

# Methane Reductions from Gas Compressors

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# U. S. Natural Gas Transmission Systems

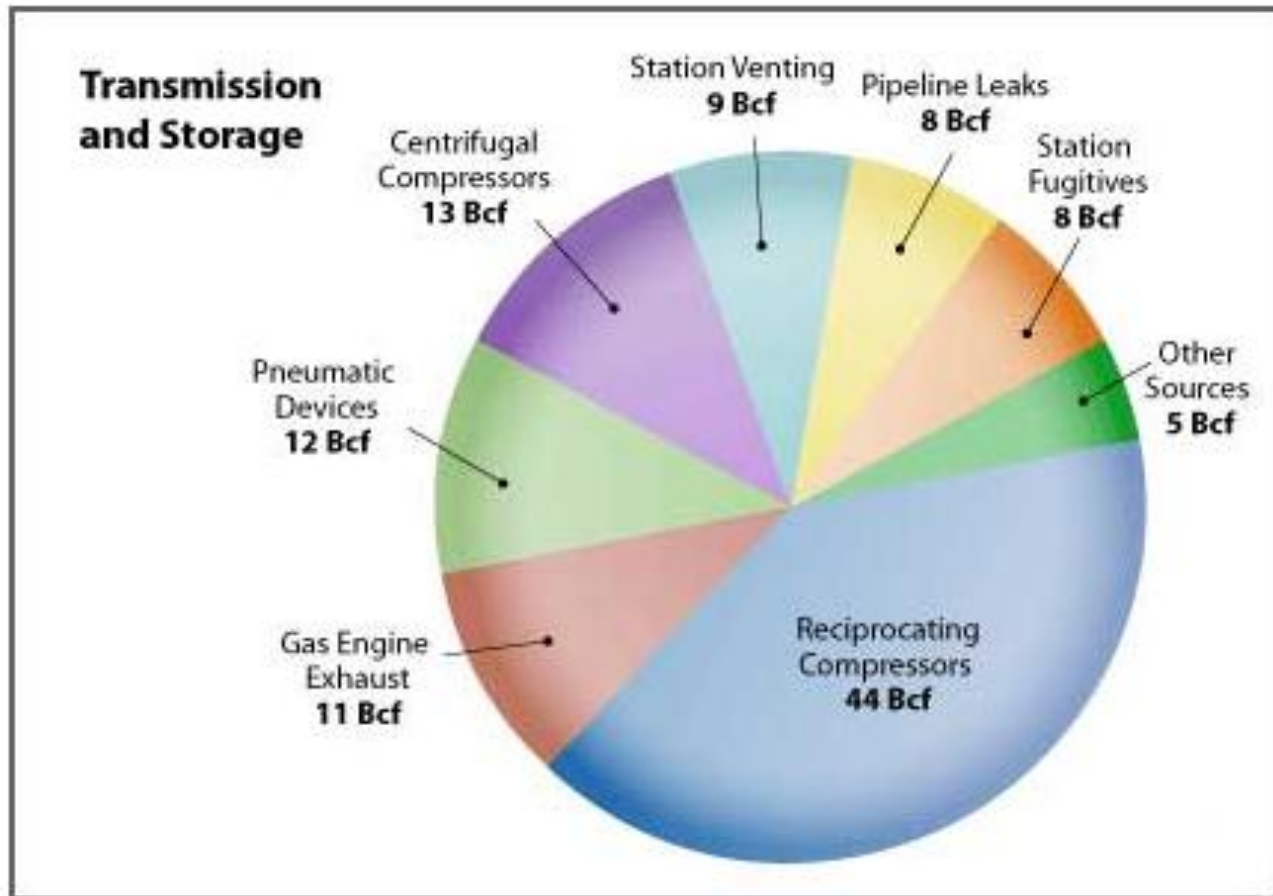
- Transmission and Gathering Systems - approximately 325,000 miles of pipe <sup>1</sup>
- Approximately 1,800 compressor stations <sup>2</sup>
- Over 50,000 reciprocating compressor engines are operated within the U.S. <sup>2</sup>

<sup>1</sup> U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration

<sup>2</sup> U.S. Environmental Protection Agency estimate



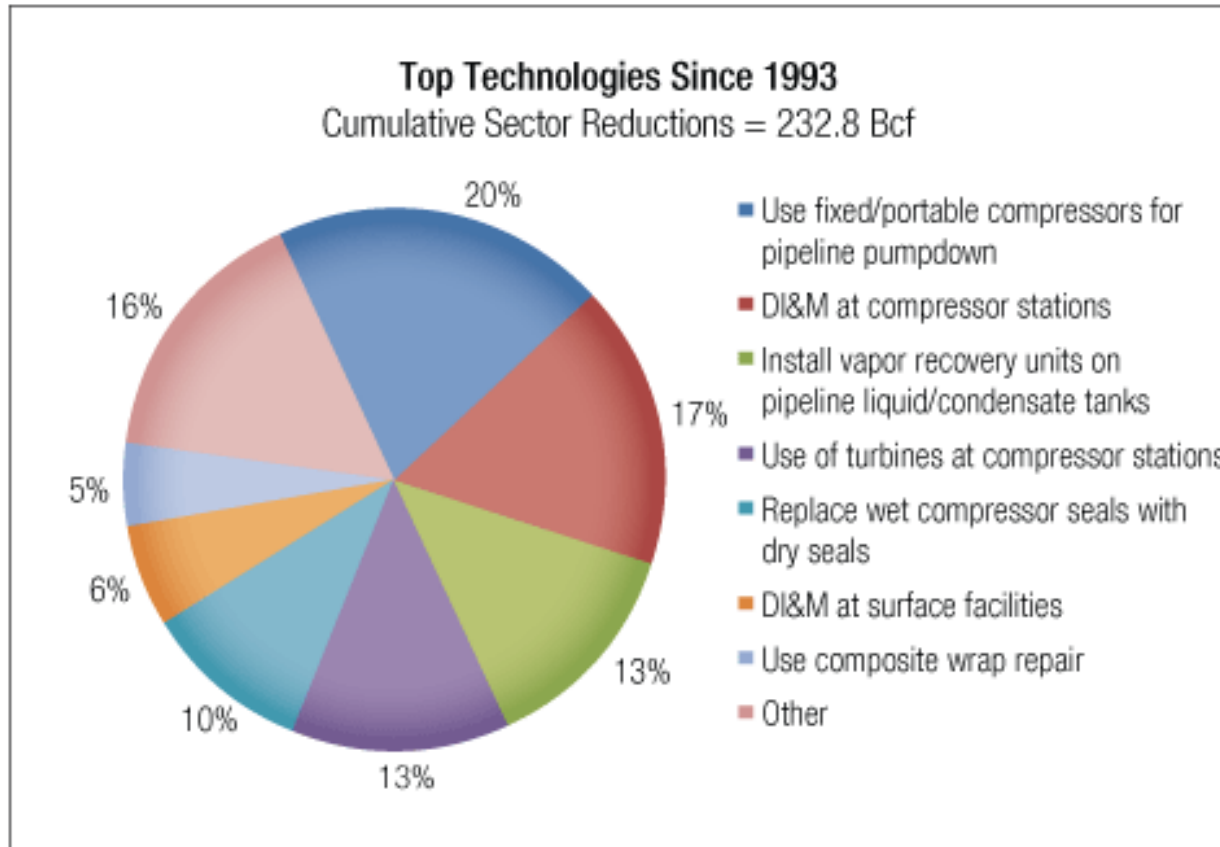
# Methane Emissions - Natural Gas Sector



[Reference: Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990 - 2009, USEPA, April, 2011](#)



# Gas Transmission Sector Reduction Technologies Since 1993



Reference: EPA Natural Gas STAR Program Web Page



# Methane Emission Reduction Technologies: Compressors

- Under the Natural Gas STAR Program, EPA identifies 12 available reduction technologies
  - Directed Inspection and Maintenance Programs
  - Compressor Rod Packing Systems
    - Reciprocating Compressors
  - Centrifugal Compressors Seals



# Compressor Stations

- Methane Emission Sources
  - Valves
  - Flanges
  - Connectors
  - Open-ended lines
  - Pressure Relief Devices
  - Blow Down



# Directed Inspection and Maintenance

- Leak Screening Techniques:
  - Infrared cameras
  - Organic Vapor Analyzers
    - Photo or flame ionization detectors
  - Acoustic Leak Detection
    - High frequency or ultrasonic detectors
  - Electronic Gas Detectors
- Leak Measurement Techniques:
  - Organic Vapor Analyzers
    - Photo or flame ionization detectors
  - Bagging Techniques
  - High Volume Samplers
  - Rotameters



# Screening and Measurement Technique Applicability

Instrument/Technique	Application and Usage	Effectiveness
Electronic Gas Detectors	Flanges, vents, large gaps, and open-ended lines.	Screening only
Acoustic Detectors Ultrasound Detectors	All components. Larger leaks, pressurized gas, and inaccessible components.	Screening only
TVA (flame ionization detector)	All components	Best for screening only. Measurement requires site-specific leak size correlation.
Bagging	Most accessible components	Measurement only; time consuming
High Volume Sampler	Most accessible components (leak rate <11.5 Mcfd)	Screening and measurement
Rotameter	Large leaks	Measurement only



# Directed Inspection and Maintenance Program

- Identify and tag components
  - Use software to track components and results
- Survey components – identify leaks
- Quantify leakage rates
  - Experience shows the majority of leaks come from small % of components
- Evaluate cost-effectiveness of leak repair
- Repair leaks
- Quantify emission reductions

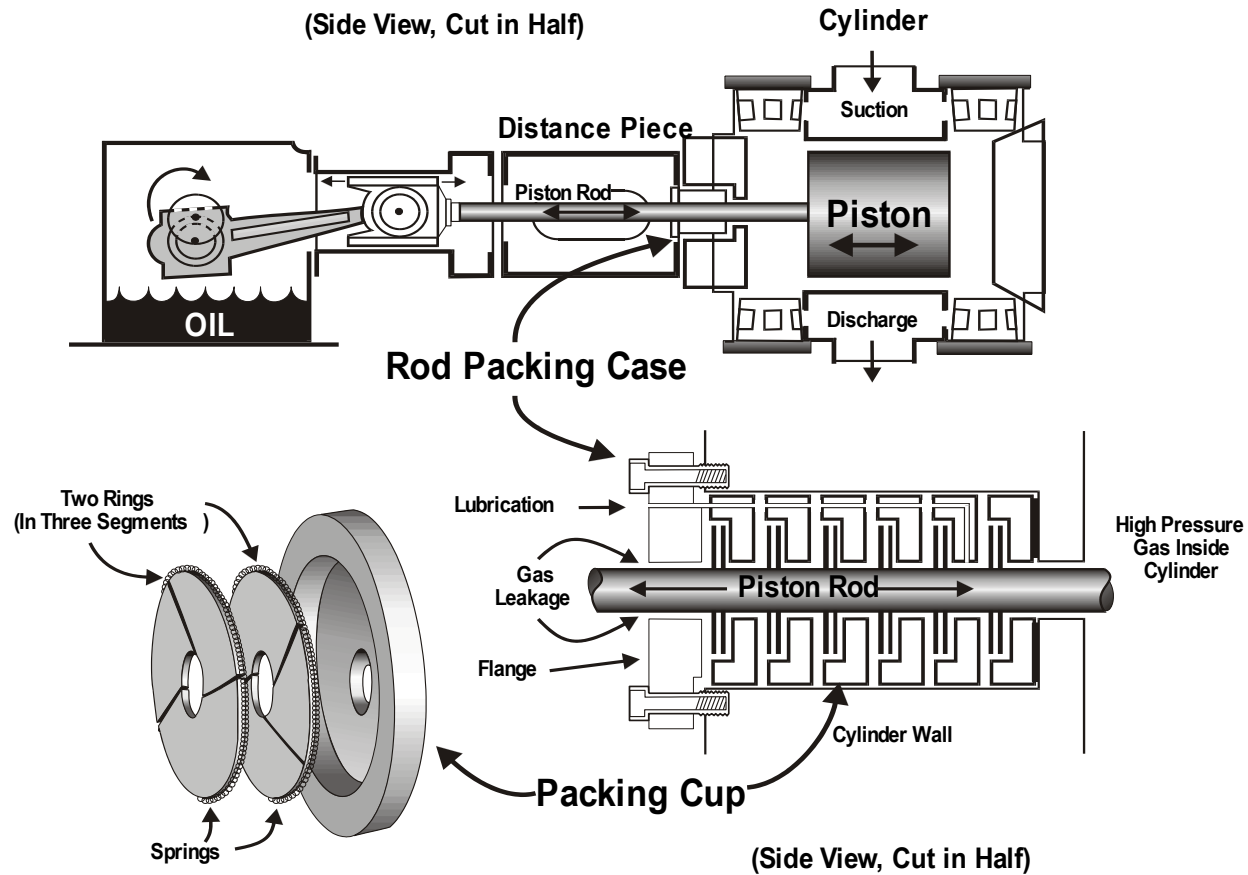


# Replace Compressor Rod Packing Systems

- Reciprocating compressors are connected to a driver operating single or multiple compressor cylinders
  - Number of Compressor Cylinders vary based on the driver power rating and speed, the pipeline operating conditions, and compression volume requirements
  - Compressor rod packing systems are used to maintain a seal around the piston rod and to prevent gas leakage from the high pressure gas in the compressor cylinder



# Typical Reciprocating Compressor Rod Packing System





# What Leaks?

- Leakage occurs from:
  - Around packing case through gasket between the case and cylinder
  - Between packing cups, typically mounted metal-to-metal
  - Ring movement as piston rod moves back and forth
  - Down the piston rod shaft
- All rod packing assemblies will eventually leak



# Reducing Rod Packing Leaks

- Establish a leakage rate baseline for new rod packing(s)
- Regularly monitor for leakage
- Determine economic replacement thresholds
  - Thresholds will vary by service requirements and packing replacement costs
- Replace packing and rods when cost-effective
  - Conventional rod packing rings may require replacement every 3 to 5 years

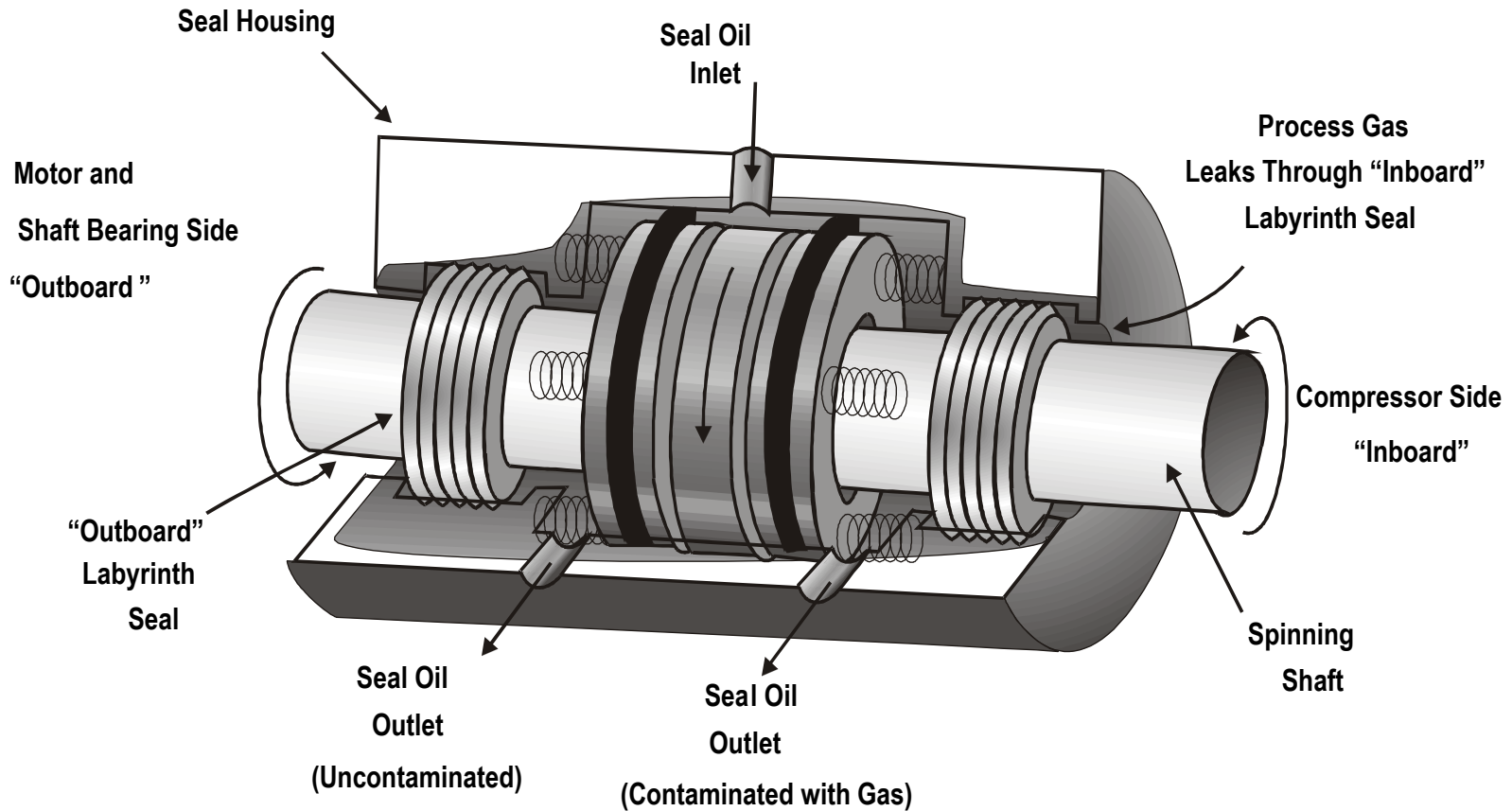


# Centrifugal Compressors

- Centrifugal compressors require seals around the rotating shaft to prevent gas escape
- Two seal systems are common
  - Older centrifugal compressors have wet seals: higher leak rates
  - Most new centrifugal compressors have dry seals: much lower leak rates

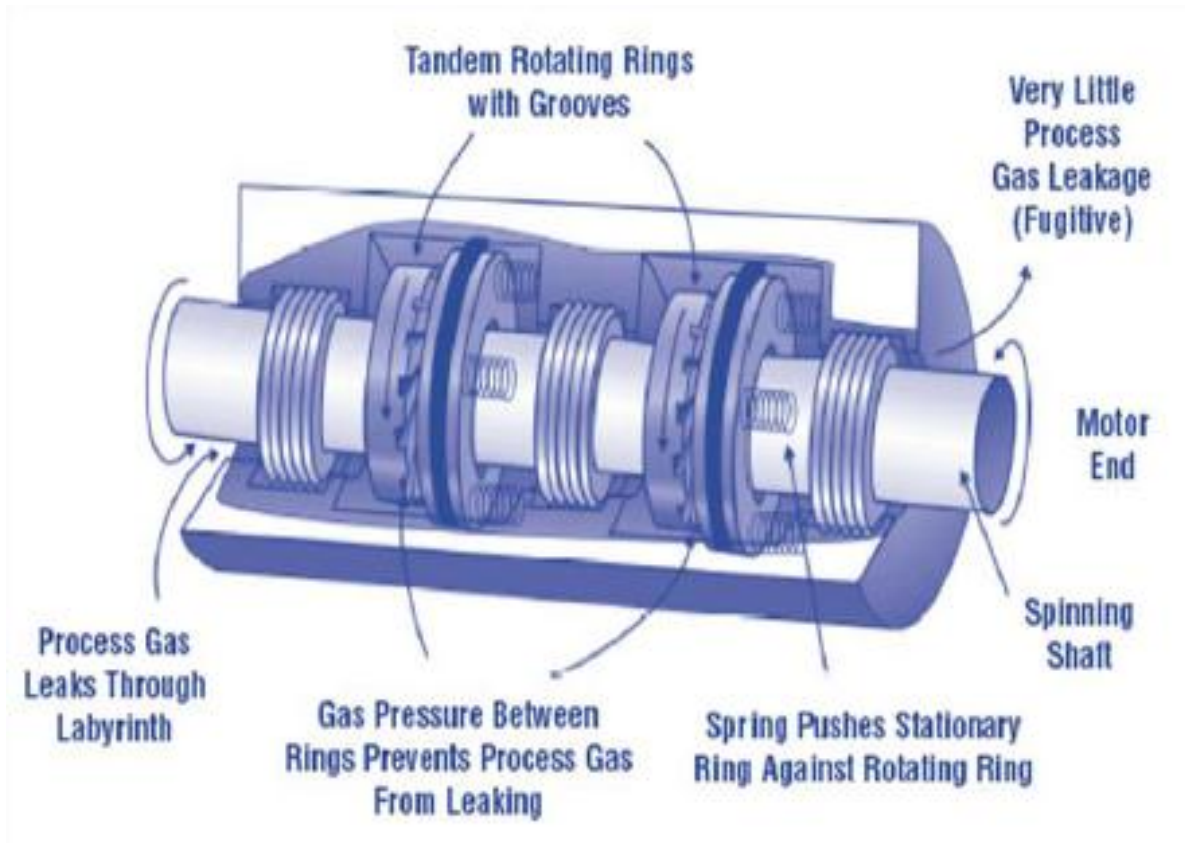


# Centrifugal Compressor Wet Seal





# Centrifugal Compressor Dry Seal





# Dry Seal Benefits

- Lower leak rates
- Mechanically simpler
- Reduced power consumption
- Improved reliability
- Lower maintenance costs
- Eliminates oil leakage into pipeline



# Kinder Morgan's Natural Gas Pipeline Operations

- Largest natural gas transporter and storage operator in US
  - Operates approximately 62,000 miles of natural gas pipelines
- Key Assets
  - Texas Intrastate Pipeline Group serving producers and customers in Texas
  - Tennessee Gas Pipeline serving markets from Texas to northeastern US markets (e.g., New York City and Boston)
  - Southern Natural Gas serving southeastern US markets (e.g., Atlanta)
  - Natural Gas Pipeline Company of America serving central and mid-western US markets (e.g., Chicago)
  - El Paso Natural Gas serving southwestern US markets (e.g., Phoenix, Tucson and California)
  - Colorado Interstate Gas, Wyoming Interstate Company and TransColorado Gas Transmission Company serving Rocky Mountain markets
  - Mohave Pipeline Company and the Ruby Pipeline serving California markets

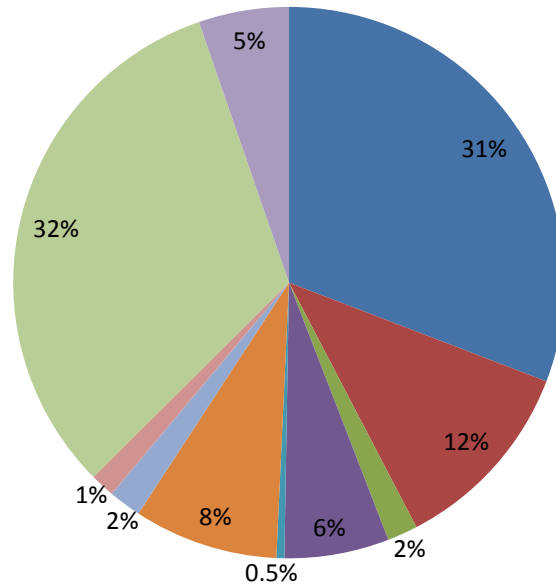


# Kinder Morgan's Natural Gas STAR Program Experience

- Kinder Morgan's natural gas pipeline companies have participated in EPA Natural Gas STAR program since 1993
- Since 1993, Kinder Morgan companies have achieved cumulative methane reductions of over 77.3 Bcf
  - Directed Inspection & Maintenance: 8.9 Bcf
  - Rod Packing & Wet Seal Replacements: 1.4 Bcf



# Kinder Morgan Cumulative Methane Reductions (1993-2010): 77.3 Bcf



- Use compressors - pipeline pumpdown (23,848,456 Mcf)
- DI&M: compressor stations (8,914,460 Mcf)
- Install electric compressors (1,376,917 Mcf)
- Use of turbines at compressor stations (4,744,894 Mcf)
- Identify and replace high-bleed pneumatic devices (358,692 Mcf)
- Use composite wrap repair (6,548,531Mcf)
- Replace compressor rod packing systems (1,482,925 Mcf)
- DI&M: surface facilities (1,110,911 Mcf)
- Install VRU on pipeline liquid/condensate tank (24,874,864 Mcf)
- Other (4,095,016 Mcf)



## More Information

- Additional information regarding methane emission reduction technologies is available from EPA's Natural Gas STAR Program Web Page:
- <http://www.epa.gov/gasstar/>
- Technical Documents are available in Arabic, Chinese, Russian and Spanish