
Title: Emerging requirements for measuring pollutants from automotive exhaust emissions

Abstract

Current measurements of particle emissions from automotive exhausts for particle sizes down to 20 nm lack traceability while mercury emitted by petrol combustion and the platinum group elements released from catalytic converters have become an issue of increasing environmental concern. Reliable metrological approaches for the measurement of such pollutants are currently lacking. In the case of mercury and platinum group elements this research is urgently needed to accurately estimate their contribution to the European pollution inventory for establishing regulatory limits regarding their release and/or presence in the environment. This Topic focuses on the development of European metrological expertise to improve the traceability and accuracy of measurements related to these pollutants.

Conformity with the Work Programme

This Call for JRP's conforms to the EMRP 2008, section on "Grand Challenges" related to *Environment* on page 24.

Keywords

Vehicle exhaust, particulate matter (PM), traceable particle related quantities, mercury, platinum group elements (PGE), emission, fuels, traceable mercury vapour measurement, mercury isotope ratio measurements, isotope dilution mass spectrometry.

Background to the Metrological Challenges

Automotive vehicles are a major source of environmental pollution particularly the primary atmospheric contaminants, such as CO, NO_x, SO_x and hydrocarbons. Petrol combustion also causes pollution with a number of inorganic elements, such as mercury (Hg), which is naturally occurring in fossil fuels while Platinum Group Elements (PGE) can be present from catalytic converters, and sub-micron particles are present in exhausts from the combustion of Diesel fuel. In order to assess the risks from these additional pollutants and introduce appropriate regulation, the ability to make practical and traceable measurements is required.

Even though the amount of mercury present in petrol is relatively low (at trace and ultra-trace level), the sizeable quantity of petrol used in Europe and worldwide may result in a relatively large emission of this pollutant into the environment. Mercury is very toxic to the environment even at low levels as it is bio-accumulated in the food chain.

To comply with the European Standard and Directive on ambient air quality, all new cars are fitted with a catalytic converter to reduce hazardous emissions of CO, HC and NO_x to below the legislated level. In recent years evidence has emerged that these converters act as an 'indirect' source of pollution with Pt, Pd and Rh (often referred to as Platinum Group Elements, PGE), which are their main components. While it was initially assumed that the (human) health risks associated with the environmental exposure to PGE were minimal, more recent studies on their toxicity, environmental bioavailability and concentrations in biologically relevant media indicate that (environmental) exposures to these metals pose a health threat, especially at a chronic, sub-clinical level.

For particles, some instruments have become available which measure the total particle mass per volume by light scattering. These instruments are more sensitive than the instruments measuring the opacity the exhaust from a vehicle, which are sometimes used for regular inspection, and can monitor

the continued efficiency of an installed particle filter. However before these new instruments can be used for regulatory purposes the correlation between the total particle mass per volume measured with a modern light scattering instrument and the opacity must be determined. The first quantitative regulation for particulates from diesel vehicles will be introduced in 2011 (Euro 5 and 6) [1] and will require traceable measurements.

Scientific and Technological Objectives

Proposers should address the objectives stated below, which are based on the PRT submissions. Proposers may identify amendments to the objectives or choose to address a subset of them, in order to maximise the overall impact, or address budgetary or scientific / technical constraints, but the reasons for this should be clearly stated in the JRP-protocol.

Specific objectives for this topic are:

- 1) the development of methods and standards for traceable measurements of mercury and platinum-group elements (PGE) in motor-vehicle exhaust emissions.
- 2) the development of methods and standards for traceable characterisation of particle emissions from motor-vehicle exhaust for particle sizes down to 20 nm. Practical application shall be demonstrated.
- 3) The development of traceable primary standards for measurements of mercury in vapour phase and primary generation methods to obtain mercury gas standards.

The focus for these objectives shall be on particles, Hg and PGE arising from car emissions under usual operating conditions. However, other pollutants, such as arising from the use of biofuels and blends may be covered in addition, if significant. The third objective may include wider application than from car emissions only.

Proposers shall give priority to work that meets documented stakeholder needs and may include measures to facilitate the development of European standards and Directives.

Proposers should establish the current state of the art, and explain how their proposed project goes beyond this.

Potential Impact

Proposals must demonstrate adequate and appropriate participation/links to the “end user” community. This may be through the inclusion of unfunded JRP partners or collaborators, or by including links to industrial/policy advisory committees, standards committees or other bodies. Evidence of support from the “end user” community (eg letters of support) is encouraged.

Where a European Directive is referenced in the proposal, the relevant paragraphs of the Directive identifying the need for the project should be quoted and referenced. It is not sufficient to quote the entire Directive per se as the rationale for the metrology need. Proposals must also clearly link the identified need in the Directive with the expected outputs from the project.

You should also detail other Impacts of your proposed JRP as detailed in the document “Guidance for writing a JRP”

You should detail how your JRP results are going to:

- feed into the development of urgent standards through appropriate standards bodies
- transfer knowledge to the automotive testing sector.

You should also detail how your approach to realising the objectives will further the aim of the EMRP to develop a coherent approach at the European level in the field of metrology. Specifically the opportunities for:

- improvement of the efficiency of use of available resources to better meet metrological needs and to assure the traceability of national standards
- the metrology capacity of Member States and countries associated with the Seventh Framework Programme whose metrology programmes are at an early stage of development to be increased

- outside researchers & research organisations other than NMIs and DIs to be involved in the work

Time-scale

The project should be of 3 years duration.

Additional information

The references were provided by PRT submitters; proposers should therefore establish the relevance of any references.

- [1] COMMISSION REGULATION (EC) No 692/2008 of 18 July 2008
- [2] Directive 2004/107/EC of the European parliament of the council of 15 December 2004 relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air