

AECC Light-duty Test Programme - PMP Measurements

AECC Objectives and Test Program

- Provide data for the PMP programme
 - improved particulate mass method.
 - new particle number measurement method.
- 4 mid-sized vehicles current Euro 4 production vehicles.
 - 1 gasoline (A1, MPI), 2 different diesels without DPF, 1 diesel with DPF
- 4 different vehicle manufacturers.
- Diesel with DPF also tested at 160000km
- All vehicles tested on NEDC + CADC (Artemis) suite.
- PM and particle number to 'frozen' PMP protocol.
- Particle size distribution measurements (ELPI).

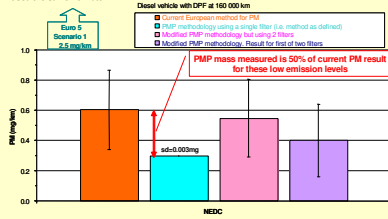
Particulate Mass and Number Measurements

- PMP mass 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 mass system:
 - 2 filters; used in 2nd phase of testing simultaneously with 1 and 2-filter PMP systems.
- PMP Particle number measurement
 - June 2004 (frozen) protocol using cyclone cut-off, evaporation tube, and Condensation Particle Counter (CPC) with 23nm cut-off.
- ELPI – Electrical Low Pressure Impactor (Dekati)

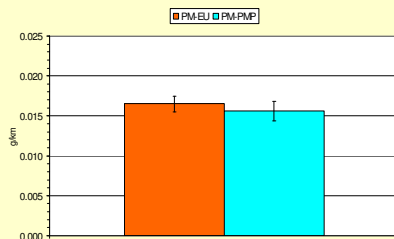
Particulate Mass

PMP versus current EU gravimetric method

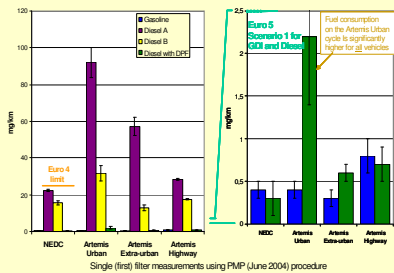
Tests were conducted using a) the current European method for PM (2 filters), b) the revised PMP methodology (as frozen June 2004) which uses a single filter, cyclone pre-classifier, heated samples etc., and c) a modified version of the PMP method retaining two filters. In this case measurements were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



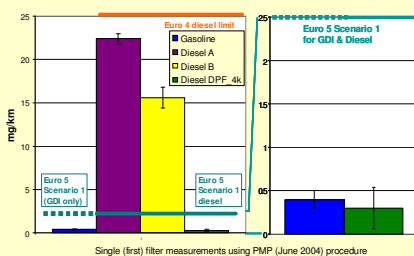
PMP versus current EU gravimetric method – Diesel B (no DPF)



PM using PMP on all cycles

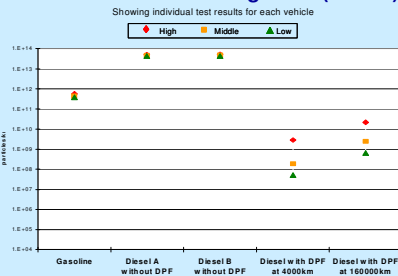


PM using PMP on NEDC at 4000km

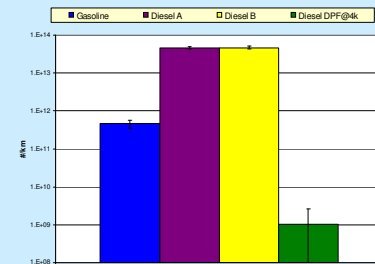


Particle Number

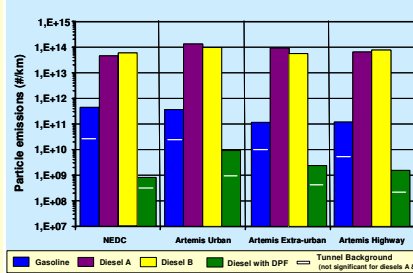
Particle numbers using PMP (NEDC)



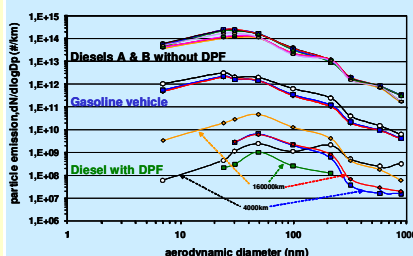
Average particle numbers using CPC (NEDC)



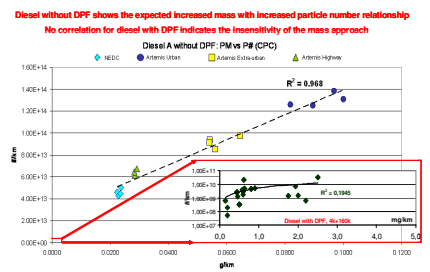
Average particle numbers using CPC



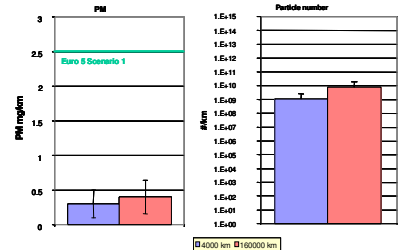
ELPI Particle size distribution (NEDC)



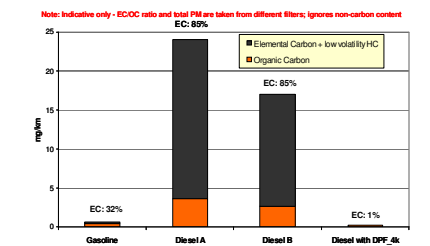
PM / particle number correlation



160000km durability - vehicle with DPF



Elemental Carbon (EC) + low volatility material & organic carbon (OC) relative to total PM NEDC tests



Conclusions

- The PMP protocol permits measurement of particulate mass below 2.5mg/km.
- The PMP protocol also permits robust particle number measurements.
- PMP mass measurement provides better consistency than the existing gravimetric measurement method
- PMP mass measurements also reduce the mass measured by up to 50% for the low PM levels obtained on DPF-equipped vehicles.
- The DPF reduces particulate mass and particle numbers of diesel emissions by a considerable margin.
- Particulate filters for light-duty diesel are durable and effective to at least 160000km.