EMPIR Call 2014 – Industry and Research Potential

Selected Research Topic number: **SRT-i25**
Version: 1.0

Title: Industrial standards in the intermediate pressure-to-vacuum range

Abstract

Traceable low absolute, differential, positive and negative gauge pressure measurements are important for the realisation of cleanroom conditions in the pharma-biotech, semiconductor, micro- and nano-technology, petrochemical and aviation industries, in power plants, weather monitoring and forecast services. There are demands of industrial and calibration laboratories for improved calibration service on the NMI level, as well as need for alternative mercury-free reference pressure standards. New pressure standards and calibration methods for the range ~1 to ~10^4 Pa will be developed to increase the efficiency and safety of industrial processes, provide a basis for new technologies and reduce the risk of environmental contamination.

Keywords

Cleanroom technology, energy production, aviation industry, weather monitoring, low gas pressure, piston gauge, liquid column manometer, calibration service, standardisation, traceability

Background to the Metrological Challenges

Low absolute, differential, positive and negative gauge pressure measurements play a vital role in numerous industrial processes. The pharmaceutical industry operates in an environment with strict requirements on safety, sterility and precision. To realise cleanroom conditions in semiconductor fabrication, micro- and nano-technologies or critical product filling systems, differential pressures must be maintained between different rooms or zones to prevent contaminated air from entering the critical zone. In hospitals and research laboratories, the pressure difference (negative pressure) prevents the spread of germs, contaminants and dust; and positive pressure in the filling room maintains the hygiene conditions during filling operations in the food and pharmaceuticals industry [ISO 14644 and ISO 14698]. Cleanrooms are highly energy intensive to operate – a pressure increase in 1 Pa in a medium size cleanroom requires 3000 kWh additional energy per annum. All pressures must be monitored continuously and with high accuracy (≤1 Pa is the desirable uncertainty target). Maintenance of these conditions demands high accuracy of positive and negative gauge pressure measurements at all stages of the traceability chain. Conventional calibration procedures (applied to instruments for low differential pressures) are extremely dependent on weather conditions, especially the stability of atmospheric pressure; and often the target uncertainty level cannot be achieved. Alternative calibration approaches and techniques need to be developed to ensure a constant low uncertainty level, independent of the ambient conditions.

Chemical and petrochemical industries are also subject to strict international requirements like the PED and ATEX [Directives 97/23/EC and 94/9/EC]; and to meet these safety and performance requirements, reliable, accurate, traceable pressure measurements must be provided. In power plants, pressure measurement plays an important role in safety (avoiding pipe and vessel overpressure situations and preventing release of harmful products into the environment), efficiency (to narrow operating ranges and prevent processes from operating at unnecessary pressures / vacuums) and cost savings; as well as indirect measurements (e.g. flow). Absolute gauge and differential pressures are measured over a wide range (0 – 20 MPa) in areas of process control, flow measurement and emissions management. Currently, nuclear power plants calibrate almost all the important pressure transmitters in their primary and secondary systems, including safety-related and non-safety-related transmitters, using high-precision pressure reference standards [EC Nuclear Regulators' Working Group, Final Report – August 2004].

The lack of adequate reference standards in Europe forces the European accredited labs to calibrate their force-balanced piston-gauges against different pressure and vacuum standards or to send their instruments to USA, which both result in unreasonably high costs. The demands of the end-users in Europe for traceable pressure measurements are predominantly covered by hundreds of calibrating laboratories accredited by

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national accreditation bodies. With advanced instrumentation, which became available in the accredited laboratories in the last decade, a need has appeared for new, more accurate primary pressure standards in the range from 1 – 10^4 Pa to provide traceability of the pressure measurements to the basis SI units on the required accuracy level of $3 \cdot 10^{-5} p$ + 5 mPa.

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 proposal.

The JRP shall focus on enabling the SI traceable measurement of absolute, positive and negative gauge pressures in the intermediate range 1 to 10^4 Pa, in order to increase the efficiency of industrial production and processes.

The specific objectives are:

1. To develop and characterise primary and transfer pressure standards for the dissemination of the pressure scale in the intermediate range between high pressure and vacuum area. This should allow comparison with primary high pressure standards (i.e. deadweight pressure balances and liquid column manometers) and primary vacuum standards (i.e. static and continuous expansion systems).
2. To develop calibration methods for positive and negative gauge pressure standards in the range -10^5 to 10^4 Pa, in order to reduce the uncertainty of the pressure (p) calibration down to 3×10^{-5} p + 1 Pa. The methods should allow accurate calibration, independent of variable ambient conditions and should improve the accuracy of the pressure measurement and calibration in industrial conditions to better than 2×10^{-4} p + 3 Pa.
3. To support the EU strategy on the restriction of mercury in measuring devices, by the replacement of primary mercury manometers with alternative pressure standards. This should include an investigation of calculable capacitors, microwave resonators and refractometry techniques as alternative pressure standards, as well as comparisons between mercury-containing and mercury-free pressure standards.
4. To establish a calibration service in the range -10^5 to 10^4 Pa for gauge pressure and 1 to 10^4 Pa for absolute pressure. The calibration service should provide a level of accuracy level relevant for industry and state-of-the-art pressure measurement instrumentation and be available for use in different European countries.
5. To engage with industries that utilise pressures in the intermediate range 1 to 10^4 Pa to facilitate the take up of the technology and measurement infrastructure developed by the project, to support the development of new, innovative products, thereby enhancing the competitiveness of EU industry.

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 and EMRP JRP IND09 (Dynamic) ‘Traceable Dynamic Measurement of Mechanical Quantities’.

EURAMET expects the average EU Contribution for the selected JRPs to be 1.5 M€, and has defined an upper limit of 1.8 M€ for any project.

EURAMET also expects the EU Contribution to the external funded partners to not exceed 30 % of the total EU Contribution to the project. Any deviation from this must be justified.

Any industrial partners that will receive significant benefit from the results of the proposed project are expected to be unfunded 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,
- Drive innovation in industrial production and facilitate new or significantly improved products through exploiting top-level metrological technology,
- Improve the competitiveness of EU industry,
- Feed into the development of urgent documentary standards through appropriate standards bodies,
- Transfer knowledge to the pressure measurement sector.

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

You should also detail how your approach to realising the objectives will further the aim of EMPIR 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.