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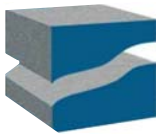
Draft presentation to GRPE

ACEA PM-3 programme

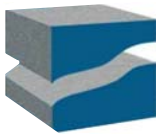
Caroline Hosier,
Pilot, ACEA Task-Force Particulates (TF-PM)
Ford Motor Company

Background



- The ACEA 1st and 2nd Particulate programmes concentrated on particulate measurement of mass, size, number and characterised particulate emissions from diesel, gasoline, diesel with trap and direct injection petrol engines.
- The ACEA 3rd particulate programme, known as PM-3 was designed to contribute to the UK Government led Particulate Measurement Programme (PMP) being run under the auspices of the UN-ECE.

Background



- PM-3 focuses on the gravimetric measurement method.
- PM-3 was initiated and funded by ACEA, using vehicles loaned from Fiat, PSA and VW. The 4th vehicle was loaned to the programme by Toyota.
- All testing was conducted at an independent laboratory, AVL-MTC in Sweden.
- The testing was completed in 2-phases.
  - The main programme
  - The recovery programme

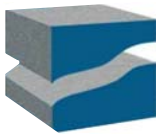
Objectives

- Primary objective: Examine potential enhancements to the existing particulate gravimetric measurement method.
  1. Increase measurement filter loading.
  2. Reduce Variability.
- Secondary objective: Investigate the potential of alternative dynamic mass-based particulate measurement methods.

Main Test outline

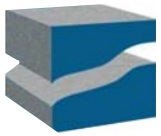
- 5 test sets using 4 particulate probes in parallel
- Filters weighed on both 1.0 μg and 0.1 μg balances.
- 4 vehicles - 3 * diesel, 1 * gasoline
- Gasoline fuel EN228 S<10 ppm
- Diesel Fuel - Swedish class 1, S<10 ppm

Main prog Probe/filter set-up



	Probe 1	**Probe 2**	**Probe 3**	**Probe 4**
Set 1: Low dilution	TX-40 + new filter holder + thermostatic control 90 l / min flow	T-60 + old filter holder 30-40 l / min flow	TX-40 + **new** filter holder without thermostatic control 90 l / min flow	TX-40 + old filter holder w/o thermostatic control 30-40 litres/min
Set 2: normal (high) dilution	TX-40 + new filter holder + thermostatic control 90 l / min flow	T-60 + old filter holder 30-40 l / min flow	TX-40 + **new** filter holder without thermostatic control 90 l / min flow	TX-40 + old filter holder w/o thermostatic control 30-40 litres/min
Set 3: Testing highest then lowest emitter diesel	TX-40 + new filter holder + thermostatic control 90 l / min flow	T-60 + old filter holder 30-40 l / min flow	TX-40 + **new** filter holder without thermostatic control 90 l / min flow	TX-40 + old filter holder w/o thermostatic control 30-40 litres/min

Probe/filter set-up 2

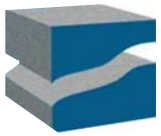


	Probe 1	**Probe 2**	**Probe 3**	**Probe 4**
Set 4: Mixing Tee close to tailpipe	TX-40 + new filter holder + thermostatic control 90 l / min flow	T-60 + old filter holder 30-40 l / min flow	TX-40 + **new** filter holder without thermostatic control 90 l / min flow	TX-40 + old filter holder w/o thermostatic control 30-40 litres/min
Set 5: normal (high) dilution	Teflo 2 micron + new filter holder + thermostatic control 90 l / min flow	T-60 + old filter holder 30-40 l / min flow	Teflo 2 micron + **new** filter holder without thermostatic control 90 l / min flow	Teflo 2 micron + old filter holder w/o thermostatic control 30-40 litres/min

Recovery Programme

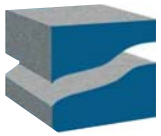
- Owing to flow rate controller errors in the original programme, it was necessary for ACEA and AVL-MTC together to run a recovery test programme. This was conducted using a single PSA diesel vehicle equipped with a DPF.

Recovery programme - 1



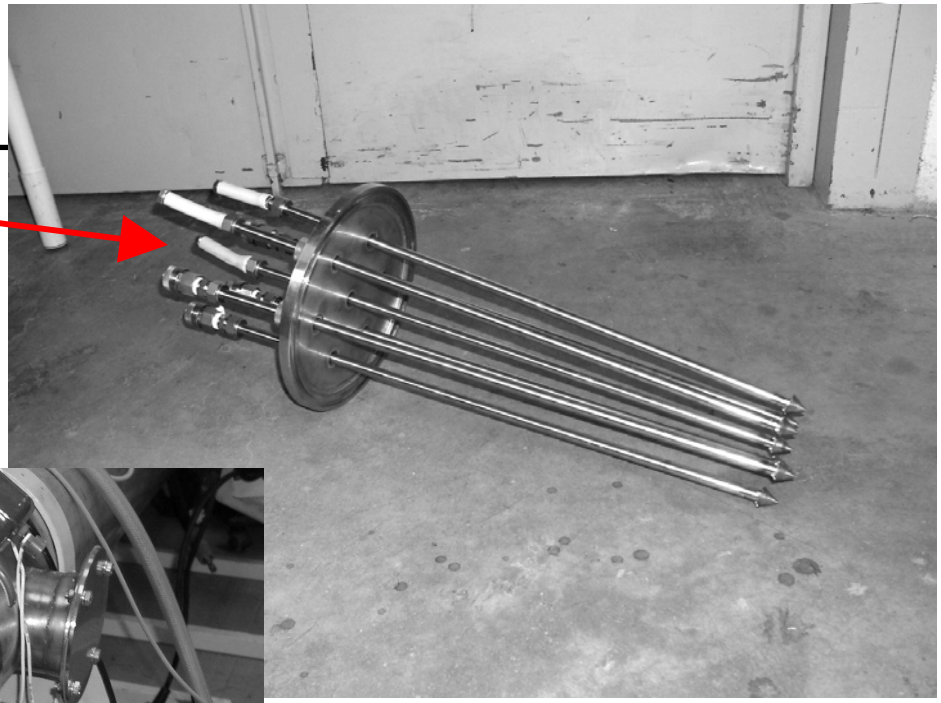
Set	No of tests and cycle	Probe 1	Probe 2	Probe 3	Probe 4
A	8 (10) **Hot** NEDC	TX-40 No heating 35 litres/min **new** holder	TX-40 No heating 35 litres/min **old** holder	TX-40 No heating 35 litres/min **new** holder	TX-40 No heating 35 litres/min **old** holder
B	6 cold NEDC	TX-40 No heating 35 litres/min **old** holder	TX-40 No heating 35 litres/min **new** holder	TX-40 No heating 35 litres/min **old** holder	TX-40 No heating 35 litres/min **new** holder
C	6 cold NEDC	TX-40 No heating **35 litres/min** old holder	TX-40 No heating **35 litres/min** new holder	TX-40 No heating **90 litres/min** old holder	TX-40 No heating **90 litres/min** new holder
D	6 cold NEDC	TX-40 No heating **90 litres/min** old holder	TX-40 No heating **90 litres/min** new holder	TX-40 No heating **35 litres/min** old holder	TX-40 No heating **35 litres/min** new holder

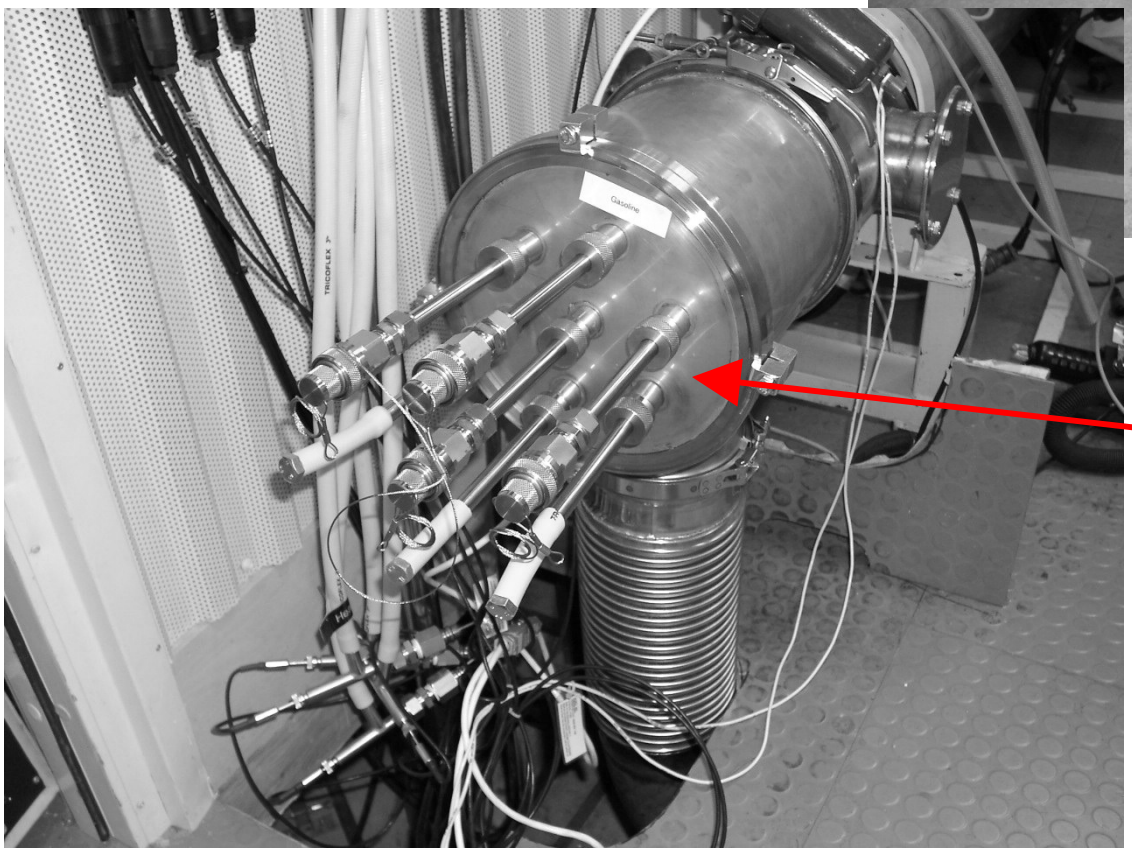
Recovery programme - 2



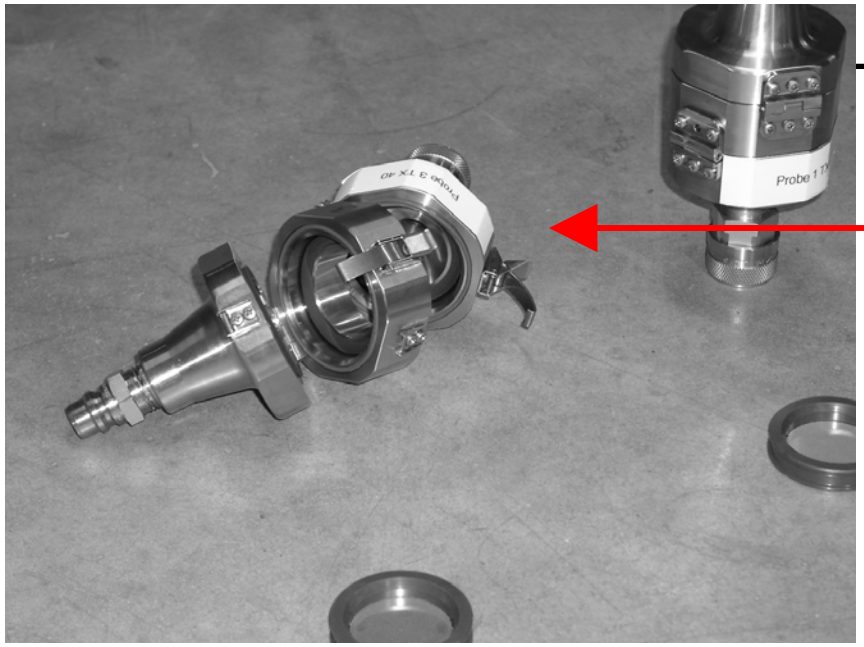
Set	No of tests and cycle	Probe 1	Probe 2	Probe 3	Probe 4
E	6 cold NEDC	TX-40 No heating **120 litres/min** old holder	TX-40 No heating **120 litres/min** new holder	TX-40 No heating **35 litres/min** old holder	TX-40 No heating **35 litres/min** new holder
F	6 cold NEDC	**TX-40** **Heating** **120 litres/min** new holder	**T-60A-30** No heating **35 litres/min** old holder	**TX-40** No heating **120 litres/min** new holder	**TX-40** No heating **35 litres/min** old holder
G	6 cold NEDC	**TX-40** **Heating** **120 litres/min** new holder	**T-60A-30** No heating **20 litres/min** old holder	**TX-40** No heating **120 litres/min** new holder	**TX-40** No heating **20 litres/min** old holder

Tunnel End-plate with mounted Probes



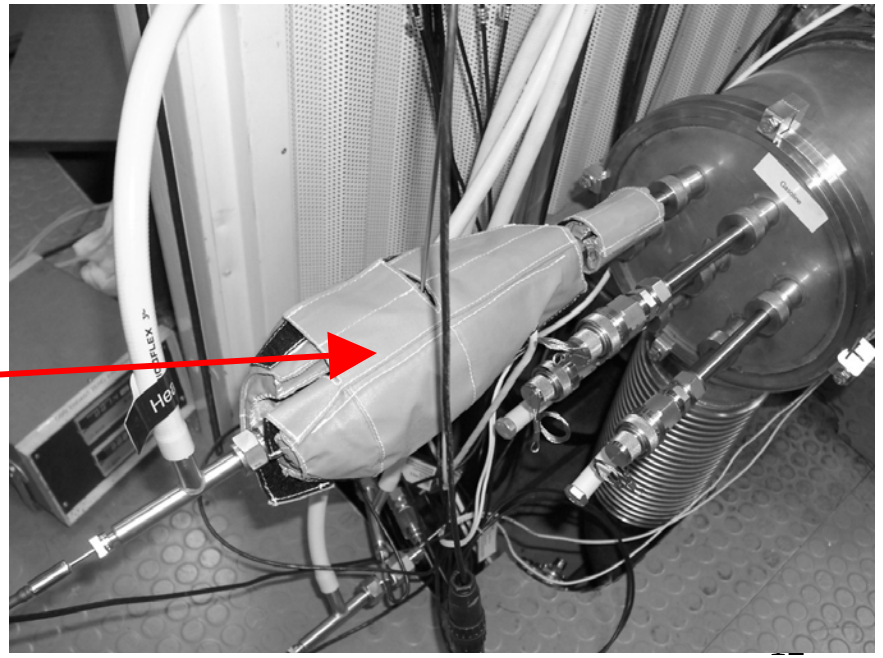


Probes mounted in tunnel.



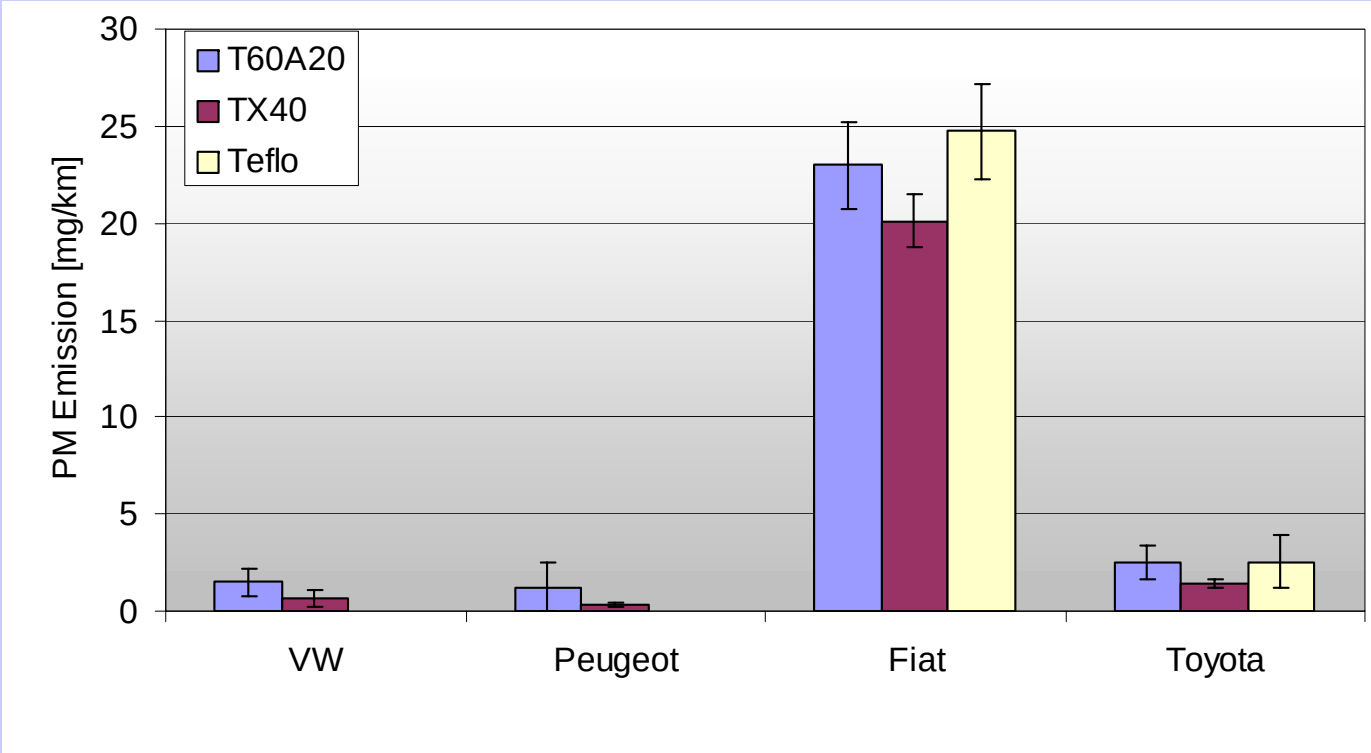
New filter holder (as specified in US HD2007)

New filter holder with thermostatically controlled heating jacket



Filter media – teflo, TX-40 & T60

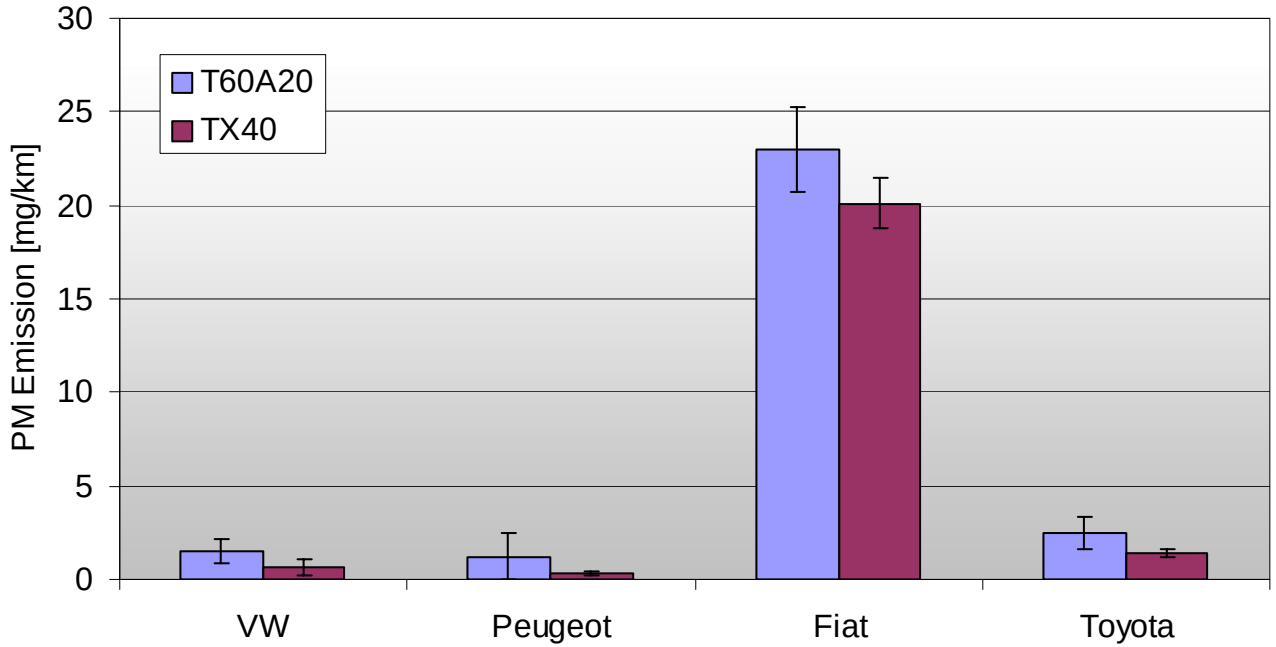
- Results from main programme

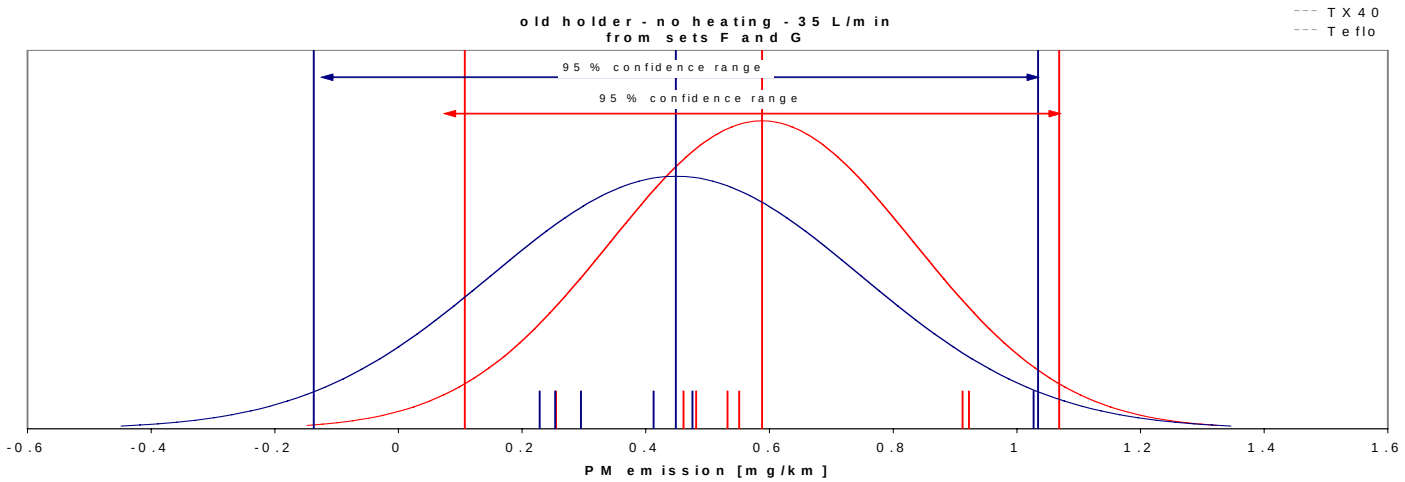


Filter material (main prog.)

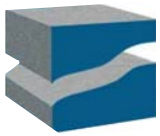
No statistical difference in average value TX-40 to T60.

No difference in Standard deviation.





Teflo filters



- Teflo filters
  - Require improved handling practices as they are very susceptible to damage.
  - Do not easily fit the filter cassettes.
  - Adequate charge neutralisation is essential
- Teflo filter showed no difference in measurement, therefore it should be allowed as an alternative.

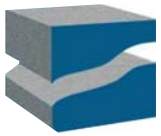
Microbalance

- At very low PM yield, the 0.1μg balance took over 20 minutes to stabilise in some cases, particularly with the teflo filter.
- 1μg balance is sufficient

Filter Holder

- No data available from 1st programme on filter holder effect
- Data from recovery programme shows no effect of changing filter holder to the US HD-2007 design

Filter Cassette



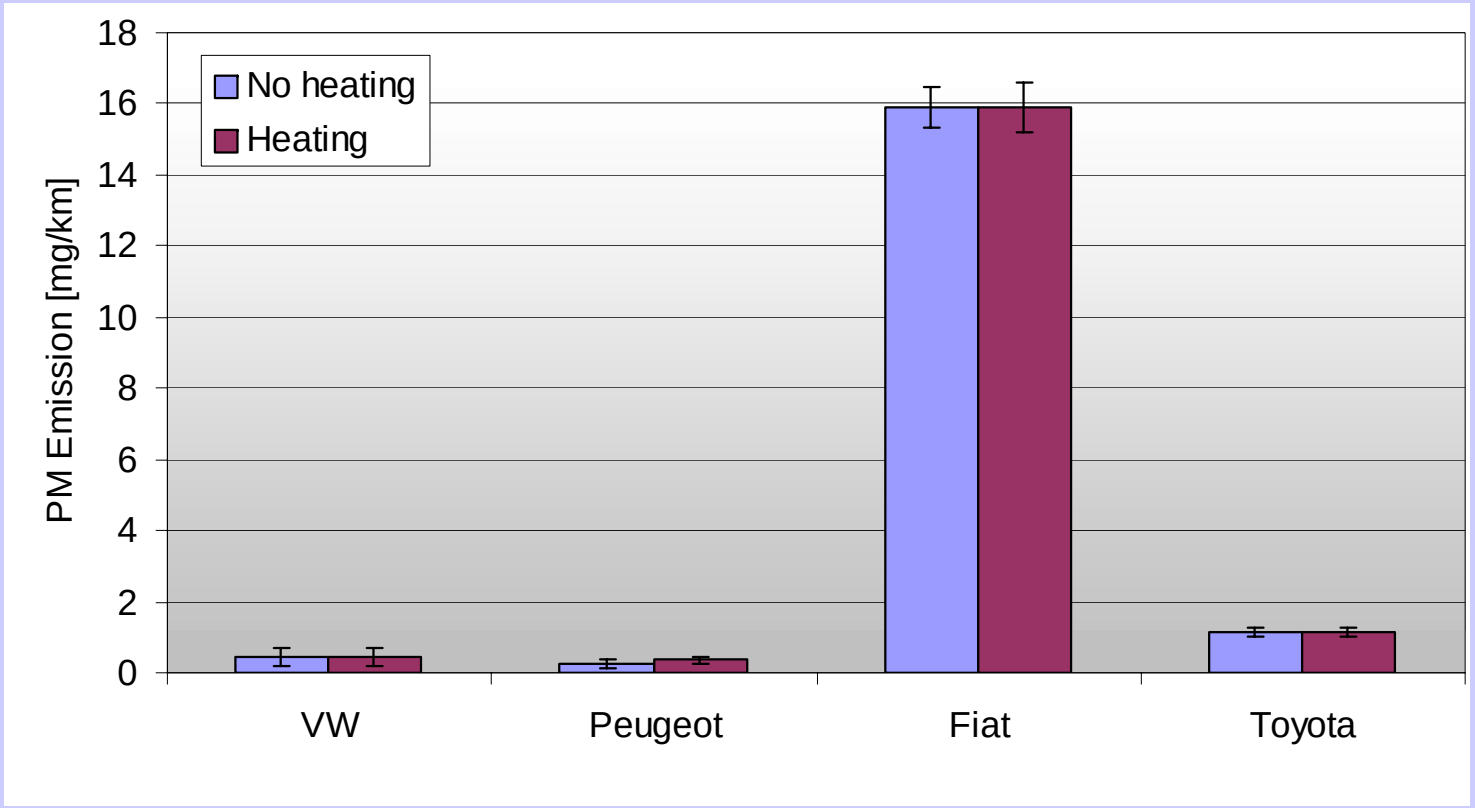
- When heavily loaded, cassette accumulates PM on the walls of the cassette itself.
- Difficult to retain all the PM from such a sample for weighing.
- The cassette has to be cleaned before being reused to relieve it from residual PM.
- Cassette itself causes some handling difficulties.
- Redesign of cassette may be required.

Thermostatic Control

- Thermostatic control
  - of the sampling line and filter holder to 47°C± 5°C for US HD-2007 filter holder.
- Thermostatic control of the sampling line and the filter holder does not improve repeatibility.
- This was confirmed in the recovery programme

Thermostatic Control (2)

- Thermostatic control of filter holder / sample lines makes no difference



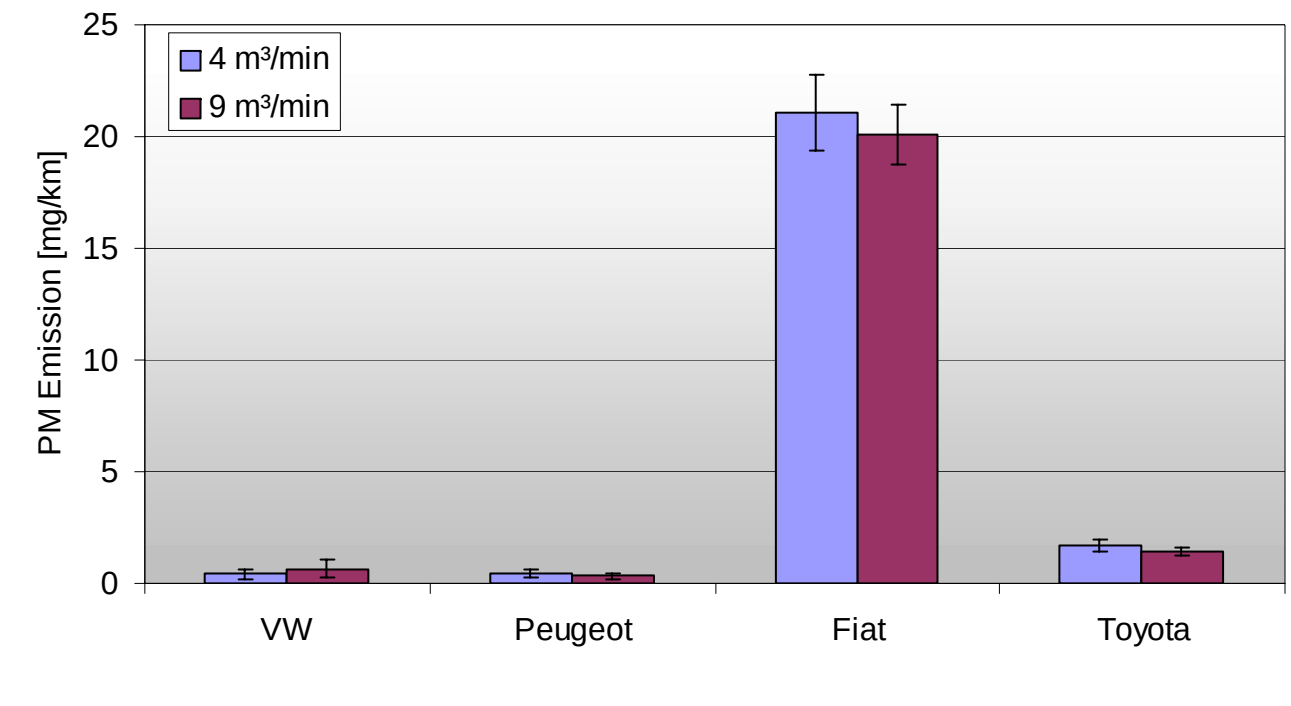
Weighing Room

- Experimentation on effect of weighing room environmental conditions (temperature/humidity) on blank and loaded filter papers.

- WAITING FOR UPDATED INFO FROM MTC

Sample Flow Rates

- No improvement of repeatibility with increasing sample flow
- Note T60 measurement filters broke at higher flows for the higher PM vehicle.



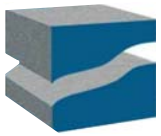
Conclusions 1 - draft

- The PM mass measurement method is suitable for measurement of very low PM emissions.
- Use of a high efficiency filter (TX40 or teflo) is recommended.
- Thermostatic control of the filter holder/sample probe makes no difference and does not improve variability.
- Filter holder design makes no difference and does not improve variability.

Conclusions 2 - draft

- The filter cassette causes some handling difficulties and may introduce errors.
- Flow rate makes no different
- The 1.0 μg balance performs better in a working environment than the 0.1μg balance.

Conclusions 3 - draft



- Measurement of Particulate mass for DPF equipped vehicles requires careful handling and control.
- The US HD-2007 adapted method adds more complication without offering any benefits.
- This study did not show a statistically significant improvement when using a single TX-40 instead of the T60 (primary + secondary) filter pair.
- The application of a single TX-40 offers the advantage of reduced weighing activities without influencing the measured results.

Conclusions 4 - draft

- A high number of tests (approximately 20%) are not valid for various reasons, even though this is a well understood method used by a reputable laboratory.
- However, the mass measurement method is suitable for measurement of PM from DPF equipped vehicles.

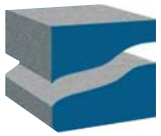
Recommendations - 1

- Modification to existing method
  - Single TX-40 or teflo filter (ie one filter per NEDC)
- Retain existing method in following respects
  - Existing filter holder
  - No heating requirement
  - No filter cassette
  - 1 μg balance

Recommendations - 2

- Other aspects
  - No benefit from increased sample flow rate
  - No benefit from decreased CVS flow rate
  - Good control of weighing room conditions essential

Suggestions for PMP Further work



- Before implementing mass measurement measures from PMP, it needs to be clearly demonstrated that they give improvements.
- Inconsistencies which we have seen from different test programmes highlight the need for further work. In such a case, ACEA would be prepared to participate (comparison of different filter materials).