# Gas STAR Technologies and Practices for DI&M and Compressor Seals
## (Opportunities for Cost Effective Methane Sensors)

EPA's Natural Gas STAR Program,

El Paso Corporation, and

Southern Gas Association

October 27, 2003

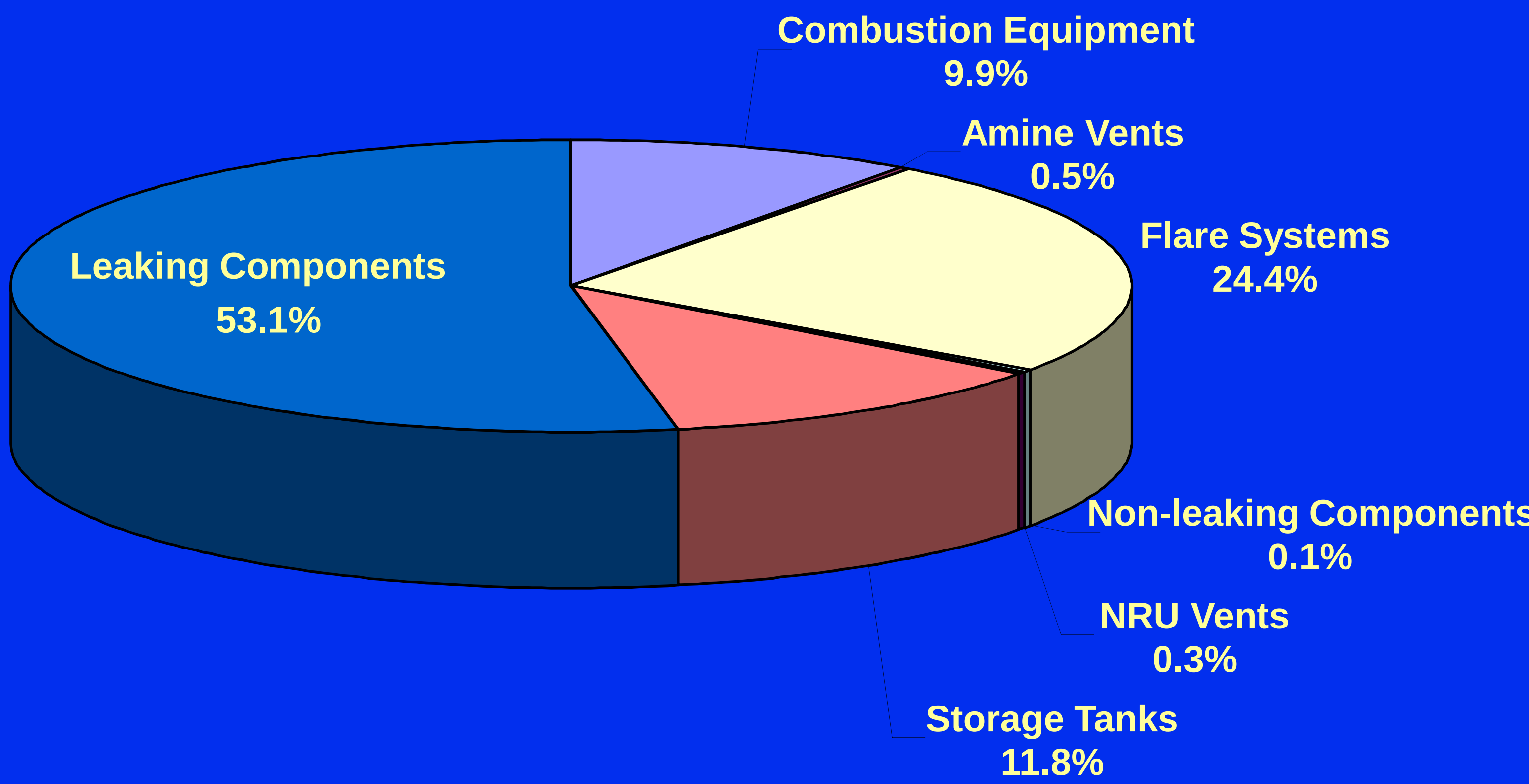
# Agenda

- **Equipment leaks**
  - What is the problem?
  - Where are the leaks?
  - What Gas STAR Partners are doing.
  - A low-cost sensor option.
- **Compressor seals**
  - What is the problem?
  - Where are the leaks?
  - What Gas STAR Partners are doing.
  - A low-cost sensor option.

# Equipment leaks
# What is the Problem?

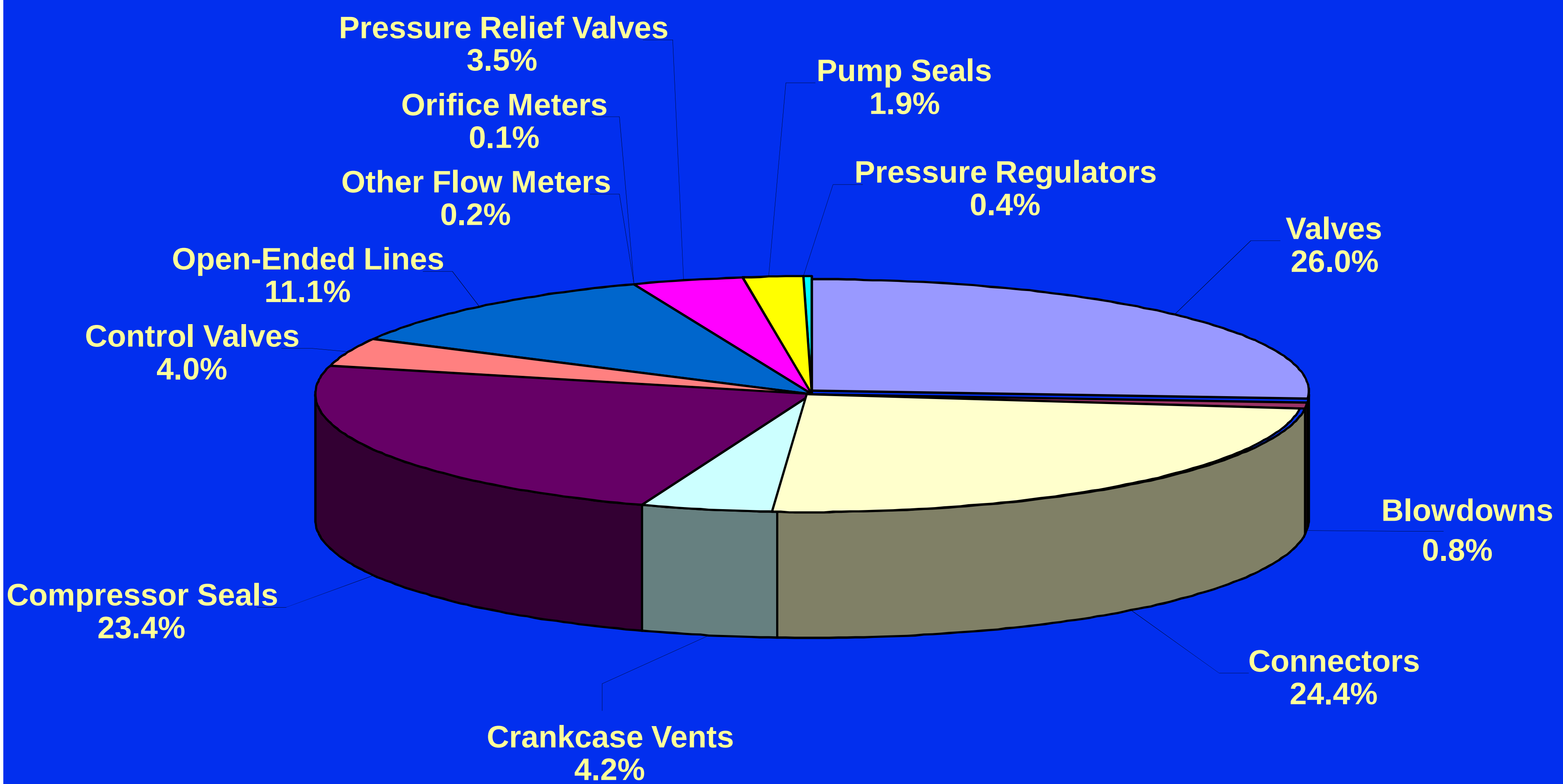
- **STAR partners find that valves, connectors, compressors and open-ended lines (OEL) are major leak sources**
  - 50.7 Bcf/yr of methane are emitted by compressors and facility components
  - 1% of the leakers contribute 90% of the emissions
- **Fugitive emissions depend on operating practices, equipment age and maintenance**

# Distribution of Natural Gas Losses by Source Category




*Source: Clearstone Engineering, 2002*

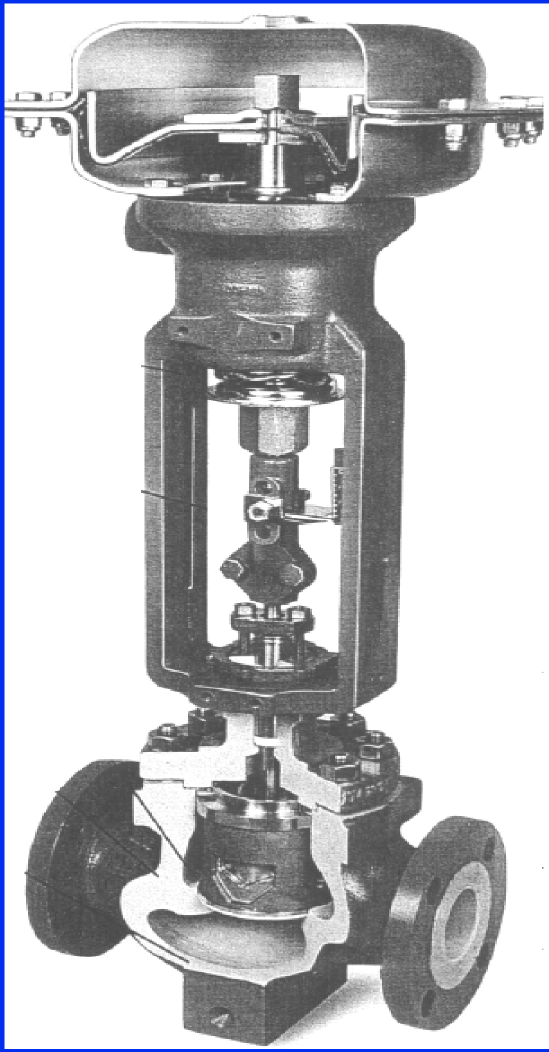
# Natural Gas Losses from Equipment Leaks by Type of Component




*Source: Clearstone Engineering, 2002*

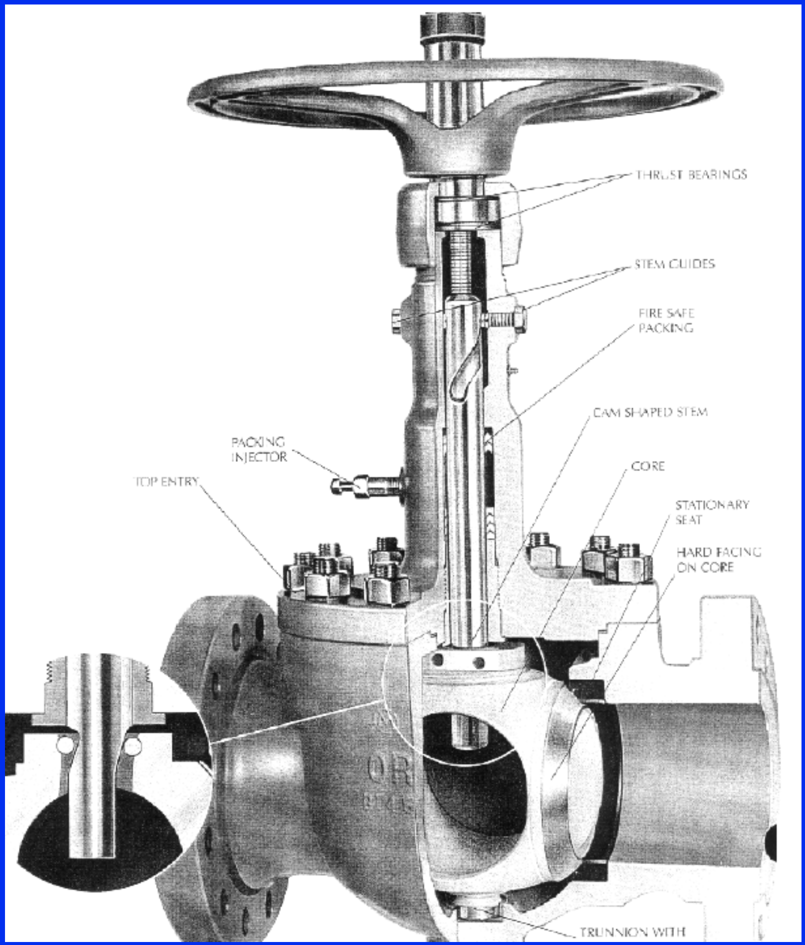
# Where are the leaks?

- **Valves account for 30%**
  - Block valves = 26%
  - Control valves = 4%
- **Stem seal leaks are the primary source**
  - Balance between packing pressure and valve movement force
  - Packing wears, requiring either more pressure or replacement



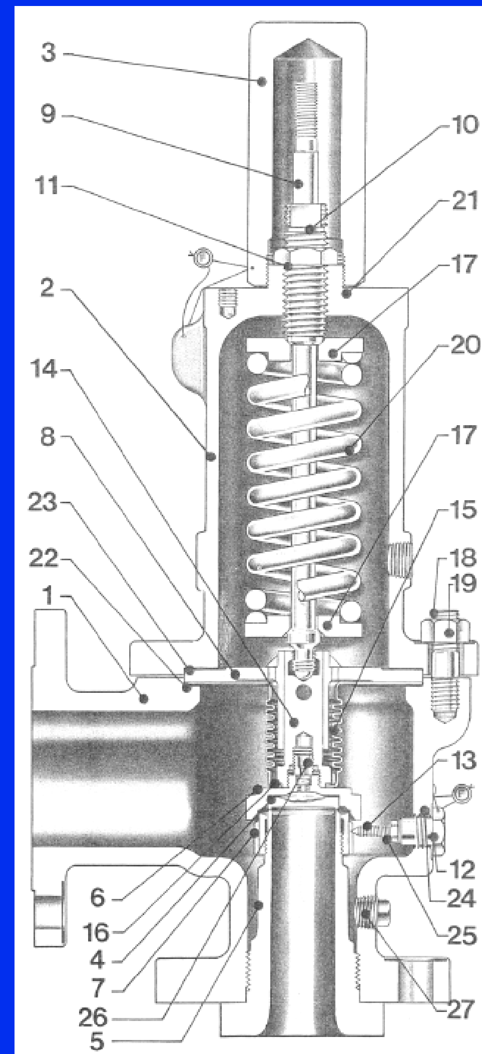
# Where are the leaks?

- **Open ended lines (OEL) account for 11%**
  - Block valves
  - Blowdown vents, motor starters, vent and drain connections
- **Through-valve leakage is the primary source**
  - Often from vent stacks
  - Valve seat wears or fouls, requiring either more pressure, cleaning or replacement



# Where are the leaks?

- **Pressure Relief Valves (PRV) account for 3.5%**
  - Fewer of them, so higher individual leakage
  - Protect equipment from over-pressure
- **Through-valve leakage is the primary source**
  - Often from vent stacks
  - Valve seat wears or fouls, requiring either cleaning or replacement



# What Gas STAR Partners are doing?

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

Acoustic Leak Detection

Leak Measurement Using a High Volume Sampler

# Current DI&M Techniques

| 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 | ★★★ | $$$ |
| Rotameter | ★★ | $$ |
| Source: EPA's Lessons Learned Study | | |

# Cost-Effective Repair Examples

| Repair the Cost Effective Components | | | |
|---|---|---|---|
| **Component** | **Value of Lost gas[1] ($)** | **Estimated Repair cost ($)** | **Payback (Months)** |
| Plug Valve: Valve Body | 12,641 | 200 | 0.2 |
| Open-Ended Line | 6,959 | 60 | 0.1 |
| Pressure Relief Valve | 982 | 293 | 3.5 |
| Gate Valve | 4,729 | 60 | 0.2 |

Source: Hydrocarbon Processing, May 2002
[1]Based on $3/Mcf gas price

# Opportunities for Inexpensive Leak Sensors

- **Application: Valves, Open-Ended Lines (OELs), Pressure Relief Valves (PRVs)**
- **Objective: Automated detection of LARGE leaks that are cost-effective to repair**
- **Potential application:**

Business as usual site visit

↓

Equipment alerts operator to cost-effective leak

↓

Operator directs repairs on the spot

# DI&M – Transmission Partner Experience

- Partner A: 15 Stations surveyed annually
  - **Survey and repairs averaged $350/station**
  - **Methane savings averaged 11,067Mcf/station**

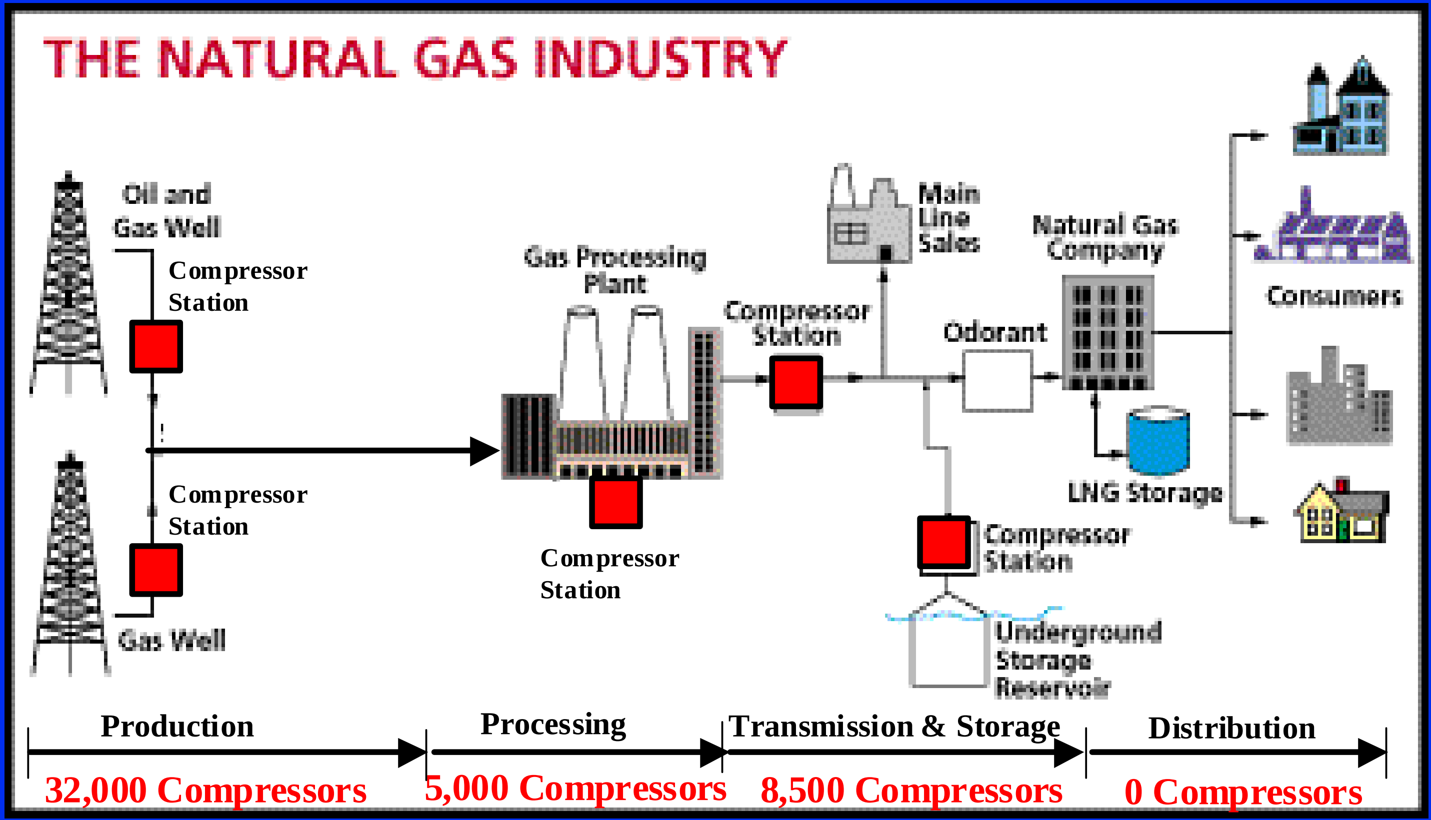
| | |
|---|---|
| Total Gas Savings | $ 498,030 |
| Total DI&M Cost | $ (5,250) |
| SAVINGS | $ 492,780 |

- Partner B: 2 Stations surveyed quarterly
  - **Survey costs $200/station**
  - **24 leaks detected & repaired; 23 repaired at average $50 each**

| | |
|---|---|
| Total Gas Savings | $ 51,240 |
| Total DI&M Cost | $ (2,750) |
| SAVINGS | $ 48,490 |

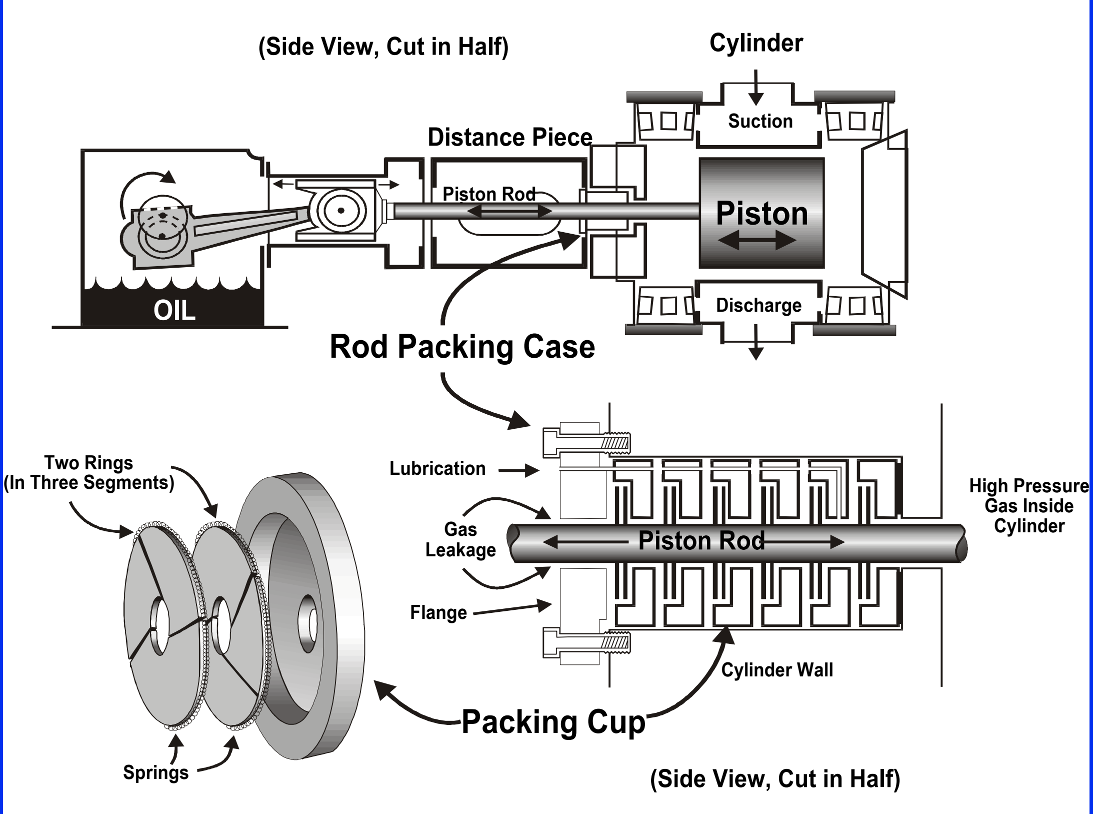
# Compressor seals
# What is the problem?

- **Compressor seals account for 23.4% of emissions**
  - 11.9 Bcf/yr of methane are emitted by compressors
  - Over 8,500 compressors in gas transmission sector



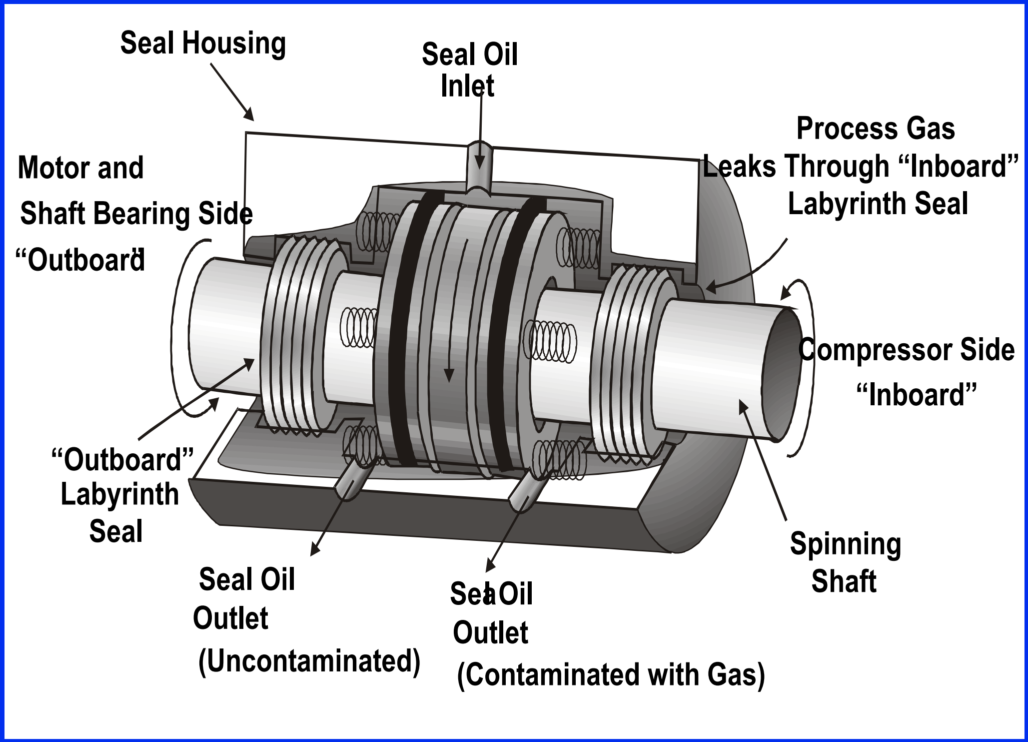
# Where are the leaks?

- Reciprocating compressor rod packing
  - Fourth largest gas industry emissions at 16 Bcf/yr
- Leakage typically occurs from:
  - Nose gasket
  - Between cups
  - Ring movement
  - Down shaft
- All packings leak
  - ~60 scfh new
  - >900 scfh worn



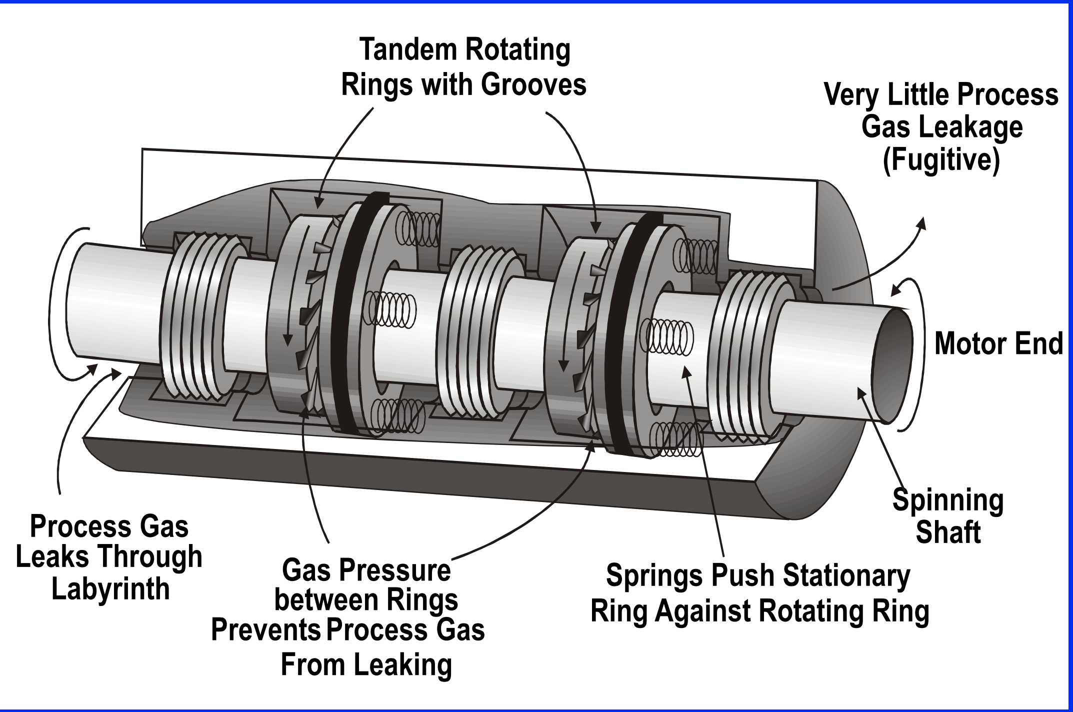
# Where are the leaks?

- **Centrifugal compressor wet seals**
  - 90% of new compressors for transmission are centrifugal
- **Leakage typically occurs from:**
  - Labyrinth seal into seal oil
  - Seal oil degassing vent
  - Very little leakage seal face
- **Seal oil vents emit**
  - 40-200 scfm



# Where are the leaks?

- **Centrifugal compressor dry seals**
  - Most new compressors are supplied with dry seals
- **Leakage typically occurs from:**
  - Labyrinth seal into static barrier
  - Seal vent after tandem seal
  - Little leakage from seal face
- **Seal vents emit**
  - 0.5-3 scfm



# What Gas STAR Partners are doing.

- Leakage is reduced through routine monitoring and seal maintenance
  - Conventional rod packing rings require replacement every 3 to 5 years
- An economic leak rate is determined based on costs and gas savings
- Replace rings when it is economical
  - Saves gas and money
  - Extends the life of the piston rod
  - Reduces methane emissions

# Best Practice Compressor Emissions Control

## Compressor Rod Packing Systems

- Partners develop an "economic replacement threshold" that defines the point when it is cost-effective to replace rings and rods

**Economic Replacement Threshold (scfh) =**

**(CR * DF) / [(H * GP) /1,000]**

**where:**

**CR = cost of replacement ($)**

**DF = company discount factor (%)**

**H = hours of compressor operation**

**GP = gas price ($/Mcf)**

# Economic Analysis

## Compressor Rod Packing System

### Economic Replacement Threshold for Packing Rings

| LRE (scfh) | Payback Period[1] (yrs) |
|---|---|
| 83 | 1 |
| 43 | 2 |
| 30 | 3 |
| 24 | 4 |
| 20 | 5 |

1 Assumes packing ring replacement costs of $1,200, $3.00/Mcf gas and 8,000 hr/yr

### Economic Replacement Threshold for Rod and Rings

| LRE (scfh) | Payback Period[1] (yrs) |
|---|---|
| 564 | 1 |
| 295 | 2 |
| 206 | 3 |
| 162 | 4 |
| 135 | 5 |

1 Assumes packing ring replacement costs of $1,200, rod replacement cost of $7,000, $3.00/Mcf gas and 8,000 hr/yr

# Opportunities for Inexpensive Leak Sensors

- **Application: Compressor seal and seal oil vents**
- **Objective: Automated detection of LARGE leaks that are cost-effective to repair**
- **Potential application:**

Business as usual site visit

↓

Equipment alerts operator to cost-effective leak

↓

Operator schedules cost-effective repairs

# Company Experience

- One partner conducted semi-annual inspections of compressor rod packing
  - Replaced packing cases at eight stations costing $1,050 per case, installed
  - Saved 55 MMcf/yr valued at $165,000

# Discussion Questions

- How accurate would sensors need to be in quantifying methane emissions?
- Would methane emissions sensor outputs need to be transmitted to a SCADA center?
- To what degree are candidate sites for low cost fugitive sensors non-electrified?
- What are other applications for inexpensive methane emissions sensors?