European Partnership on Metrology
Call 2023 –Fundamental Metrology, Industry, Normative and Research Potential

Selected Research Topic number: **SRT-n03**
Version: 1.0

Title: Metrology for reliable liquefied energy gases measurement

Abstract

The EU aims to be climate-neutral by 2050, in line with the European Green Deal and the Paris Agreement COP21. The hydrogen strategy for a climate-neutral Europe identifies liquefied hydrogen (LH_2) and liquefied ammonia as significant for energy transport. Therefore, reliable measurements of liquefied energy gases are needed to facilitate the EU's energy transition. Further to this, the European Green Deal identifies (liquid) carbon storage as a priority, however currently liquefied carbon dioxide (LCO_2) measurements lack traceability. To support the adoption of liquefied gas measurement systems into documentary standards metrologically validated methods are needed for their custody transfer. In addition, measurement campaigns are needed to determine the accuracy of liquefied energy gas measuring equipment under process conditions, as well as reference datasets for liquefied energy gas flow, composition, and temperature measurement.

Keywords

liquefied energy gases, LNG, LH_2, LCO_2, liquid ammonia, flow metering, composition, temperature

Background to the Metrological Challenges

Liquefied natural gas (LNG) now accounts for about 25 % of EU's gas demand and a conservative estimate is that EU's financial risk in LNG imports is 700 million € per year. Given this, it is unsurprising that Hydrogen Europe and Hydrogen Europe Research have communicated an urgent need for validated flow meters, temperature sensors, and sampling methods in the field of LH_2 transportation. These are needed to guarantee the safety, quality, reliability and robustness of measurements in support of custody transfer and hydrogen measurement.

The previous project 20IND11 MetHyInfra, developed traceability for LH_2 mass flow measurements with an uncertainty of 0.3 % - 0.8 %. Other systems in industry have claimed a mass flow measurement uncertainty of approx. 0.25 % and prototype temperature sensors have claimed to measure LH_2 temperatures at -253 °C with an accuracy of ±0.05 °C. But in order for these industrial prototypes and systems to be accepted they need to be metrologically validated in process conditions (i.e. applicable to LH_2). Existing calibration infrastructures can only provide partial traceability with basic calibrations typically performed in ambient gas or liquid conditions. However, in LH_2 process conditions new uncertainty sources arise, and thus the accuracy of the measuring equipment (for flow, composition, and temperature) needs to be verified in such conditions.

The EMN Energy Gases has identified the need for reliable traceability for LNG flow rate measurement for 200 m^3/h – 1000 m^3/h and above, and robust reference standards for LNG and liquefied biomethane flow and composition standards. The previous projects ENG03 LNG, ENG60 LNGII and 16ENG09 LNGIII developed a metrological infrastructure for LNG custody transfer, and validated, SI-traceable LNG flow and LNG composition calibration equipment. However, to build confidence in these systems, and to enable their adoption into documentary standards, reference datasets are needed.

New flow and composition calibration facilities are currently under development for LCO_2, (which can reach -40 °C). But these new calibration facilities also need to be supported by validated and accurate measurement equipment. Further to this, traceability for flow, composition, and impurity measurements does not yet existing.

Ammonia is recognised as a possible synthetic fuel or means of energy transport in the hydrogen strategy for a climate-neutral Europe. Indeed, in the future LNG terminals maybe adapted for transporting liquid ammonia. With the expected role of ammonia in the EU's energy transition, a metrological framework and SI- traceable measurements of liquid ammonia are urgently needed. This includes the calibration and verification of measurement equipment under liquid ammonia conditions.

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 metrology research necessary to support standardisation in liquefied energy gases measurements.

The specific objectives are

1. To demonstrate, SI-traceable and reliable LNG flow meter measurements with a target accuracy of 0.5 % and an overall calibration uncertainty of 0.17 % (k = 2). This should include the evaluation of the effect of (i) repeated temperature cycles, (ii) 2-phase flow, (iii) meter insulation and (iv) flow meter drift, on meter accuracy. In addition, to assess the reliability of meter diagnostics and assess alternative fluid calibration on flow meter accuracy under liquefied gas conditions.
2. To determine (i) the measurement accuracy, (ii) sampling errors and (iii) reliability of LNG and liquefied biomethane composition measurement equipment and measurements. This will include the production of publicly available reference datasets of LNG composition measurements. In addition, to demonstrate a target uncertainty of less than 0.3 % (k = 2) for the online determination of LNG density, using SI- traceable reference datasets.
3. To produce SI-traceable reference datasets containing liquefied energy gas temperature measurements including their associated uncertainties in the range: 0.5 °C – 3.0 °C (k = 2). In addition, to determine the:
   (i) measurement errors and measurement accuracy of liquefied energy gas temperature in LH_2 (-253 °C) and LNG (-162 °C) conditions,
   (ii) the uncertainty for temperature sensor calibration up to -253 °C, applicable for LH_2 using extrapolation methods,
   (iii) the overall uncertainty of temperature measuring systems in liquefied energy gas process conditions.
4. To produce SI-traceable calibration procedures for (i) liquefied energy gases (LNG, LH_2), and (ii) liquefied gases related to energy transition (LCO_2, liquid ammonia). This will include intercomparisons with existing SI-traceable liquefied gas calibration standards.
5. To contribute to the standards development work of the technical committees ISO/TC 28, OIML TC8, CEN/TC 282, CEN/TC 408, and IEC/TC65 SC65B and to EMN Energy Gases to ensure that the outputs of the project are aligned with their needs, communicated quickly to those developing the standards and to those who will use them, and in a form that can be incorporated into the standards at the earliest opportunity.

The proposed research shall be justified by clear reference to the measurement needs within strategic documents published by the relevant Regulatory body or Standards Developing Organisation or by a letter signed by the convenor of the respective TC/WG. EURAMET encourages proposals that include representatives from industry, regulators and standardisation bodies actively participating in the projects. The proposal must name a “Chief Stakeholder”, not a member of the consortium, but a representative of the user community that will benefit from the proposed work. The “Chief Stakeholder” should write a letter of support explaining how their organisation will make use of the outcomes from the research, be consulted regularly by the consortium during the project to ensure that the planned outcomes are still relevant, and be prepared to report to EURAMET on the benefits they have gained from the project.

Proposers should establish the current state of the art and explain how their proposed research goes beyond this. In particular, proposers should outline the achievements of the EMRP and EMPIR projects ENG03 LNG, ENG60 LNGII, 16ENG09 LNGIII, 20IND11 MetHyInfra and how their proposal will build on those.

EURAMET expects the average EU Contribution for the selected JRPs in this TP to be 1.0 M€ and has defined an upper limit of 1.3 M€ for this project.

EURAMET also expects the EU Contribution to the external funded beneficiaries to not exceed 30 % 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 energy sector.

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.