Transmitted by the expert from OICA

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ACEA position paper

Why the PMP laboratory verification study is not a sufficient basis for establishing Particle Number limit values

Background:
The most recent test programme within the PMP activity is the light duty laboratory verification test programme. As part of the final report on the laboratory verification, it is anticipated that there will be recommendations for a new particle number measurement method and future particle number limit values[1], although the latter was not in the original scope of the test programme. There are already provisions within the drafting of the European Light Duty emission standards to incorporate Particle Number under stabilised (accumulation mode) running conditions in addition to Particulate Matter mass measurement.

Issue:
The laboratory verification programme is not sufficient to allow robust limit value setting for particle number measurement to be made on a legal type approval basis since;

1. The full range of test variability (calibration, measurement, set up, interpretation, vehicles, laboratory) has not been quantified.
2. Very few diesel cars with particle filters or lean burn direct injection gasoline vehicles were tested. The range of vehicles was rather limited and did not represent the full range of engine sizes and / or vehicle size (from sub-B to D or E class cars, or vans). It was also not possible to test diesel vans equipped with DPF as there were none available on the market at the time of the test programme.

Recommendation:
As a first phase, the PMP activity should initiate a full round robin test; i.e. single vehicle tested in different laboratories where instrumentation is set up and calibrated according to the internal procedure of the laboratory without the presence of a golden engineer or a golden instrument.

A second phase would include testing with a significantly increased number of vehicles before making recommendations on appropriate particle number limit values. The issue of regeneration needs to be adequately addressed and incorporated.

Justification for Round Robin test:
The PMP interlab comparison used a golden system, golden vehicle and a golden engineer in order to ensure that a standard setup was used. This approach very clearly establishes the test to test repeatability of the method, but not the general reproducibility in terms of the setup, different equipment or vehicles. It is evident from the laboratory verification study that whilst the Golden Engineer was available, that the setup and use of the equipment worked effectively, however, in the first laboratory where he could not be present, there were already some issues with the set up and handling of the CPC instrument.

[1] verbal statements from the chairman during the 16th PMP and PMP session 16, document 5 (meeting minutes)

In other industries, such as pharmaceutics (drug manufacture / analysis methods), fuel (new analytical procedures – see attachment 1 for CEC recommended procedures for development of a new test method) and cement manufacture (particle sizing), a full round-robin study is carried out before a new standardised measurement method is introduced. Precedent for this in the automotive emission field in Europe was in the selection of laboratories for the EPEFE study as part of the first Auto-Oil activity and also when the cycle changed to delete the initial unmeasured 40 second idle.

The absolute calibration requirements are not yet established, although some progress has been made. ISO has now adopted calibration of particle number measurement systems as a new work item, therefore, it is anticipated that it would be about 2 years before a final calibration standard is available. The proposed calibration method duration is not compatible with certification laboratory activities (linked to the number of tests).

The interlaboratory comparison does not replicate the conditions under which industry would have to apply the measurement method. Industry development and certification laboratories typically have to complete 6 tests (and preconditionings) per 8 hour shift, with normally 2 shifts per day and working 5 days / week. The instrumentation has not been challenged under these virtually continuous operation conditions.

Further work required before PN (particle number) limit values can be determined:
OICA has identified a number of issues which need to be resolved before PN limit values can be established. These are as follows:

1. Vehicle to Vehicle variability for CoP / In-Service Compliance:
   There has been no work done on variability between multiple vehicles of the same type (ie emission version). This is particularly important for Conformity of Production (COP) and / or in-service compliance testing. Both of these use statistical assessment methods to determine whether the sample of vehicles passes/fails or whether more vehicles are required to be tested. The in-service compliance requirements today also have an outlier failure criterion – again, a full understanding of the natural variability of diesel vehicles and their particulate filters is necessary before appropriate limit values can be established and enforced.

2. Clean particle filter performance at CoP:
   There is also a clear lack of data available on the performance of new, clean diesel particle filters (conformity of production testing) which might be expected to have higher than normal particle number emissions as the filter is completely clean and there may be some oil on the inside of the exhaust system from the manufacturing process. These vehicles will be sold to customers as new vehicle and therefore it is extremely expensive to put mileage on these vehicles as there is a risk that the customer will not accept a 'used' vehicle. Whilst this could be addressed using the evolution co-efficient, it might be that the co-efficient appears very high and could be questioned by the Technical Services.

3. Assigned Deterioration Factors:
   Deterioration factors for PN need to be developed for certification in order to be in line with the other pollutant (gaseous and PM mass) procedures. If the PN measurement is required at conformity of production, this would also require application of an assigned deterioration factor. To date, no significantly robust study has been carried out on this aspect.

4. Regeneration Measurements:
   As mentioned above, the PMP study has not addressed the DPF (diesel particle filter) regeneration requirements in any significant depth. The current text of ECE-83.05 contains requirements to perform a set of tests at various conditions in order to calculate the 'Ki' regeneration factor, which

is then applied to the measured results obtained from testing when the DPF is in accumulation mode (also called stabilised running mode). It is clear that this part of the procedure could not be applied at the for PN measurements. The PN measurement method has not been assessed for robustness to emissions during regeneration. Tests under these conditions require resetting of the sample dilution and control characteristics of the volatile particle remover in order to ensure the particle concentration remains in the correct range for the CPC.

5. PN system calibration procedure:
   Finally, before limit values can be established, the robustness of the calibration procedure has to be established in order to fully quantify the errors and uncertainties arising from this procedure. In this case, the calibration is not only restricted to the CPC, but the system calibration including the VPR (volatile particle remover) must be considered.

6. Air Quality / Impact Assessment:
   Before limit values are established, there is a clear requirement to perform an air quality / impact assessment. There is seriously limited data on particle number exposure (personal and/or epidemiological studies) and no air quality national emission ceilings – therefore, since it is proposed to establish the PN limit to be equivalent to the PM mass limit, there is no benefit from moving to double testing requirements, particularly since it will not be possible to meet the proposed Euro-5 diesel PM mass limits without fitment of a diesel particle filter.

   A recent equivalent case highlights the need for comprehensive test data before limit values on the number of particles emitted can be established. When GRB endorsed a new test procedure for vehicle drive-by noise measurements to replace the current one and opened discussions on the corresponding limit values, the Commission rejected the recommendations of an independent study based on over 300 vehicles (260 cars & light trucks and 50 heavy trucks) as not convincing enough and is proposing that double testing is carried out at Type Approval for all vehicles certified on noise measurement during a two year period before limit values for the new test procedure can be legislated.

7. Vehicle to Vehicle variability for COP / In-Service Compliance:
   Lead time to Euro-5 is now very short. It has been said that the PMP system has been well known for some time now as the final report is being drafted. However, it could not be known in advance that the candidate CPC system would be recommended without significant modification.

8. Vehicle to Vehicle variability for COP / In-Service Compliance:
   The motivation to introduce a second particle measurement method in addition to the gravimetric method remains questionable, particularly when both method have similar coefficients of variation (COV) which is the standard deviation divided by the mean of the measurements, and when it is said that the particle number limit value will be established to be equivalent to the limit value for the gravimetric method.

Summary:
For the above reasons, OICA continues to have major concerns with the apparent desire of some regulators to recommend particle number limit values at this time. OICA recommends that a real round-robin test programme is established by the PMP group to address a number of the issues highlighted in this document.

ATTACHMENT 1:

Information from CEC (Co-Ordinating European Council, for development of performance tests for transportation fuels, lubricants and other fluids).

3. Types of Groups

3.1. Test Development Group (TDG)

Responsible for taking a proposed new test procedure from the concept stage to publication of a CEC Test Method. The work is usually in two phases. Phase 1 takes the work to the stage of acceptable repeatability and discrimination normally in a single laboratory leading to production of a draft Test Method. Phase 2 requires reproducibility to be established in multiple laboratories and a test method to be published.

CEC Constitution – Operating Guidelines – Issue 3 - April 2006

Guideline 9

The CEC Test Method Development Process

No.	Activity	Who	Action
1.	Request a new test method	Anybody	Submit request using appropriate template-see Guideline 2, Appendix 1.
2.	Review request.	Board	Confirm that need is agreed.
3.	Identify sponsors	Board	See Guideline 13. If group is voluntary go straight to 7
4.	Choose test laboratory	Board	In case of tender, see Guideline 10.
5	Confirm sponsors and obtain letters of intent	Secretariat	See Guideline 13.
6	Form TDG	Board	Convene first meeting. See Guideline 11
7.	Develop phase 1 of the test	TDG	Lab(s) conducts test work. TDG meets regularly to review progress. See Guideline 11.
8.	Complete phase 1 of test development	TDG.	Demonstrate satisfactory repeatability and discrimination. Write up draft test method.
9.	Check and issue draft test method	Secretariat	See Guideline 15.
10.	Sign off Phase 1	Board	Confirm that test meets Contract requirements (if applicable) and CEC standards.
11.	Identify sponsors and funding for Phase 2.	Board	Commission phase 2. See Guideline 13
12.	Develop phase 2 of the test in multiple labs.	TDG	See Procedure 1 (CEC Statistics Manual)
13.	Complete test development in multiple laboratories.	TDG	Meet reproducibility targets. Modify test method if necessary and send to Secretariat for publication.
14.	Sign off TDG and Phase 2	Board with help from SDG	Endorse acceptable reproducibility and accept method for publication.
15.	Identify sponsors and funding for surveillance.	Board	Set up SG and nominate officers.
16.	Maintain test quality.	SG	Run ongoing Round-Robin tests / Test Monitoring. See Procedure 1, Statistics Manual.

Note: At any time during the test development process:

- If consensus cannot be reached, the minority view must be conveyed to the Management Board.
- Changes to tests that have significant cost implications must be referred to the Management Board