

NGV Emissions Status

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U.S. Department of Energy*



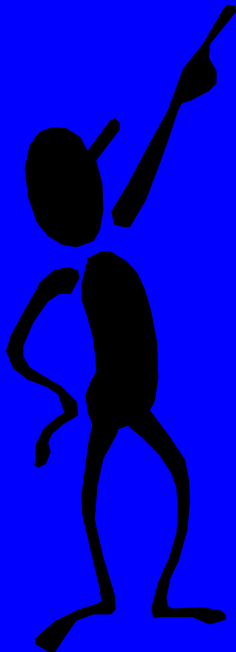
*San Antonio, TX
September 2004*

HD Technology options

✓ ***Straight Diesel***

✓ ***Natural Gas***

✓ ***Hybrid-Electric***



Testing Methods

- Engine Testing
- Chassis Testing
- In-Service Testing

Engine Testing



Chassis Testing



In-Service Testing



Understanding Emissions

- What's Important and Why ?
- Don't spend time on problems that have already been solved !
- What are the (EPA) rules ?
- How accurate are the numbers ?



U.S. Environmental Protection Agency

EPA “receives more complaints from the public about emissions from transit buses than all other environmental issues combined.”

Understanding Emissions

- What's Important and Why ?

Poor Air Quality Villains

The letters 'CO' are written in a bold, brown, serif font inside a light pink oval with a bright cyan border.

**Carbon
Monoxide**

The letters 'PM' are written in a bold, black, serif font inside a grey oval with a white border.

**Particulate
Matter**
(black soot)



Volatile Organic Compounds

- ✓ **Unburned Hydrocarbon (HC) exhaust
and evaporative HC emissions**
- ✓ **Paints & Thinners**
- ✓ **Some Industrial By-products**
- ✓ **Natural Organic Respiration**
... (trees and foliage)



Other Important VOC Terms

- ✓ **HC** – Hydrocarbons
- ✓ **NMHC** – Non Methane Hydrocarbons
(**NMOG** – *Non Methane Organic Gases*)
- ✓ **THC** – Total Hydrocarbons

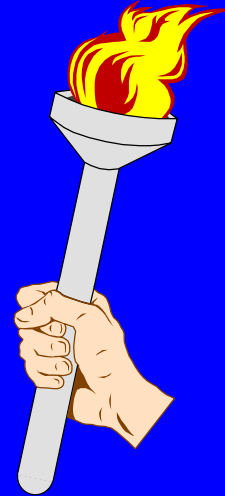
THC = reactive HC + methane



Nitrogen Oxides

Products of Combustion

- ✓ **Motor Vehicle Exhaust**
- ✓ **Industrial boilers/turbines/furnaces**
- ✓ **Airplanes & Locomotives**
- ✓ **small engines, charcoal, fireplaces**

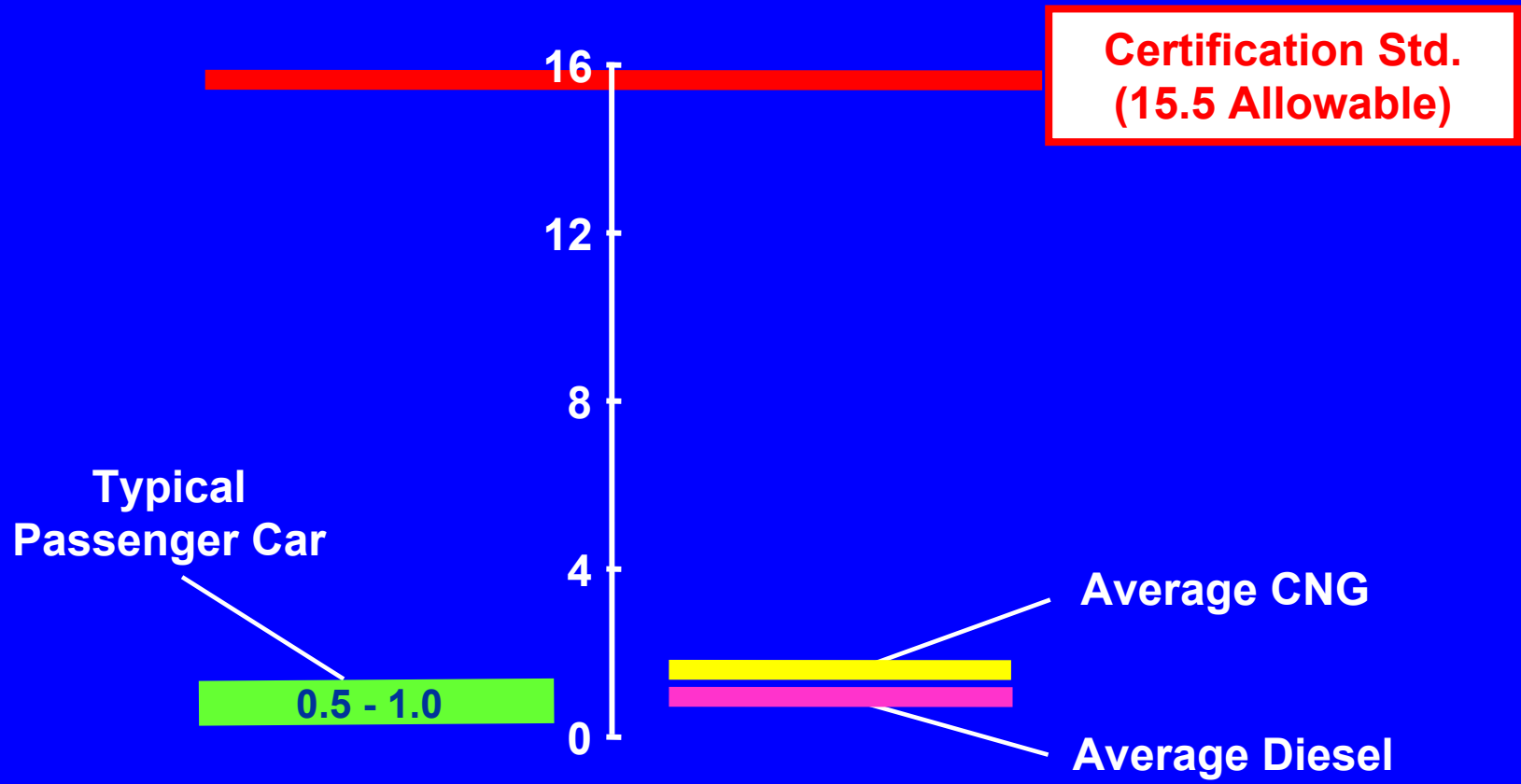




Understanding Emissions

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CO Emissions (Units g/bhp-hr)



Test Results (g/bhp-hr)

CBD Test Cycle	THC	CO	NOx	PM
WMATA DIESEL	0.03	0.37	5.03	0.002
NYCT DIESEL	0.01	0.30	5.32	0.040
LAMTA DIESEL	0.01	0.28	6.47	0.020
NYCT CNG	4.91	2.74	3.38	0.004
WMATA CNG	3.65	0.06	2.80	0.003
LAMTA CNG	1.89	1.85	3.05	0.010
NYCT HYBRID	0.02	0.02	2.74	0.002
OCTA HYBRID	0.00	0.01	2.99	0.010

OCTA and LAMTA buses tested by CARB in 2001.

NYCT buses tested by Environment Canada in 2001.

WMATA buses tested by West Virginia University in 2002

Understanding Emissions

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- What are the (EPA) rules ?

EPA Emission Requirements for Heavy Duty Trucks and Buses*

Year	THC	CO	NOx	PM
1994	1.3	15.5	5.0	.07
1996	1.3	15.5	5.0	.05
1998	1.3	15.5	4.0	.05
2004	.5	15.5	2.5	.05

Emission levels that engines must meet to be certified.

*

Measured in grams/brake horsepower/hour.

EPA Emission Requirements for Heavy Duty Trucks and Buses

Percent of Engines Sold Each Year that Must Meet Emission Standards				
	NMHC .14	NOx 0.2	PM .01	CO 15.5
2007	50%	50%	100%	100%
2008	50%	50%	100%	100%
2009	50%	50%	100%	100%
2010	100%	100%	100%	100%

Emission levels that engines must meet to be certified.

- Measured in grams/brake horsepower/hour.
- Hydro-carbon measurement changes from Total HC to Non-Methane HC in 2007.

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How Accurate are the numbers ?

- **Analytical Limitations** – *too small to measure*
- **Mobile 6 Limitations**
 - *Designed to measure regional impact*
 - *Based on historic default values*
 - *No simple direct and accurate conversion method from g/mile to g/bhp*
 - *No hybrid provisions*
 - *Recent and future technology improvements not accounted for*
- **Other models are already being developed:**
Air-Cred, new EPA model (MOVES), CARB
- **Comparing Apples to Apples ???**

Test Results (g/bhp-hr)

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Test Results (g/bhp-hr)

CBD Test Cycle	NOx
WMATA DIESEL	5.0
NYCT DIESEL	
LAMTA DIESEL	
NYCT CNG	
WMATA CNG	2.8
LAMTA CNG	
NYCT HYBRID	
OCTA HYBRID	

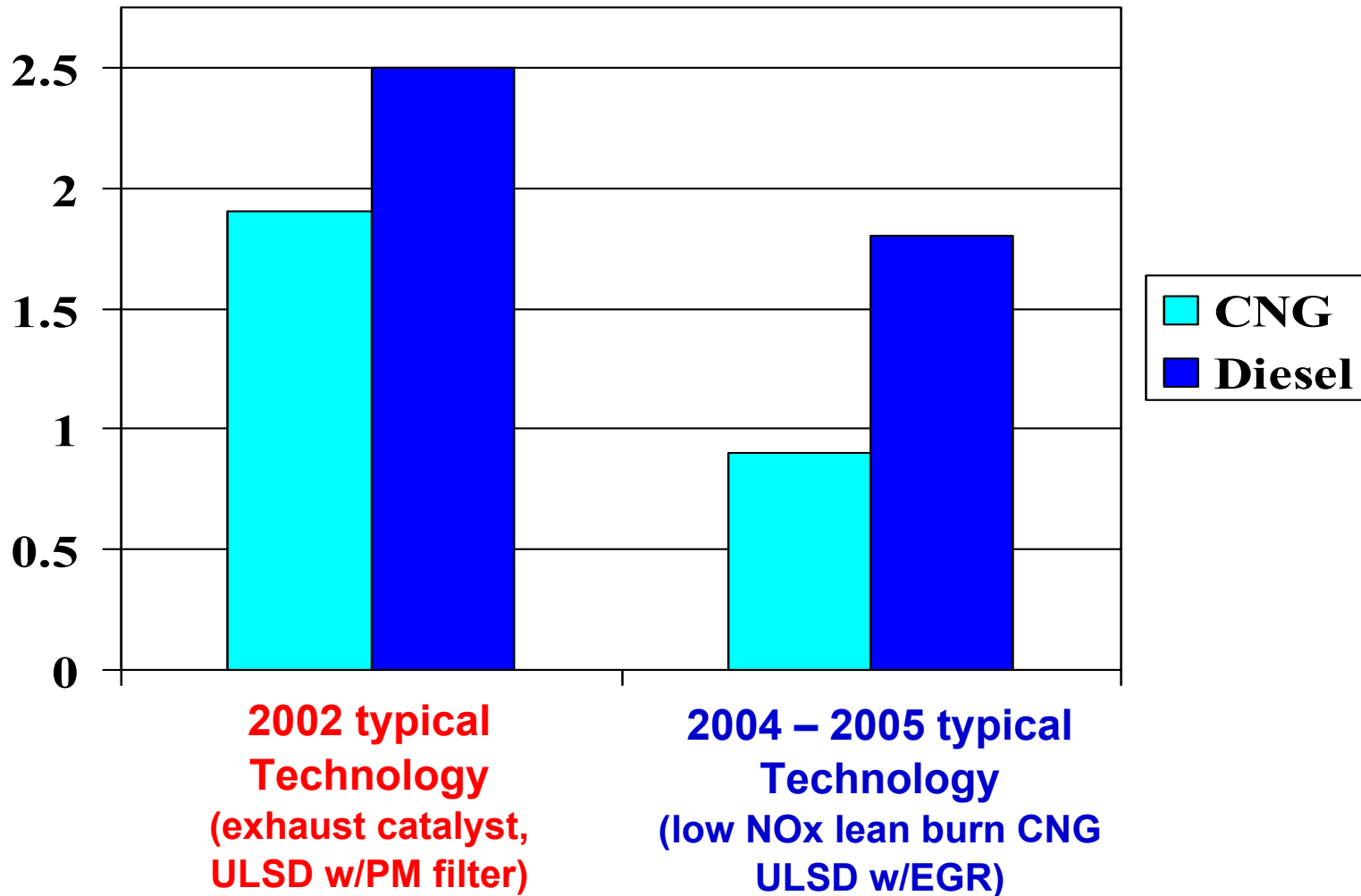
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2004 WMATA Bus Test Update

(NOx preliminary results – g/mile)



WMATA buses tested by West Virginia University in 2004

Planning for the Future

Take Advantage of Hydrogen/CNG Infrastructure Synergies:

- *Hydrogen/CNG blending benefits*
- *Common CNG and Hydrogen building requirements*
- *Alt-Fuel Hybrid flexibility*

Major Recommendations

- (A) Consider Technology Mix to match needs and limitations - *Existing fleet vs. new acquisitions*

- (B) Refine Vehicle Procurement specs – *Specify NOx performance criteria, not just minimum EPA requirements. Ask suppliers to warrant in-use emissions.*



**QUESTIONS
&
DISCUSSION**