

Directed Inspection and Maintenance and Infrared Leak Detection

Lessons Learned from Natural Gas STAR



Occidental Petroleum Corporation and
California Independent Petroleum Association

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epa.gov/gasstar



Directed Inspection and Maintenance and Infrared Leak Detection Agenda

🔥 Methane Losses

- 🔥 What are the sources of emissions?
- 🔥 How much methane is emitted?

🔥 Methane Recovery

- 🔥 Directed Inspection and Maintenance (DI&M)
- 🔥 DI&M by infrared leak detection

🔥 Is Recovery Profitable?

🔥 Partner Experience

🔥 Discussion

Methane Losses

- Over 500,000 producing oil wells nationally
- Fugitive emissions from oil production wells and facilities are estimated to be 2.4 billion cubic feet per year (Bcf/year)
 - Worth \$16.8 million at today's gas prices

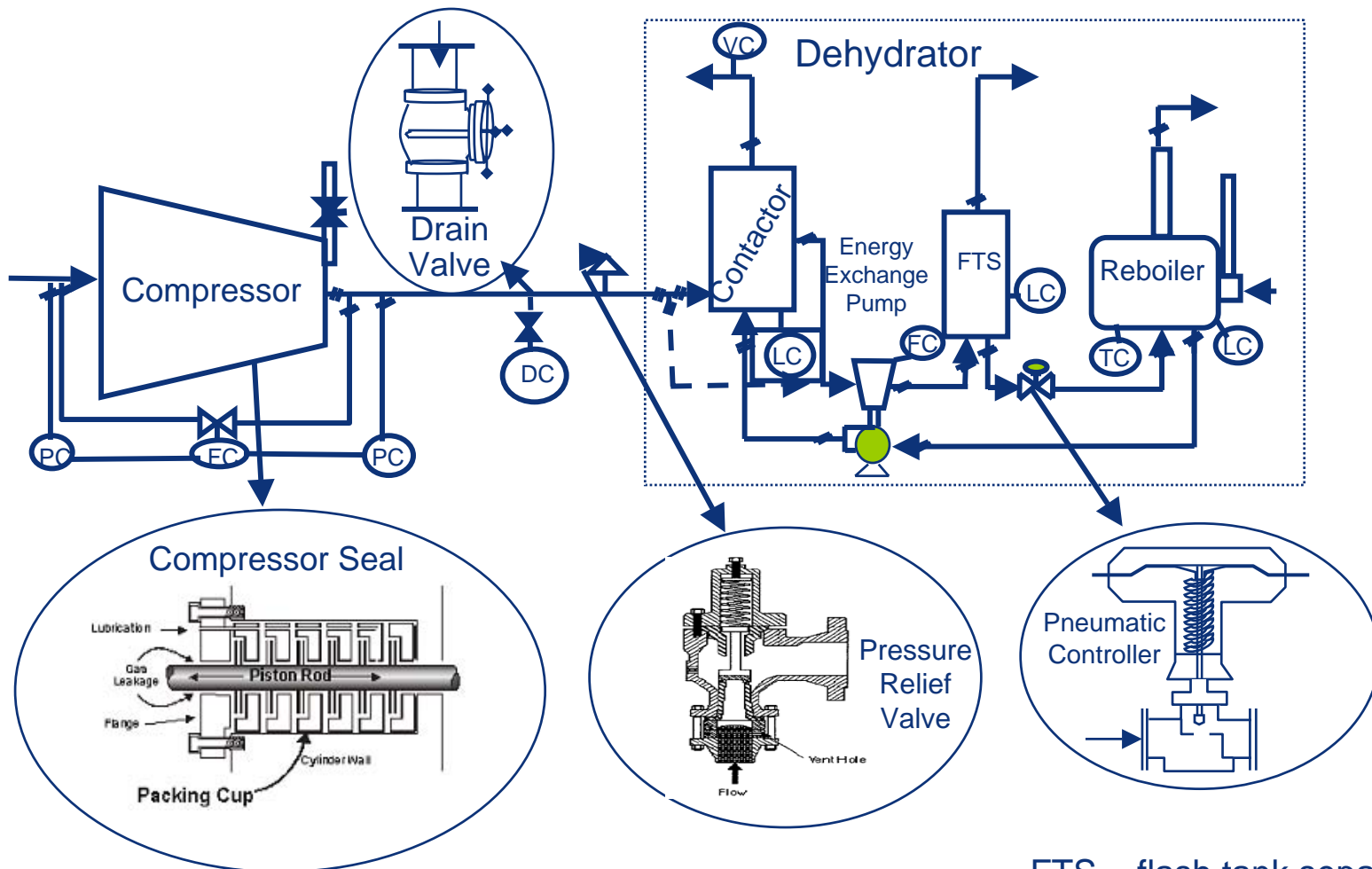


Source: Newfield

What is the Problem?

- ❖ Methane gas leaks are invisible, unregulated, and go unnoticed
- ❖ Natural Gas STAR Partners find that valves, connectors, compressor seals, and open-ended lines (OELs) are major methane emission sources
 - ❖ In 2005, 1.1 Bcf of methane was emitted as fugitives by well heads and related components alone
 - ❖ Production fugitive methane emissions depend on operating practices, equipment age, and maintenance

Sources of Methane Emissions



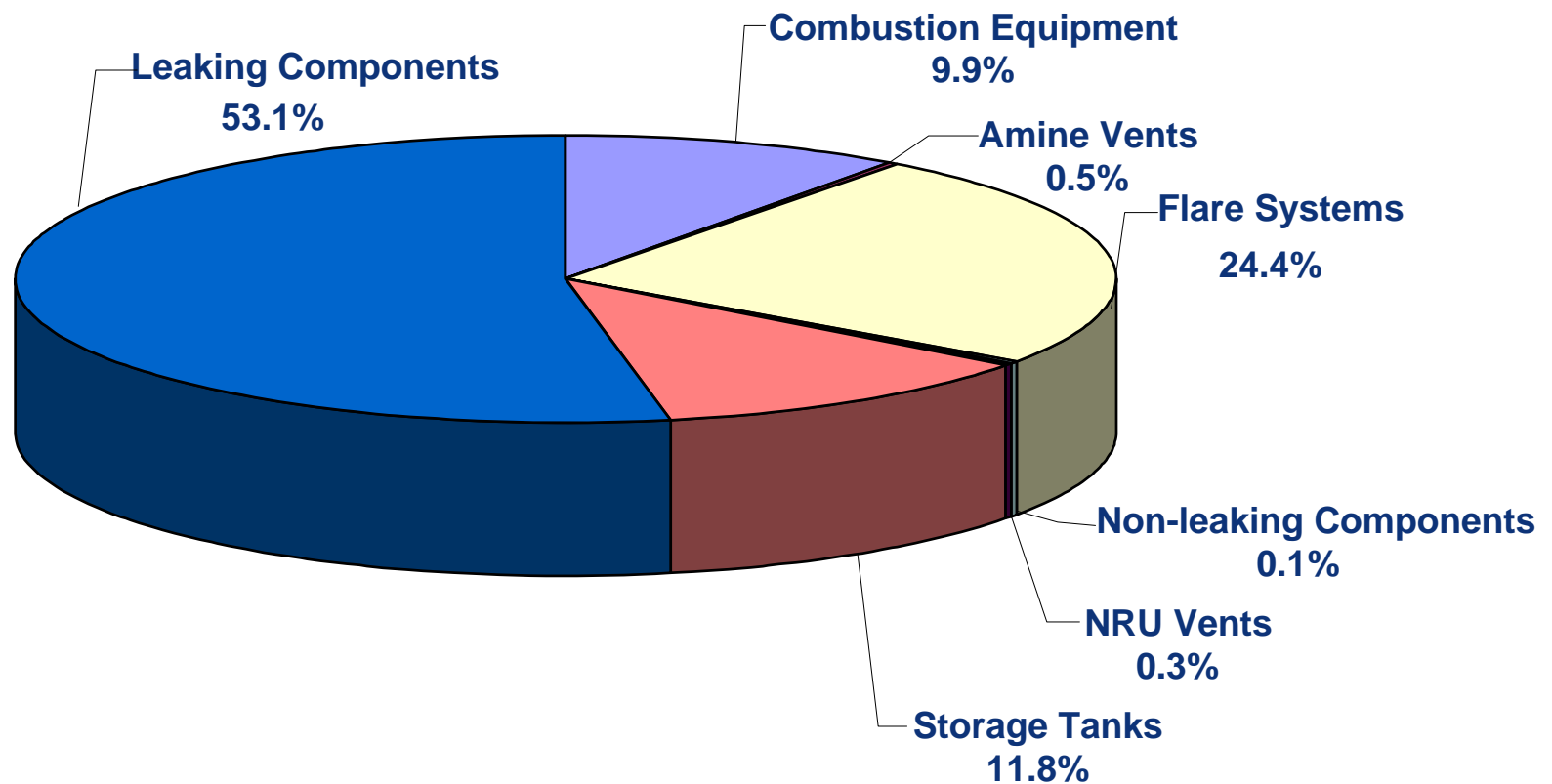
FTS = flash tank separator

What are the losses? - Clearstone

- Clearstone studied four gas processing plants
 - Screened for all leaks
 - Measured larger leak rates
 - Analyzed data
- Principles are relevant to all sectors
 - Fugitive leaks from valves, connectors, compressor seals, and lines still a problem in production
 - Solution is the same

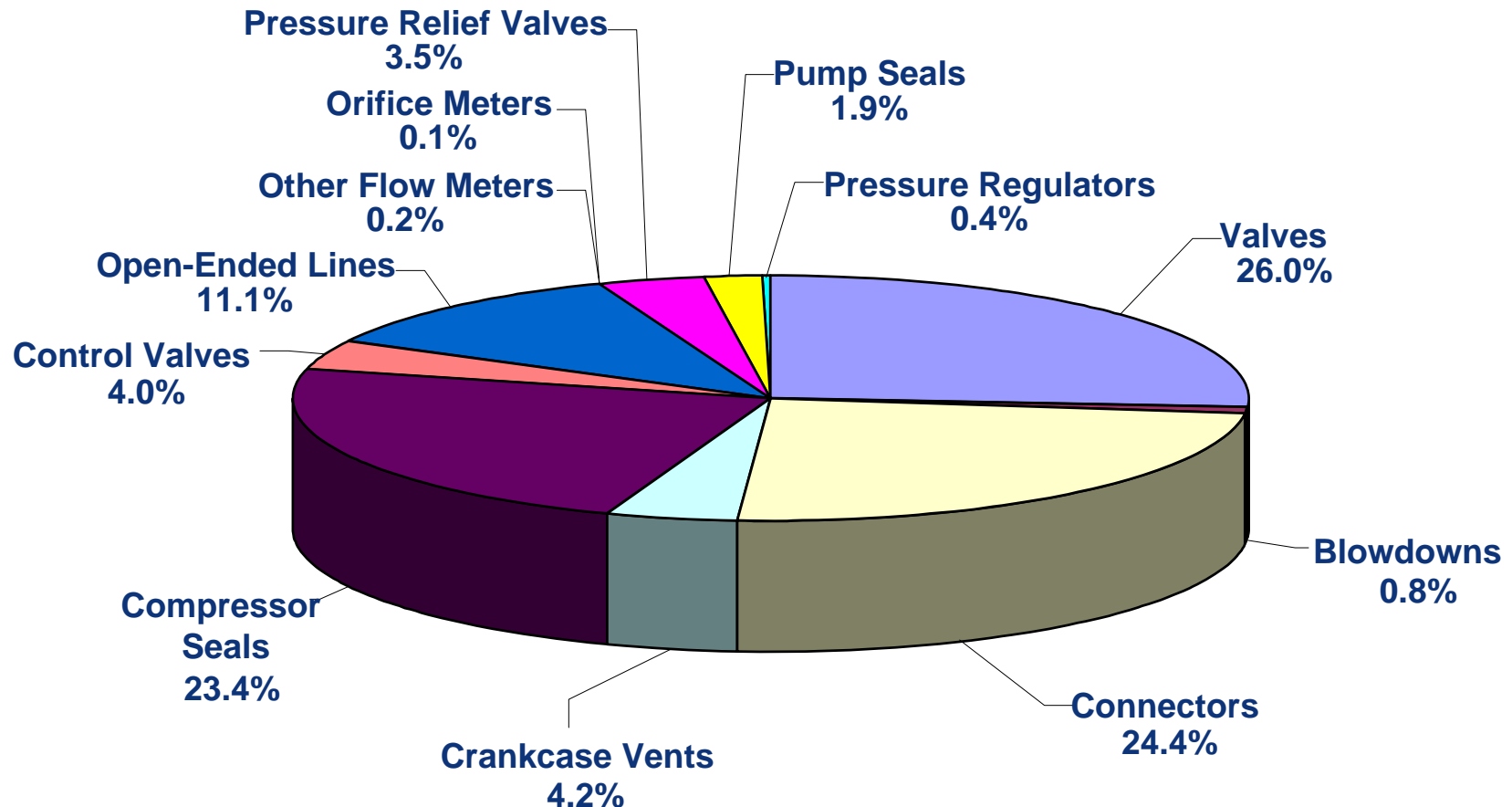


Distribution of Losses by Source Category



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	% Leak Sources	Estimated Average Methane Emissions per Leaking Component (Mcf/year)
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 four gas processing plants in Wyoming and Texas to evaluate opportunities to economically reduce methane emissions.

Mcf = Thousand cubic feet

How Much Methane is Emitted?

Summary of Natural Gas Losses from the Top Ten Leak Sources¹

Plant Number	Gas Losses From Top 10 Leak Sources (Mcf/day)	Gas Losses From All Leak Sources (Mcf/day)	Contribution By Top 10 Leak Sources (%)	Contribution By Total Leak Sources (%)
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	892.8	53.5	1.85

1 – Excluding leakage into flare system

Methane Recovery

- 🔥 Fugitive losses can be dramatically reduced by implementing a directed inspection and maintenance 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 leak sources with information on where to look “next time”

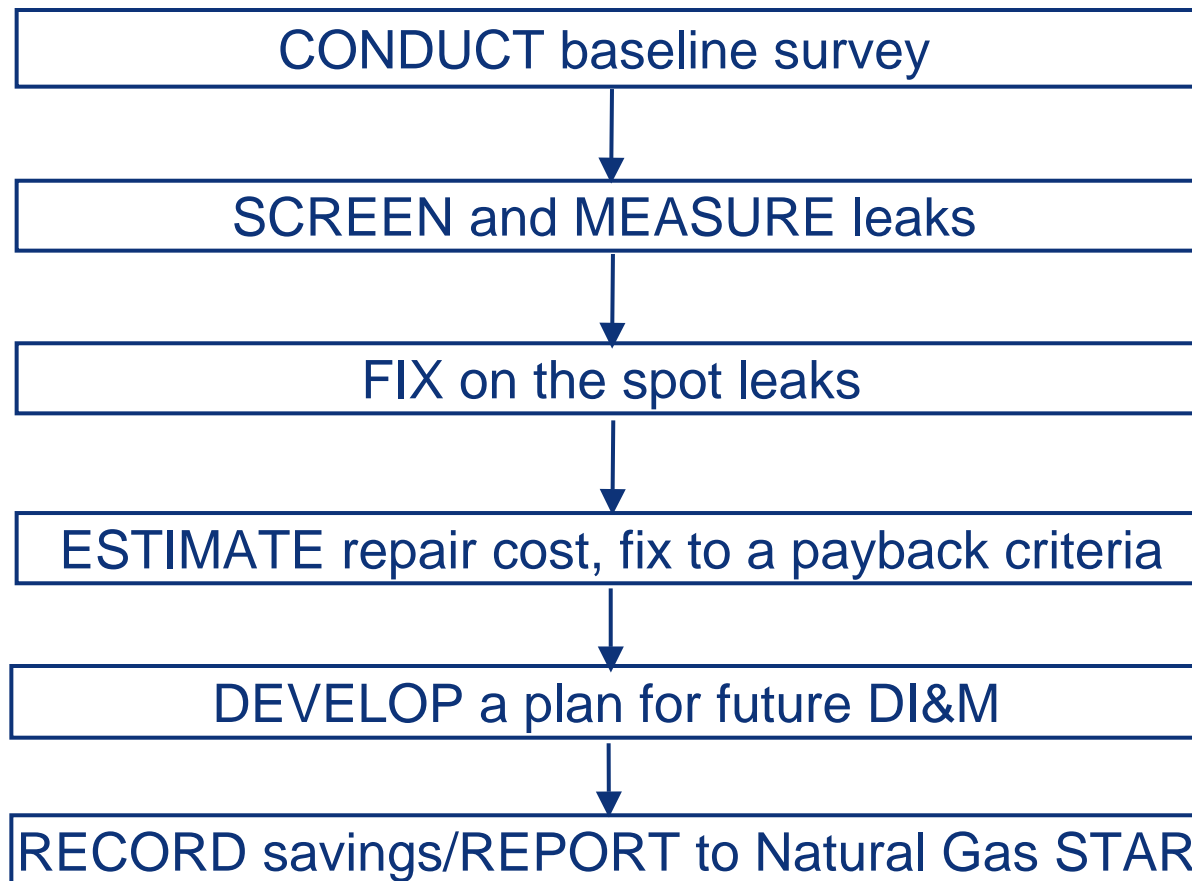
What is Directed Inspection and Maintenance?

- Directed Inspection and Maintenance (DI&M)
 - 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



Source: Targa Resources

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
 - 🔥 Infrared leak detection

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
 - 🔥 Calibrated bagging



How Do You Implement DI&M?

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	★★★	\$\$\$

Source: EPA's Lessons Learned

* - Least effective at screening/measurement

\$ - Smallest capital cost

*** - Most effective at screening/measurement

\$\$\$ - Largest capital cost

Estimating Comprehensive Survey Cost

- 💧 Cost of complete screening survey using high volume sampler (processing plant)
 - 💧 Ranges \$15,000 to \$20,000 per medium size plant
 - 💧 Rule of Thumb: \$1 per component for an average processing plant
 - 💧 Cost per component for remote production sites would be higher than \$1
- 💧 25 to 40% cost reduction for follow-up survey
 - 💧 Focus on higher probability leak sources (e.g. compressors)

DI&M by Infrared Leak Detection

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



Source: Leak Surveys Inc.

Infrared Methane Leak Detection

- 🔥 Video recording of fugitive leaks detected by various infrared devices



Is Recovery Profitable?

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			

Economic Analysis of DI&M of OELs

Economic Analysis of DI&M of Open-Ended Lines at Large and Small Gas Plants¹

	Small	Large
Inspection of Plants OELs (Man-day/year)	1	1
Inspection of Booster OELs (Man-day/year)	2	3
Inspection Prep and Record (Man-day/year)	NA	3
Repairs & Maintenance (Man-days)	1	2
Labor Cost (\$/day)	500	500
Total Labor Cost (\$/year)	2,000	4,500
Methane Savings (Mcf/year)	3,319	4,526
Gas Savings (Mcf/year) ²	3,688	5,029
Gas Saving Value (\$/year)	25,816	35,203
Payback (year)	<1	<1

1 – Based on data presented by Targa Resources on July 26, 2006. Assumes two inspections per year

2 – Gas values based on \$7/Mcf

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 valves, engine-starters, and pressure relief valves represent <3% of components but >60% of methane emissions
- 🔥 The business of leak detection has changed dramatically with new technology



Source: Chevron

Partner Experience - Targa Resources (formerly Dynegy)

- 🔥 Surveyed components in two processing plants: 23,169 components
- 🔥 Identified leaking components: 857 about 3.6%
- 🔥 Repaired components: 80 to 90% of the identified leaking components
- 🔥 Annual methane emissions reductions: 198,000 Mcf/year
- 🔥 Annual savings: \$1,386,000/year (at \$7/Mcf)



Partner Experience - Chevron

- 🔥 Chunchula, Alabama gas processing plant
 - 🔥 Plant processes 37.5 MMcf/day
 - 🔥 Survey conducted April 4 to 9, 2005
- 🔥 Screening equipment
 - 🔥 Soaping solution, sniffers, infrared camera
- 🔥 Quantification
 - 🔥 High volume sampler
- 🔥 17,000 components screened
 - 🔥 224 components (1.3%) were found to be leaking



Source: Chevron

Discussion

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