

**Corrections to document ECE/TRANS/WP.29/GRPE/2010/7**

Introduction

The following corrections to ECE/TRANS/WP.29/GRPE/2010/7 are proposed :-

1. Clarification related to correcting or compensating the control of the Partial Flow Dilution System (PFDS) for the dilute exhaust sample extracted by the Particle Number Measurement System (PNMS) system. Correction of an error in the equations for compensating PFDS flow for particle number sample extraction is also required.
2. Modification related to the PNMS sample probe installation into the tunnel section of the PFDS

The proposed modifications are necessary to reflect actual current arrangements for connecting available PNMSs to PFDS systems without requiring special changes to either and to correct an error in the equations. The modifications requested do not affect the accuracy or performance specifications of either the PFDS or the PNMS stated within GRPE/2010/7 and reflect the arrangements used during the Golden Measurement Systems during the PMP Heavy Duty Inter Laboratory Correlation Exercise (HD-ILCE).

Item 1. Clarification related to correcting or compensating the control of the Partial Flow Dilution System (PFDS) for the dilute exhaust sample extracted by the Particle Number Measurement System (PNMS) system

Modifications shown in bold and strikethrough.

In Annex 4C, paragraph 4.2.2, amend the text to read:

“4.2.2 The instantaneous exhaust gas flow rate into the dilution system ( $q_{mp}$ ), used for controlling the proportionality of sampling, shall be corrected according to one of the following methods;

- (a) In the case where the extracted particle number sample flow is discarded, equation (83) in Annex 4B, paragraph 9.4.6.2 shall be replaced by the following:

$$q_{mp} = q_{mdew} - q_{mdw} + q_{ex}$$

$$\text{---} q_{mp} = q_{mdew} \text{---} q_{mdw} \text{---} q_{ex}$$

Where:

$q_{mp}$  = sample flow of exhaust gas into partial flow dilution system, kg/s

$q_{mdew}$  = diluted exhaust mass flow rate, kg/s

$q_{mdw}$  = dilution air mass flow rate, kg/s  
 $q_{ex}$  = particle number sample mass flow rate, kg/s

The  $q_{ex}$  signal sent to the partial flow system controller shall be accurate to within 0.1% of  $q_{mdew}$  at all times and should be sent with frequency of at least 1 Hz.

- (b) In the case where the extracted particle number sample flow is **fully or partially** discarded, but an equivalent flow is fed back to the dilution system upstream of the flow measurement device, equation (83) in Annex 4B, paragraph 9.4.6.2 shall be replaced by the following:

$$q_{mp} = q_{mdew} - q_{mdw} + q_{ex} - q_{sw}$$

~~$$q_{mp} = q_{mdew} - q_{mdw} - q_{ex} + q_{sw}$$~~

where:

$q_{mp}$  = sample flow of exhaust gas into partial flow dilution system, kg/s  
 $q_{mdew}$  = diluted exhaust mass flow rate, kg/s  
 $q_{mdw}$  = dilution air mass flow rate, kg/s  
 $q_{ex}$  = particle number sample mass flow rate, kg/s  
 $q_{sw}$  = mass flow rate fed back into dilution tunnel to compensate for particle number sample extraction, kg/s

The difference between  $q_{ex}$  and  $q_{sw}$  sent to the partial flow system controller shall be accurate to within 0.1% of  $q_{mdew}$  at all times. The signal (or signals) should be sent with frequency of at least 1 Hz”

#### Justification

The wording of GRPE/2010/7 currently permits two methods for correcting or compensating the PFDS for the extracted diluted exhaust supplied to the PNC :-

- Mathematical correction using a real time signal equivalent to the extracted flow of diluted exhaust by the PNMS
- Return of a flow to the PFDS that is equivalent to that extracted by the PNC

In some measurement systems, including the Golden Systems used in the PMP HD-ILCE, the flow returned to the PFDS upstream of the PFDS diluted flow measurement is made up of **two** sources :-

- the unused bypass flow of the PNMS
- plus a flow of HEPA filtered air that is equivalent to the diluted exhaust volume actually used by the PNMS

The combination of the two flows provides a correction of the extracted flow of diluted exhaust within the accuracy specifications described within GRPE/2010/7, but

the text requires modification to clarify that this combination of returned flows is permitted.

The equations in GRPE/2010/7 for compensating for particle number sample extraction are in error (conflicting with the conservation of mass). In the equations the particle number sample flow  $q_{ex}$  should be added and the returned equivalent flow  $q_{sw}$  subtracted.

## Item 2. Modification related to the PNC sample probe installation in PFDS

Modifications shown in bold.

In Annex 4C, Appendix 1, paragraph 1.2.1, amend the text to read:

“1.2.1. The particle sampling point shall be located within a dilution system.

The sampling probe tip or particle sampling point and particle transfer tube (PTT) together comprise the particle transfer system (PTS). The PTS conducts the sample from the dilution tunnel to the entrance of the VPR. The PTS shall meet the following conditions:

In the case of full flow dilution systems and partial flow dilution systems of the fractional sampling type (as described in Annex 4B, Appendix 3, section A.3.2.1) the sampling probe shall be installed near the tunnel centre line, 10 to 20 tunnel diameters downstream of the gas inlet, facing upstream into the tunnel gas flow with its axis at the tip parallel to that of the dilution tunnel. The sampling probe shall be positioned within the dilution tract so that the sample is taken from a homogeneous diluent/exhaust mixture.

In the case of partial flow dilution systems of the total sampling type (as described in Annex 4B, section A.3.2.1) the particle sampling point or sampling probe shall be located in the particulate transfer tube, upstream of the particulate filter holder, flow measurement device and any sample/bypass bifurcation point. The sampling point or sampling probe shall be positioned so that the sample is taken from a homogeneous diluent/exhaust mixture. ***The dimensions of the particle sampling probe should be sized not to interfere with the operation of the partial flow dilution system.***

Sample gas drawn through the PTS shall meet the following conditions:

***In the case of full flow dilution systems, it shall have a flow Reynolds number (Re) of < 1700;***

***In the case of partial flow dilution systems, it shall have a flow Reynolds number (Re) of <1700 in the PTT i.e. downstream of the sampling probe or point,***

It shall have a residence time in the PTS of  $\leq 3$  seconds.

Any other sampling configuration for the PTS for which equivalent particle penetration at 30 nm can be demonstrated will be considered acceptable.

The outlet tube (OT) conducting the diluted sample from the VPR to the inlet of the PNC shall have the following properties:

It shall have an internal diameter of  $\geq 4$ mm;

Sample Gas flow through the OT shall have a residence time of  $\leq 0.8$  seconds.

Any other sampling configuration for the OT for which equivalent particle penetration at 30 nm can be demonstrated will be considered acceptable.”

#### Justification

Annex 4C – Appendix 1, Paragraph 1.2.1 of GRPE/2010/7 defines the particle transfer system (PTS) of the PNMS as being comprised of the sampling probe tip and the particle transfer tube (PTT). Paragraph 1.2.1 then continues to specify that the flow within the PTS should be laminar (Reynolds Number  $< 1700$ ) and with a residence time within 3 seconds.

For some designs of PFDS, it is not practical to insert a sample probe of sufficient diameter to provide laminar flow without interfering with the design of the PFDS dilution tunnel itself. The proposed modification to the wording disappplies the requirement of laminar flow for the relatively short length of sampling probe within the PFDS. Since flow within the PFDS itself is turbulent this has no impact on measured particle number concentrations.

-----