

Title: Metrology to foster the transition to sustainable and low-emission transport

Abstract

The EU's goal to reduce the transport industry's carbon emissions by 90 % by 2050 requires a rapid and smooth use of sustainable fuels. The first practical step for the decarbonization process is to use fuel blends by retrofitting the existing engines in shipping and aviation industry. This will require i) reliable characterisation and monitoring of blend's chemical and physical properties, ii) the traceable measurement of low flow rates for fluid systems, and iii) for flowmeters on ships procedures and protocols to evaluate mechanical and hydraulic vibration. Submitted proposals should establish the necessary metrology to support the smooth uptake of alternative and synthetic fuels in the aviation and shipping industries by addressing quality, safety, and performance metrics required when alternative fuels are used and to provide the results to end users (flowmeter manufacturers, aviation and shipping industry).

Keywords

Sustainable and efficient transport, low emission transport, fuel properties, fuel consumption monitoring, retrofitting, next-generation aviation fuels, next-generation marine fuels, cold flow characteristics, flowmeters, flowmeters on ships

Background to the Metrological Challenges

The European Green Deal set the ambitious target to reduce emissions from transport by 90 % by 2050 compared to 1990 [1]. The ReFuelEU Aviation initiative launched in 2021 includes an obligation for airlines to uplift aviation fuel blended with sustainable aviation fuels (SAF) when departing from EU airports [2]. Aviation fuel suppliers will have to blend increasing amounts of SAF with kerosene, starting with a minimum blend of 2 % in 2025 and rising to 63 % in 2050. From 2030, 1.2 % of the overall fuel must also be synthetic, rising to 35 % in 2050. This framework requires a fuel consumption monitoring programme, increasing the importance of reliable fuel data usage for reporting purposes to the authority. The Commission proposal defines SAF as 'drop-in' aviation fuels (fuels substitutable for conventional aviation fuel) that are: i) either synthetic aviation fuels, ii) advanced biofuels produced from feedstock such as agricultural or forestry residues, algae and bio-waste, or iii) biofuels produced from certain other feedstocks with 'high sustainability potential' (e.g., used cooking oil, certain animal fats) that meet the sustainability and GHG emissions criteria. Operators will need to adapt to these changes. On the other hand, the Carbon Intensity Indicator (CII) introduced in 2023 involves recording the actual CO₂ emissions for ships in service with 5,000 gross tonnage (GT) or more. The CII is significantly influenced by the type of fuel used, the ship's efficiency, and ship's operating parameters so transition actions are starting to take place in the ship industry. Regarding the ship industry, one of the measures to reduce CO₂ is the use of blends of conventional and green fuels which will affect the existing fleet to retrofit the ship engines to run on blended or dual fuels.

Nevertheless, some fuels do not mix adequately (e.g., methanol and diesel) and it requires some metrological research regarding physical and chemical properties measurements to assess blending control, energy density, viscosity, and density measurements. Furthermore, flow measurements play a crucial role in operation monitoring and engine development as well as consumption determination. It is common practice to calibrate a master meter with a primary standard and then use this standard to calibrate the flowmeters on the test benches deployed in the various applications. Experience shows that overcorrection and under correction are common, and depending on the type of the meter, mass and volume output data can differ

significantly. For example, to enable a retrofitting of the existing ship fleet the accurate measurement of low flow rates below 1 l/h is required as this is the only way to parametrise the engine control unit (ECU) accordingly. Furthermore, a traceable and reliable calibration of flowmeters at low flow rates (from 0.01 l/h to 1 l/h) is needed and it will contribute to the reliable detection of leaks in fluid systems.

Key properties of aviation fuels containing synthesized hydrocarbons are specified in ASTM D7566 (Standard Specification for Aviation Turbine Fuel Containing Synthesized Hydrocarbons). These requirements must be supplemented and extended, and new test methods and understanding of properties values must be produced to facilitate online measurements for dynamic blending. The proposal will develop metrological systems to facilitate the smooth uptake of alternative and synthetic fuels in aviation and shipping industries. This will be done by addressing quality, safety, and performance metrics required when alternative and sustainable feedstocks are blended with petroleum derived fuels. The metrological systems will encompass laboratory based testing of fuels and flowmeters and in-situ measurement of properties during fuel blending, loading, and on-board. The results will provide the opportunity to NMIs/DIs to expand their capabilities in the measurement of low flow rates, and to provide enough information to standards developing organisations to update or create new standards (e.g., ISO, CEN, ASTM International).

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 proposal shall focus on metrology research necessary to support the smooth uptake of alternative and synthetic fuels in the aviation and shipping industries by addressing quality, safety, and performance metrics required when alternative and sustainable feedstocks are blended with petroleum-derived fuels as drop-in replacements for the latter.

The specific objectives are

1. To establish traceable and validated methods for the determination and control of key physical and chemical properties of next-generation aviation fuels. The methods will target: i) blends of sustainable aviation fuels (SAF) with petroleum kerosene, and ii) important properties such as cold flow characteristics (e.g., freezing point, low-temperature viscosity, density), calorific value, and chemical composition (e.g., specifically, aromatic content). The established methods will be focused on the flow properties of next-generation aviation fuels in the temperature range from -50 °C up to 50 °C and pressures up to 150 bar.
2. To establish traceable and validated methods for the determination and control of key physical and chemical properties of next-generation marine fuels. The methods will target: i) blends of alternative and synthetic fuels with petroleum-derived bunker fuels, and ii) important properties such as mixing, viscosity, density, calorific value, and vapour pressure. The established methods will consider flow properties of next-generation marine fuels in the temperature range between 15 °C and 75 °C and pressures up to 300 bar.
3. To provide metrological infrastructure to calibrate flowmeters most commonly used in aviation and shipping industries ranging from 1 l/h down to 10 ml/h with fuels or fuel substitutes. The targeted measurement uncertainties are between 0.5 % and 5 % depending on the flow rate and test fluid (e.g., fuels such as SAF, alternative and synthetic fuels).
4. To provide a procedure and protocol to evaluate the performance of flowmeters on ships for mechanical and hydraulic vibration. To use as input the 3D vibration measurements at flowmeter installation sites on ships. At least three ship sizes or types will be considered.
5. To facilitate the take up of the technology and measurement infrastructure developed in the proposal by the measurement supply chain (calibration laboratories), standards developing organisations (ISO, CEN, ASTM International), and end users (e.g., flowmeter manufacturers, aviation and shipping industry).

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 needs, in particular those supporting the European Green Deal. To enhance the impact of the research, the involvement of the appropriate user community such as industry, standardisation and regulatory bodies is strongly recommended, both prior to and during methodology development.

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 project(s) 20IND13 SAFEST and 18HLT08 MEDDII and how their proposal will build on those.

Proposers should note that the programme funds the activity of researchers to develop the capability, not the required infrastructure and capital equipment, which must be provided from other sources.

EURAMET expects the average EU Contribution for the selected JRPs in this TP to be 2.8 M€ and has defined an upper limit of 3.5 M€ for this proposal.

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 proposal's 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 flowmeter manufacturing, aviation and shipping industry.

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 Metrology 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.

Timescale

The project should be of up to 3 years duration.