Directed Inspection and Maintenance and IR Leak Detection

Lessons Learned from Natural Gas STAR

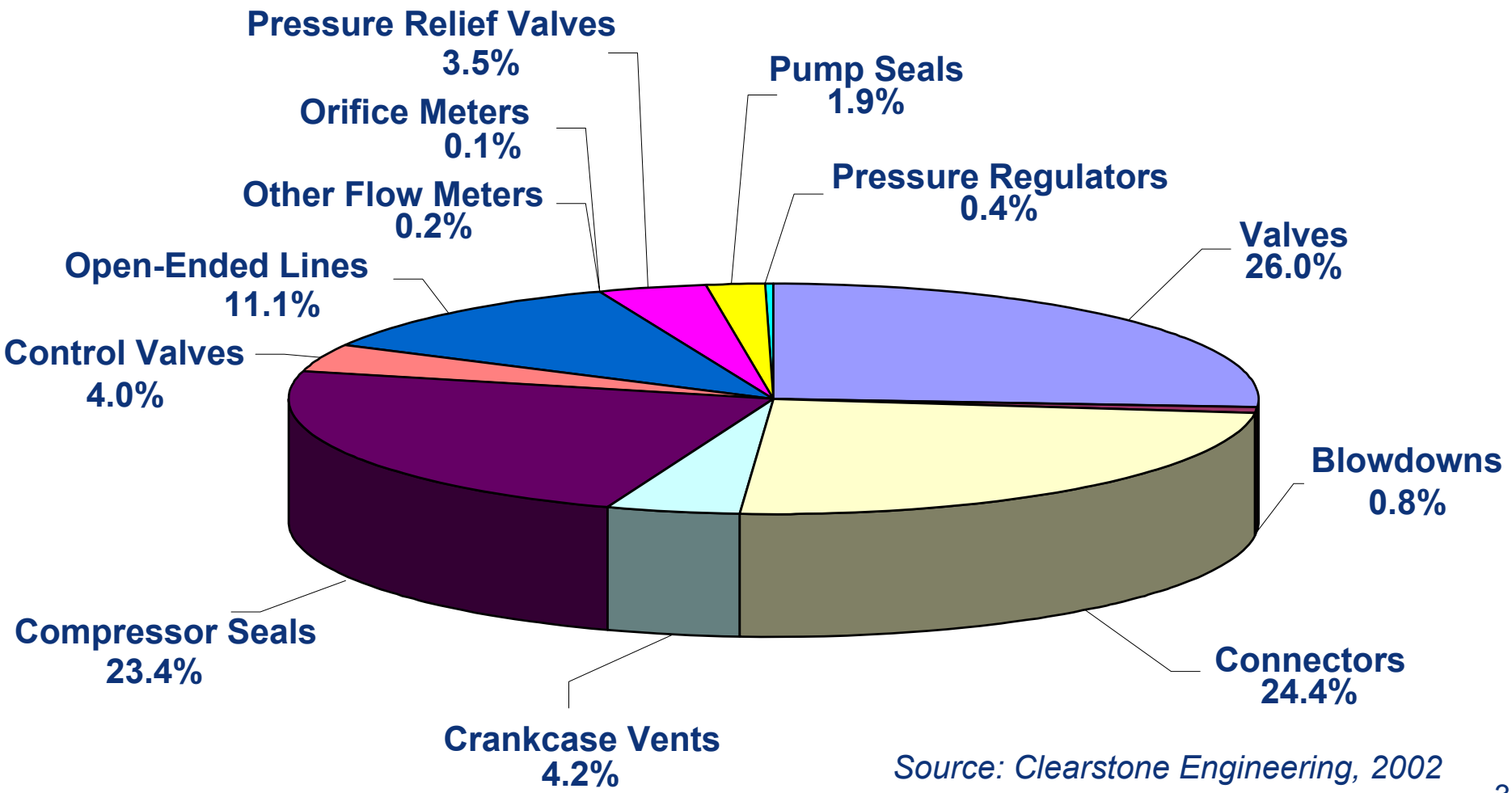
Producers Technology Transfer Workshop

Occidental Oil and Gas and EPA's Natural Gas STAR Program
Midland, TX
June 8, 2006

Directed Inspection and Maintenance (DI&M): Agenda

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

Methane Losses by Equipment Type

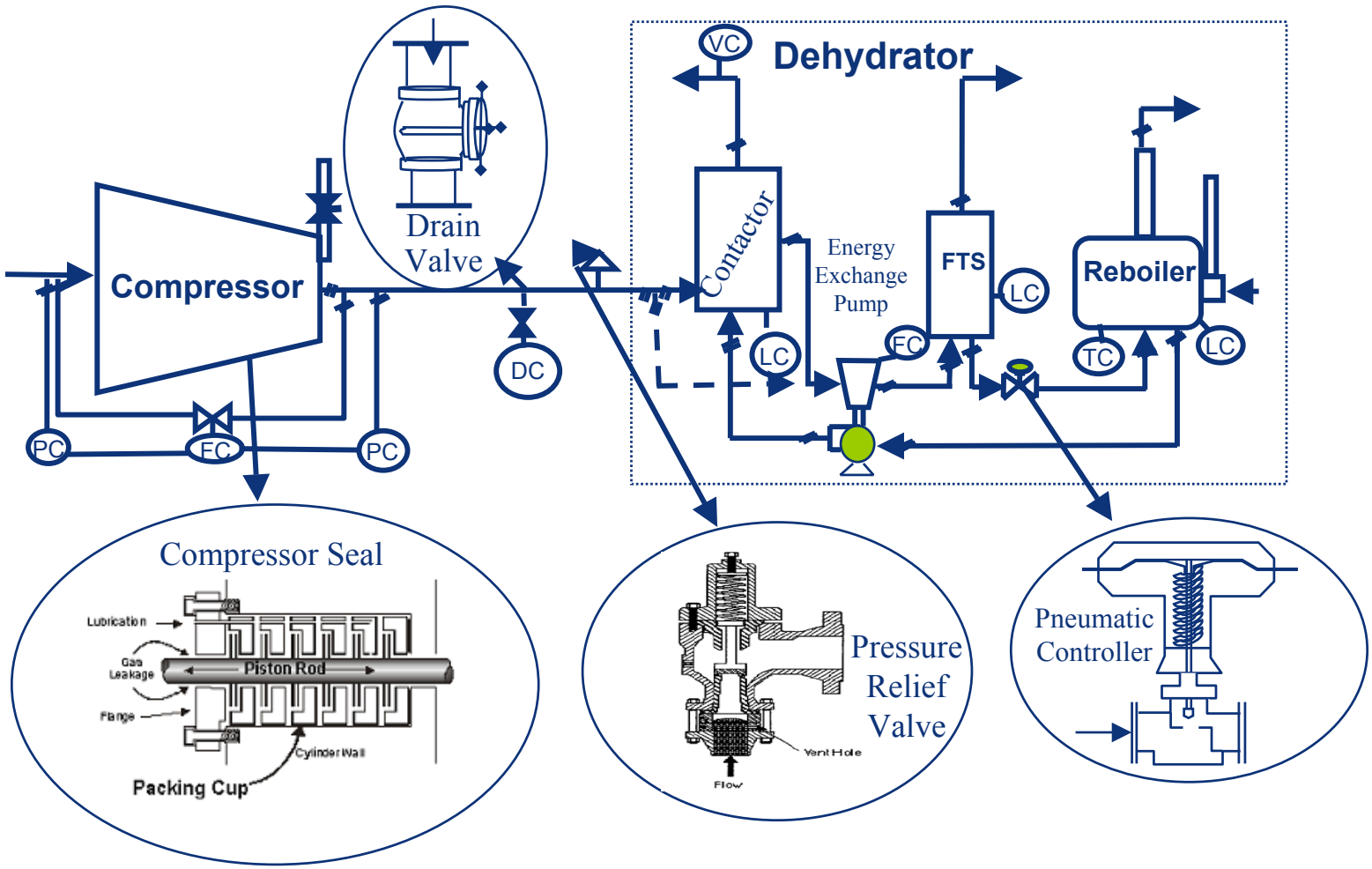


Source: Clearstone Engineering, 2002

What is the Problem?

- 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 sources
  - 27 Bcf of methane emitted per year by reciprocating compressors seals and OELs, each contributing equally to the emissions

What are the Sources of Emissions?



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.

How Much Methane is Emitted?

- A total of 101,193 components were screened at four processing plants

Summary of Natural Gas Losses from the Top Ten Leakers[1]				
Plant No.	Gas Losses From Top 10 Leakers (Mcf/day)	Gas Losses From All Equipment Leakers (Mcf/day)	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

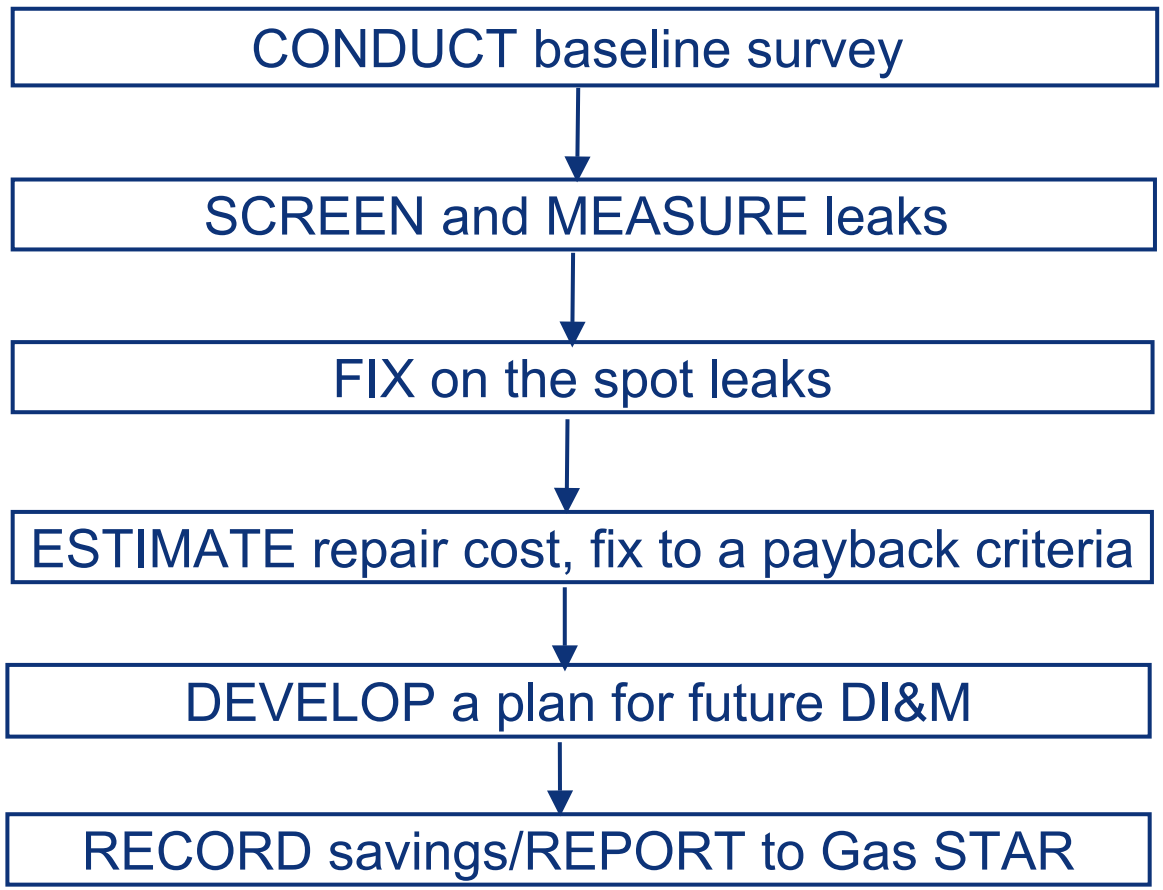
- Fugitive losses can be dramatically reduced by implementing a DI&M program
  - Voluntary program to identify and fix leaks that are cost effective to repair
  - Survey cost will pay out in the first year
  - Provides valuable data on leakers with information of where to look

What is DI&M?

- 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 (LDAR) program

How Do You Implement DI&M?



Screening and Measurement

Summary of Screening and Measurement Techniques		
Instrument/ Technique	***Effectiveness***	***Approximate Capital Cost***
Soap Solution	* *	$
Electronic Gas Detectors	*	$$
Acoustic Detection/ Ultrasound Detection	* *	$$$
Toxic Vapor Analyzer (FID)	*	$$$
Bagging	*	$$$
High Volume Sampler	* * *	$$$
Rotameter	* *	$$
Infrared Detection	* * *	$$$

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

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

$ - Smallest capital cost

$$$ - Largest capital cost

Infrared Gas Imaging

- Video recording of fugitive leak found by infrared camera

- More video available from FLIR Systems:
  www.flirthermography.com/smartLDAR

How Do You Implement DI&M?

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

Leak Measurement Using a High Volume Sampler

Is Recovery Profitable?

Repair the Cost Effective Components			
Component	**Value of Lost Gas[1] ($)**	**Estimated Repair Cost ($)**	**Payback (Months)**
Plug Valve: Valve Body	29,496	200	0.1
Union: Fuel Gas Line	28,362	100	0.0
Threaded Connection	24,374	10	0.0
Distance Piece: Rod Packing	17,847	2,000	1.4
Open-Ended Line	16,238	60	0.0
Compressor Seals	13,493	2,000	1.8
Gate Valve	11,034	60	0.1

[1]Based on $7/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, blowdowns, engine-starter and pressure relief valves represent <3% of components but >60% of methane emissions
- The business of leak detection has changed dramatically with new technology

DI&M - Industry Experience

- Partner A: Leaking cylinder head was tightened, which reduced the methane emissions from almost 64,000 Mcf/year to 3,300 Mcf/year
  - Repair required 9 man-hours of labor
  - Gas savings were approximately 60,700 Mcf/year
  - Value of gas saved was $424,900/year at $7/Mcf
- Partner B: One-inch pressure relief valve emitted almost 36,774 Mcf/year
  - Required five man-hours of labor and $125 of materials
  - Value of the gas saved was $257,400 at $7/Mcf

Discussion Questions

- To what extent are you implementing these opportunities?
- How could these opportunities be improved upon or altered for use in your operation?
- Can you suggest other methods for reducing emissions from leaking components?
- What are the barriers (technological, economic, lack of information, manpower, etc.) that are preventing you from implementing these practices?