

Pilot Project for Methane Emissions Reductions from Process Equipment in Pemex Gas y Petroquímica Básica

Production Division



Methane to Markets
Partnership Expo

BEIJING, CHINA
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PEMEX Organizational Structure



Petróleos Mexicanos (PEMEX) operates through a Corporative Office and Four Subsidiary Entities, to wit:

Exploration and Production (PEP)



Gas production

Crude oil
production



- Refining
- Exports

Refining (PR)



Destilates

- Local markets
- Exports

Pemex Gas and Basic Petrochemicals (PGPB)



- PPQ, PEP
- Local clients
- Exports

- Gas Sweetening
- Liquid recovery
- Fractioning

Petrochemicals (PPQ)



- Local clients
- Exports

- Methane Derivatives
- Ethane Derivatives
- Propane Derivatives
- Aromatics and Derivatives

PEMEX Infrastructure 2006



PEMEX operates a complex and vast network of production, processing, storage, transmission and distribution facilities:



Production fields	364
Finished wells	6,080
Maritime platforms	199
Refineries	6
Working Processing Centers	12
Petrochemicals complexes	8
Refinates Storage Terminals	77
LPG Distribution Terminals	20



PEMEX Main Facts



	Unit	2003	2004	2005	2006
<i>PRODUCTION</i>					
Crude oil	Thousands of barrels/day	3,371	3,383	3,333	3,256
Natural gas	Mcfd	4,498	4,573	4,818	5,356
Refined products	Thousands barrels/day	1,556	1,587	1,554	1,545
Petrochemicals	Thousands tons/year	10,296	10,731	10,603	10,961
<i>SALES</i>					
Total	Millions of Pesos	646,716	811,815	966,284	1,062,495
Domestic	Millions of Pesos	433,024	493,069	525,583	546,738
Exports	Millions of Pesos	213,692	318,746	440,701	515,757

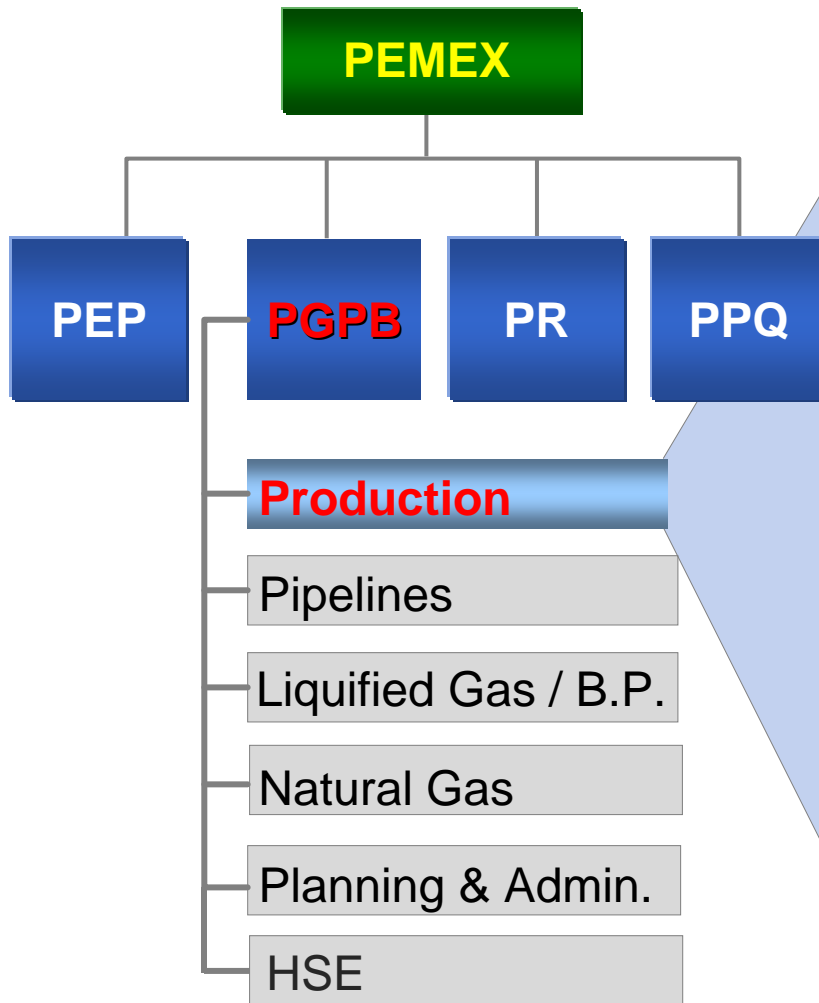
Pemex opportunity areas



Pemex has been working in several opportunity areas to reduce methane emissions:

- **Oil and gas production: Gas flaring and crude oil stabilization**
- **Gas processing plants**
- **Fugitive emissions in gas processing plants and natural gas transportation pipelines**
- **Energy efficiency**

Gas Processing at PGPB



Production Division Mission

Processing natural gas and its liquid hydrocarbons in an efficient, clean, and safe manner to meet the requirements of our clients and related entities; to encourage team work, the incorporation of added value within a framework of transparency and accountability by means of a comprehensive management of quality, safety, health, and environmental protection standards.

Gas Processing at PGPB



Production Division Processing Facilities:

- Pemex Gas Production Division's main activities are natural gas processing and liquid gas recovery.

- PEMEX has 9 gas processing complexes in Mexico: 3 in the Northern Region, 1 in the Central Region and 5 in the Southeast Region.

Gas Processing Complexes

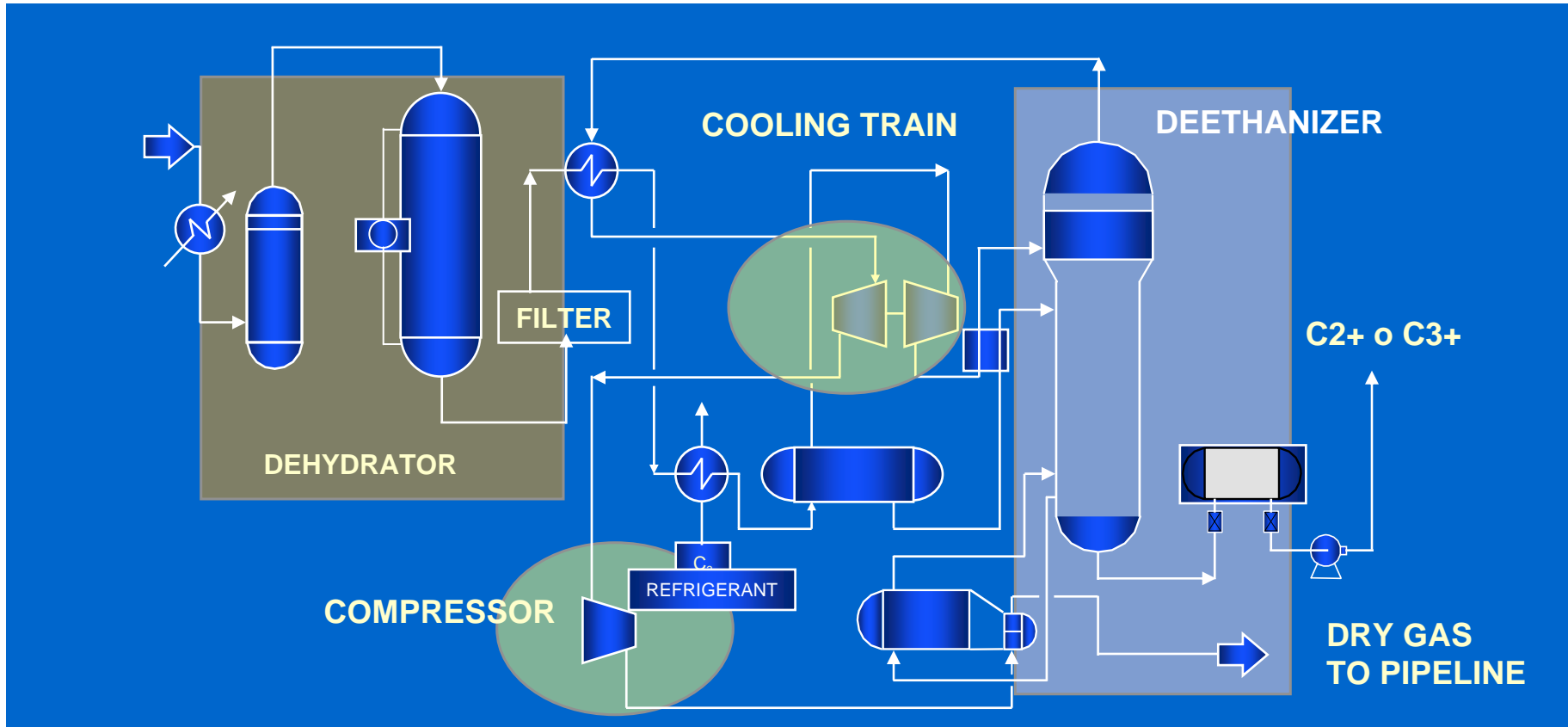


Gas Processing at PGPB



Due to the process nature, methane emissions can occur in different equipment and components, such as:

- Process lines and equipment
- Internal combustion engines
- Pumps
- Controls
- Tanks
- Natural Gas Compressors





Methane Emissions Reductions in PEMEX

- **Quantification of fugitive methane emissions in sample PEMEX installations**
 - Natural gas compressors operating with wet seals
 - Connections, valves and instruments in gas processing plants

- **Baseline measurements**
 - Leak identification and quantification
 - Carried out in August 2006
 - Co-financed by USAID through Methane To Markets program support

- **Rehabilitation and repair**
 - Compressor dry seal installation as part of repowering
 - Leak repair and component replacement
 - All implementation costs by PEMEX

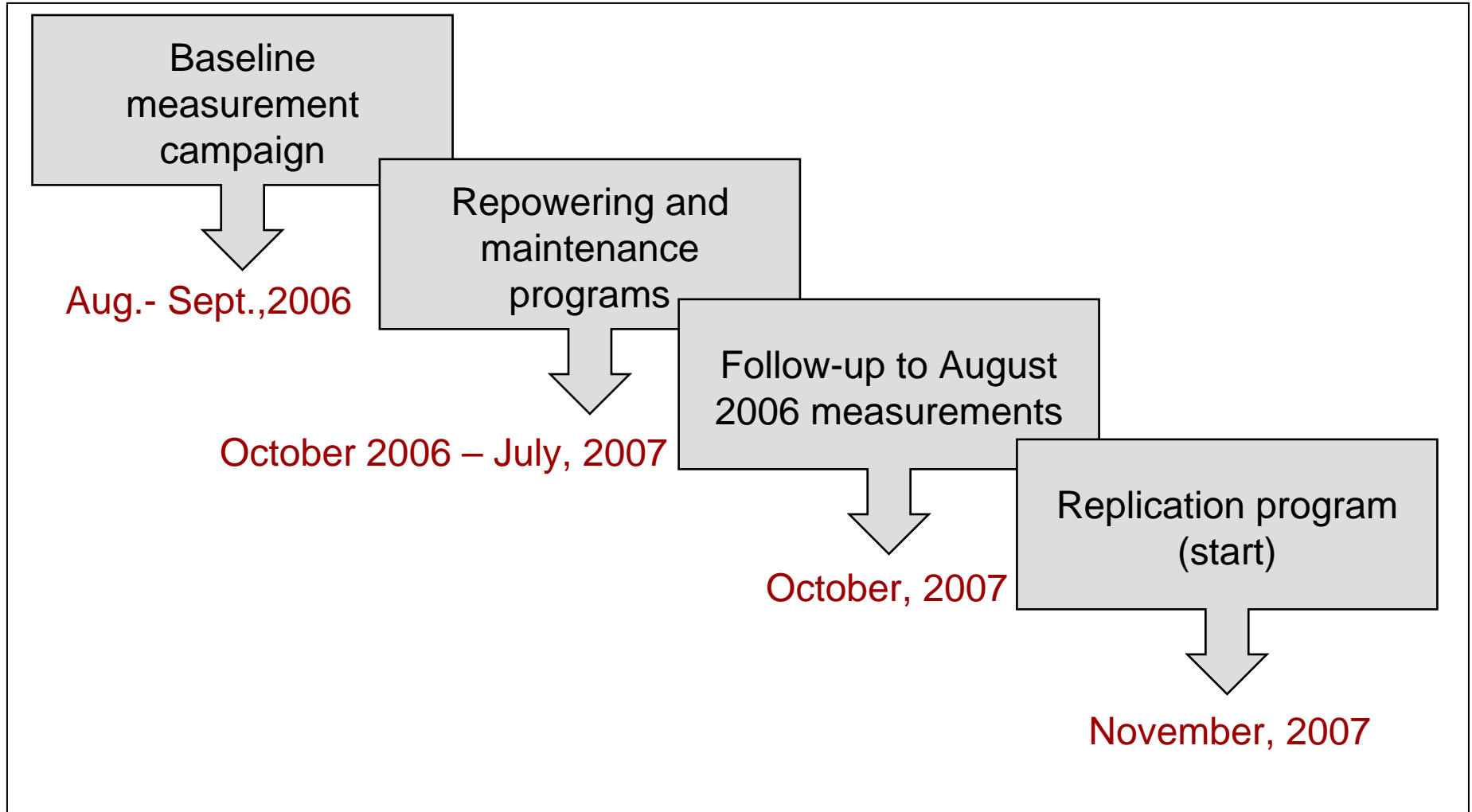
- **Post-Implementation measurements**
 - Compressor system leak identification and quantification
 - Carried out October 2007 with USAID, Methane To Markets

Pilot Project Objectives



- Quantify fugitive methane emissions in PEMEX installations
- Test methods to reduce leaks, and quantify cost-benefit
- Replicate results widely throughout PEMEX
 - Improve environmental, safety and financial performance
 - Create an environmental vision in order to promote a broader participation in world emissions markets (M2M and Kyoto CDM)

Pilot Project Stages





Measurement Equipment: Leak Detection

- Leak detection at the facilities was conducted using a combination of catalytic oxidation/thermal conductivity detectors (Heath Gasurveyors 6-500) and the Heath Remote Methane Leak Detector (RMLD), which operates by a Tunable Diode Laser Spectroscopy specifically for methane gas.



Methodology Used for the Pilot Project



Measurement Equipment: Leak Quantification

- The Hi-Flow Sampler uses a high flow rate of air to completely capture the gas leaking from the component.
- A catalytic oxidation/thermal conductivity sensor is used to measure the sample concentration in the air stream of the high flow system. The Hi-Flow Sampler essentially performs an enclosure measurement using the flow regime induced by the sampler instead of a physical enclosure.



Hi – Flow Sampler



Estimated Savings from Conversion to Dry Seals (baseline measurements)

After performing measurements, calculations were made in order to adjust results for corrected gas conditions; methane leaks from oil tank were not considered for emission determination.

Results

- **Average vent rate/compressor:** **43.11 SCFM**
- **Maximum vent rate:** **53.13 SCFM**
- **Minimum vent rate:** **24.10 SCFM**
- **Secondary vent:** **0.41 SCFM**

Remarks:

Figures are lower than those described in EPA-430-B-012.

Minimum vent rate corresponds to a recently repaired compressor wet seals



Estimated Savings from Conversion to Dry Seals (on baseline measurements)

It was measured that the average real methane emissions from the wet seal system of each of the GB-203 A/B/C compressors was 40.6 SCFM (43.10 SCFM – 2.5* SCFM), corresponding to 20.5 MMCF natural gas per year (@ 96% utilization factor).

Benefits per Compressor

- Environmental: Emissions reduction of 7,310 Ton of CO₂e/y
- Economics:
 - 126,690 US \$/year in natural gas commercial value.
 - 58,480 US \$/year in carbon bonds sales.
 - **185,170 US \$/year Total**

**Corrected guaranteed normal operation dry seal leak / compressor*



Dry Seal Conversion Costs

- **Cost estimation for substituting wet seals with dry seals amounts to:**

**Mx \$ 5.17 MM
(US\$ 444,000) for
each compressor.***



** These costs include dry seal engineering, execution, installation and tests as well as the control panel.*

Methodology Used for the Pilot Project



FINANCIAL ESTIMATION

Oct 2006

Estimation Dry Seals (For One Engine)

Cash Flow	Años	MILLION DOLLARS											
		0	1	2	3	4	5	6	7	8	9	10	
Incremental Incomes			0.1852	0.1852	0.1852	0.1852	0.1852	0.1852	0.1852	0.1852	0.1852	0.1852	0.1852
Total incremental incomes			0.1852	0.1852	0.1852	0.1852	0.1852	0.1852	0.1852	0.1852	0.1852	0.1852	0.1852
Incremental costs													
Initial Investment		0.444											
Variables Costs													
Operation and Maintenance Costs		0	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Water		0	0	0	0	0	0	0	0	0	0	0	0
Fuel		0	0	0	0	0	0	0	0	0	0	0	0
Electric Energy		0	0	0	0	0	0	0	0	0	0	0	0
Taxes		0	0	0	0	0	0	0	0	0	0	0	0
Total Variable Costs		0	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Fixed Costs													
Work		0	0	0	0	0	0	0	0	0	0	0	0
Maintenance		0	0	0	0	0	0	0	0	0	0	0	0
Others (Insurances)		0	0	0	0	0	0	0	0	0	0	0	0
Total Fixed Costs		0	0	0	0	0	0	0	0	0	0	0	0
Total Costs		0	0	0	0	0	0	0	0	0	0	0	0
Net Cash Flow		-0.44	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17

Savings vs. Costs Comparison

Financial analysis of the project renders the following results:

• A NPV of 0.53 US MM\$

Net Present Value

Años	0	1	2	3	4	5	6	7	8	9	10
Flujo Neto Efect	0	0	0	0	0	0	0	0	0	0	0
Valor Presente	0	0	0	0	0	0	0	0	0	0	0

VPN = \$ 0.53

The Project is Profitable

• 37 % IRR on the investment (including carbon bonds)

Return Internal Rate

Años	0	1	2	3	4	5	6	7	8	9	10
Flujo Neto Efect	0	0	0	0	0	0	0	0	0	0	0
Valor Presente	0	0	0	0	0	0	0	0	0	0	0

TIR = 37.05%

The Project is Profitable

Return-on-Investment

Años	0	1	2	3	4	5	6	7	8	9	10
Flujo Neto Efect	0	0	0	0	0	0	0	0	0	0	0
Acumulado	0	0	0	0	0	0	1	1	1	1	1

PRI = 2 años 7 meses

The Project is Profitable

• The simple payback period for the expected investment is 2.6 years

Follow-up Results: Dry Seals (3 compressors)



**Average vent rate
before substitution:
43.11 cfm**

**Average vent rate
after substitution:
0.02 cfm**

**Reduction in
methane emissions:
7,718 Mcf/year/compressor
*(13% higher than estimated)***



Follow-up Results: Valve Repair/Replacement



**Leak rates before
substitution: 2.58
cfm - 0.05 cfm**

**Leak rates after
substitution:
< 0.05 cfm**

**Reduction in
methane emissions:
3,089 Mcf/year**

Follow-up Results: Valves, Connections and Instrument Maintenance



**Leak rates before
maintenance:
9.46 cfm - 0.01 cfm**

**Leak rates after
maintenance:
< 0.06 cfm**

**Reduction in
methane
emissions:
18,246 Mcf/year**





Summary of Compressors Seals and Fugitive Emissions

- **Drastic reduction in methane emissions:
89,053 Mcf/year
(97.83% of originally measured emissions)**
- **Total emissions reduction:
31,777 ton CO₂e per year**

Follow-up Results: Economic



- Overall economic benefits:
 - Natural gas commercial value: \$550,350/year @ \$6/MMBtu
 - Carbon bonds sales: \$317,770/year @ \$10/tCO₂e

- Maintenance cost:
 - Valves maintenance: \$50,000/year

- Inversion:
 - Wet seals substitution: \$1,350,000
 - Valves substitution: \$ 150,000

- Simple payback: 1.8 years



The Pilot Project for reduction of methane emissions has resulted in:

- **Excellent response from PEMEX maintenance and operations**
- **Successful application of new technology**

And has provided:

- **Cost savings**
- **Higher productivity**
- **The safeguarding of public health and safety**
- **Legal compliance**
- **Greater competitiveness**

And demonstrated:

- **Staff commitment and a beginning of change in the culture**



Replicate the project on a wider scale inside PGPB and throughout PEMEX

- Top-level management support
- Cross-functional teams
- Integrate into management programs already in place at PEMEX
 - Train workers in every facility
 - Buy equipment for leaks screening and measurement
- Create a data base
 - Census of leaks and equipment

Replication Project: Compressor Seals



Identifying prospects

67 natural gas centrifugal compressors are installed at the Production Subdivision's work centers. Only 30% of them have dry seals installed, mainly at the newer facilities.

	<u>Wet Seal Compressors</u>	<u>Dry Seal Compressors</u>
Production 67 compressors		
Cactus	15	-
New Pemex	11	-
Pemex City	3	3
Coatzacoalcos	3	-
Poza Rica	4	-
Reynosa	2	-
Burgos	0	18
La Venta	5	-
Matapionche	3	-
Total	46	21

Replication Project: Compressor Seals



Identifying the prospect

- Based on M2M materials, statistical values and experience, it was estimated that the expected emission from each dual wet seal could be around 40 SCFM = 68 m³/hr.
- Based on the suppliers proposal, the maximum methane venting to the atmosphere under normal operation from each repowered compressor dry seal would be: 11 m³/hr ≈ 6.5 SCFM
- An initial estimate shows an investment project of \$22 million, with annual savings approaching \$12 million

CPG CIUDAD PEMEX



GB-203 A/B/C

Next Steps: Replication of Measurements



Measurement campaign to identify additional savings – new pilot project at Nuevo PEMEX gas processing plant

- **Integrated measurement of emissions:**
 - fugitive methane emissions
 - unburned hydrocarbon emissions
 - burner, boiler, heater efficiencies
 - CO₂ emissions
 - emissions from flares
 - flow measurement validation
- **Expected additional savings**
- **Pilot measurement work in October and November 2007 at Nuevo PEMEX**



Conclusions



One of the top strategic priorities of PEMEX Gas and Basic Petrochemicals Production Division is the technological modernization of its installations in compliance with Quality, Safety, Health, Environmental Protection, Sustainable Development and Added Value (AVA) policies, therefore, this project meets all established premises.

- **Considering the cost-benefit ratio from methane recovery and the abatement of equivalent carbon dioxide emissions, this project justifies its profitability.**
- **Based on this characteristics, this project has a high replication potential in all PEMEX installations using this type of compressors.**
- **Methane to Markets support through USAID/Mexico has been and will prove fundamental to ratify the project's potential, verify real life situations and assess its replication at all PEMEX gas compression facilities.**

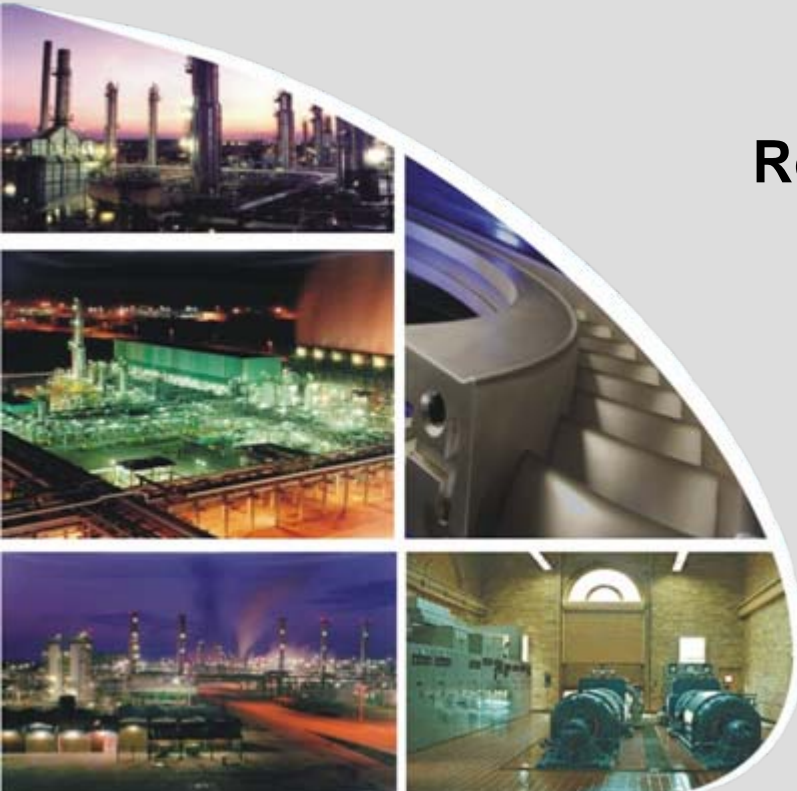


Thank You!

Pilot Project for Methane Emissions Reductions from Process Equipment in Pemex Gas

Javier Bocanegra
Operations, Corporate Direction
jbocanegra@pemex.gob.mx

www.pemex.com




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