Message from Professor Michael Kühne, Director of the BIPM

2011 was declared the International Year of Chemistry by the United Nations as a world-wide celebration of the achievements of chemistry and its contributions to the well-being of humankind. The impact on our daily lives of chemical measurements is far-reaching and of enormous benefit although it often goes unnoticed. In general, metrology is an essential but largely hidden aspect of modern society. With a theme of 'Chemical Measurements – for our life, our future', for this year's World Metrology Day, the vital contribution of measurements in this field is being recognized.

The 2011 International Year of Chemistry celebrates the centenary of the award of the Nobel Prize in Chemistry to Marie Sklodowska Curie, recognizing her discovery of the elements radium and polonium. On our website one can find photographs taken at the BIPM in 1904 of Marie Curie, her husband Pierre Curie and daughter Irène Curie, together with Charles-Edouard Guillaume, at that time Deputy Director and later Director of the BIPM. All four were either already Nobel Laureates, or would become Nobel Laureates (twice in the case of Marie Curie). The BIPM was the custodian of the original radium standard prepared by Marie Curie and used for the very first activity comparisons in the field of ionizing radiation. Today, although the original radium standard no longer exists, the BIPM maintains the international reference standards in ionizing radiation for both dosimetry and activity measurements.

The importance of chemical measurements is well established within the International System of Units (SI). A decision was taken in 1971 to include 'amount of substance' and 'mole' as a base quantity and SI base unit respectively, with the support of the International Union of Pure and Applied Chemistry (IUPAC), the International Union of Pure and Applied Physics (IUPAP) and the International Organization for Standardization (ISO).

In today's economy, goods and information are exchanged globally, and international travel and the cross-border transport of livestock and agricultural products are commonplace. This trend is inherent to modern economic prosperity

and is set to continue. Our wellbeing also depends on issues that have an impact on our quality of life, such as health care, the environment and food quality. A strong international measurement and standards infrastructure is critical to ensuring that products and services meet their specifications, to assure equity in trade and to underpin a high quality of life. The statement 'if you cannot measure it you cannot control it' is as true today as it ever was. In the field of chemical measurements, certified reference materials (CRMs), measurement standards and reference measurement results provide stated references upon which analytical laboratories can anchor their measurement results. The traceability of measurement results to internationally accepted and stated references, together with their stated measurement uncertainties, as described in ISO/IEC 17025, provides the basis for their comparability and global acceptance.

Meeting the need for reliable and reproducible chemical measurements and certified reference materials is a major activity for the International Metrology Community and National Metrology Institutes. The development of reference materials for chemical properties has been part of the mission of certain National Metrology Institutes since the early 1900s. This role and activity intensified with the formation of the BIPM's Consultative Committee for Amount of Substance: metrology in chemistry (CCQM), with its wide ranging programme of chemical measurement comparisons. These comparisons address wide ranging measurement capabilities related to, for example: cholesterol and glucose; illegal drugs; high risk food contamination; environmental emissions and air quality.

Establishing a better understanding of climate change particularly underlines the need for long term, reliable and reproducible measurements, a need confirmed by the major intergovernmental and international bodies concerned, such as the World Meteorological Organization (WMO), the Intergovernmental Panel on Climate Change (IPCC), and UN Agencies. Indeed in the field of climate change monitoring, the reliability of measurements is a prerequisite for the long-term monitoring of greenhouse gases, their use in radiative and climate change models, and monitoring the effectiveness of mitigation activities. A good example of where international activities have reduced the uncertainty of measurements is for surface ozone. The adverse effects of increased surface ozone concentrations are well reported, notably because of concerns related to premature deaths related to respiratory disease and damage to agricultural crops. Additionally, the best estimate for the net increase in radiative forcing due to tropospheric ozone from pre-industrialized times until 2005 (IPCC AR4) ranks tropospheric ozone as an important greenhouse gas. Concerns over these effects and the need to control them provide the strongest drivers for accurate long-term measurements.

The role of chemical measurements in ensuring healthy food is emphasized in regulations and supported by international measurement programmes. Reference materials and methods are required to underpin a broad range of food analyses including contaminant analysis, nutritional food additive analysis including vitamins, and the analysis of residues. Residues in foodstuffs can originate from deliberate use of banned substances, from incorrect use of regulated plant protection agents or veterinary drugs or from unintentional contamination during the production process. Regulated measurements of substances in foods require

high quality chemical measurements with stated uncertainties to ensure measurement results meet performance criteria.

The safety of water is of global concern, with regulations being implemented to ensure the good quality of surface, ground and coastal waters. Comparison activities which started in Europe and were expanded to the global level by the CCQM, are contributing to the development of a sustainable traceability and dissemination system providing comparable measurement results in water monitoring. Among the priority lists of substances to be assessed as the basis of water quality, the inorganic analytes (nickel, cadmium, lead, mercury) are being studied with the aim of assuring the reliability of measurement results at limit values for these substances.

There is a general move to greater efficiency in the use of fossil fuels with a reduced environmental impact, the latter is also a concern in the disposal of waste products. Accurate chemical measurements are a key component in addressing these issues. In the past, the measurement of sulfur in fuels and combustion systems has received principal attention, but mercury emissions are now attracting regulatory interest because of the potential risk to human health. Measurements of carbon will also become more important as trading systems come into force to combat the radiative forcing effects from the release of carbon dioxide into the atmosphere.

With concerns over the limited supply of non-renewable forms of energy there is growing interest in renewable sources of energy, which brings new challenges. Biofuels, for example, are far more varied in composition than the fossil fuels they displace, requiring the development of a range of new measurement standards and CRMs to support both quality control and trade.

In the field of health, reliable measurements are needed both for therapeutics and diagnostics. Recent regulations for diagnostics have required that ‘the traceability of values assigned to calibrators and/or control materials must be assured through available reference measurement procedures and/or available reference materials of a higher order.’ This led to the development of a database of higher order reference materials, methods and services under the auspices of the Joint Committee for Traceability in Laboratory Medicine (JCTLM) operated by the BIPM, the International Federation of Clinical Chemistry and Laboratory Medicine (IFCC) and the International Laboratory Accreditation Cooperation (ILAC). The database provides a unique resource, identifying higher order reference materials, methods and measurement services in laboratory medicine, and thus supporting the *in vitro* diagnostics industry, its regulators and those active in the field of laboratory medicine. By facilitating uniform national and regional implementations of traceability requirements, the database helps avoid potential technical barriers to trade.

In summary, reliable chemical measurements have met, and will continue to be needed to meet the global challenges of clean air, safe water, sustainable energy, healthy food, advanced materials, and dependable medicines.

The traceability of such measurements to the SI is, and will remain, a cornerstone for their reliability both now and in the future, and will thus continue to contribute to the prosperity and well being of humankind.