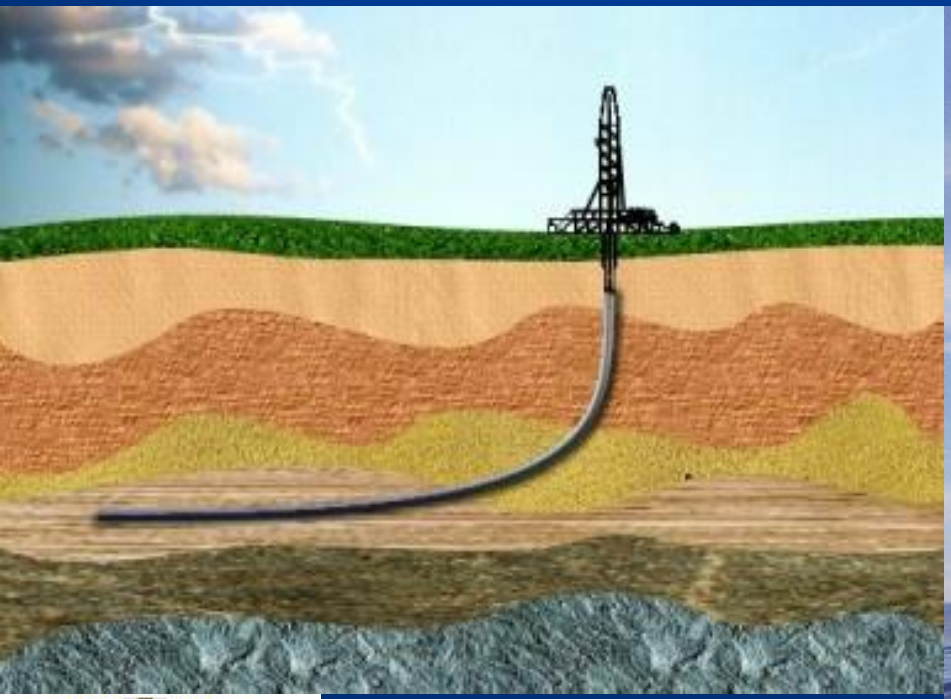
Environmental Concern in Gas Collecting and Transfer Installations

Seminar, DNV Technology Center - Gdynia

02 December, 2011



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Shale Gas Operation Consultant

Gdansk University of Technology

Czym jest gaz z łupków dla Polski?

- Jeżeli USA traktuje 20% wydobywanego gazu z łupków kategoriami Bezpieczeństwa Narodowego…

- -to jakimi kategoriami Polska winna traktować import 65% gazu który nie jest zbilansowany exportem?

Pytania?

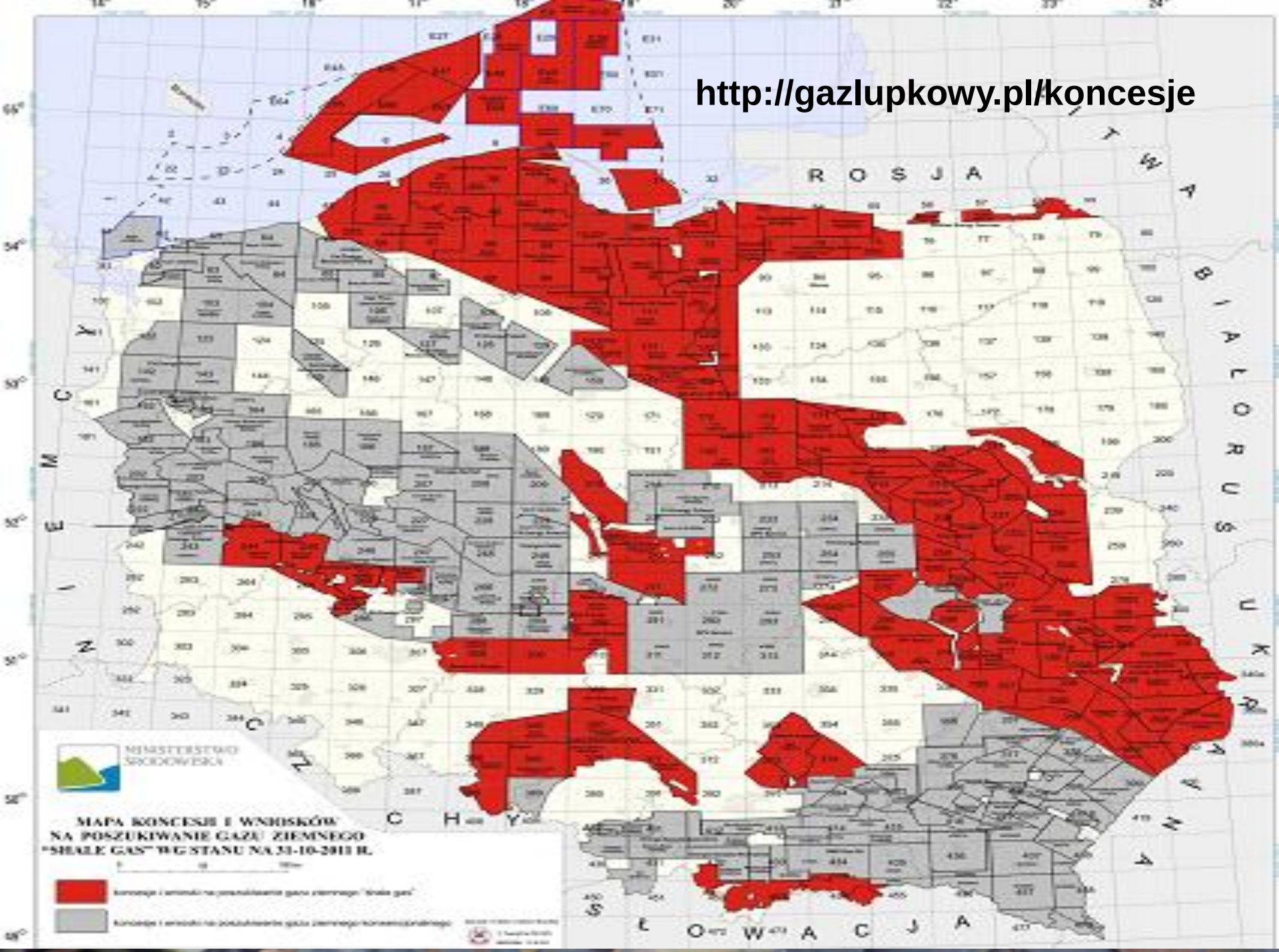
- Czy potrzebujemy nieprzerwanych dostaw gazu dla przemysłu i naszych mieszkań?

- Czy grozi nam zaciskanie pasa, zwiększenie podatków, ciecia budżetowe drukowanie pieniędzy, inflacja, syndrom Grecji aby zapłacić dostawcom gazu ponad $500 za 1000m3 gaz?

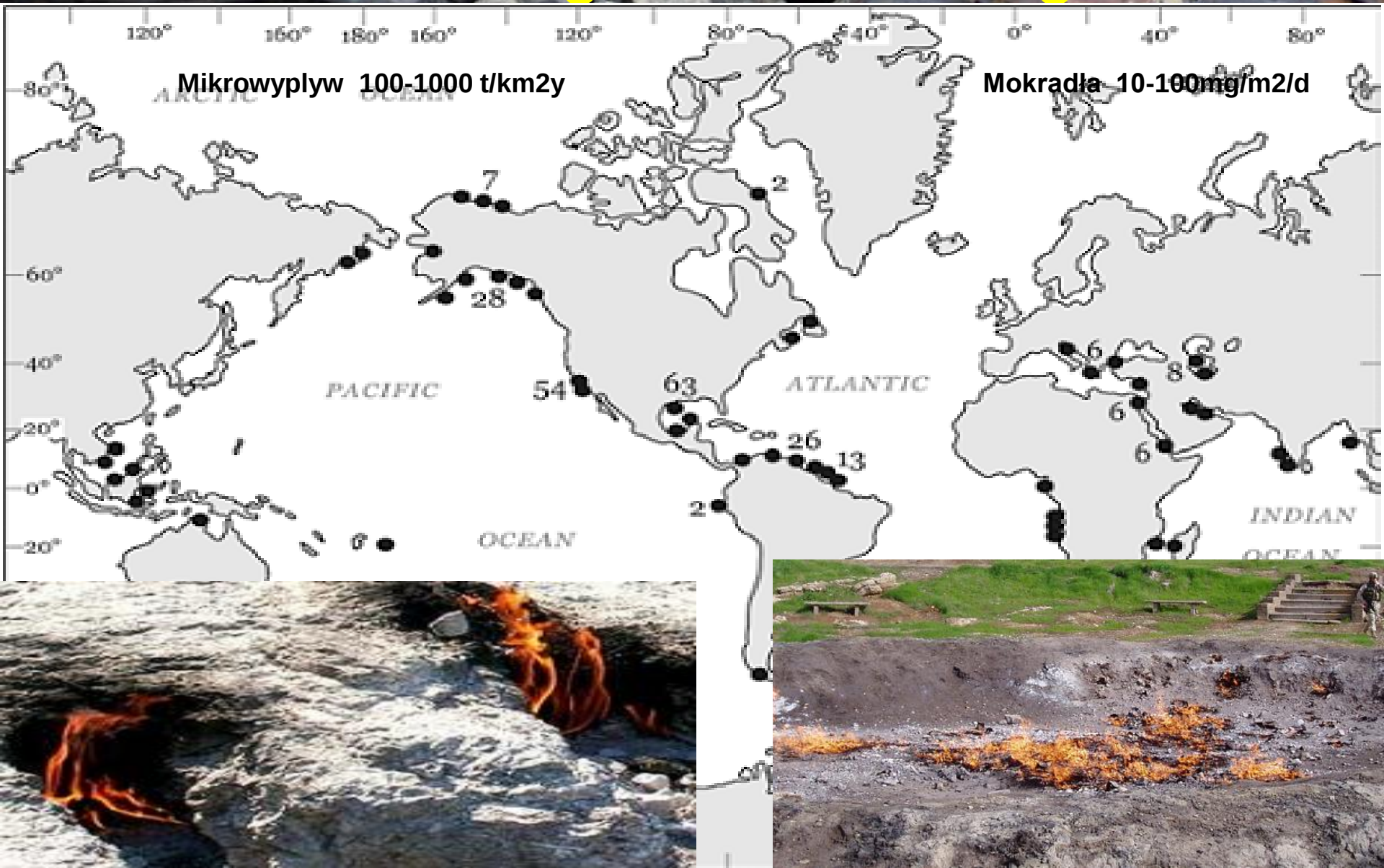
- Czy dar Matki Natury jakim jest gaz z łupków będzie naszym bogactwem narodowym i szansa na wyjście z globalnego kryzysu czy przekleństwem?
- Czy damy szanse inwestorom zbadać opłacalność wydobycia gazu z łupków w ciągu najbliższych 3-5lat?
- Czy jesteśmy gotowi na oferty nowych miejsc pracy oferowanych Polsce w dobie kryzysu?

Installations Planning Consideration in Kaszuby

- Local populations concern to win hearts and minds
- Requirements of melting it with landscape
- Noise proof containers options for compressors engine or power generators
- Dual fuel engine option
- Gas supply to local population considerations
- Power supply to local population option


http://gazlupkowy.pl/koncesje
ROSJA
BIAŁORUŚ
UKRAINA
SŁOWACJA
CZECHY
NIEMCY
MINISTERSTWO ŚRODOWISKA
MAPA KONCESJI I WNIOSKÓW NA POSZUKIWANIE GAZU ZIEMNEGO "SHALE GAS" WG STANU NA 31-10-2011 R.

Methane Seepage Worldwide
C12 Termogenic C13 Organic




Reference,
Journal of Petroleum Technology
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http://www.spe.org/jpt/print/archives/2011/11/14Methane.pdf

Methane Leak Detection and Measurement Technologies

- Portable Infrared Methane Detectors
- Mobile Infrared & Optical Methane Detectors
- Catalytic / Thermal Conductivity / Electrochemical Detectors
- Infrared Laser Based - Remote Methane Leak Detectors
- Infrared Gas Imaging Cameras
- High Flow Samplers
- Calibrated Measurement Bags
- Aerial Leak Detection

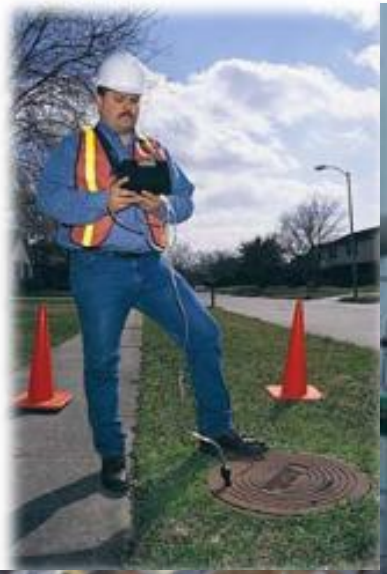
Portable Infrared Methane Detector

Optical Methane Detector

Multifunction Gas Detectors

Catalytic oxidation, thermal conductivity hydrocarbon detectors

Display reading in lower explosive range of gas (LEL) and % volume gas

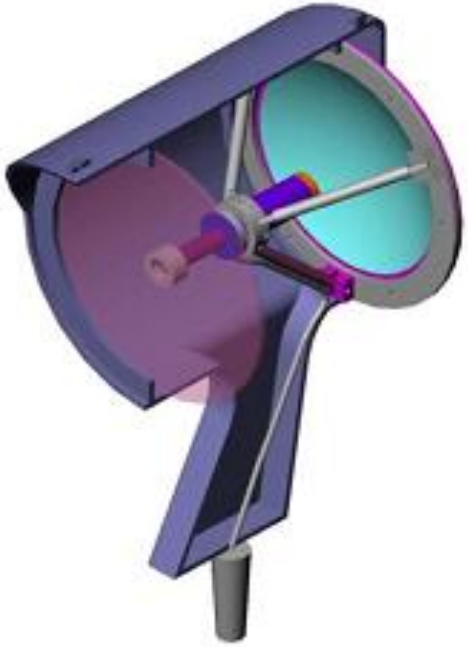


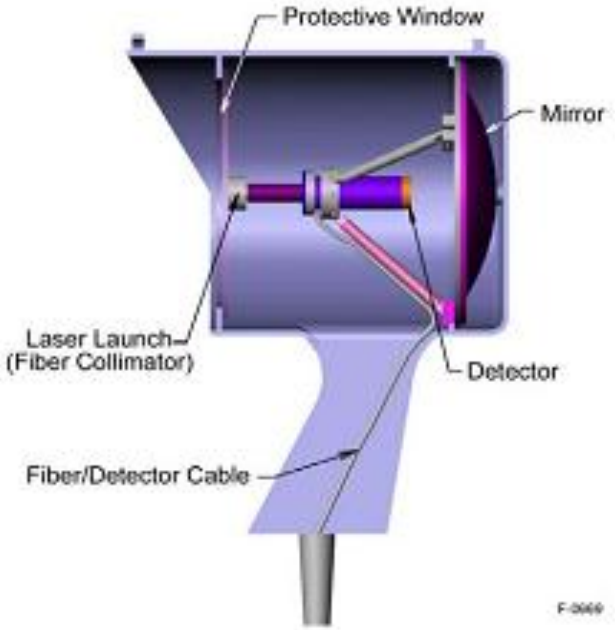
Remote Methane Leak Detection

Works using Tunable Diode Laser Absorption Spectroscopy (TDLAS)

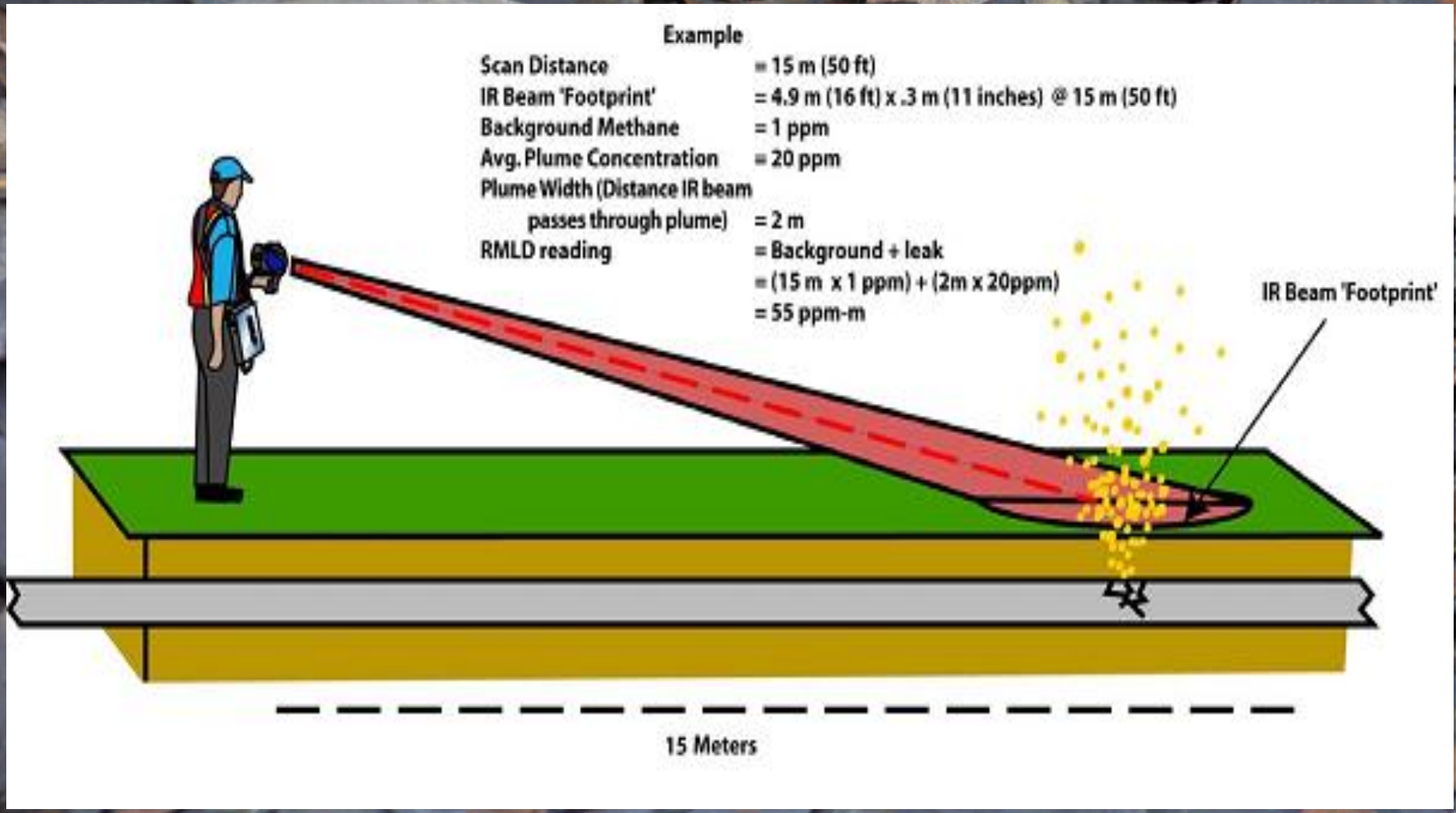
Specific to methane gas only

Displays gas reading in parts per million metered





RMLD Gas Detection Measurement



Infrared Gas Imaging Camera

Hi Flow Sampler Application

Advantages:

- Total leak capture
- Measures leak rate directly
- Accuracy of calculated leak rate = +/- 10 % of reading
- Can measure 30 components per hour
- Repair decision based on leak rate and repair costs

Accuracy of calculated leak rate

– +/- 10% of reading

Temperature:

– Operating.....0 to 50 °C (32 to 122 °F)
– Storage.....-40 to 60 °C (-40 to 140 °F)

Measurable leak rate

– 0.05 to 10.5 standard cubic feet per minute (scfm) or 1.42 to 226 liters per minute (LPM)

Measurement method

– Differential pressure across restriction

Calibrated 3 Cubic Feet Measurement Bag

Aerial Methane Gas Leak Survey

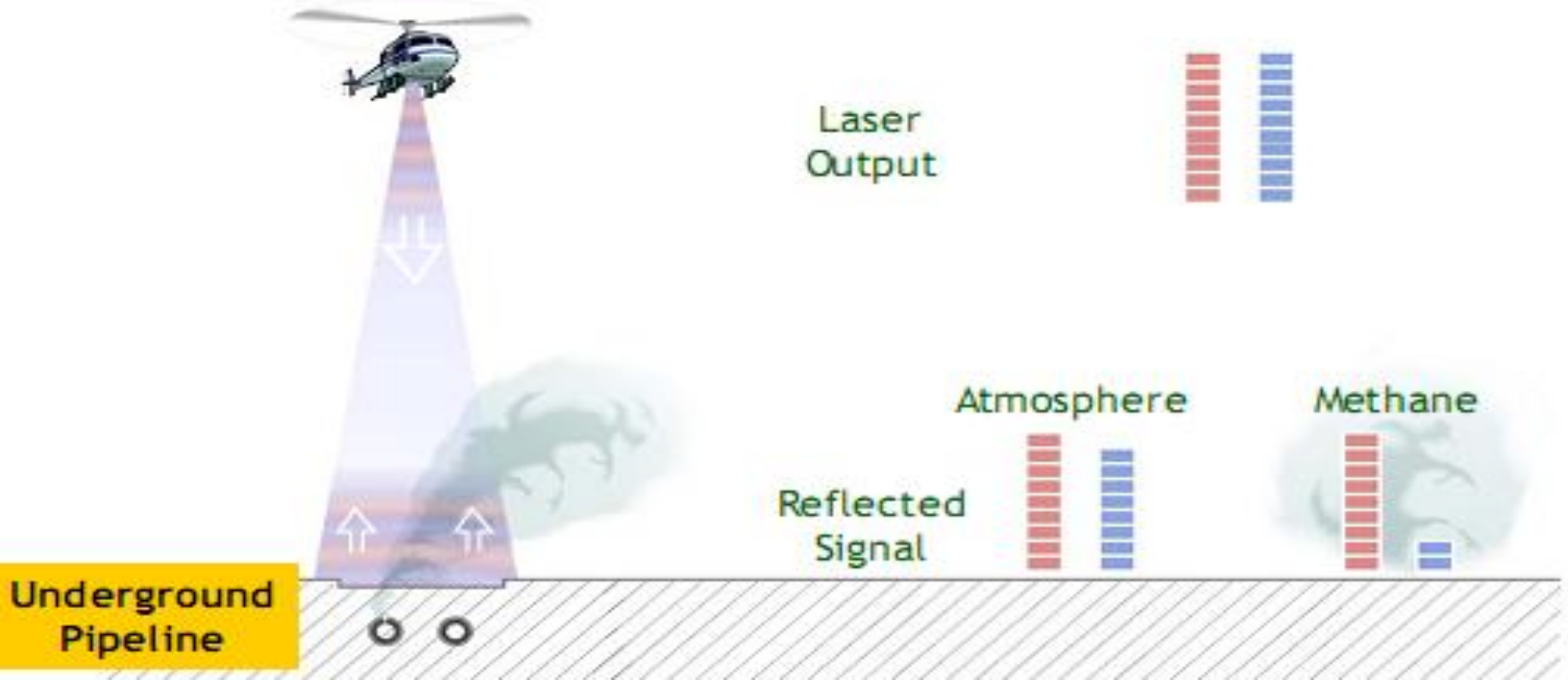
Aerial leak surveys with infrared leak detection devices can aid in leak identification over large sections of pipelines

Aerial surveys can be conducted in helicopters or fixed wing aircrafts using both active and passive IR detection devices

Source: LaSen Inc.

Airborne Pipeline Gas Leak Survey

- ALPIS (Airborne Lidar Pipeline Inspection Service)
- Over 10 times faster than ground surveys
- Full coverage of the right-of-way
- Easy access to rough terrain and non-disruptive to private land owners



Effectiveness of inspection

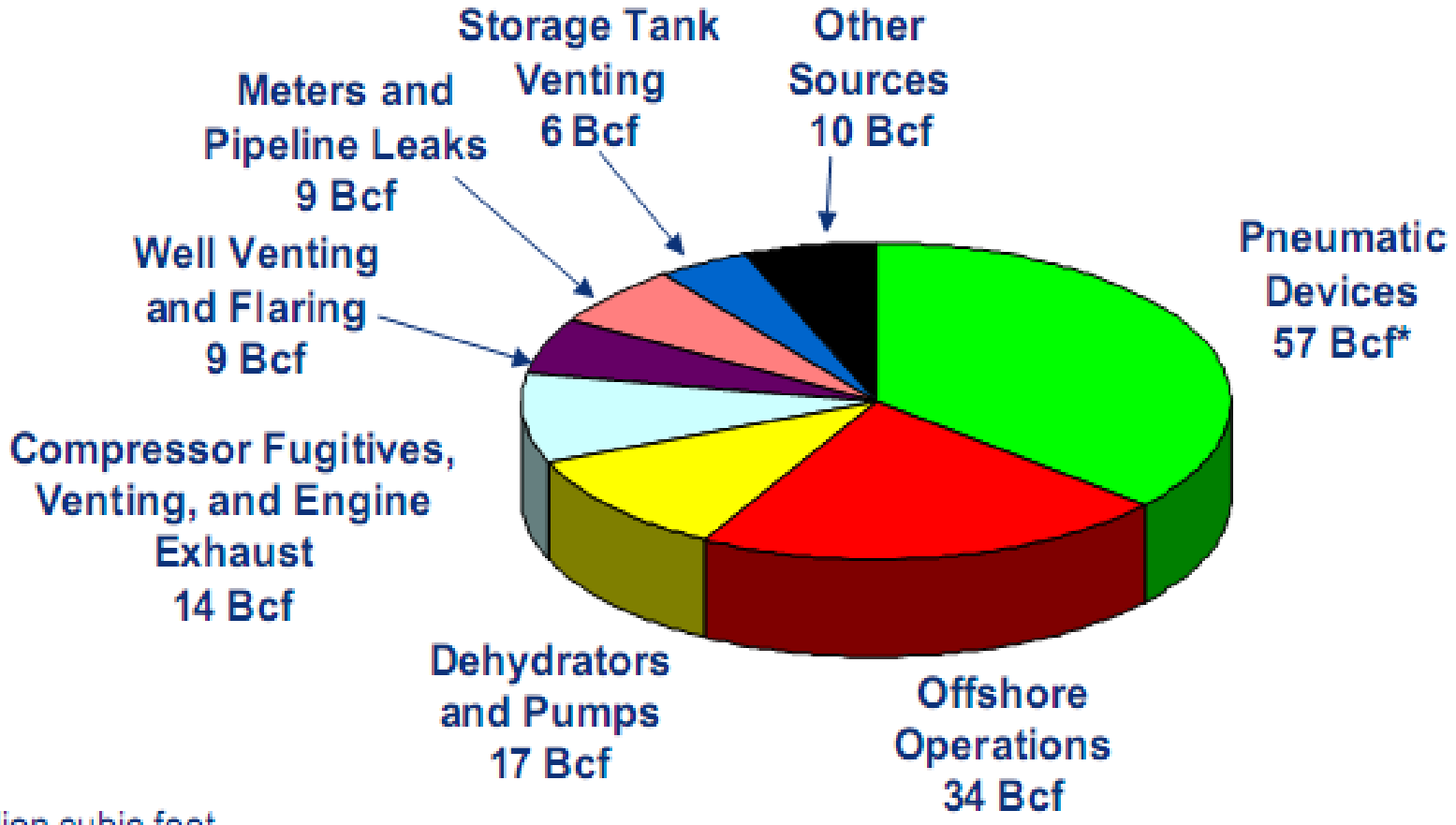
15 miles of transmission line inspected on April 13, 2006

Cost of Inspection $1,875.00 *

Annual Product Loss $16,407.00**

LASEN Marker	Indication size	As-Found Daily Leakage Rate (mcf)	Annual Leakage Rate (mcf) m=1,000	Annual BTU Loss	Annual product loss ($)	Description of leak and repair
A-210994	medium	0.1776	64.82	64,824,000	583.42	Leak found on fuel tap valve operator (booster station). Lubricated stem and operated valve to stop leak.
A-216681	small	0.4181	152.61	152,606,500	1,373.46	Leak found from plug in top of drip valve. Removed, cleaned, taped and replaced plug to stop leak.
A-231599	medium	0.1672	61.03	61,028,000	549.25	Leak found from plug in top of drip valve. Removed, cleaned, taped and replaced plug to stop leak.
A-316434	medium	0.5017	183.12	183,120,500	1,648.08	Leak found within booster station yard (piping). Will have to hand excavate to perform repair(s).
A-357112	large	1.5840	578.16	578,160,000	5,203.44	Leaking dresser coupling repaired with full encirclement sleeve.
A-357584	small	1.7280	630.72	630,720,000	5,676.48	Leaking dresser coupling repaired with full encirclement sleeve.
A-387233	small	0.4181	152.61	152,606,500	1,373.46	Leak was from a thermocouple in meter tube. Will isolate meter tube and replace leaking thermocouple.
Total		4.9947	1,823.07	**1,823,065,500**	**16,407.59**	

Methane Emissions From Natural Gas Production Sector (2005)



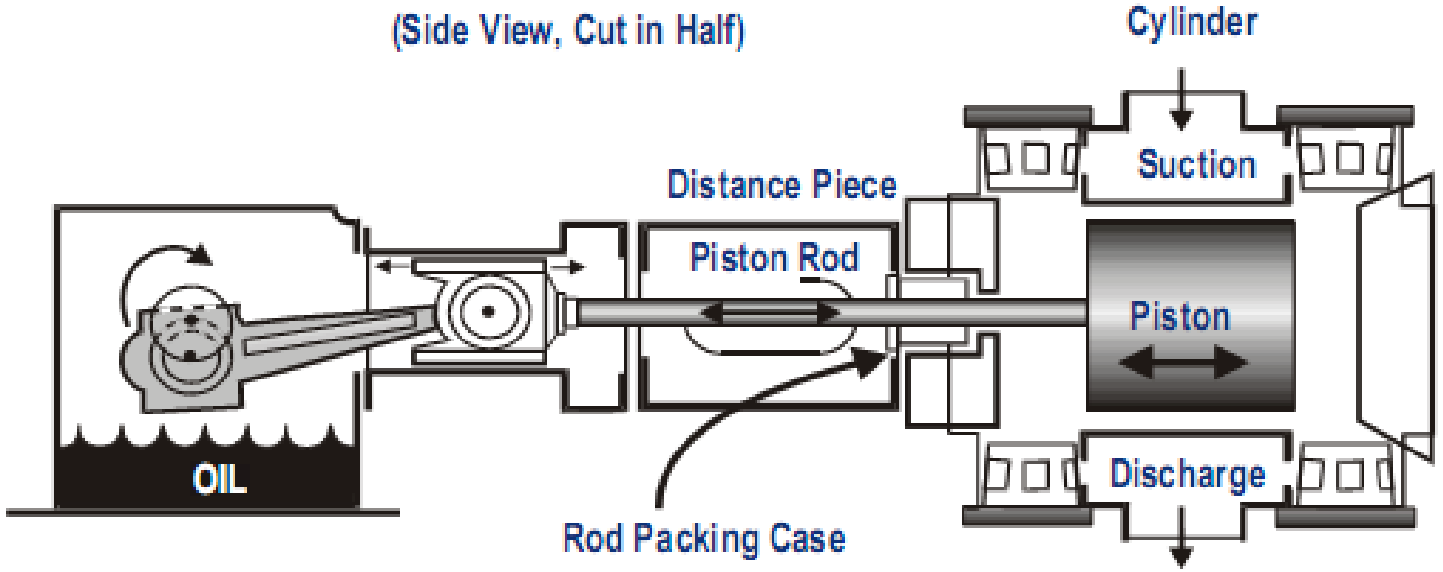
*Bcf = billion cubic feet

EPA. *Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990 – 2005*. April, 2007. Available on the web at: http://yosemite.epa.gov/oar/globalwarming.nsf/content/ResourceCenterPublicationsGHGEmissions.html
Natural Gas STAR reductions data shown as published in the inventory.

Methane Loss From Reciprocating Compressors

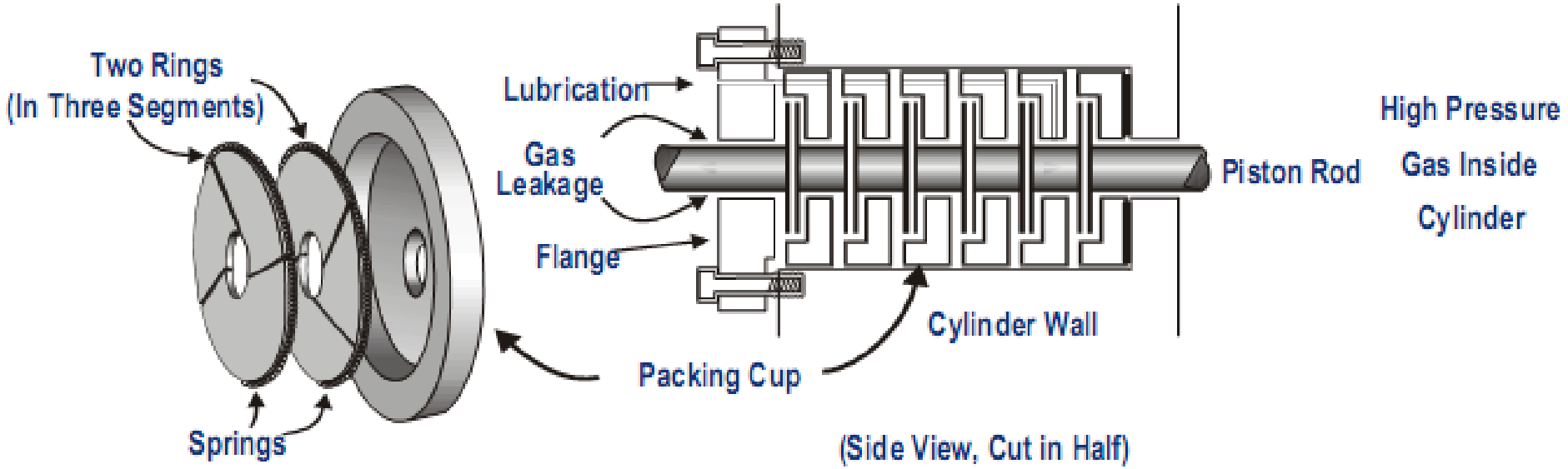
Reciprocating compressor rod packing leaks some gas by design

- Newly installed packing may leak 60 cubic feet per hour (cf/hour)
- Worn packing has been reported to leak up to 900 cf/hour



Reciprocating Compressors
Rod Packing

- A series of flexible rings fit around the shaft to prevent leakage
- Leakage may still occur through nose gasket, between packing cups, around the rings, and between rings and shaft



Impediments to Proper Sealing

Ways packing case can leak

- Nose gasket (no crush)
- Packing to rod (surface finish)
- Packing to cup (lapped surface)
- Packing to packing (dirt/lube)
- Cup to cup (out of tolerance)

What makes packing leak?

- Dirt or foreign matter (trash)
- Worn rod (.0015”/per inch dia.)
- Insufficient/too much lubrication
- Packing cup out of tolerance (≤ 0.002”)
- Improper break-in on startup
- Liquids (dilutes oil)
- Incorrect packing installed (backward or wrong type/style)

Emission from Running Compressor	99	cf/hour-packing
Emission from Idle/Pressurized Compressor	145	cf/hour-packing
Leakage from Idle Compressor Packing Cup	79	cf/hour-packing
Leakage from Idle Compressor Distance Piece	34	cf/hour-packing

Leakage from Rod Packing on Running Compressors

Packing Type	Bronze	Bronze/Steel	Bronze/Teflon	Teflon
Leak Rate (cf/hour)	70	63	150	24

Leakage from Rod Packing on Idle/Pressurized Compressors

Packing Type	Bronze	Bronze/Steel	Bronze/Teflon	Teflon
Leak Rate (cf/hour)	70	N/A	147	22

Cost of Rod Replacement

- Assess costs of replacements
  - A set of rings: $ 675 to $ 1,100
    (with cups and case) $ 2,100 to $ 3,400
  - Rods: $ 2,500 to $13,500
    - Special coatings such as ceramic, tungsten carbide, or chromium can increase rod costs

- Determine economic replacement threshold
  - Partners can determine economic threshold for all replacements
  - This is a capital recovery economic calculation

Economic Replacement Threshold (cf/hour) =

$$\frac{CR * DF * 1{,}000}{(H * GP)}$$

Where:

CR = Cost of replacement ($)

DF = Discount factor at interest *i* =

$$DF = \frac{i(1+i)^n}{(1+i)^n - 1}$$

H = Hours of compressor operation per year

GP = Gas price ($/thousand cubic feet)

Example: Payback calculations for new rings and rod replacement

CR = $1,620 for rings + $9,450 for rod
= $11,070
H = 8,000 hours per year
GP = $7/Mcf

DF @ i = 10% and n = 1 year

$$DF = \frac{0.1(1+0.1)^1}{(1+0.1)^1 - 1} = \frac{0.1(1.1)}{1.1-1} = \frac{0.11}{0.1} = 1.1$$

DF @ i = 10% and n = 2 years

$$DF = \frac{0.1(1+0.1)^2}{(1+0.1)^2 - 1} = \frac{0.1(1.21)}{1.21-1} = \frac{0.121}{0.21} = 0.576$$

One year payback

$$ER = \frac{\$11{,}070 \times 1.1 \times 1{,}000}{(8{,}000 \times \$7)} = 217 \text{ scf per hour}$$

Replace packing when leak reduction expected will pay back cost

- "leak reduction expected" is the difference between current leak rate and leak rate with new rings

Rings Only

Rings: $1,620
Rod: $0
Gas: $7/Mcf
Operating: 8,000 hours/year

Leak Reduction Expected (cf/hour)	Payback (year)
32	1
17	2
12	3
9	4

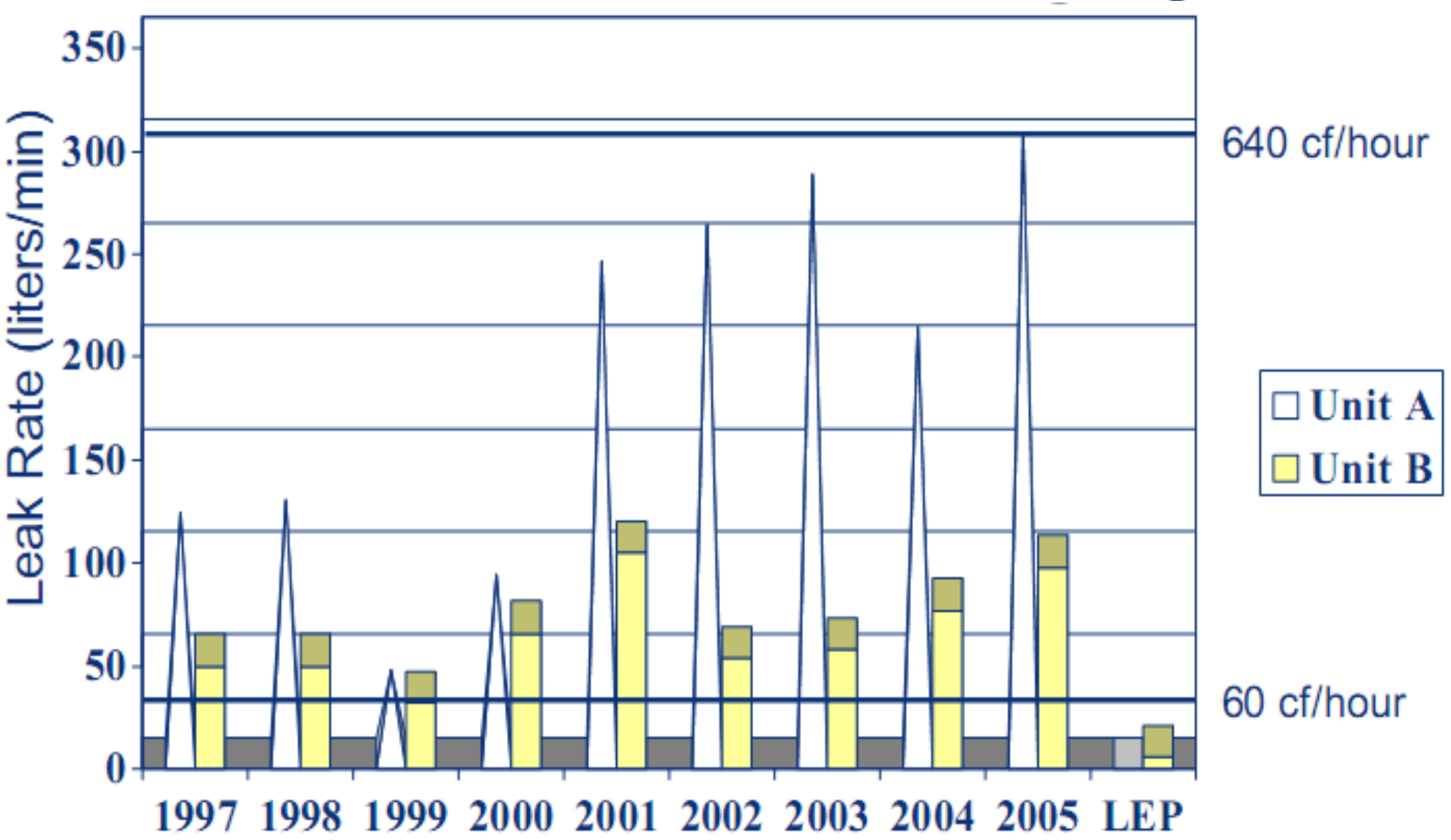
Rod and Rings

Rings: $1,620
Rod: $9,450
Gas: $7/Mcf
Operating: 8,000 hours/year

Leak Reduction Expected (cf/hour)	Payback (year)
217	1
114	2
79	3
62	4

Installed Low Emission Packing (LEP)

- Testing is still in progress
- After 3 months, leak rate shows zero leakage increase



Gas Leak Caused Piper Alpha Disaster that Changed Industry's Inspection Standards and QA/QC

What can make Polish Shale Gas successful?

- **Application the best practices upstream and downstream**
- **SAFETY IS FIRST**
- **Environment friendly operation**
- **Friendly law to players**
- Each technology has its limits and cost
- Investors support by independent QA/QC and corrective action/lesson learned/shared with all players
- Ccontinuous learning and education
- Team Work, Awareness Buildup, PJSM


Reference,
Journal of Petroleum Technology
Society of Petroleum Engineers
http://www.spe.org/jpt/print/archives/2011/11/14Methane.pdf
Dziękuje za uwagę
Jan Krzysiek
POLYTECHNICA GEDANENSIS
PATRIAE MARIQUE FIDELIS
CZYSTA ENERGIA
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Thank you