

Title: Metrology for the quantification of non-exhaust emissions for improved product formulation and Euro 7 compliance

Abstract

Non-exhaust emissions (NEE) from vehicle brakes, tyres and road surfaces are the dominant source of particle emissions from road traffic. As part of Europe's drive towards net zero, traffic is moving away from internal combustion engines, and hence NEE are becoming of increased concern in urban areas. The new Euro 7 legislation will for the first-time bring emission limits for all motor vehicles, i.e., cars, vans, buses and lorries under a single set of rules. The Euro 7 standards will also broaden the range of driving conditions that are covered by on-road emissions tests and contain limits for particle emissions from brakes and tyre abrasion. However, to support Euro 7 legislation SI-traceable methods and validated reference samples are needed for NEE particle measurements. Euro 7 standards also need supporting with recommended design criteria for NEE sampling devices and an assessment of methods for on-road sampling in different ambient conditions.

Keywords

Non-exhaust emissions, tyre wear, brake wear, road surface, road dust, particle composition, source apportionment, product formulation, chemical analysis

Background to the Metrological Challenges

In some European countries, more than 50 % of current particle emissions from road vehicles are from NEE. NEE emissions are becoming of such concern that, for the first time, tyre and brake wear (i.e. brake particle emission limits and tyre abrasion limits) will be included in the EC's new Euro 7 legislation. However, to assess conformity to the new Euro 7 limits new SI-traceable methods are needed for the accurate and reliable sampling of NEE emitted from tyres and brakes.

With the implementation of the new Euro 7 limits on tyre abrasion and brake particle emissions, it is hoped that accurate measurements of NEE can support industry in the production and formulation of brakes, tyres and road surfaces that contain less harmful constituents and shed fewer harmful particles. There are currently three main approaches to mitigating NEE and their harmful effects: (1) reducing the hazardous nature of tyres, brakes and road surfaces, (2) reducing the number of particles emitted at source, e.g. by designing low-shedding road surfaces, and (3) by collecting the particles as they are released as a vehicle drives. Thus, robust and accurate methods to assess the effectiveness of these approaches are needed.

Although exhaust emissions are generally well characterised, the contribution, composition and impact of NEE particles is currently poorly characterised in different urban environments. Thus, analytical methods and data curation methods such as source apportionment need to be developed and standardised to accurately quantify NEE sources in different environments. Further to this, there is a lack of knowledge for how much organic matter is emitted from different NEE sources, as well as the elemental composition in NEE sources (e.g. Zn for tyres, Cu, Ba, Sb and Sn for brakes, Fe, Cu and Si for road surfaces).

Currently, the physico-chemical properties of particulate matter from NEE sources cannot be traceably determined due to the lack of suitable reference materials and the complexity of the emissions. This includes differences in the chemistry (elemental and organic composition) between bulk materials, the fine particle fraction and the ultrafine fraction. Therefore, new size-segregated reference materials that are representative for all three particle classes (brake, tyre, road surface) are needed. Such reference materials must be suitable for laboratory, on-road and road-side measurements so that they can be used for product quality control as well as for calibrating analytical instruments for accredited laboratories.

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 protocol.

The JRP shall focus on the traceable measurement and characterisation of NEE for improved product formulation and Euro 7 compliance.

The specific objectives are

1. To accurately determine the chemical composition and physical properties of particles emitted from tyres, brakes and road surfaces. This will include robust uncertainty evaluation using SI- traceable, matrix-specific analysis methods in order to determine the organic and elemental composition of NEE.
2. Using the methods developed in Objective 1, to develop and characterise at least three sets of matrix-specific and size-segregated reference samples of (i) tyre wear, (ii) brake wear, and (iii) road surface wear. The reference samples must be suitable for use as calibration samples and for method validation for testing laboratories.
3. To define recommended design criteria for tyre, brake and road surface sampling devices for use with laboratory test benches. This will include the analysis of representative samples for measurements of (i) particle number concentration, (ii) particle mass concentration and (iii) particle size distribution. In addition, to assess the performance of on-road tyre and brake sampling devices for measuring (i) particle number concentration, (ii) particle mass concentration and (iii) particle size distribution and identify the differences between laboratory, on-road and road-side measurements.
4. To assess the efficiency of methods for on-road sampling of NEE to collect particles from a variety of sources under different climatic conditions (temperature and humidity) and vehicle speeds. This will be done using the (i) methods from Objective 1, (ii) reference samples from Objective 2 and (iii) the sampling devices from Objective 3. In addition, to chemically analyse the particles sampled by these devices, and compare them to source tyre, brake and road surfaces using data modelling and source apportionment techniques.
5. To facilitate the take up of the technology and measurement infrastructure developed in the project by the measurement supply chain, standards developing organisations (CEN/TC 264 Air Quality, CEN/TC 301 Road Vehicles, ISO/TC 201 Surface Chemical Analysis), metrology community (EMN Climate and Ocean Observation, EMN Pollution Monitoring) and end users (e.g. AQUILA, The European Tyre and Rubber Manufacturer's Association (ETRMA), The European Tyre and Rim Technical Organisation (ETRTO)).

These objectives will require large-scale approaches that are beyond the capabilities of single National Metrology Institutes and Designated Institutes. Proposers shall give priority to work that meets documented industrial needs and include measures to support transfer into industry by cooperation and by standardisation. An active involvement of industrial stakeholders is expected in order to align the project with their needs – both through project steering boards and participation in the research activities.

Proposers should establish the current state of the art and explain how their proposed project goes beyond this. In particular, proposers should outline the achievements of the EMPIR projects 16ENV07 AEROMET, 19ENV08 AEROMET II and how their proposal will build on those.

EURAMET expects the average EU Contribution for the selected JRPs in this TP to be 1.9 M€ and has defined an upper limit of 2.3 M€ for this project.

EURAMET also expects the EU Contribution to the external funded beneficiaries to not exceed 35 % of the total EU Contribution across all selected projects in this TP.

Any industrial beneficiaries that will receive significant benefit from the results of the proposed project are expected to be beneficiaries without receiving funding or associated partners.

Potential Impact

Proposals must demonstrate adequate and appropriate participation/links to the 'end user' community, describing how the project partners will engage with relevant communities during the project to facilitate knowledge transfer and accelerate the uptake of project outputs. Evidence of support from the "end user" community (e.g. letters of support) is also encouraged.

You should detail how your JRP results are going to:

- Address the SRT objectives and deliver solutions to the documented needs,
- Feed into the development of urgent documentary standards through appropriate standards bodies,
- Facilitate improved industrial capability or improved quality of life for European citizens in terms of personal health, protection of the environment and the climate, or energy security,
- Transfer knowledge to the environmental and transport sectors.

You should detail other impacts of your proposed JRP as specified in the document “Guide 4: Writing Joint Research Projects (JRPs)”

You should also detail how your approach to realising the objectives will further the aim of the Partnership to develop a coherent approach at the European level in the field of metrology and include the best available contributions from across the metrology community. 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 EURAMET Member States whose metrology programmes are at an early stage of development to be increased
- organisations other than NMIs and DIs to be involved in the work.

Time-scale

The project should be of up to 3 years duration.