THE WRI CENTER FOR SUSTAINABLE TRANSPORT

Cleaning up the Fleet: Case Study from Mexico City

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EMBARQ

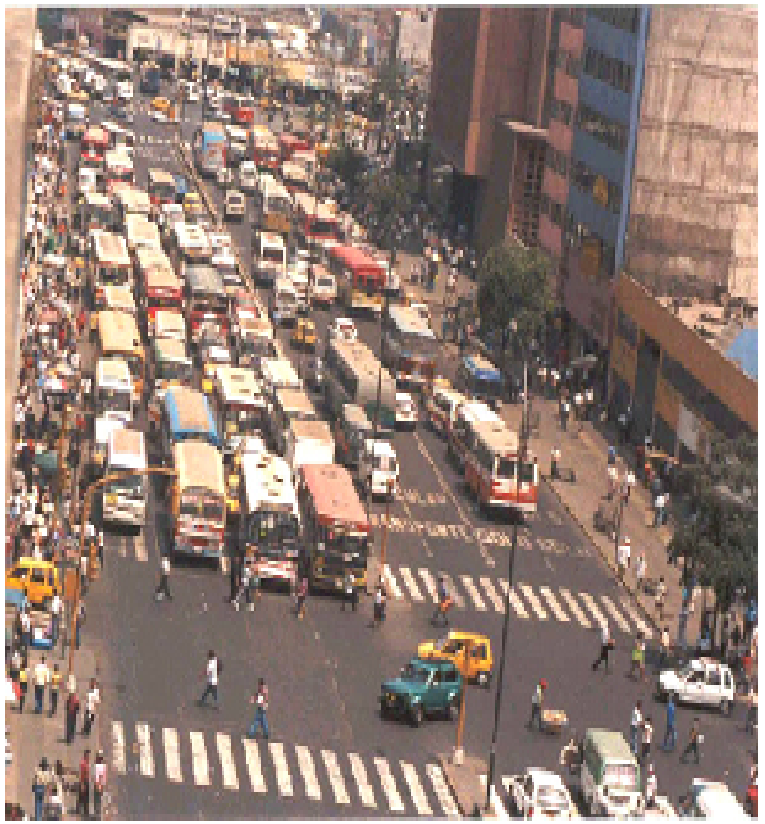
- A catalyst for socially, financially, and environmentally sound solutions to the problems of urban mobility

EMBARQ

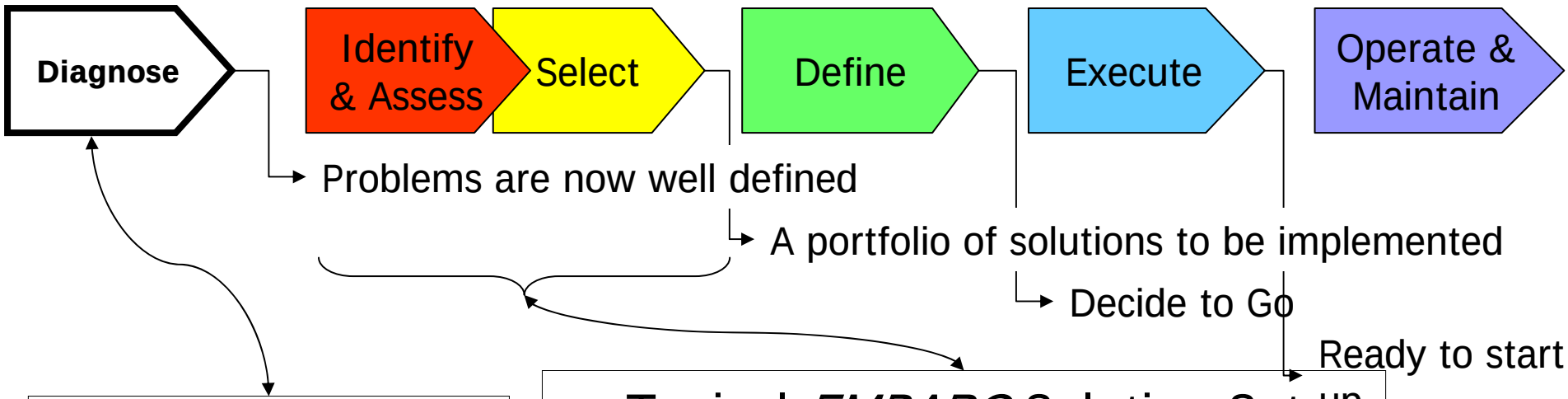
- A network of centers for sustainable transport, in Mexico, Brazil and Turkey and coming soon … India.

What Do We Mean When We Talk About Sustainability?

- **Technical Sustainability**
- **Economic Sustainability**
- **Social Sustainability**
- **Environmental Sustainability**
- **Political Sustainability**



Sustainable Transport Solutions



Typical Diagnosis Outputs

- Emissions Inventory
- Indicators
- Preliminary assessment of transit system quality
- Political assessment – is time right to succeed?

Typical *EMBARQ* Solution Set

- Mass Transit - BRT typically, and/or transit system business model restructuring
- Non-motorized transport
- Transport demand management
- Traffic engineering
- **Retire, Replace, or Retrofit for emissions control**
- Transport oriented development
- Policy reforms to enable any of the above

Mexico City


RUTA 9


McDonald's
FOX


FOX ESCUCHA LA VOZ DEL PUEBLO
RTP


MATEMATICAS

Tractor trailers
75,000

Light trucks
19,000

Buses
30,000

Other
9,100

Passengers
32,000

Diesel Retrofit Pilot Project, Mexico City

Project Partners:

Mexico City Mayor Andres Mateo Lopez Obrador and US Ambassador Tony Garza demonstrating that handkerchiefs held to retrofitted smokestacks stay clean even after exposure to exhaust.

- Center for Sustainable Transport of Mexico City (Project manager)
- US EPA financial and technical support; US AID financial support
- SEMARNAT-INE (National Environment Agency and National Institute of Ecology)
- Mexico City Secretariat of Environment (Coordination and logistical support)
- RTP (Mexico City's diesel bus fleet)
- World Resources Institute (WRI)/ *EMBARQ* (Project sponsor and technical advisor)
- NESCCAF, EETPI (Technical consultants)

Diesel Retrofit, Overview

Retrofit Technologies can be any change to an engine system that improves the engine's emission performance:

- Catalyst or filter
- Other devices or systems like SCR
- Engine upgrade or engine re-flash
- Early engine or vehicle replacement
- Cleaner fuels or additives
- Idling control equipment
- Combination of above

Diesel Retroft Overview, con't.

- Typical sequence in demonstration program
  - Fleet Selection
  - Temperature data logging of exhaust
  - Project design
  - Request bids for retrofit devices
  - Baseline emission testing
  - Install retrofit devices
  - "Break in" for one month in normal use
  - 2nd Emission testing
  - Operate for 10-11 months
  - Retest

The bus fleet

20 buses from the Mexico City diesel bus fleet (RTP) were chosen for the project. These operated for 10 months (3 testing campaigns)

8 Ayco International buses, 2001.

8 Mercedes-Benz Prototype buses, 1991.

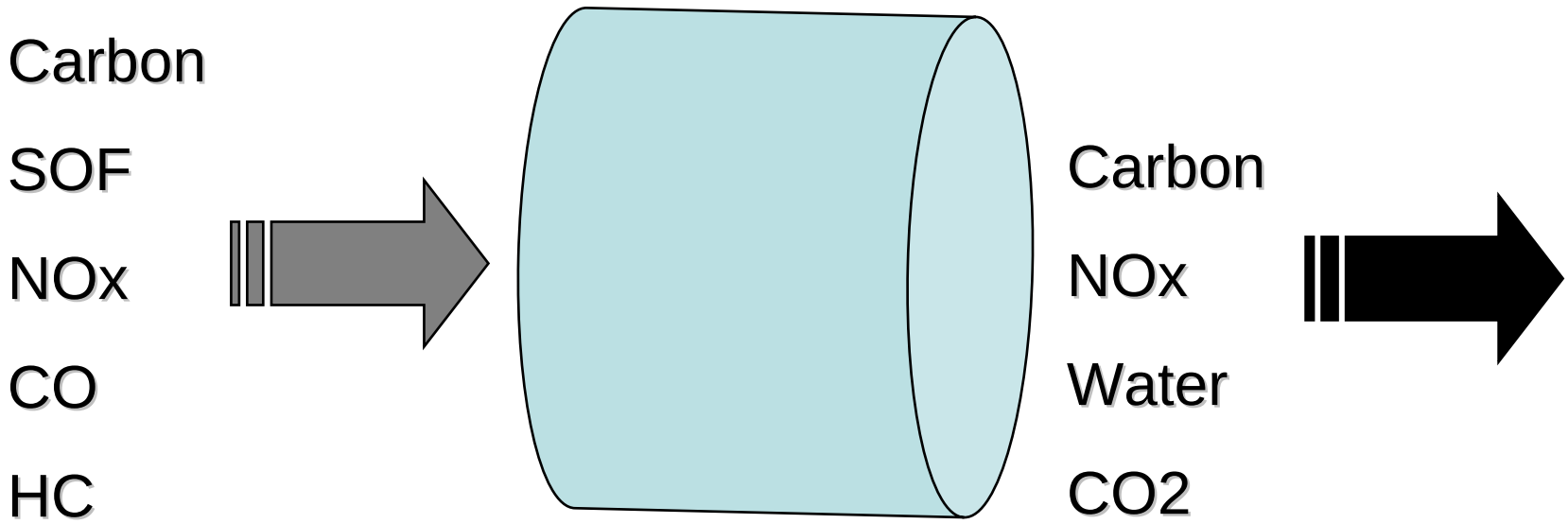
4 Mercedes Torino buses from 2002 were also fitted with particulate filters and tested in the third testing phase.

U.S. EPA-certified technology was employed:

Catalyst-based diesel particulate filters are designed to operate exclusively with ultra-low-sulfur diesel (ULSD) and shown to remove 99% of ultra-fine particulate in the exhaust.

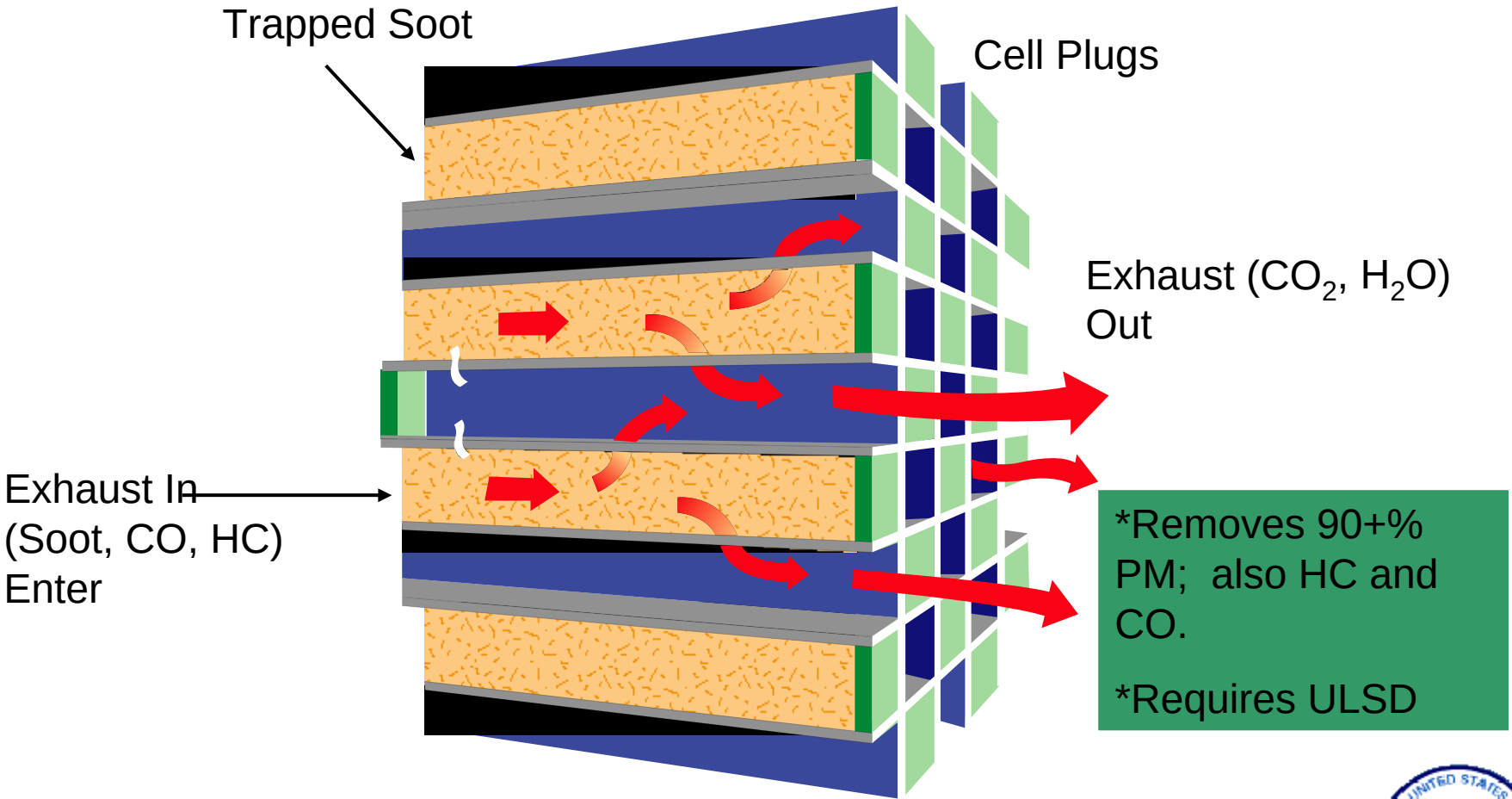
Diesel oxidation catalysts such as this were used with older buses for compatibility, but do not remove ultra-fine particulates.

Diesel Oxidation Catalysts



Reduce PM 20-30% by reducing the soluble organic fraction SOF. Also reduce carbon monoxide (CO), hydrocarbons (HCs) and toxics.

Diesel Particulate Filter Technology



Ultra-low-sulfur diesel (ULSD)

ULSD for the project was imported from the U.S., with the kind permission of PEMEX, the Mexican state oil company, and stored in separate, locked tanks to prevent contamination by lower-quality fuel. Buses' fuel tanks were also locked during testing.

The success of the retrofit project prompted PEMEX to begin producing ULSD by late 2007, three years ahead of schedule and of higher quality than originally planned.

THE RAVEM – Ride Along Vehicle Emissions Measurement

Testers used the Ride-Along Vehicle Emissions Measurement (RAVEM) system, which permits real-time measurement of HC, CO, CO_2, NO_x, and particulates at the tailpipe.

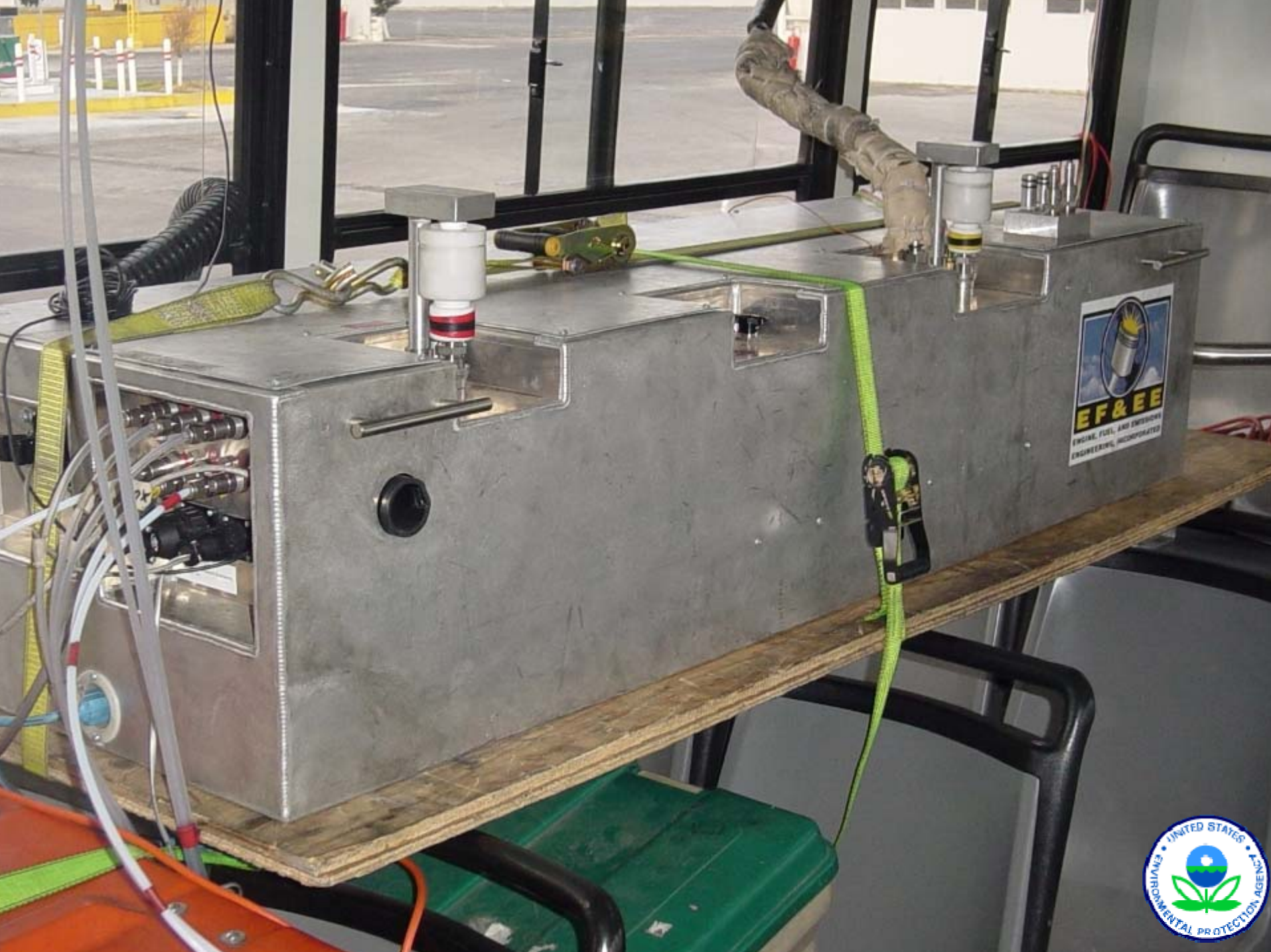
Measuring Tailpipe Emissions
Fixed Cycle Course and City Streets

Inside view of retrofitted bus during emissions measurement, showing trace gas containers.

Emissions were measured at three points:

- Baseline - before any improvements.
- Stabilizing - after 4,000 km (2,500 miles) of vehicle operation.
- Performance - after 55,000 km (34,175 miles) of vehicle operation.


PRAXAIR
PRAXAIR


EF&EE
ENGINE, FUEL, AND EMISSIONS
ENGINEERING, INCORPORATED
UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY

"For your health, this bus is cleaner"

Training local operators

20 mechanics and 40 bus operators learned how the emissions control devices work, how to install them, and driving techniques for best performance. The training also reduced variations in driving behavior between tests, improving test validity.


USO
EXCLUSIVAMENTE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RTP
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2005 4 14

Project Results

The tests and analysis proved that for a reasonable cost, government authorities can determine key emissions characteristics and successfully carry out a program to reduce particle emissions from existing buses.

Percentage reduction of key pollutants after retrofit, using ULSD fuel	
1991 buses (DOC)	**2001 buses (DPF)**
20-30% PM	**90% PM**
52-70% CO	**90% CO**
20-33% NOx	**10% NOx**

- 90% reduction in particulate emissions for newer buses.
- 20% reduction for older buses.
- Strong performance even at high altitude.

Retrofitting Mexico City's Diesel Fleet

- Exhaust retrofit of existing heavy vehicles;
  90% less PM, 20% less NOx
  with catalyst-based diesel particulate filters
- Used cleanest diesel available (<15 PPM)
- Careful testing to pick best buses to retrofit
- Competitive bidding for equipment; venders (Fleetguard & Johnson Matthey were active partners contributing to success of pilot

Findings from third emission testing round:

- **Durability of exhaust pollutant reduction** was well maintained, and even improved (see Table 2). DOC reduction of PM ranged 22-29%, and DPF reduction of PM ranged 83-92%.

- DOC technology was not very effective in reducing PM emissions – especially fine PM. Re-powering older vehicles might be a better option for reducing PM emissions.

- NOx reduction can be attributed in part to the use of ULSD (typically 5-10%). It is believed, however, that driver variability had the greatest impact on NOx emissions, resulting in a mix of net increases and reductions of this pollutant. This was also the case for CO2 and fuel consumption.

- Experience gained in this project strongly suggests that more time and attention be paid to fixing exhaust leaks before and after the installation of retrofit equipment.

Retire, Replace, Retrofit: The Way Forward

Based in part on results from Mexico City, *EMBARQ* recommends a two-part approach to reduce pollution from diesel bus fleets:

• **Retire/Replace.** Some buses in developing cities are so old and dirty that no retrofit technology is effective. These are the first priority for removal from service. They should be replaced with newer, cleaner models equipped with the best emissions control equipment possible, given local fuel quality.

• **Retrofit.** Newer trucks and buses with electronic exhaust control systems can be made at least 90% cleaner by retrofitting with diesel particle filters and ULSD fuel. Some older, mechanically controlled vehicles can be retrofitted to achieve more modest reductions, although the most hazardous ultra-fine particles will not be removed.

A comprehensive strategy to retire,/replace and retrofit heavy-duty vehicles can lead to significant, cost-effective improvements in air quality.


PEGASO

ON TO THE REST OF THE WORLD…

EMBARQ is now working with other cities in Mexico, Brazil, Turkey and Asia to lay the groundwork for Retire, Replace, Retrofit strategies; Bus Rapid Transit systems; emissions inventories; and other sustainable transport initiatives.)

Thank You

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SHELL FOUNDATION

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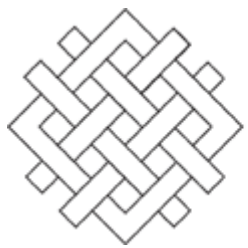

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