

CCT member and observer Activity Report

Period: May 2024 to May 2026

Institute: VSL B.V. National Metrology Institute

State economy: The Netherlands

Number of persons involved in thermometry of the institute: 7

Short summary of research and development:

The thermometry and humidity laboratory participates in multiple European research projects:

1. The EMPIR project 20IND06 PROMETH2O “Trace Water in Ultrapure Gasses” where the enhancement factors of water in N₂ and Ar gas were measured in order to validate new water vapour enhancement factor formulations (completed in 2024).
2. The EMP project 21GRD05 Met4H2 “Metrology for the Hydrogen Supply Chain”. VSL, along with NPL, INRiM, and DTU has successfully completed the first pilot comparison of the realisation of dew points and amount fraction water vapour in hydrogen gas (completed in 2025).
3. The EMP project 23IND09 MaritimeMET “Metrology for green maritime shipping: Emission control through traceable measurements and machine learning approaches”. VSL is developing a traceable dynamic temperature probe that will be used to measure temperature profiles of internal maritime combustion engines.
4. The EMP 24GRD07 CryoMet “Metrology for reliable liquefied energy gases measurement”. VSL is the coordinator of this project. We are also involved in performing cryogenic temperature measurements and quantifying key uncertainty contributions under process conditions in liquified energy gases (LNG, and LH₂).
5. The development of compact spectroscopic methods to traceably measure humidity to 0.5 ppm. This project is a collaboration between UL (University of Ljubljana) and VSL, supported by the Erasmus+ program.

Additionally, we are active participants/members of the Technical Committee of Thermometry (EURAMET) and CCT WG-Hu.

Brief summary of recent comparison activity:

The thermometry laboratory at VSL is taking part in several (key) comparisons:

1. LNE-Cnam, NPL, PTB, SMD, and VSL have performed a pilot comparison on the freezing point of zinc to attempt to . The results will be published in the proceedings of the 2025 TEMPMEKO/ISHM held in Reims, France.
2. VSL is participant in the pilot comparison on trace water in hydrogen standards over the nominal range from $0.5 \mu\text{mol}\cdot\text{mol}^{-1}$ to $50 \mu\text{mol}\cdot\text{mol}^{-1}$ which is piloted by NPL.
3. VSL is **pilot** for the coming EURAMET.T-K7 key comparison.
4. VSL is **co-pilot** in the CCT-K6.2021 key comparison.

Brief summary of other activities:

Conference contributions:

1. "AN EXTENSIVE DIRECT-CELL COMPARISON OF ZINC FIXED-POINT CELLS", M.R. Panman, C. de Bruin - Barendregt, M. Dobre, R.I. Veltcheva, J. Pearce, L. Buenger, F. Sparasci, 2025 TEMPMEKO – ISHM Joint Symposium, Reims, France.
2. "MARITIMEMET: METROLOGY FOR GREEN MARITIME SHIPPING – DYNAMIC TEMPERATURE", M.R. Panman, W. Stiphout, A. Seymour, P. Dekker, M. Voldán, M. Králová, L. Kňazovická, E. Amer, F. Arrhén, A. Fateev, 2025 TEMPMEKO – ISHM Joint Symposium, Reims, France.
3. "HARMONIZATION OF VSL'S HUMIDITY STANDARDS FOR TRACE WATER MEASUREMENTS IN PROCESS AND ENERGY GASES", M.R. Panman, A. Novak, W. Stiphout, N. Abdulhussain, S. Persijn, M. van Dijk, G. Kok, GasAnalysis 2026, Paris, France.
4. "MaritimeMET: Metrology for Green Maritime Shipping - Emission control through traceable measurements and machine learning approaches", Zhechao Qu *et. al*, IMEKO TC3|TC5|TC16|TC20|TC22 Joint Conference 2026 & the 3rd International Conference on Dynamic Measurement.
5. "DEVELOPMENT OF MEASUREMENT AND CALIBRATION METHODS FOR DYNAMIC PRESSURE AND TEMPERATURE, WORK PROGRESS OF THE EPM-PROJECT MaritimeMET: WP2", Eynas Amer, Fredrik Arrhén, Yasin Durgut, Alexander Fateev, Abdullah Hamarat, Richard Högström, Matthijs Panman, Zhechao Qu, Ajoy Ramalingam, Christophe Sarraf, Michal Voldán, IMEKO TC3|TC5|TC16|TC20|TC22 Joint Conference 2026 & the 3rd International Conference on Dynamic Measurement.

Additionally, we have continued the renewal of obsolete equipment. This includes: the acquisition of a new two-pressure relative humidity generator; replacement of our low and high temperature calibration baths (for both contact thermometry and frost point realisation); acquisition of two new chilled mirror hygrometers; production of 15 new triple point of water fixed points.

Link to bibliography or list of bibliography (last 5 years):

The following items are unfortunately not yet available to the public:

1. 21GRD05 Met4H2 deliverable “D5 - Intercomparison on trace water in hydrogen standards over the nominal range from 0.5 $\mu\text{mol}\cdot\text{mol}^{-1}$ to 50 $\mu\text{mol}\cdot\text{mol}^{-1}$ with conclusions and recommendations for future improvements”.
2. 20IND06 PROMETH2O deliverable “Deliverable 5 - Report on the development and validation of correlation equations for the enhancement of water vapour in N₂, Ar and H₂ in the temperature range from -30 °C to -90 °C and at pressures from 0.1 MPa to above 1 MPa”. This deliverable will also be published as a book this title “Water Vapor Enhancement Factor: Theory and Experiments”.
3. Tabandeh, S. *et al.*, “A functional equation for the water vapor enhancement factor in non-polar carrier gases: experiments and validation”, *in preparation*, 2026.
4. 2025 TEMPMEKO – ISHM Joint Symposium proceedings, “An Extensive Direct Zinc Fixed-Point Cells Comparison”, *submitted*, Reims, France.