Publishable JRP Summary Report for ENV51 MeTra Traceability for Mercury Measurements

Background

Mercury in its many chemical forms is highly toxic to human, animal and environmental health. Its ability to accumulate in terrestrial and aquatic biosystems makes it a particularly insidious threat to environmental sustainability. Its long lifetimes and ability to be transported in air over long distances mean that it is ubiquitous to all environmental compartments and is a pollutant of global concern. The increase in the presence of mercury in the environment has been due to human activity over the last one hundred years, and whilst legislation is in place to limit human releases, **the assessment of the ongoing effect of mercury on humans and the environment is critically dependent on accurate measurements to assess concentrations and trends**. This challenge is complicated by the various chemical forms of mercury and its presence in a number of different matrices.

Despite this, **the measurement infrastructure to provide traceable measurements of forms of mercury** that are currently regulated and to underpin advanced analytical techniques to support the next generation of environmental mercury measurement **is absent in Europe, and globally.**

In order to prevent global environmental pollution and damage to health caused by mercury, **a new convention named the "Minamata Convention on Mercury" has been agreed.** The global and legally binding Convention was adopted at the UNEP Diplomatic Conference held in October 2013 in Japan.

European Directives are awaiting the arrival of a solid metrological infrastructure providing traceability and reduced uncertainties for mercury measurements to enable the introduction and subsequent enforcement of target values for mercury, and to ensure the reliability and comparability of measurement results, as is the case for similar toxic elements covered by legislation.

Need for the project

As a result of its highly toxic nature the use of mercury is being phased out for many applications and limited to a mass fraction of mercury in products of less than 1000 mg/kg in any current usage or new application. Mercury is classified as a priority hazardous substance (PHS) due to its persistent, bio accumulative and toxic properties. For **PHS, European Member States are legally obliged to progressively reduce discharges, emissions and losses to zero within the next 20 years**. Unfortunately mercury is still entering the European environment in large amounts and with large uncertainties. It is also entering via trans-boundary transport from other parts of the world. Due to the global transport of mercury, releases in other parts of the world are as important to Europeans as domestic emissions. In the **UNEP 2013 document "Global Mercury Assessment"** the global emissions to air from anthropogenic sources were estimated at 1960 tonnes in 2010. Despite recent progress in improving the available knowledge base, these emissions estimates still have large uncertainties, giving a range of between 1010 and 4070 tonnes. Furthermore, potentially important sectors were identified as emitters, whose effect has not yet been quantified, including the use of mercury in vinylchloride monomer production, secondary metals production and ferro-alloys, oil and gas extraction, and transport.

Overall, indications are that mercury emissions from industrial sectors have increased again since 2005.

Without improved pollution controls or other actions to reduce mercury emissions, mercury emissions are likely to be substantially higher in 2050 than they are today.

EMRP European Metrology Research Programme ▶ Programme of EURAMET

The EMRP is jointly funded by the EMRP participating countries within EURAMET and the European Union

Scientific and technical objectives

This JRP will put in place an underpinning traceability framework for the measurement of mercury in all environmental compartments. This is needed to ensure the quality, comparability and traceability of measurement results.

Specifically the JRP addresses the following scientific and technical objectives:

- To develop a calibration infrastructure enabling the traceable assessment of mercury in air to support European legislation for gaseous emissions and air concentrations and as part of the global mercury observing system.
- To develop a metrological in-line measurement method and calibration infrastructure enabling the traceable assessment of mercury thresholds specified in European legislation and as part of the global mercury observing system for continuous and semi-continuous Hg(0) and Hg(II) measurement in (harsh) matrices such as stationary source emissions or liquid media, including the use of sensor technology.
- To develop a metrological infrastructure for emerging requirements in mercury science such as the evaluation of mercury concentrations in indoor air from the use of mercury containing compact fluorescent lamps.
- To develop primary measurement procedures for mercury speciation in water and biota in order to improve mercury monitoring through the aquatic ecosystems and to support European legislation. This will include the evaluation of transformation artefacts associated with sample collection and preparation, in order to minimise species conversion post-sampling.
- To develop and accurately perform bulk and compound specific isotope signature measurement methods for Hg(0) and Hg species.
- To develop and accurately perform ratio measurement for light isotopes (C, N, H, O) in organo-Hg species in order to detect contaminant transformations and migration.

Furthermore, this project will investigate unique samples from the German Environmental Specimen Bank that document large mercury concentration changes over the last decades. The analysis will employ the procedures developed and validated by the JRP to identify and track the sources and pathways of mercury in the environment. This will add significant value to the collection held under the ESB whilst also demonstrating the outputs of the JRP on real samples.

Expected results and potential impact

This JRP will establish the required **metrological infrastructure for mercury measurements in all environmental media**, as required by current and future national and international legislation aimed at controlling mercury emissions and releases.

An overarching target of the JRP is to **support the implementation and assessment of the Minamata Convention on mercury** – the global and legally binding treaty aimed at reducing global mercury emissions – together with EC Directives and Member State objectives to reduce the presence of mercury in the environment.

The outcome of this JRP will provide end users with the underpinning infrastructure for producing primary calibration standards and traceable measurement results. Quantitative determination of Hg is of the utmost importance to a variety of applications, e.g. ambient air and water quality monitoring programmes as well as industrial sectors such as energy production and refineries.

Traceable measurements will help to better understand human and environmental exposure to mercury, thereby working towards improving environmental sustainability and the health of the EU citizen, especially those more susceptible to mercury.

Traceable measurements with defensible uncertainties will also help to demonstrate trends in mercury concentrations, its speciation in different media, and its movement between environmental compartments. This JRP will support mercury risk management and chemical policy.

Traceable measurements with lower uncertainties will help European industry meet the requirements of mercury abatement and emissions legislations with greater confidence and at low cost, resulting in huge overall savings across the EU, whilst making EU industry cleaner and more competitive globally.

The JRP's engagement with users of measurement results, instrument producers, national metrology institutes outside Europe, standardisation bodies and policy makers will ensure that the impact of the metrology developed by the JRP is maximised especially with respect to **supporting the implementation of legislation and policy oriented research worldwide**. The JRP will:

- Enable traceable assessment of mercury concentrations against those specified in European legislation and as part of the global mercury observing system through the development of a calibration infrastructure using an innovative primary mercury standard. The impact of this will be the validation of regional and global scale atmospheric mercury models that are used in the evaluation of different policy options for reducing mercury pollution impacts on human health and ecosystems.
- Enable comparable and validated procedures for continuous and semi-continuous Hg(0) and Hg(II) measurement in matrices such as stationary source emissions particularly relevant to industrial sectors and the management of mercury contaminated sites. The impact of this will be the provision of reliable calibration practices for in-line/in-situ methods, which will ensure faster measurement and comparable results.
- Implement traceable methods for indoor mercury measurements as part of the emerging requirements in mercury exposure from the use of mercury containing compact fluorescent lamps. The impact of this will be the provision of consistent measurement data which are able to support the implementation of EU Directive 2002/95/EC (RoHS Directive).
- Provide fully traceable measurements with uncertainty statements for mercury species in water and biota. The impact of this will be to improve the LOQ and the measurement uncertainties of mercury monitoring and observing systems up to about one order of magnitude, as in the case of water, in order to understand temporal and spatial patterns of mercury transport and deposition to, and evasion from, terrestrial and aquatic ecosystems.
- Develop traceable measurements of bulk and compound specific mercury isotope ratio measurements as well as traceable light isotope measurements in order to obtain combined information on the locations of potential Hg sources and their fate and distribution pattern in the environment. The impact of this will be the availability of consistent and comparable analytical tools to strengthen the policy relevance of basic research currently undertaken by numerous groups in Europe and worldwide to elucidate migration and transformation of environmental Hg and its compounds as well as for the identification of sources, sinks and pathways.
- Engage users of measurement results, instrument producers, National Metrology Institutes outside Europe, standardisation bodies and policy makers, in order to strengthen the power of metrologically established methodologies in Hg measurements in support of the implementation of worldwide legislation and policy oriented research. The impact will be improved reliability of results and the consequent quality of decision making in Hg monitoring programmes where correct evaluations are essential for human and environmental life.

JRP start date and duration:	1 October 2014, 3 years
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