



Advanced testing facility for gas sensors validation under controlled conditions

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Small sensor systems developed over the last decade have demonstrated great potential for air quality and trace pollutant monitoring. These systems are widely available on the market and can provide a fast and lower-cost alternative that is complementary to reference methods. There could, however, be a number of issues in the quality of the data from such sensor systems, as they are prone to interferences, temporal drift, low accuracy and lack of metrological traceability. Therefore, adherence to Technical Specification (TS) 17660-1 (Air quality – Performance evaluation of air quality sensor systems – Part 1: Gaseous pollutants in ambient air), issued by the European Committee for Standardization (CEN), is essential for ensuring data quality through a structured metrological assessment. The TS is designed for gaseous pollutants and entails laboratory and field tests that are complex and require high-accuracy, dedicated facilities. The laboratory validation includes preliminary tests to evaluate response time, lack of fit of the regression function and repeatability followed by a series of extended tests designed to assess long-term drift, cross-sensitivities by interfering gases, temperature effects, humidity effects and memory effects of main gas, temperature and humidity.

In this work, we outline the performance of the Multiple Atmosphere Controlled Environment (MACE) facility under several experimental regimes demonstrating how this state-of-the-art facility can be used to perform the laboratory tests described in TS 17660-1. The MACE is an advanced testing facility developed at the National Physical Laboratory (UK) designed to evaluate the performance of gas sensors and assist in the development of new products that meet the requirements of air quality legislation. The facility can create reproducible and stable environmental conditions under a range of temperature, relative humidity, and gas concentrations and compositions. The MACE consists of an environmental chamber that houses six stainless steel exposure pods and includes an insulated environment for delivering temperature-controlled tests. Accurate single and multiple test atmospheres are generated by blending zero air with traceable gas mixtures via an array of calibrated mass flow controllers. The desired relative humidities are generated by a dedicated vaporizer unit. The exposure chambers are connected to an array of reference instruments capable of measuring priority pollutants, including NO, NO₂, SO₂, CO, CO₂ and O₃. Here we present the results of tests on a set of sensor systems performed using the MACE, demonstrating that the facility can perform all the tests outlined in the TS. This makes the

MACE one of only a few facilities worldwide that meet the requirements specified in the TS.

This work represents the first step toward standardizing small sensor systems, with subsequent stages involving full validation of the TS (including field tests) and its adoption as a Standard, which are currently underway. This work, along with the implementation of quality assurance and quality control practices, will ensure that the data from small sensor systems are traceable and of the highest quality possible.