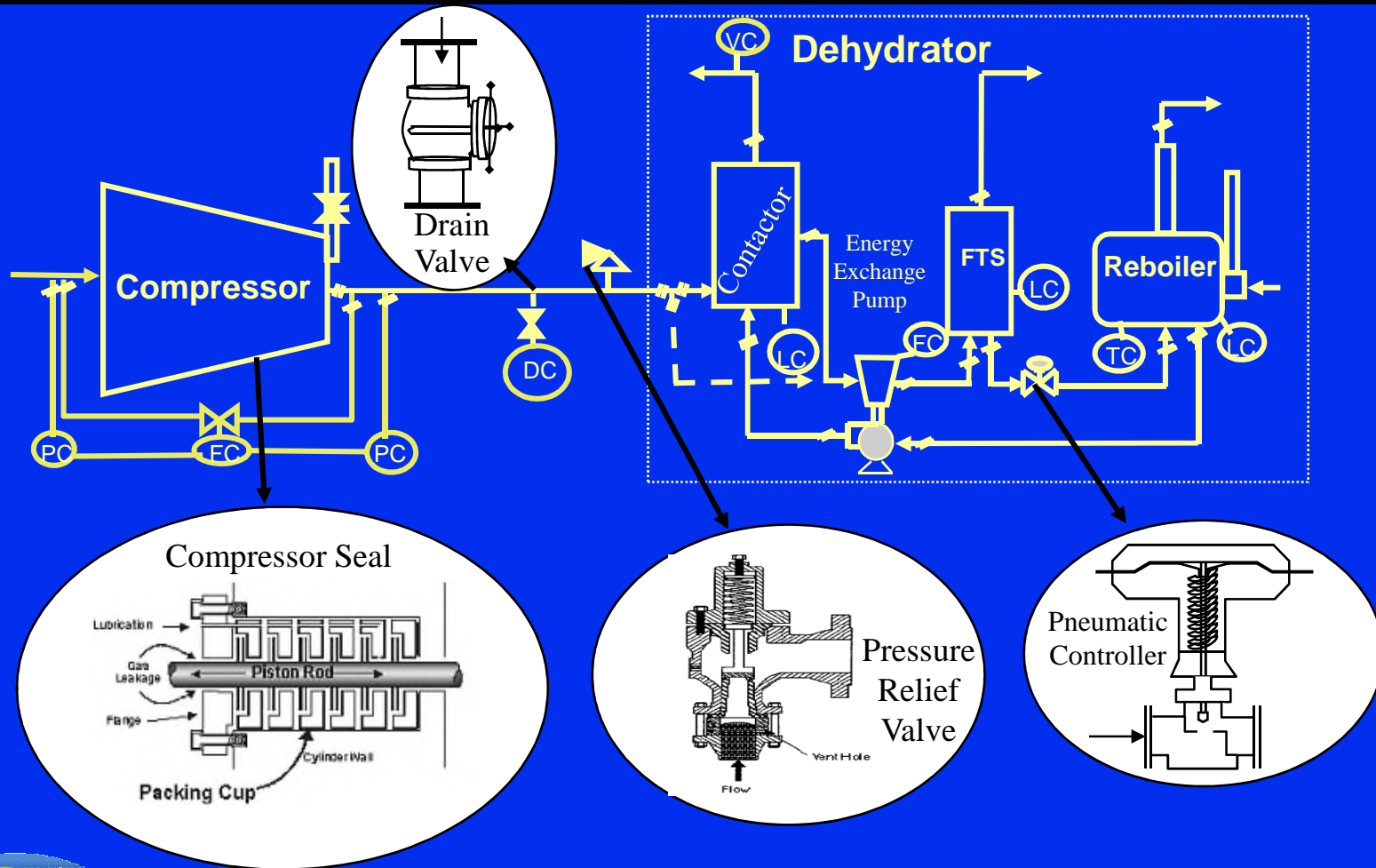


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What are the Sources of Emissions?



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How Much Methane is Emitted?

Methane Emissions from Leaking Components

Component Type	% of Total Methane Emissions	% Leaks	Estimated Average Methane Emissions per Leaking Component (Mcf/year)
Valves (Block & Control)	26.0%	7.4%	66
Connectors	24.4%	1.2%	80
Open-Ended Lines	11.1%	8.1%	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.



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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



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 (VOC) leak detection and repair program (LDAR)

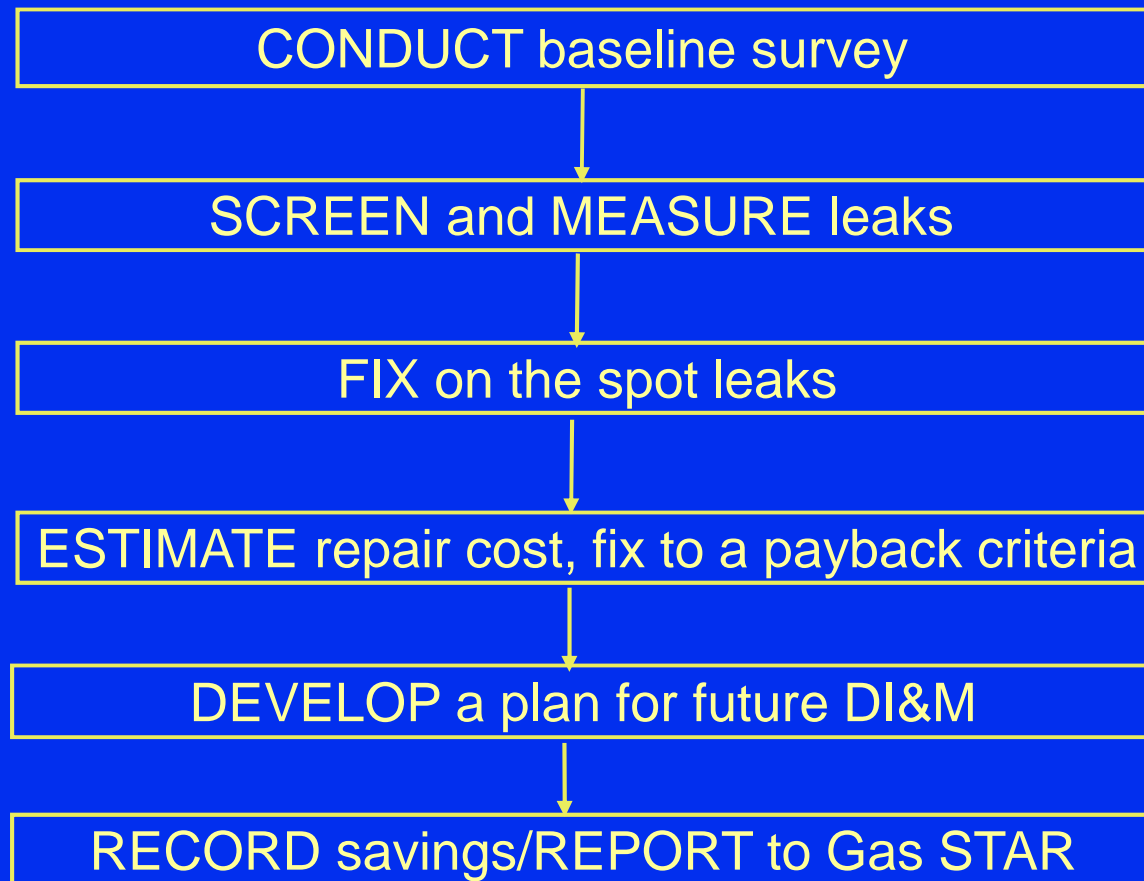


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How Do You Implement DI&M?



How Do You Implement DI&M?

- ★ Screening - finding 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



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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



Is Recovery Profitable?

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



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



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DI&M - Partner Experience

- ☆ Partner A: Leaking cylinder head was tightened, which reduced the methane emissions from almost 64,000 Mcf/yr to 3,300 Mcf/yr
 - ◆ Repair required 9 man-hours of labor
 - ◆ Gas savings were approximately 60,700 Mcf/yr
 - ◆ Value of gas saved was \$182,100/year at \$3/Mcf
- ☆ Partner B: One-inch pressure relief valve emitted almost 36,774 Mcf/yr
 - ◆ Required five man-hours of labor and \$125 of materials
 - ◆ Value of the gas saved was \$110,300 at \$3/Mcf



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