

Particulate mass and number tests on Euro 4 light-duty vehicles

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- Test programme details
- PM & particle number measurements
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AECC test programme

- 4 current Euro 4 production vehicles
 - 1 gasoline with TWC
 - 2 different Diesels without DPF
 - 1 Diesel with DPF.
- 4 different vehicle manufacturers.
- Standard mid-sized vehicles.
- Vehicles aged to 4000km.
- Diesel with DPF run to 160000km (on-road ageing) and then the test programme was repeated.
- Tests conducted at AVL-MTC (a Type Approval agency in Sweden).



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Euro 4 test vehicles

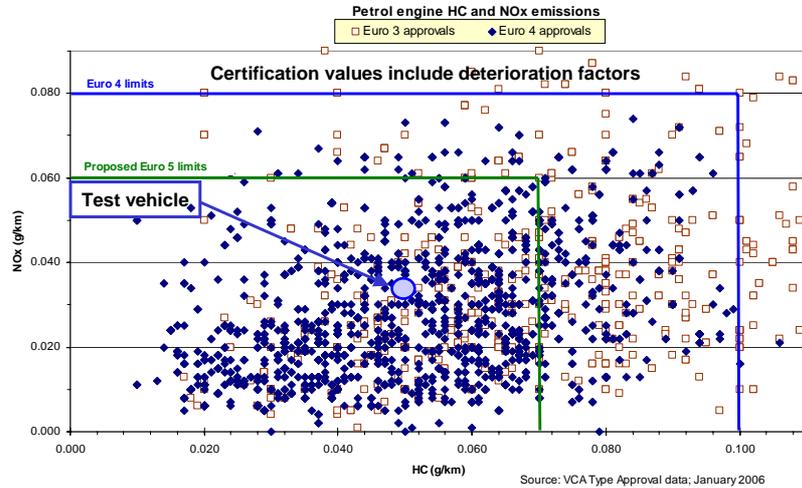
	Gasoline vehicle	Diesel 'A' without DPF	Diesel 'B' without DPF	Diesel with DPF
Engine Type	In-line 4 16 valve	V6 24 valve	In-line 4 16 valve	In-line 6 24 valve
Injection system	Sequential MPI	Distributor pump DI	Common Rail DI	Common Rail DI
Displacement (cm³)	1791	2496	2204	2993
Power (kW@rpm)	90@6000	120@4000	103@4000	160@4000
Emission Control	TWC 2 lambda	EGR 2 x DOC	cooled EGR 3 x DOC	EGR DOC underfloor C-DPF



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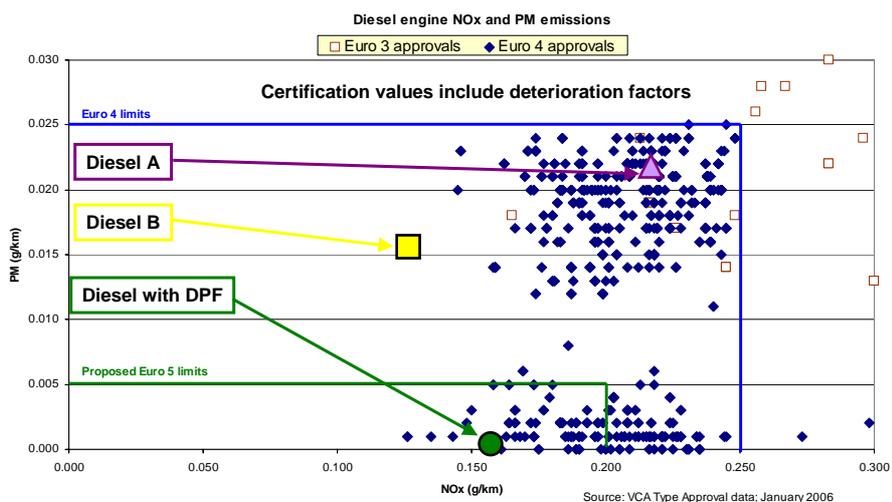
Gasoline passenger cars Type Approval values



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Diesel passenger cars Type Approval values



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AECC test programme outline

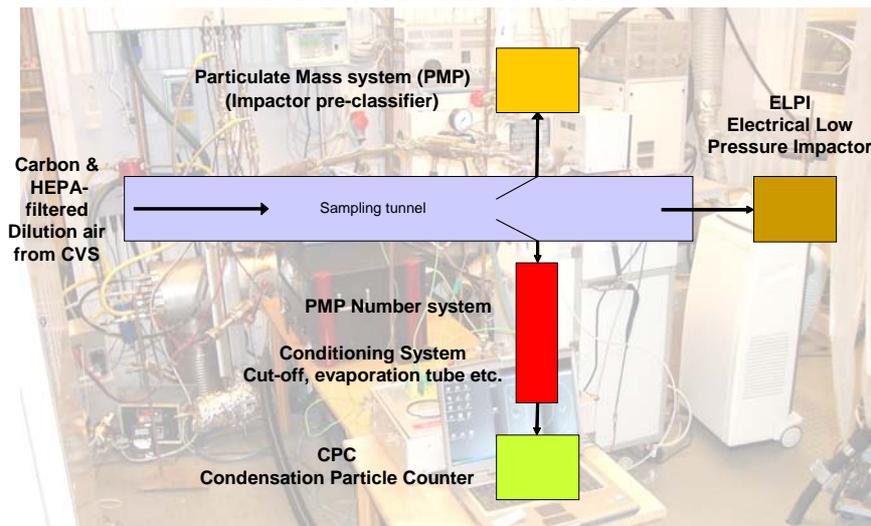
- All vehicles tested on cold-start NEDC.
- All vehicles tested on hot-start Artemis Urban, extra-urban and highway cycles.
- Standard CEC Reference Fuels used for all tests.
- Standard Swedish Road fuels for de-greening / durability.
- Regulated g/km ('bag') emissions.
- Engine-out and continuous tailpipe regulated emissions.
- PM and Particle Number to 'frozen' PMP protocol.
- Particle Size distribution measurements (ELPI).
- Continuous Size & Number distribution.



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General arrangement: PMP Particulate Mass & Particle Number measurement



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Particulate Mass PM

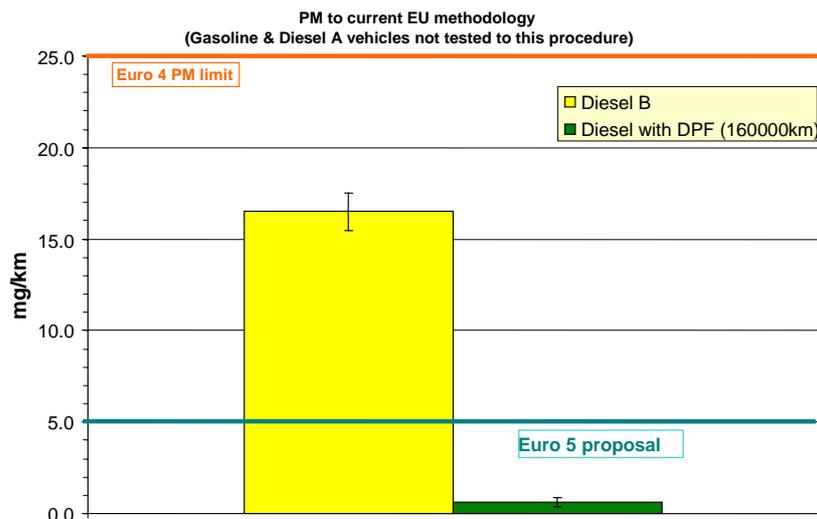
- PMP system:
 - Modified particle mass measurement to June 2004 (frozen) protocol except 2 filters used in 1st phase of testing.
 - Data for single (first) filter and 2 filters to examine effect of 2nd filter on repeatability and mass.
 - Simultaneous sampling with single filter PMP system and 2 filter PMP system in 2nd phase of testing to allow direct comparison.
- Conventional EU system:
 - 2 filters; used in 2nd phase of testing simultaneously with 1 and 2-filter PMP systems.
- The same flow rate was used for each measurement and each test.



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PM to current methodology (NEDC)

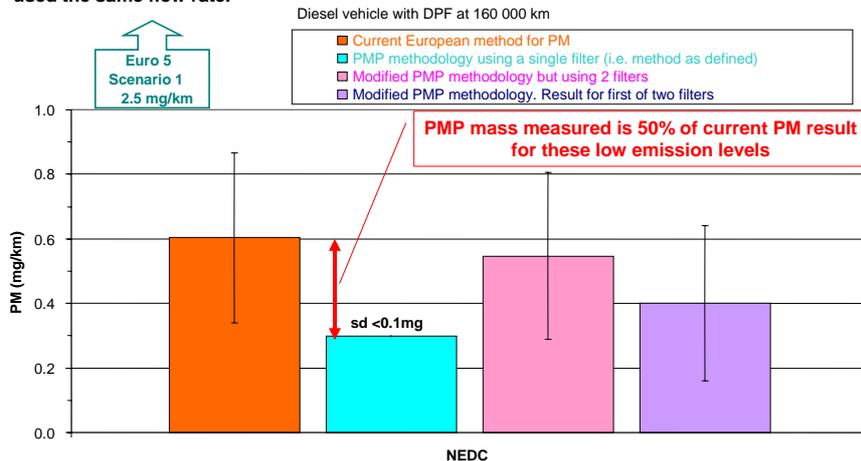


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PMP versus current EU gravimetric method

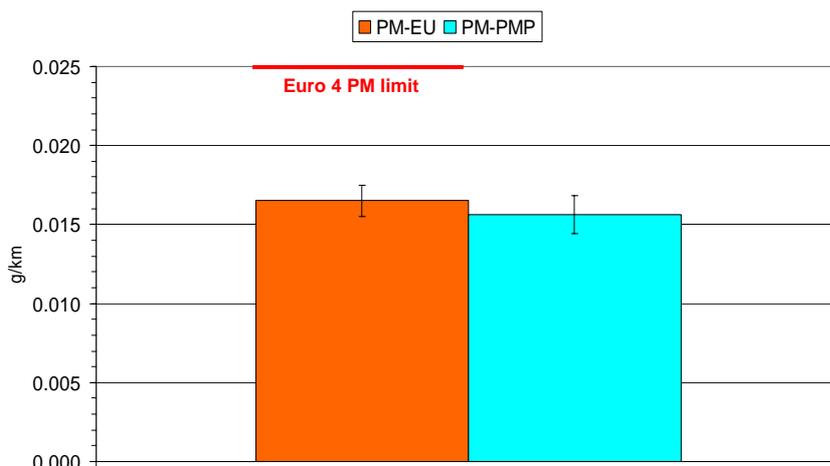
Tests were conducted using **a)** the current European method for PM (2 filters), **b)** the revised PMP methodology (as frozen June 2004) which uses a single filter, cyclone pre-classifier, heated samples etc., and **c)** a modified version of the PMP method retaining two filters. In this case measurements were obtained using both filters and using only the first filter, for comparison. All used the same flow rate.



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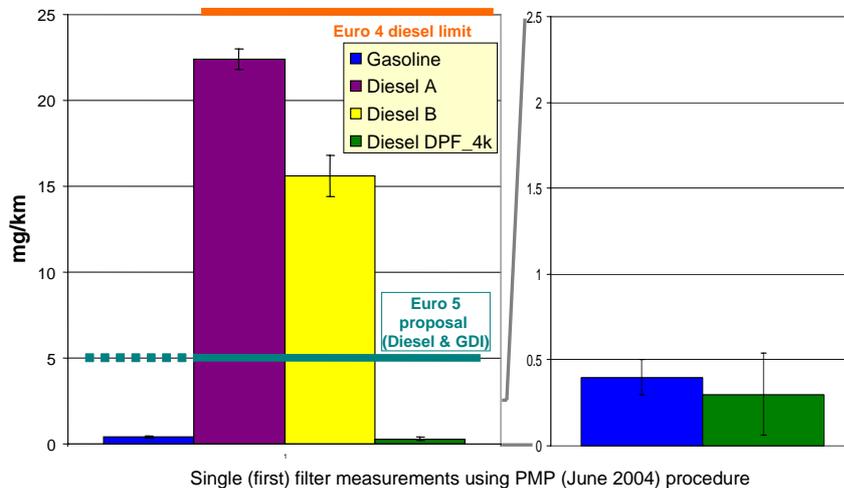
PMP versus current EU gravimetric method - Diesel B (w/o DPF)



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PM using PMP on NEDC at 4000km



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Particle Number and Size

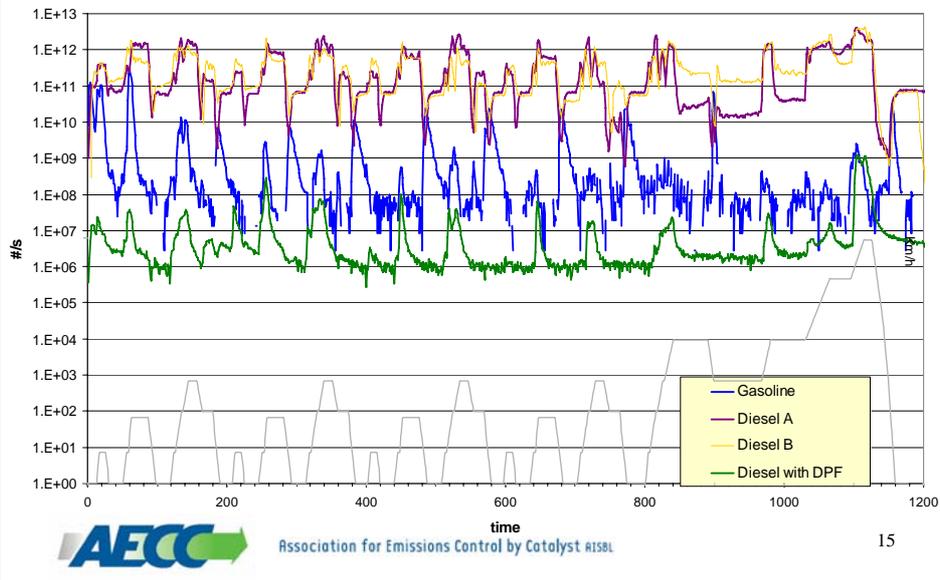
- PMP (Particulate Measurement Protocol) system
 - Particle Number measurement (total number per km) to the June 2004 (frozen) protocol using cyclone cut-off, evaporation tube, and Condensation Particle Counter (CPC) with 23nm cut-off.
Also provides continuous data (number per second).
- ELPI – Electrical Low Pressure Impactor (Dekati)
 - 1 Hz Particle Number and Size distribution (7nm to 6µm) direct from tunnel without evaporation tube, so includes volatile HCs.



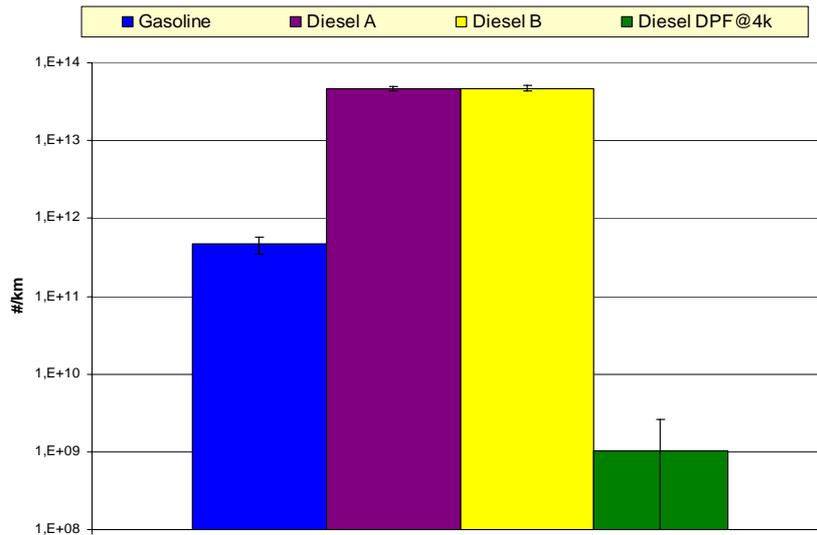
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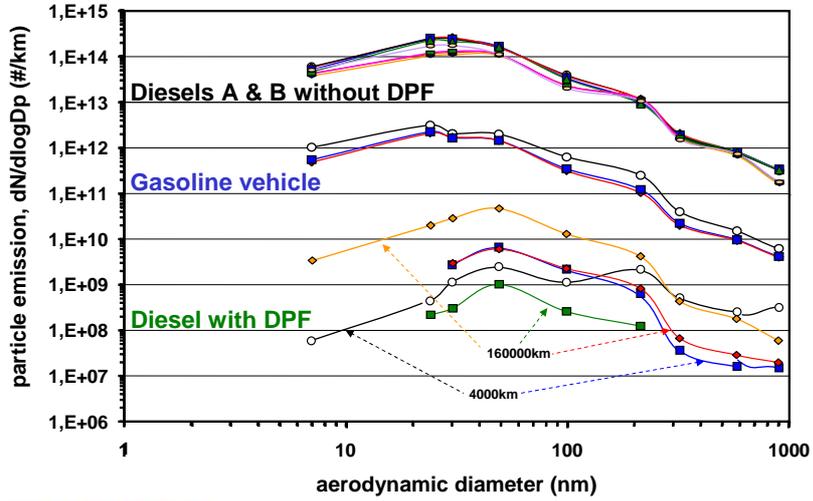
Continuous CPC Particle Numbers - comparison of 4 vehicles (NEDC)



Average Particle Numbers using CPC (NEDC)



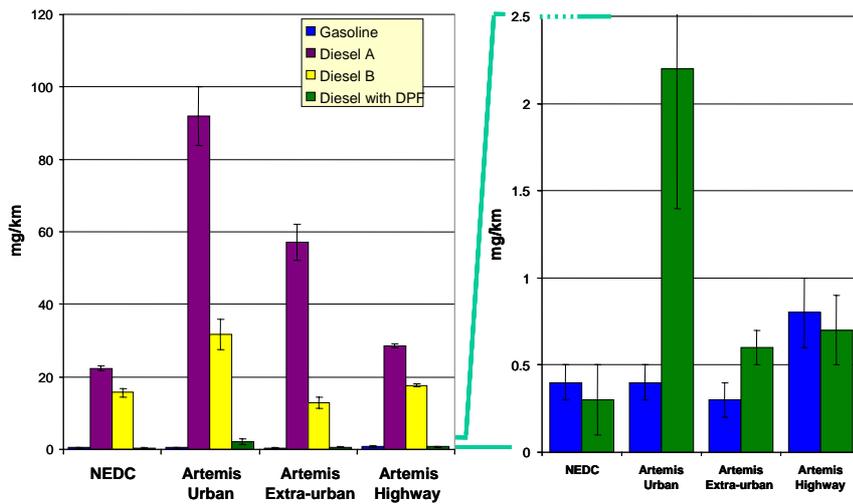
ELPI Particle Size distribution (NEDC)



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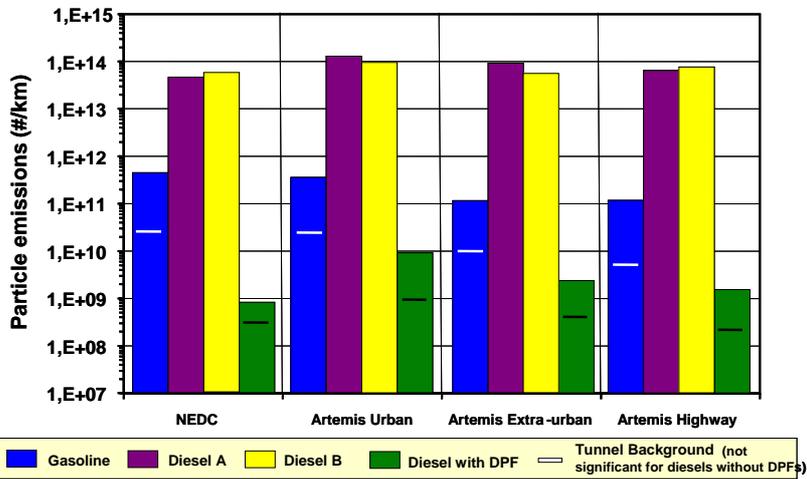
PM Emissions: Artemis cycles



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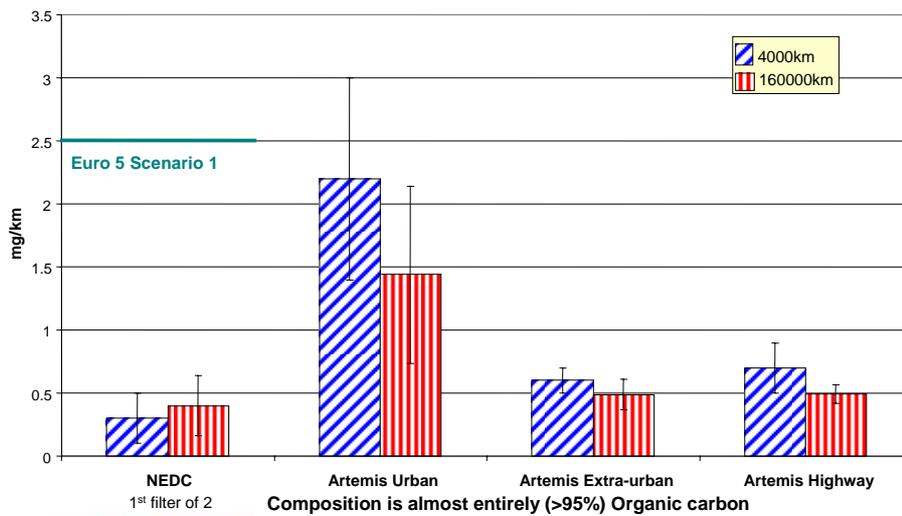
Particle Number Emissions: Artemis cycles



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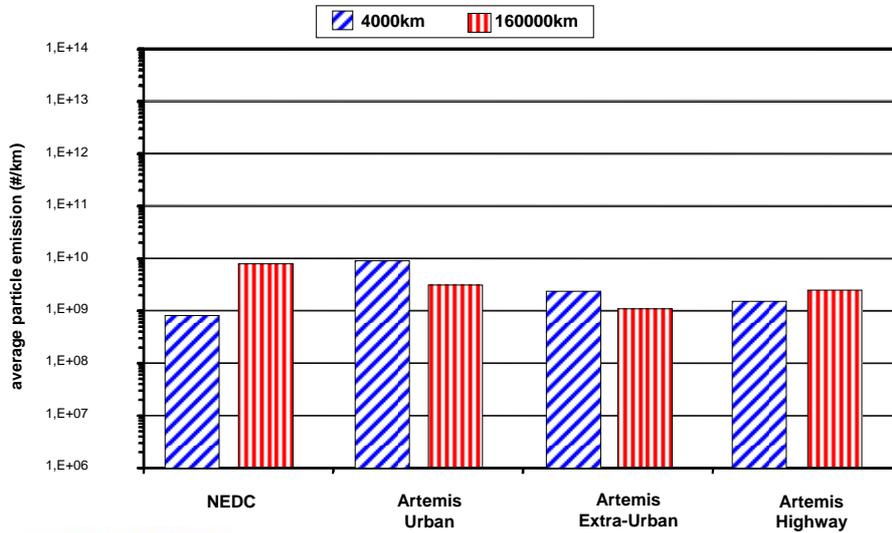
PM emissions at 4000 and 16000km Artemis Cycles with NEDC for comparison



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PMP Particle numbers at 4000 and 160000km Artemis Cycles with NEDC for comparison



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Conclusions from the AECC test programme

- The PMP protocol permitted measurement of Particulate Mass at low levels typical for DPF-equipped vehicles and robust Particle Number measurements.
- Results indicate that Particulate filters reduce Particulate Mass and Particle Numbers of Diesel emissions by a considerable margin.
- Durability of the Light-duty Diesel vehicles with DPF was demonstrated to 160000km.
- PMP mass measurement provided better consistency than the existing gravimetric measurement method but also reduces the mass measured by up to 50% for the low PM levels obtained on the DPF-equipped vehicle.



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The image shows a screenshot of the AECC website. The header includes the AECC logo and the text "Association for Emissions Control by Catalyst". The main navigation menu on the left lists: Home, AECC, Air Quality & Health Effects, Emissions Legislation, Engine & Vehicle Emissions, Technology, Applications, Conservation, Newsletter, and Publications. The main content area features a banner with a woman in a car and the text "WORKING IN PARTNERSHIP FOR CLEANER AIR". Below the banner, there are sections titled "Who are AECC and what do we do?", "What are the emission control technologies?", and "Catalyst equipped cars". A large blue text overlay reads "Thank you for your attention" and "www.aecc.be". The footer contains the AECC logo, "Association for Emissions Control by Catalyst AISBL", and the number "23".

Thank you for your attention

www.aecc.be

AECC Association for Emissions Control by Catalyst AISBL 23

The image shows the AECC logo and footer information. The logo consists of the letters "AECC" in a bold, blue, sans-serif font, followed by a green arrow pointing to the right. To the right of the logo is the text "Association for Emissions Control by Catalyst AISBL". The number "24" is located in the bottom right corner.

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