Directed Inspection and Maintenance and IR Leak Detection

**Lessons Learned
from Natural Gas STAR**

**Producers and Processors
Technology Transfer Workshop**

**Western Gas Resources and
EPA's Natural Gas STAR Program
Gillette and Rock Springs, WY
May 9 & 11, 2006**
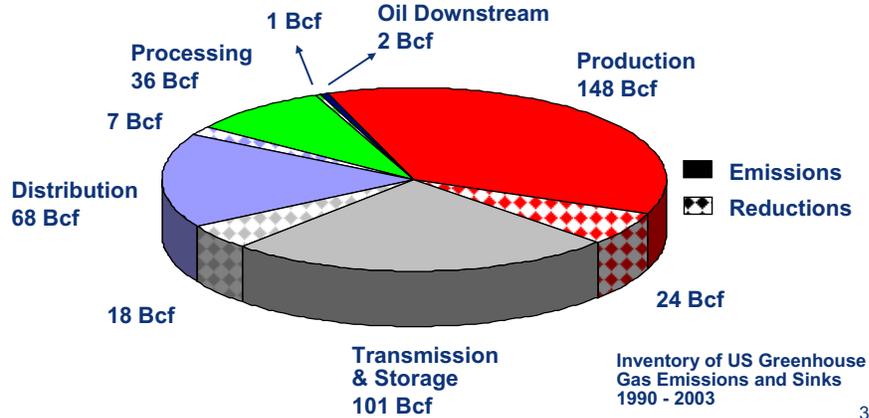
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Directed Inspection and Maintenance (DI&M): Agenda

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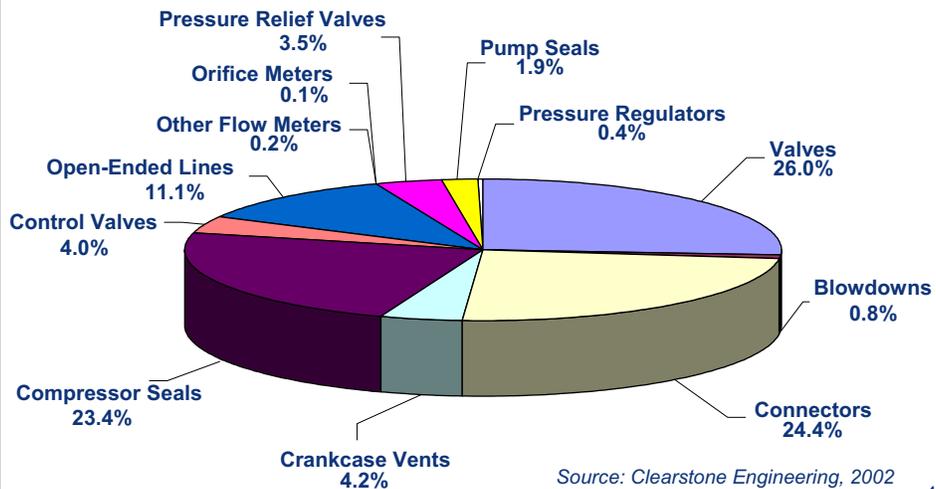◊ Discussion Questions

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Natural Gas Industry Emissions

◊ Production and Processing sectors responsible for over half of the natural gas industry emissions

Processing 36 Bcf
1 Bcf
Oil Downstream 2 Bcf
Production 148 Bcf
7 Bcf
Distribution 68 Bcf
18 Bcf
Transmission & Storage 101 Bcf
24 Bcf

■ Emissions
Reductions

Inventory of US Greenhouse Gas Emissions and Sinks 1990 - 2003

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Methane Losses by Equipment Type

Pressure Relief Valves 3.5%
Orifice Meters 0.1%
Other Flow Meters 0.2%
Pump Seals 1.9%
Pressure Regulators 0.4%
Open-Ended Lines 11.1%
Control Valves 4.0%
Valves 26.0%
Compressor Seals 23.4%
Blowdowns 0.8%
Crankcase Vents 4.2%
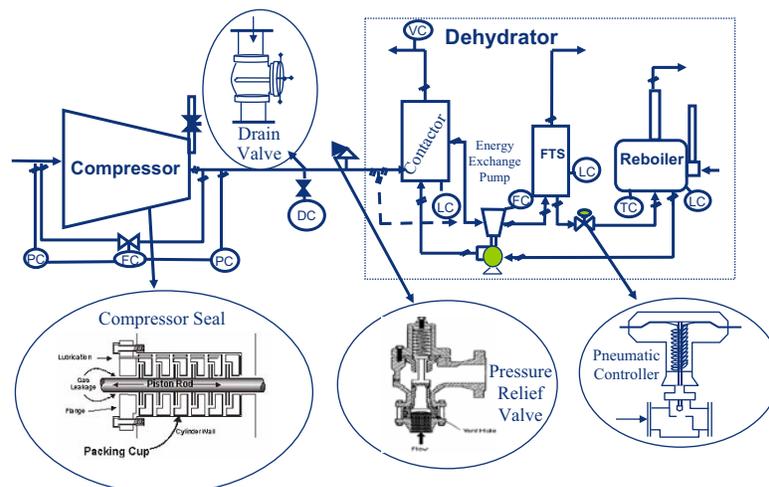**Connectors 24.4%**

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.			

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 (Mcfd)	Gas Losses From All Equipment Leakers (Mcfd)	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
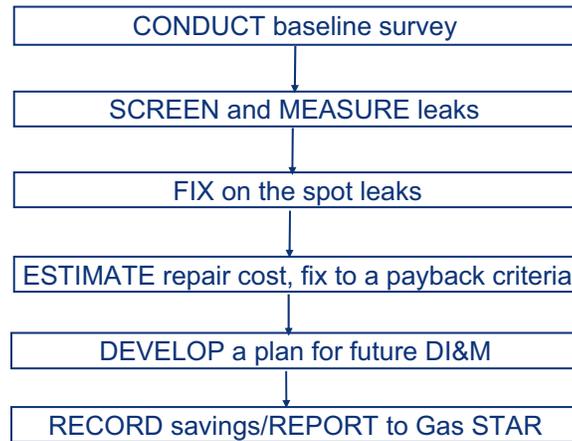- ◊ Provides valuable data on leakers with information of where to look

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 program (LDAR)

How Do You Implement DI&M?

CONDUCT baseline survey

↓

SCREEN and MEASURE leaks

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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

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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

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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
  ◊ Calibrated bag

Leak Measurement Using a High Volume Sampler

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Screening and Measurement

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	* * *	$$$
Rotameter	* *	$$
Infrared Detection	* * *	$$$

* - Least effective at screening/measurement $ - Smallest capital cost

*** - Most effective at screening/measurement $$$ - Largest capital cost

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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 Leak Detection

⬧ The following companies have helped Natural Gas STAR partners reduce methane emissions with optical leak imaging

- ⬧ **FLIR Systems**
  - ⬧ http://www.flir.com/
- ⬧ **ITT Industries – ANGEL Service**
  - ⬧ http://www.ssd.itt.com/angel/
- ⬧ **Leak Surveys Inc.**
  - ⬧ http://www.leaksurveysinc.com/

⬧ The following companies have helped Natural Gas STAR partners reduce methane emissions with remote leak detection

- ⬧ **Heath Consultants**
  - ⬧ http://www.heathus.com/

FLIR Systems

◊ GasFindIR

   ◊ Scan thousands of components per SHIFT

   ◊ Detect small leaks from several feet away

   ◊ Detect big leaks from hundreds of feet away

   ◊ Aerial surveillance of flowlines

http://www.flirthermography.com/media/GasFindIR%20Brochure.pdf

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ITT Industries – ANGEL Service

◊ Airborne Natural Gas Emission Lidar (ANGEL) Service

   ◊ ANGEL system can detect, image, and map emissions of natural gas

   ◊ Samples more than 500 million cubic feet of atmosphere per minute

   ◊ Can survey more than 1,000 miles per day

   ◊ One plane can cover 25% of U.S. transmission pipelines per year

http://www.ssd.itt.com/angel/faq.shtml

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Leak Surveys Inc.

- **HAWK System**
  - LSI will provide pinpointed, real-time visualization of gas leaks recorded in standard digital video formats
  - Gas imaging is normally performed from up to 50 feet on the ground, 2 miles from the air
  - The time required to carry out the inspection is greatly reduced, with more complete leak detection

http://www.leaksurveysinc.com/hawks_work.htm

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Heath Consultants

http://www.heathus.com/InfoCenter/rmld.pdf

- **Remote Methane Leak Detector (RMLD)**
  - Detect leaks up to 100 feet away
  - Remote detection allows the user to safely survey areas that may be difficult to reach or access
  - Potential for productivity gains, reduced operations and maintenance costs, and a safer survey

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Infrared Gas Imaging

♦ Video recording of fugitive leak found by infrared camera

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

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, blowdown, engine-starter and pressure relief valves represent <3% of components but >60% of methane emissions
- The business of leak detection is changing 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 $424,900/year at $7/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 $257,400 at $7/Mcf

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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?

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