

# **WLTP DTP PM-PN Subgroup Activities, Progress & Future Plans**

4<sup>th</sup> DTP Meeting  
Geneva  
12<sup>th</sup> January 2011  
Chris Parkin

# Outline

- Organisation
- Meetings Held
- Open Issues
- Closed Issues
- Future Plans

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# Organisation

- Terms of Reference & Plan of Activity
  - WLTP-DTP-PMPN-01-02
- Sub-group divided into small groups reviewing
  - Dilution system & PM sampling specifications
  - PM weighing chamber specifications, PM calibration and calculations
  - Periodic regeneration measurement and DPF conditioning
  - Particle number measurement & calibration
- Small groups will meet/teleconference between Sub-group meetings & report back to sub-group

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## Subgroup Meetings Held

- **1<sup>st</sup> Web Conference – 7<sup>th</sup> July**
  - Agreed Terms of Reference and Plan of Activity
  - Agreed decision on whether to mandate both PM and PN measurement was for DTP, WLTP or GRPE
  - Measurement ranges of  $<2 - 50\text{mg/km PM}$  &  $<6 \times 10^{11} - 5 \times 10^{13} \text{ \#/km PN}$  (to include OBD test cases)
  - PN during regen identified as an Open Issue
- **2<sup>nd</sup> Web Conference – 11<sup>th</sup> August**
  - Regulatory content comparison work subdivided into themes for examination by “small groups”
  - Use of secondary dilution, CVS max temperature during regen and background correction identified as additional Open Issues

## Subgroup Meetings Held

- **3<sup>rd</sup> Web Conference - 15<sup>th</sup> September**
  - Relevant regulatory content template completed
  - Small group regulatory comparison initial conclusions reported
  - Planning of further small group meetings
- **4<sup>th</sup> Web Conference – 1<sup>st</sup> October**
  - Further conclusions from small group regulatory comparison work reported
  - Plan of post October Activity agreed
- **5<sup>th</sup> Meeting – 4<sup>th</sup> November**
  - Lab processes dilution system specification reviewed
  - Open Issues List reviewed. Some issues closed, agreed data gathering required to resolve other issues, consideration of some (linked) issues deferred

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## Open Issues

### Transfer, dilution & PM sampling

- CVS temperature (non-regen tests)  $<52^{\circ}\text{C}$  (ECE & Jp),  $47^{\circ}\text{C} \pm 5^{\circ}\text{C}$  (US)
- CVS temperature during regen  $<190^{\circ}\text{C}$  (ECE & Jp),  $<52^{\circ}\text{C}$  single dilution  $<190^{\circ}\text{C}$  double dilution (US)
- Transfer tube coupling sealing materials – *minimise contact with exhaust*
- Transfer tube insulation
- Transfer tube length
- Use of remote mixing tee e.g. for SI engines and implications on dilution system requirements
- Dilution air filtration efficiency 99.97% (US), 99.95% or H13 (ECE) – 99.95% *subject to EPA views*
- PM/PN dilution air background correction permitted (US & Jp), tunnel background permitted (ECE) – *permit up to specified maxima subject to EPA & CARB views*
- Dilution tunnel pressure variation at mixing point

# Open Issues

## Transfer, dilution & PM sampling

- Particle pre-classifier probe mounted or in-line alternatives, location of in-line pre-classifier – *clarify these are alternatives and need not be on filter holder*
- Double dilution permitted (Jp & US), not permitted (ECE)
- Dilution tunnel pre-conditioning
- Temperature of dilute gas should be controlled by dilution not cooling (US)
- Requirements to verify proportionality of PM sampling
- Dilution air temperature  $>15^{\circ}\text{C}$  (Jp),  $25^{\circ}\text{C} \pm 5^{\circ}\text{C}$  (US)
- Sampling pump location
- Single PM filter for whole test or filter per cycle phase – *separate filter per phase* NB  
DEPENDS ON DHC DECISIONS ON PHASE LENGTH v WEIGHTING FACTORS
- Back-up filters – *No back-up filters subject to CARB views on artefact correction*
- PM probe diameter
- Distance/residence time from PM probe to filter holder

## Open Issues

# Transfer, dilution & PM sampling

- Temperature at PM flow meter, constant or measured real-time for flow correction
- PM sampling shut-off valve position relative to filter holder. May need upstream valve for PHEV multiple cycle sampling to facilitate filter paper changes
- Minimum filter mass – *Delete?*
- Filter face velocity 20-80cm/s (ECE), 100-105 cm/s (US), 35-100cm/s (Jp)
- Filter paper type. Recommend or merely allow PTFE membrane. Velocity at which collection efficiency defined.

## Open Issues

### **Weighing chamber, microbalance & PM calibration**

- Tolerances for temperature, dew point temperature and relative humidity. Not all regions have requirements for all three parameters.
- Micro-balance precision tighter in US 1065 & J42 than for US 86 and R83. Various recommendations are given for micro-gram balance installation, static neutralisation & shielding. – *Consolidate guidance, review precision on a cost-benefit basis*
- Filter conditioning time US 1065 has no maximum time. Differences exist in max time permitted between removal of filter from stabilisation environment and emissions test; time allowed to return filter to stabilisation environment after the emissions test; and max conditioning time permitted. – *Specify static nullifier?*
- Sample filter handling various guidance provided.

## Open Issues

### **Weighing chamber, microbalance & PM calibration**

- Microbalance calibration weight requirements not specified (US part 86 & ECE), “E2” weights (Jp), NIST traceable within 0.1 % uncertainty (US part 1065). Only US part 1065 puts a specification on cal mass relative to unused filter mass.
- Microbalance calibration frequency discrepancy between zero/span requirements and annual cal requirements.
- Reference filter weighing, max time between sample and ref filter weighing after the emissions test vary. Acceptance criteria and actions if initial results out of tolerance vary. US part 86 requires ref filters to be covered at all times. US part 1065 recommends balance exercise and substitution weighing method.
- PM calculations equivalent except US 1065 generalised, not CVS specific.
- Specify detailed flow meter calibration procedure in WLTP – Yes?

# Open Issues

## PN

- PN measurement during DPF regen
  - Is VPR volatile removal efficiency sufficient
  - Is tetracontane appropriate for evaluating efficiency if used for regeneration measurements
- VPR minimum solid particle penetration efficiency (none at present ECE)
- Use average or second by second particle concentration reduction factor
- PNC calibration frequency (12 months)
- PNC calibration aerosol materials
- VPR particle concentration factor validation (3 monodisperse sizes)
- VPR filtration specification for dilution air and leak checks

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# Closed Issues

- Avoidance of condensation in dilution/sampling systems – *Lab Processes Sub-Group proposal has been reviewed and is acceptable*
- Permissible variation in static pressure at exhaust tailpipe – *Lab Processes Sub-Group proposal has been reviewed and is acceptable*
- Use of heat exchanger for PM sample flow control – *Not required*
- Dilution system residence time - *Lab Processes Sub-Group proposal has been reviewed and is acceptable*
- Molar based PM calculations - *Lab Processes Sub-Group proposal has been reviewed and is acceptable*



# Closed Issues

- Particle sampling system bend radii – *WLTP should specify radius of curvature should be “as large as possible”*
- Dilute exhaust gas thermocouple type – *Type need not be specified*
- PM probe location on CVS centreline – *Not necessary*
- Isokinetic sampling – *Outside of WLTP Phase 1 scope*
- PM filter holder design/stain area – *At least 1075mm<sup>2</sup> stain area*
- VPR volatile removal efficiency specification – *Retain current specification*
- PNC flow check 5% tolerance - *Retain*

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# Future Plans

## to May 2011

- Objectives
  - Gather (primarily existing) data to review and resolve Open Issues
  - Commence drafting of PM-PN elements of GTR text
- Working Method
  - small groups, meeting by web and telephone conference, will gather data and develop proposed solutions to Open Issues
  - Proposed solutions, along with rationales, will be circulated to the subgroup. The subgroup will decide whether to accept the proposed solution or refer back to the small group for further consideration
- Sub-group Meetings
  - 31<sup>st</sup> January
  - March
  - May

# Future Plans

## **June 2011**

- Objectives
  - Reach final agreement on all Open Issues
  - Continue drafting PM-PN elements of GTR text

## **July – September 2011**

- Objectives
  - Complete drafting of PM-PN elements of GTR text