ORGANISATION INTERNATIONALE DES CONSTRUCTEURS D'AUTOMOBILES
INTERNATIONAL ORGANIZATION OF MOTOR VEHICLE MANUFACTURERS

06 Aug 2007

GRPE Informal Group PMP

Volatile particle remover calibration procedure –draft rev.3
OICA detailed comments

General Comments on VPR calibration

- Whilst the document is named "Volatile Particle Remover Calibration Procedure", it only takes into account solid particles penetration and volatile particles removal efficiencies. There is absolutely no mention of how to manage calibration of the diluters.
- There is a mixing into the document of two different items :
  - Solid particles penetration and volatile particles removal efficiencies regarding verification of the general characteristics of a VPR.
  - Work that has been done during the GRPE-PMP inter laboratories exercise as an example
- The choice of 30 nm diameter particle seems to have a major impact on calibration difficulty (Need of a specific PNC in addition)
- Some devices are needed in addition to the measurement PNC:
  - 1 **calibrated** PNC able to measure 30 nm diameter particles
  - 1 solid particles generator
  - 1 C40 particles generator (may be the same as for solid particles)
  - 1 **calibrated** electrostatic classifier (optional)
  - 1 extra **calibrated** dilutor
  - 1 **calibrated** flow meter
  - 1 computer with two available acquisition ports (or two different computers)
- PNC used during PMP interlaboratory exercise did not fulfil the penetration criteria specified in AEA document.

Comments on PMP Golden system compliance with VPR calibration:

It has been noted that the Golden System used in the UN-GRPE PMP Inter-laboratory Correlation Exercise does not meet the criteria as stipulated in the Draft document for R83 and the document "Volatile Particle Remover". In R83 it states that the penetration of solid particles in the particle counting system shall be 50%, 55% and 60% or better at 30, 50, and 100 nm particle diameters. The calibration document is inconsistent – referring to 60,70 and 80% penetration efficiencies at the same particle sizes as mentioned above.

On page 57 figure 49 in the report "Particle Measurement Programme (PMP) Light-duty Inter-laboratory Correlation Exercise (ILCE-LD Final Report" (GRPE-PMP-18-2) it is evident that the Golden System does not pass the limit of 80% penetration at either 30, 50, or 80 nm. The penetration efficiency is as low as 30% at 30 nm diameter, and 40% at 50 nm diameter.

Two main conclusion can be drawn from this fact:

- A small number of commercial instruments which meet the criteria outlined in R83 are expected to be supplied during early 2008, however, these are on an individual basis – it is not clear when volume orders could be fulfilled. There continues to be a long lead time to purchase, install and commission any particle counting system.

- The measured number values from the tested vehicles in the Inter-laboratory Exercise are too low. Since the system measures only 30% of the particles the number stated in the report ought to be increased by at least a factor of three. This ought to be considered if any limit values are discussed.

Specific Comments

2 VPR Overview

The description given in this chapter refers to a specific VPR design.
Because, as for any other sampling or measurement device, it could be achievable to reach the efficiency targets, functional specifications should be written first.

- Solid particles penetration efficiency
- Volatile particles removal efficiency
- Total dilution range

The specific design should be given only as an example.

Calibration Methods

OICA supports the principle outlined by METAS which is to take a systems approach and develop an 'overall concentration reduction factor' using a particulate source. The METAS proposal needs to be further developed but presents a preferred approach. OICA does not support the validation of every individual component in the VPR – this is more useful from a diagnostic perspective in case there is a fault. OICA believes the METAS approach could be taken one step further to introduce an aerosol into the tunnel rather than post-cyclone as METAS currently proposes.

OICA is concerned that the requirements are that the Technical Services are to conduct the calibration. The usual practice is for Manufacturers to perform the chassis rolls and measurement equipment calibrations in-house, with the procedures being validated by the Technical Services. This allows flexibility with timing of the calibrations to fit with the work schedule in the most time and cost effective manner. Concerns regard whether the Technical Services will have sufficient expertise to conduct the calibrations themselves, whether there will be sufficient number of calibration experts to support the necessary scheduling for all Auto Makers as well as the substantial costs of paying them to conduct the lengthy procedures.

As a fundamental principle, OICA believes that the calibration equipment should be able to come to the test cell, rather than the measurement equipment having to be taken to the calibration equipment.

3.1 Calibration Criteria

The dilution ratio calibration needs to be included as this is the function of the VPR that may mostly be affected by use of the VPR (due to particle deposition in the dilution units). The method for calibrating the gas diluters as described in the PMP report is quite inaccurate for the reasons below. This further enhances the fact that either an overall calibration is needed similar to the propane injection test for gaseous exhaust measurements, or at least a detailed and reasonable calibration routine describing the calibration of the diluters.

The calibration gas used for the calibration has been changed to NO. Errors introduced by the NOx converter must be considered.

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3.1.1 Solid particle penetration efficiency

Particle concentration shall be in the range (1,000 – 10,000 particles.cm^{-3}) (cf. 3.1.1 and 3.2.1) upstream the VPR.
The minimum dilution ratio to be used with the model of VPR described is around 1:150 (1:15 followed by 1:11 for minimization of thermophoretic losses)
So the maximum particles concentration to be measured by the PNC in these calibration conditions is around 60 down to 6 particles.cm^{-3}. OICA supports the error analysis activity proposed in the PMP roadmap.
The range less than 2000 particles/ccm is not directly calibrated.
The minimum penetration efficiency of 60% in PMP is not achieved with the golden System.
Temperature and flow conditions should be defined otherwise this contributes to measurement failures. Potential errors have been reduced, but the variation can still be quite high – for example, Horiba penetration efficiency at 90% and Matter at 60% for 30nm particles – this could lead to significant measurement differences.

3.2 Calibration Aerosol

3.2.1 Solid particles

The document presents sodium chloride as a good solid particles source.
As the solid particles PMP focus on are mainly carbonaceous, it needs to be verified that sodium chloride particles behave the same as carbonaceous particles inside the VPR before this procedure could be accepted.
How can it be verified that the response curve for different sizes is stable?
What are the key influences ?

4.3 Calculation of penetration efficiency of solid particles

The calculation should be done with a particulate source for establishing the dilution factors. A gas dilution factor is not representative. The diluters should be considered as part of a system, not evaluated separately. There may be system interactions which are not taken into account by the individual component checks.

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