

# Emissions of Motorcycles and Mopeds

Hearing on “Clear Internal Market Rules for Mopeds, Scooters &  
Motorcycles”, European Parliament IMCO Committee  
Brussels, 22 March 2011

Dirk Bosteels, AECC

[www.aecc.eu](http://www.aecc.eu)



Association for Emissions Control by Catalyst AISBL

# Association for Emissions Control by Catalyst (AECC) AISBL

AECC members: European emissions control companies

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CORNING

**EMITEC**

**IBIDEN CO., LTD.**

JM 

Johnson Matthey



NGK Europe GmbH

 **Rhodia**

  
**umicore**  
Automotive  
Catalysts






*Technology for exhaust emissions control on all new cars  
(OEM and Aftermarket) and an increasing number of  
commercial vehicles, non-road applications and motorcycles.*



Association for Emissions Control by Catalyst AISBL

# AECC Motorcycle Test Program

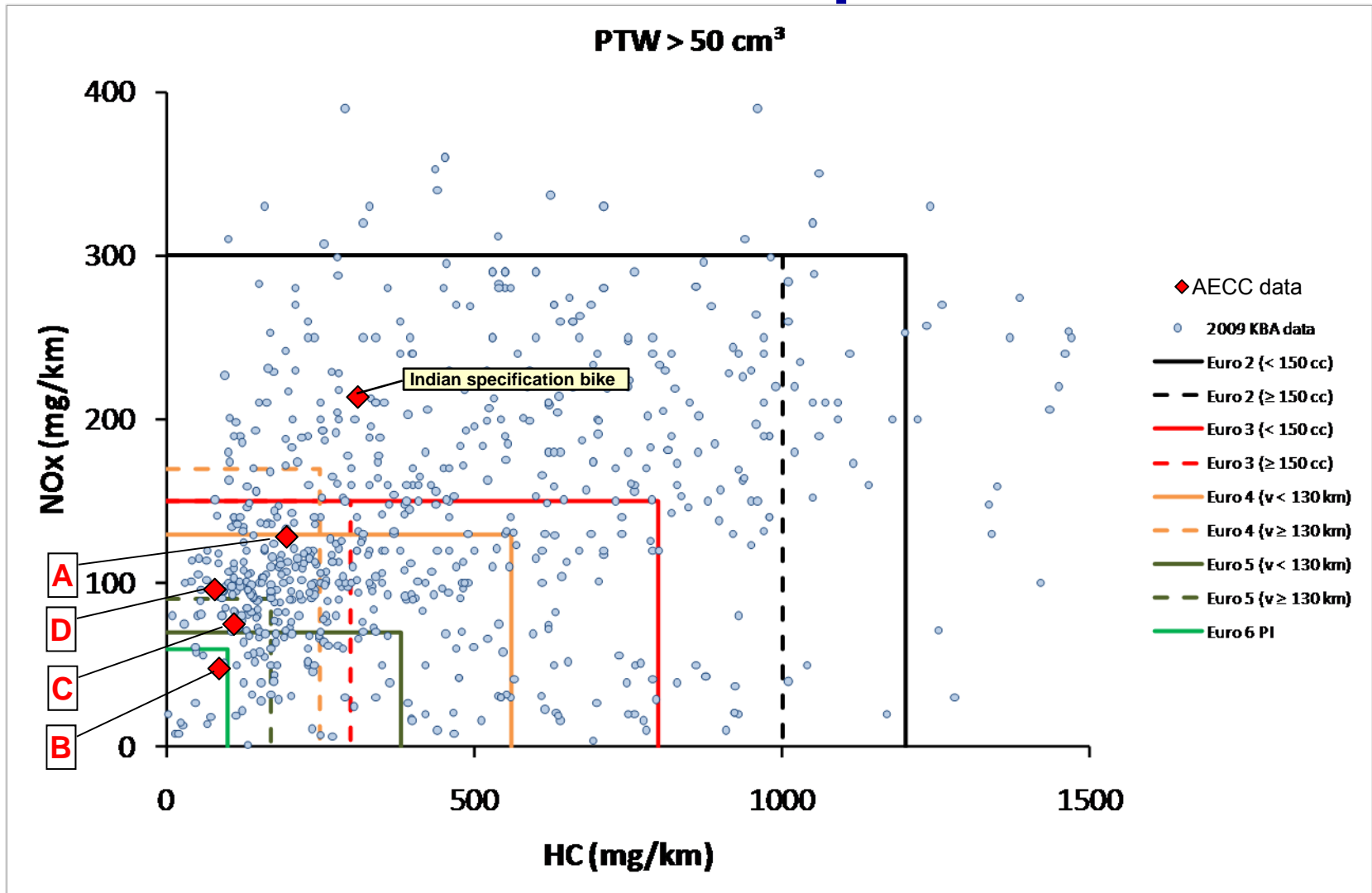
- 5 motorcycles were tested:
  - 3 Euro 3 bikes from European and Japanese OEMs.
  - 1 Euro 3-homologated bike from Asian OEM.
  - 1 Indian specification bike.

Bike	Engine	EFI	Open/Closed Loop Control	Secondary Air Injection (SAI)	Catalyst	Spec.	WMTC Class	km at test start	
A	800cc V4.	y	Closed	y	y	Euro 3	3.2	8000	
B	800cc in line 2-cyl.	y	Closed	n	y	Euro 3	3.2	1000	
C	1300cc in line 4-cyl.	y	Closed	y	y	Euro 3	3.2	1000	
D	500cc 1-cyl.	y	Closed	y	y	Euro 3	3.2	1000	
E	149cc 1-cyl.	n	N/A	y	y	Indian	2.1	1000	

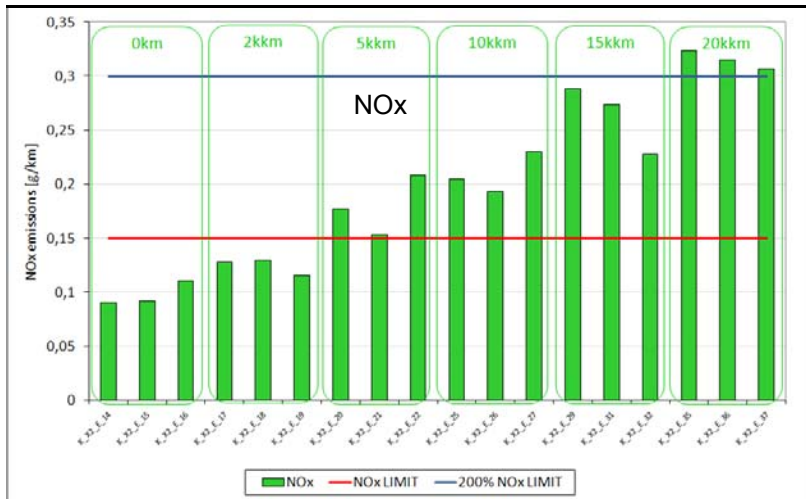
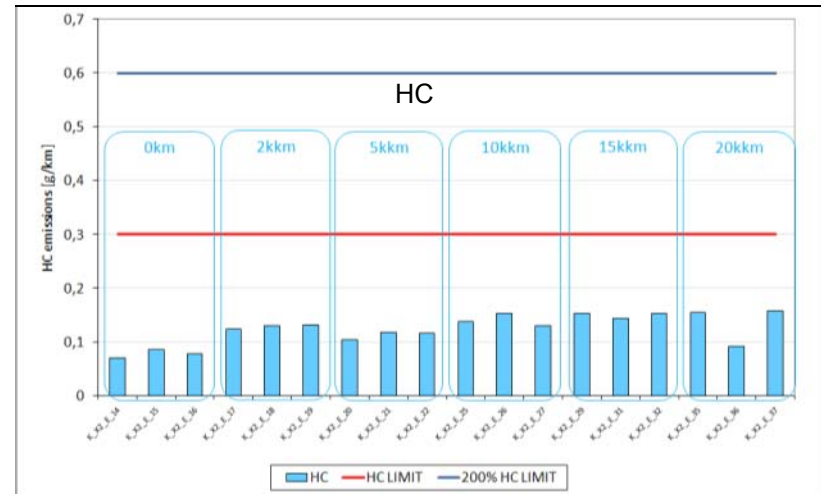
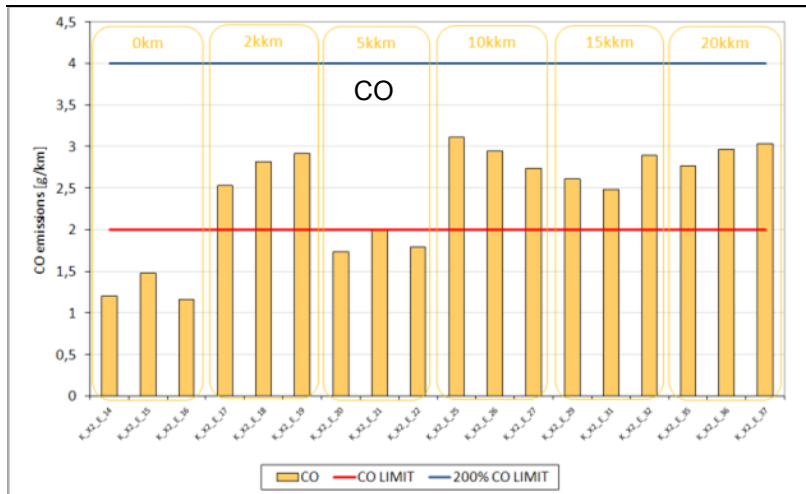
# Euro 3 Motorcycles Failures

- Several test vehicles failed to meet emissions limits in 'as received' conditions.
- When received, bike A failed all emissions tests. Oxygen sensor leads were found to be crossed, so the engine was not running closed loop. OBD would have detected this failure. After correction, the bike met the Euro 3 emissions limits.
- 2 examples of the imported (Euro 3 homologated) bike D both failed Euro 3 limits initially. The 2<sup>nd</sup> example eventually passed after a specific pre-conditioning recommended by the importer and the use of reference fuel for the Euro 3 test.

# Test Results (without durability) relative to Euro 4-6 Proposed Limits



# Mileage Accumulation on Bike D



- The imported Euro 3 bike tested for AECC exceeded Euro 3 CO limits after only 2 000 km and Euro 3 NOx limits after only 5 000 km.
- Tests were terminated at 20 000 km as NOx was at 2x limit value.

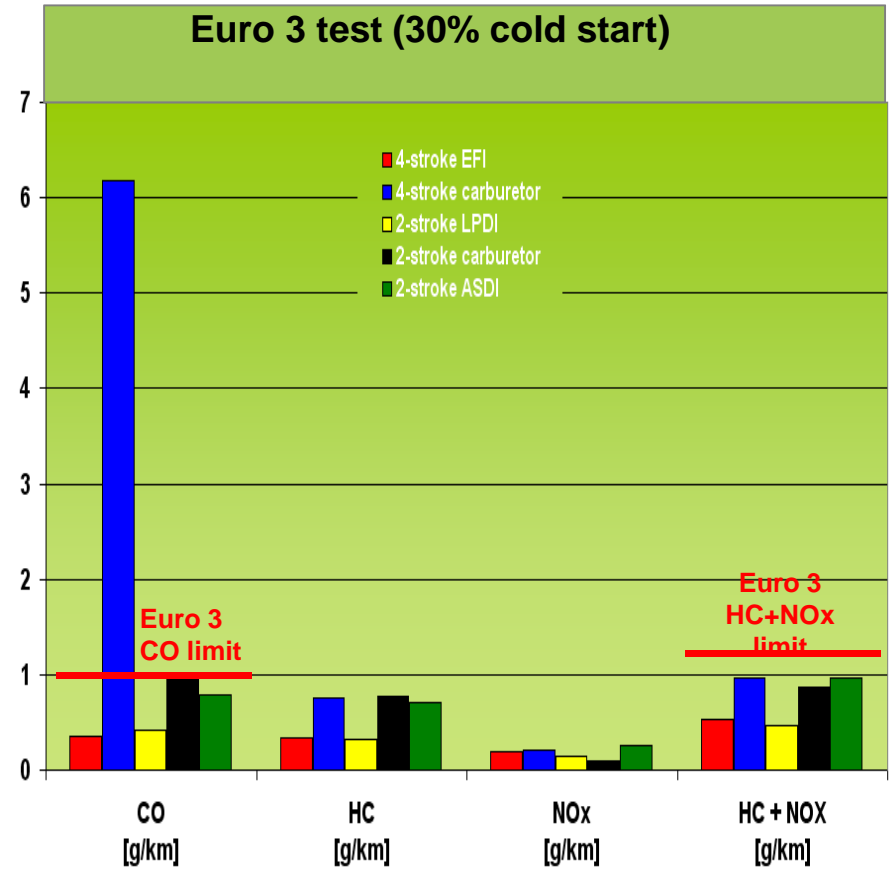
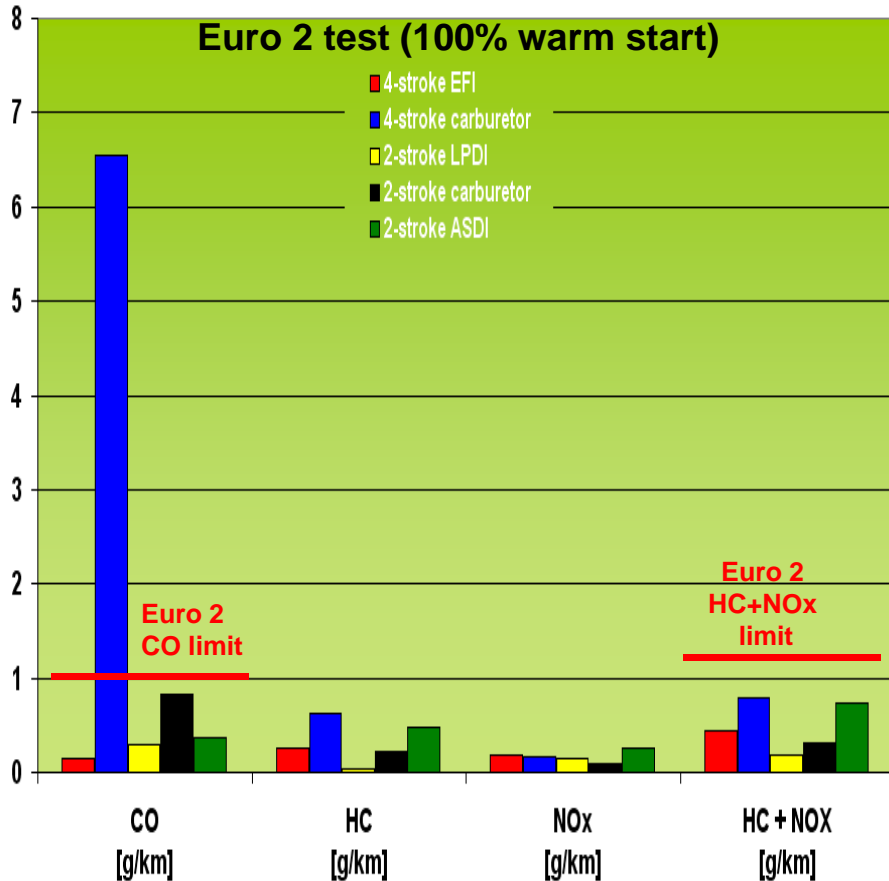
# AECC Mopeds Test Program

- 5 European Euro 2 mopeds were tested on:
  - ECE Reg.47 cycle to current Euro 2 legislation (warm start).
  - ECE Reg.47 cycle to Euro 3 proposal (cold & hot start, 30% weighting for cold start).
  - Low-speed option of WMTC part 1 (cold & hot start, 50% weighting for cold start).

Vehicle	Specifications	Mixture preparation	Emissions Control	Max. velocity	Emission standard
<i>4-stroke EFI</i>	4-stroke / 4-valve SOHC 3 kW, liquid cooled	EFI with $\lambda$ -sensor	3-way catalyst	44 km/h restricted by leaning	EURO 2; ECE Reg.47
<i>4-stroke carburetor</i>	4-stroke / 2-valve SOHC 2.88 kW, fan cooled	carburettor (constant depression)	1 oxidation catalyst secondary air	48 km/h restricted by ignition retarding	EURO 2; ECE Reg.47
TUG 2-stroke <i>LPDI</i>	2-stroke 3.7 kW, liquid cooled	<u>L</u> ow <u>P</u> ressure <u>D</u> irect <u>I</u> njection	1 oxidation catalyst	47 km/h restricted by leaning	Designed for EURO 3; ECE Reg.47
<i>2-stroke carburetor</i>	2-stroke 2.3 kW, fan cooled	carburettor (slider)	1 oxidation catalyst secondary air	>50 km/h. Throttle closed at 50 km/h for these tests	Designed for EURO 3; ECE Reg. 40
<i>2-stroke ASDI</i>	2-stroke 4 kW, liquid cooled	<u>A</u> ir <u>S</u> upported <u>D</u> irect <u>I</u> njection	1 oxidation catalyst	42 km/h restricted by leaning	EURO 2; ECE Reg.47

Note: 2-stroke carburettor moped was Swiss spec., where speed is not limited to 45km/h. Throttle was cut at 50 km/h for tests on this bike to give comparable results, but this may have resulted in lower emissions than if speed had been limited (part load instead of full load at high speed).

# ECE Reg. 47 Test Results

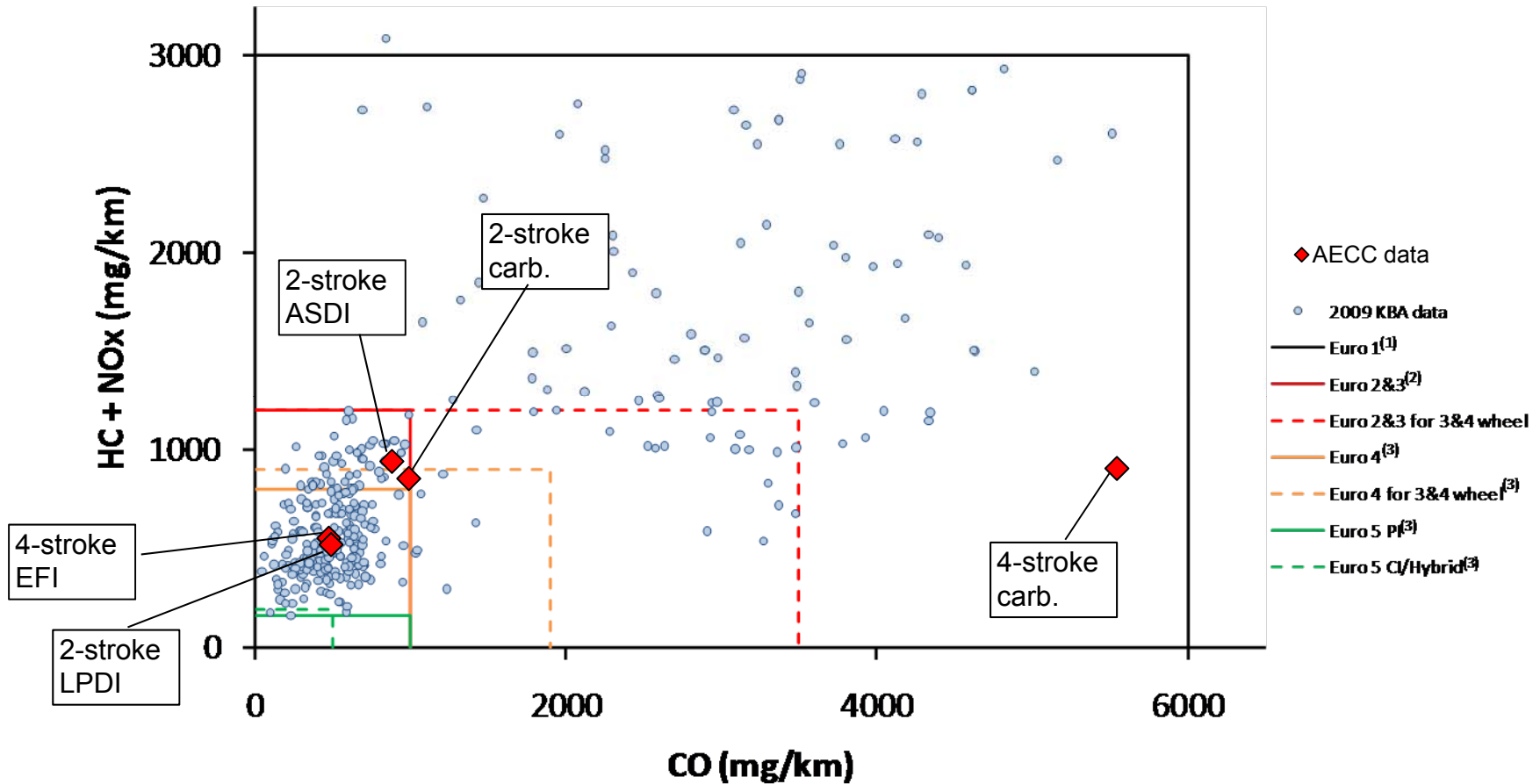


- The 4-stroke carburettor moped had CO emissions well above the test limit.
- All other mopeds met both the Euro 2 and proposed Euro 3 limits, although the 2-stroke carburettor vehicle was very close to the CO limit.
- All results are without durability.



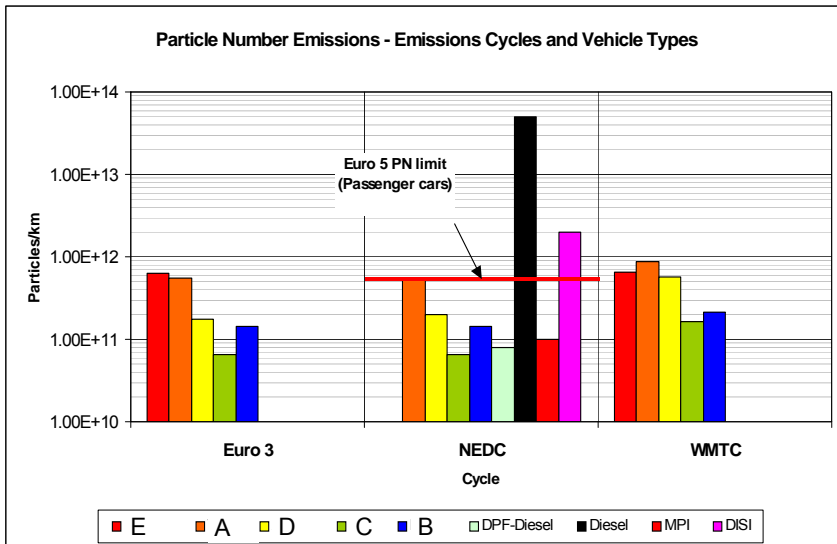
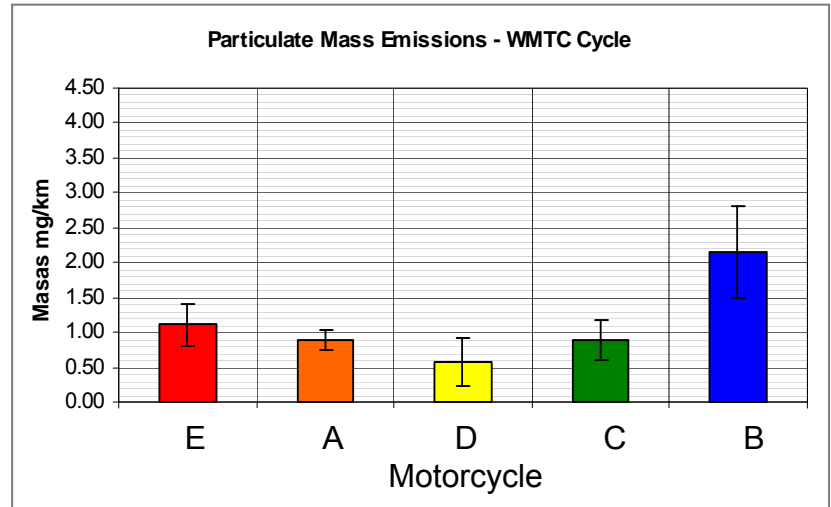
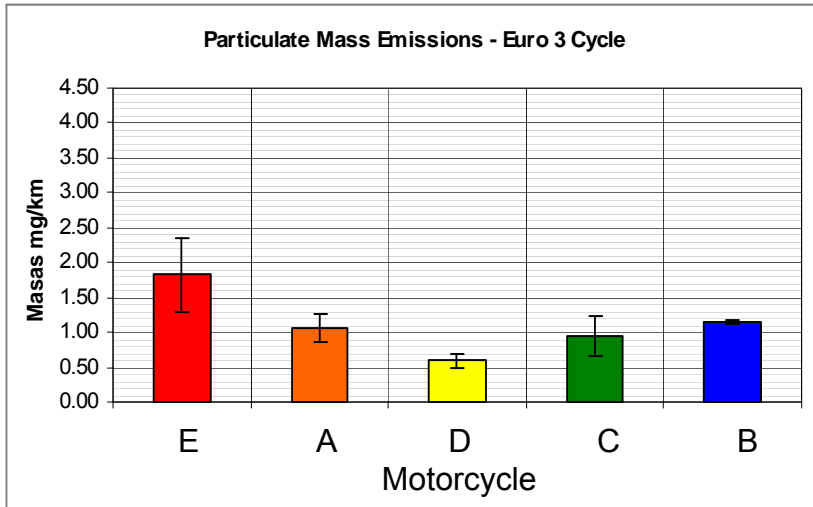
# Test Results (incl. cold start but no durability) relative to Euro 3-5 Proposed Limits

PTW  $\leq 50 \text{ cm}^3$



- (1) Euro 1 for 3&4 wheel is not shown
- (2) There is no difference between the emission limits of Euro 2 and Euro 3 but Euro 3 is cold start
- (3) The emission limits of THC and NOx are actually separated for Euro 4 & 5

# Particulate Mass & Number - Motorcycles

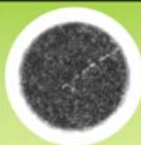
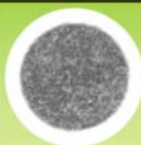





- Similar mass levels were attained from all motorcycles on both WMTC and Euro 3 cycles.
- Particulate Mass emissions on both cycles were <2.5 mg/km, well below the 4.5 mg/km level proposed for the 3<sup>rd</sup> step (for Euro 6).
- All bikes show Particle Numbers on the NEDC emissions levels of <math>6 \times 10^{11}</math>/km.

# Particulate Mass & Number - Mopeds

	PM	PN (to PMP)
Euro 3 cycle (8 x ECE) unweighted	mg/km	particles/km
4-stroke EFI	2.52	$3.84 \times 10^{12}$
4-stroke carburettor	5.05	$1.98 \times 10^{13}$
2-stroke LPDI	6.68	$2.35 \times 10^{13}$
2-stroke carburettor	12.39	$2.78 \times 10^{14}$
2-stroke ASDI	10.04	$1.09 \times 10^{14}$

- Only the 4-stroke EFI would meet the PM limit of 4.5 mg/km proposed for the Euro 5 stage.
- Particle Number emissions measured by PMP-based method range from  $3.8 \times 10^{12}/\text{km}$  to  $2.8 \times 10^{14}/\text{km}$  (levels similar to diesel cars without particulate filters).
- Compositional analysis shows very little elemental carbon (mostly organic carbon).

ECE R47	Pallflex EMFAB 4000 lpm sampling 112
<i>4-stroke EFI</i>	
ECE R47	Pallflex EMFAB 4000 lpm sampling 113
<i>4-stroke carburetor</i>	
ECE R47	Pallflex EMFAB 4000 lpm sampling 114
<i>2-stroke LPDI</i>	
ECE R47	Pallflex EMFAB 4000 lpm sampling 115
<i>2-stroke carburetor</i>	
ECE R47	Pallflex EMFAB 4000 lpm sampling 116
<i>2-stroke ASDI</i>	

# Some Considerations on COM(2010) 542

- AECC supports the final stage of emissions proposed by the EC but the intermediate stages are too weak and could be strengthened. Most motorcycles and mopeds tested already meet the next emissions stages (and one motorcycle already meets the proposed Euro 6 stage without durability).
- 3-wheel mopeds benefit from relaxed emissions limits at proposed Euro 3 and 4 stages but there is no technical justification for this.
- Better engine control (Air-to-Fuel Ratio control) is needed for mopeds to ensure low emissions. Catalysts only cannot solve the emissions problem.
- Regarding Particles emissions from mopeds, similar levels than diesel cars without Diesel Particulate Filter have been measured.
- Emissions limit values of hybrid vehicles should be defined according to the technology of their internal combustion engine (and not all aligned to CI engines as currently proposed).
- AECC strongly supports the introduction of OBD requirements and durability requirements, without which it is possible that some motorcycles might not be equipped with durable catalytic converters.



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**Who are AECC and what do we do ?**

AECC is an international non-profit scientific association of European companies making technologies for engine exhaust emissions control.

The members of AECC are companies operating worldwide in the research, development, testing and manufacture of key technologies for emissions control.

Their products are the ceramic and metallic substrates for catalysts and filters; autocatalysts (substrates with catalytic materials incorporated or coated); adsorbers; filter-based technologies to control particulate emissions from diesel and other lean burn engines; and speciality materials incorporated into the catalytic converter or filter.

Catalyst-equipped cars were first introduced in the USA in 1974 but only appeared on European roads in 1985 and in 1993 legislation forced their use on cars. Now more than 275 million of the world's 500 million cars and over 85% of all new cars produced worldwide are equipped with autocatalysts. Catalytic converters and filters are also fitted to heavy-duty vehicles, tractors and non-road engines and vehicles.

**What are the emission control technologies?**

Exhaust gas contains carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NOx) and particulate matter (PM). The main technologies used to treat exhaust to remove harmful gases and particles are:

- autocatalysts
- adsorbers (traps)
- filters

There are more details on the technology pages.



*Thank you for your attention*

