Facility Optimization
And
Directed Inspection & Maintenance Programs

An EPA Best Management Practice

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Agenda

1. Industry Research Findings
2. DI & M Programs
3. 7 Step Process
4. Partner / Client Experiences
5. Reporting Objectives
6. Rallying Company Support (Your Battle Cry)

Industry Research on Leakage From Compressor Stations

- Extensive research conducted by Indaco and sponsored by AGA's Pipeline Research Committee *International* (PRC*I*), the Gas Research Institute (GRI) and the U.S. Environmental Protection Agency (EPA) Gas STAR Program
- Program Goals: Refine component emission factors for compressor stations to determine most effective ways to detect and quantify leaks, and to evaluate cost effective options for leak mitigation.

What is the Problem?

- Gas leaks are invisible, unregulated and go unnoticed
- STAR Partners find that valves, connectors, compressor seals and open-ended lines (OELs) are major sources
  - 27 Bcf methane emitted per year by reciprocating compressor seals and OELs
  - Open ended lines contribute half these emissions
- Facility fugitive methane emissions depend on operating practices, equipment age and maintenance

Industry Research on Leakage From Compressor Stations

- Indicates gas losses at compressor stations average 35,000 Mcf/station/year
- Equivalent to a loss of $140,000/year at $4/Mcf.
- Cost of Service + Repairs = $30,000
- Payback Period = 2.5 months
- Profits Increase with Time

Approach to Reducing Leakage

- Institute a measurement program that accurately measures all leaks
- Station personnel then have the information necessary to weigh the cost of the leak repair versus the value of the lost gas for each leak.

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How Can These Losses Be Reduced?

- Implementing a Directed Inspection and Maintenance (DI&M) Program

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What is 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

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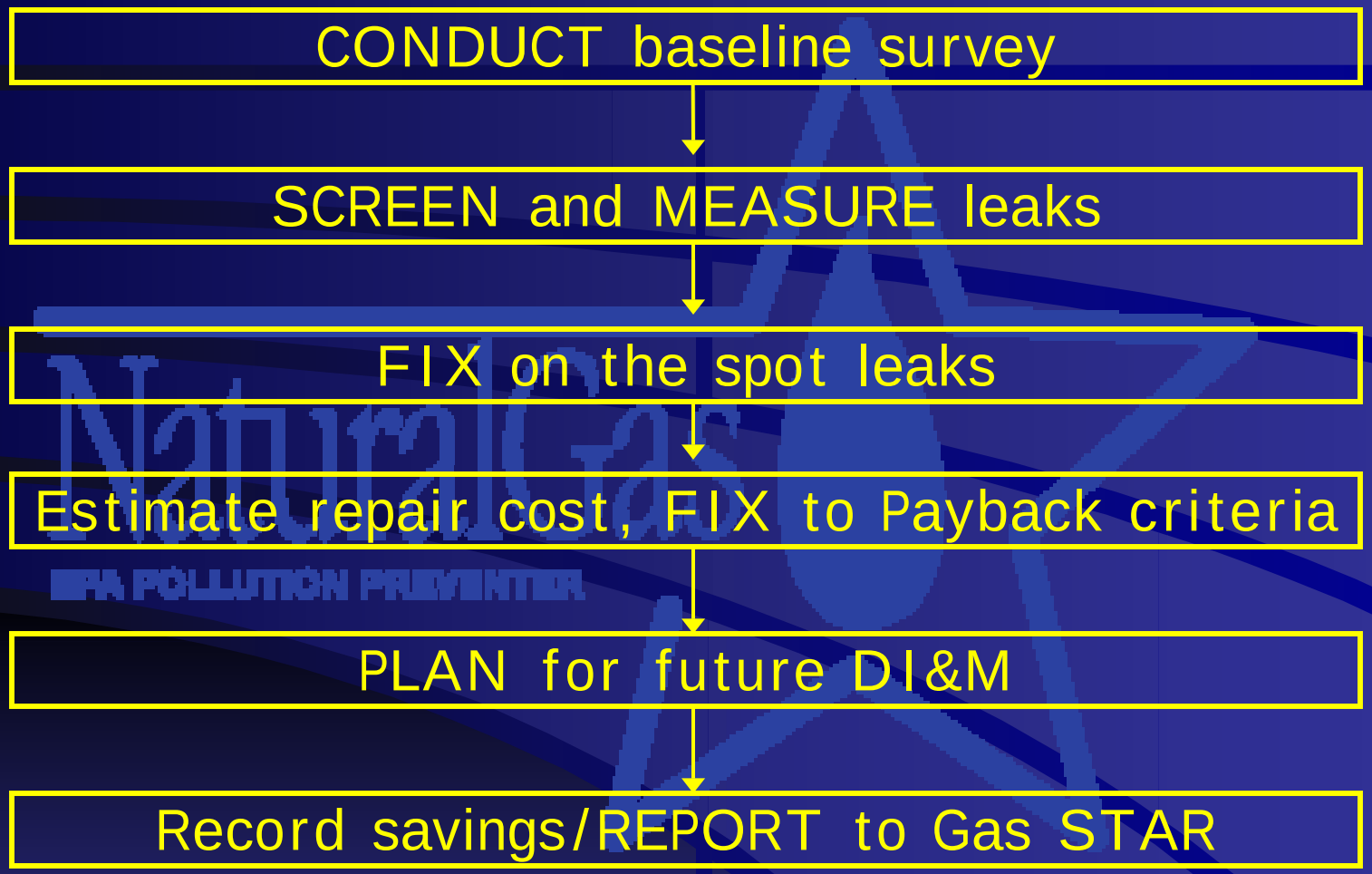
How Do You Implement a DI&M Program?



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Step 1
Familiarize & Strategize

- Walk Through Facility and Determine Plan Of Attack
- Focus your attention on all Vented Components (I.e., Packing Vents, Distance Piece “dog-house” Vents, Blowdown Vents, Pressure Relief Vents, Starter Gas Vents, ESD Vents & even Crankcase vents).
- Determine safe approach to access vents with the use of ladders, man-lifts and OSHA Certified Fall Protection.

Step 2
Screening & Tagging

- Recommend the use of a reliable pump-driven combustible gas indicator that can see down to 50 PPM.
- For Vented Components, recommend measuring as you go.
- For Standardized Components, recommend screening and tagging.

Partial List of Potential Leak Sources

- Compressor Unit Valves
- Relief Valves
- Unit Blowdowns
- Compressor Packing
- Meter Tubes
- Valve Stems
- Fuel Valves
- Various Piping & Vessel Flanges
- Online Gas Analyzers
- Centrif. Comp. Seals
- Pipeline Damage

Top 4 Typical Fugitive Sources

- Reciprocating Compressor Packing
- Blow Down Valves
- Unit Valves
- Condensate Tank

"Find The Needle In The Haystack"

Leak Survey Methods

- **Leak Detection**
  - Soap solution
  - Flame Ionization
  - Catalytic oxidation/thermal conductivity
  - Ultrasonic
  - Visual
  - Tag and number leaks on standard components

Step 3

Measuring Leakage or Emissions

- **Leak Measurement**
  - Hi Flow Samplers
  - Vent-Bag™
  - Hot Wire Anemometer

Measurement Methods

- For leaks up to 10 cfm – Hi Flow Sampler

  10 cfm @ $5/Mcf = $26,280
- For leaks 10 – 240 cfm – Vent-Bag Method

  50 cfm @ $5/Mcf = $131,400

  100 cfm @ $5/Mcf = $262,800
- For leaks >180 cfm - Anamometer

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Hi-Flow Sampler Applications

- Originally developed as a research tool for determining emissions
- Now used to help reduce the greater than $200 million of gas lost yearly from natural gas facilities
- Allows repair decisions to be made based on the cost of the gas lost from each leak

Hi Flow Sampler Applications

Advantages:

- Total Leak Capture
- Measures Leak Rate Directly
- Can Measure 30 components per hour
- Repair Decision Based on Leak Rate & Repair Costs

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Hi Flow Sampler Technology

- Captures Entire Leak
  - Measures Flow Rate (F) and Concentration (sample)
  - Subtracts the background (back) Concentration
  - Leak Rate = F x (sample – back)

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Condensate Tank Leakage Identified Loses/Savings

Estimated Annual Loss
$54,061/yr
Or
13,515 Mcf/yr

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Step 4
Fix On The Spot Leaks

DI&M – Partner Experience

- **Example 1:** 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**
- **Example 2:** 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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DI&M – Partner Experience

- **Example 3:** Blowdown valve leaked almost 14,500 Mcf/yr
  - **Rather than replace the expensive valve, Partner spent just $720 on labor and materials to reduce the emissions to approximately 100 Mcf/yr**
  - **Value of gas saved was $43,200 at $3/Mcf**
- **Example 4:** Tube fitting leaked 4,121 Mcf/yr
  - **Very quick repair requiring only five minutes reduced leak rate to 10 Mcf/yr**
  - **Value of the gas saved was $12,300 at $3/Mcf**

Heath/Indaco Client Experience

Distribution & Transmission Company
Midwest

- Largest leaks measured across rod packings of running compressors.
- Total leak rate at site was 18,200 scfh. Unit 3 had largest leak at 11,800 scfh, accounting for 64.6% of the total leak rate from packings.
- Operated 5 months of the year, leak rate is equivalent to $179,600/year @ $2.7/Mcf (Enough gas to heat 374 homes with an average monthly gas bill of $40).
- This figure works out to be $327,600 at $5/Mcf.

Appendix I: Leak Rates at Company Compressor Station, Louisiana

Leak Tag Number	Engine ID, Model, Compressor #	Status	Check At	Source of Leak/ Component	Leak Rate (scfm)	Activity factor	Yearly Leak rate (Mcf/yr)	Cost ($/Yr) @ $3/Mcf	Comments on Replacement/Repair
	Eng. 3, BA6, Total	Running	Rod Packing Vent	Rod Packing	53.25	0.80	22392.4	$67,177	All Packing changed in the last 10 years. Distance Piece Vent combined with Rod packing vent. Unit Valves on schedule for replacement. Two engines each year according to supervisor.
	Eng. 7, BA6, Total	Running	Rod Packing Vent	Rod Packing	39.30	0.76	15699.1	$47,097	All Packing changed in the last 10 years. Distance Piece combined with Rod Packing Vent. Unit Valves on Engines 7-10 were replaced after 2000.
	Eng. 7, BA6, Total	Idle and Pressurized	Rod Packing Vent	Rod Packing	43.27	0.24	5458.2	$16,374	All Packing changed in the last 10 years. Distance Piece combined with Rod Packing Vent. Unit Valves on Engines 7-10 were replaced after 2000.
	Eng. 3, BA6, Total	Idle and Pressurized	Rod Packing Vent	Rod Packing	32.37	0.20	3403.2	$10,209	All Packing changed in the last 10 years. Distance Piece Vent combined with Rod packing vent. Unit Valves on schedule for replacement. Two engines each year according to supervisor.
	Eng. 10, HBA6, Total	Running	Rod Packing Vent	Rod Packing	7.60	0.80	3194.5	$9,584	All Packing changed in the last 10 years. Distance Piece combined with Rod Packing Vent. Unit Valves on Engines 7-10 were replaced after 2000.
	Station Blow Down Valve 1-6	Pressurized	Blow Down Vent outside gate	Valve, Blow Down	5.75	1.00	3021.8	$9,066	Blow Down Valves for units 1-6 are all originals. They were installed in 1950. Common Blow Down Vent is located on the far West side.
6-B	Outside, Unit Valve Area	Pressurized	Discharge Unit Valve, #C	Valve, Stem	4.88	1.00	2566.5	$7,700	# C Unit Valve on Discharge line in back of Eng 6
	Eng. 4, BA6, Total	Running	Rod Packing Vent	Rod Packing	6.42	0.69	2327.1	$6,981	All Packing changed in the last 10 years. Distance Piece Vent combined with Rod packing vent. Unit Valves on schedule for replacement. Two engines each year according to supervisor.

Step 6

Perform Maintenance and or Repair and Conduct Post Measurement

- Determine true savings achieved
- Determine accurate emission reductions achieved for EPA Gas Star report

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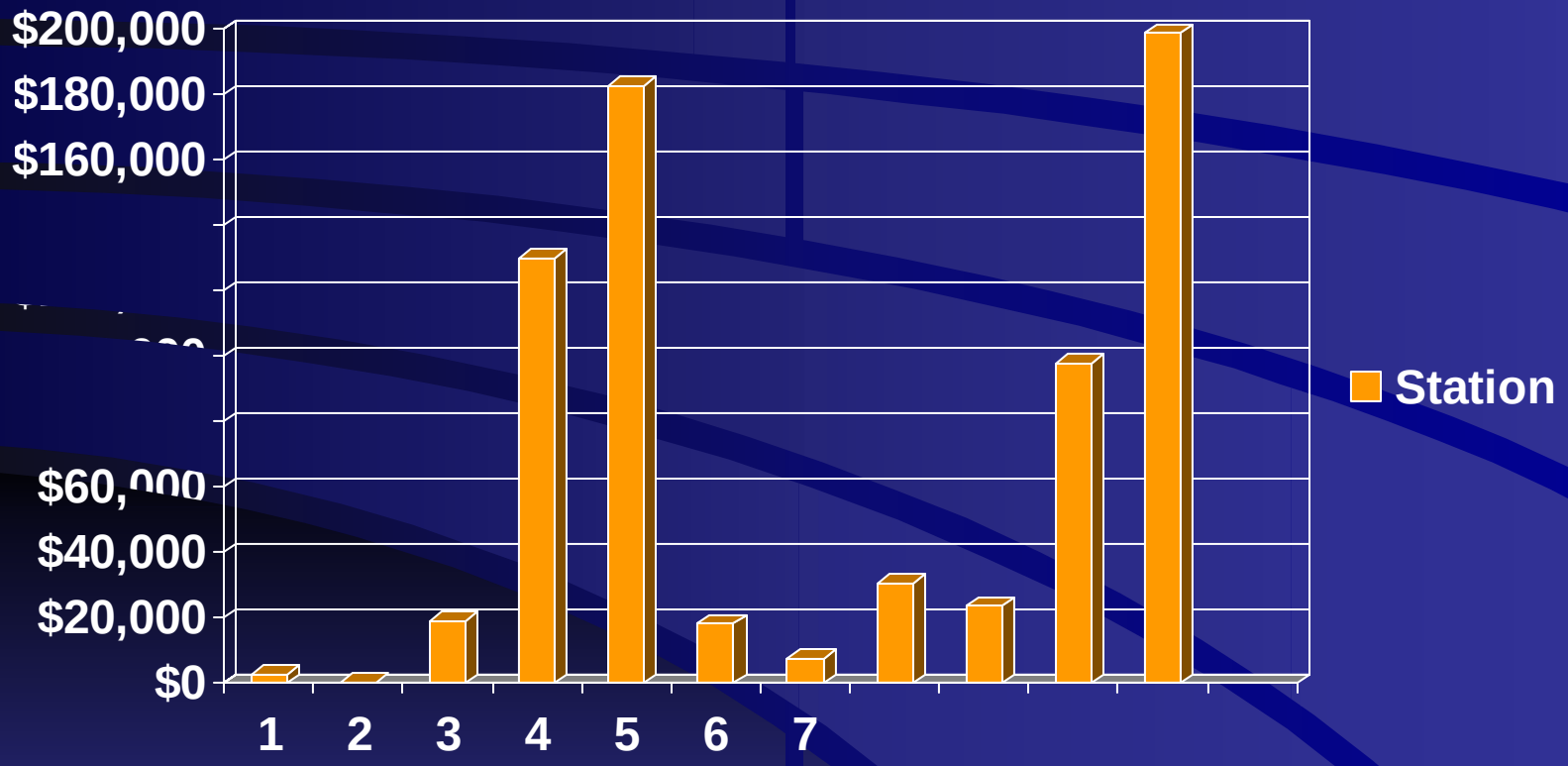
Typical Company Profile of Methane Emissions on a Station to Station Survey



Assumes a cost of $3/Mcf

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Primary Objectives of a Leak Rate Measurement Survey

- Identify & Measure all leaks
- Rank Order Leaks ($$/Mcf)
- Prioritize Maintenance & Repair
- Target Largest Leaks at Each Station and Repair As Soon As Possible
- Improve Profit Margins
- Provide Baseline Emission Factors Per Station

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Secondary Objectives of Leak Rate Measurement Program

- Identify Unsafe Conditions and Lower the Risk of Accidents
- Audit of Facility/Reality Check
- Provide Hard Data On Emission Reductions to EPA Gas STAR Program
- Demonstrate Environmental Awareness to Public and Shareholders
- Data to Support Future Credits

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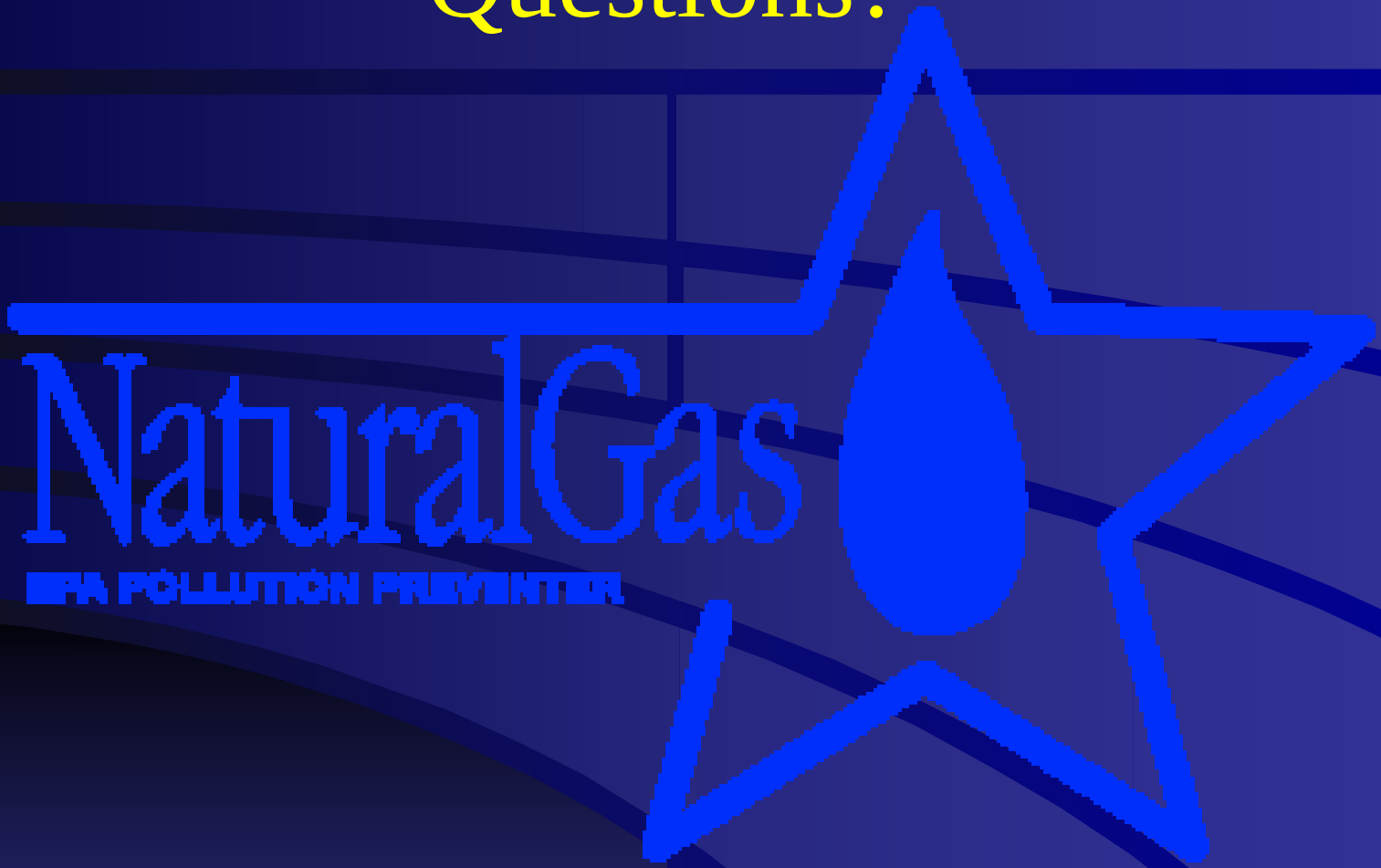
Questions?



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