Metrological Traceability of Measurement Results in Chemistry

In recent years, the concept of "traceability" in chemical measurement has received an extraordinary amount of attention. It has been the theme of numerous workshops and symposia. It is frequently used in the chemical literature as an accepted concept with a seemingly obvious meaning. Demonstration of metrological traceability is required in documents from the International Standards Organization (ISO), International Laboratory Accreditation Cooperation (ILAC), and the Bureau International des Poids et Mesures (BIPM), among others, which makes its implementation almost compulsory for any measurement laboratory. (In this project, the systematic term "metrological traceability" is used to distinguish the concept from other types of traceability such as documentary traceability and material traceability.)

However, many people concerned with metrology in chemistry tacitly or privately concur that there is no unequivocal, internationally agreed definition of traceability of a measurement result in chemistry. This is a rather remarkable state of affairs because lack of clarity about such an important and widely used concept makes it difficult to reach world-wide agreement on its use. There are only a few examples of documented traceability of chemical measurement results produced by field laboratories, reference material producers, or even national metrology institutes.

The definition of traceability in the *International Vocabulary of Basic and General Terms in Metrology* (1993) reads:

> **traceability**: property of the result of a measurement or the value of a standard whereby it can be related to stated references, usually national or international standards, through an unbroken sequence of comparisons all having stated uncertainties (VIM 6.10—ref: BIPM, IEC, IFCC, ISO, IUPAC, IUPAP, OIML, *International Vocabulary of Basic and Metrological Terms in Metrology*, 2nd edition, ISO GenŁve, 1993)

The first step toward clarification of the concept "metrological traceability" is to state some current problems:

- the lack of understanding that metrological traceability to a common stated metrological reference is a precondition for comparability of measurement results
- the widespread perception that a unit from the International System of Units (SI) is the only possible stated metrological reference in metrological traceability of chemical measurement results
- the claim that a measurement result can be metrologically traceable to an institution
- the lack of clarity of the distinction between metrological traceability and measurement uncertainty
- the confusion between the quantity value carried by an artifact used as a calibrator and the artifact itself
- the fact that few certified reference materials or CRM certificates indicate the metrological traceability of the certified quantity value(s)
- the belief that the use of a (C)RM as a so-called "trueness control" material establishes metrological traceability
- the assumption that participation in an interlaboratory comparison or proficiency testing scheme provides metrological traceability of a measurement result
- the belief that metrological traceability is a property of a material, measurement method, or measurement procedure
- the use of inaccurate language such as "traceability to the SI"
- the lack of a definition of the concept "traceability chain"
- the lack of a definition of the concept "stated metrological reference"
- the perception that metrological traceability does not apply to measurement results in routine laboratories

These problems hamper communication about measurement. Numerous interactions with analytical chemists around the world have revealed that basic concepts in metrology, with very few exceptions, are not included anymore in the text books of analytical chemistry. This may be an underlying reason for many of the listed problems.

To address this situation, IUPAC has approved a project on metrological traceability, which has the following objectives:

- to elucidate the concept "metrological traceability" of a measurement result and list its characteristics, and to describe the relations between metrological traceability and other concepts such as calibration, measurement uncertainty, and comparability
- to formulate requirements for establishing metrological traceability

- to give specific examples of metrological traceability of chemical measurement results

The project task group is highly interdivisional and includes members from the Commission on Isotope Abundances and Atomic Weights of the Inorganic Chemistry Division; the Subcommittee on Nomenclature, Properties, and Units in Laboratory Medicine of the Chemistry and Human Health Division; the Interdivisional Working Party for Harmonization of Quality Assurance; and the Analytical Chemistry Division. A draft report will be circulated extensively within IUPAC for comment. The amended final version will be published in *Pure and Applied Chemistry*. Interested readers are invited to consult the IUPAC Web site and follow the link to the project home page, or consult with the Task Group Chairman Paul De BiŁvre <paul.de.bievre@skynet.be>.

www.iupac.org/projects/2001/2001-010-3-500.html

Environmental Implications of Endocrine Active Substances

The International SCOPE/IUPAC Symposium on Endocrine Active Substances (EASs), held 17–21 November 2002 in Yokohama, Japan, was a major milestone in the project coordinated by the Chemistry and the Environment Division and led by Dr Junshi Miyamoto. (SCOPE is the Scientific Committee on Problems of the Environment of the International Council for Science.) The project objectives are to critically evaluate the issues relating to the effects of EASs on man and the environment, to prioritize research needs, and to offer some manageable actions facilitating risk assessment and risk communication. The symposium was organized around four major topics:

- molecular mode of action of nuclear receptors
- environmental fate and metabolism of EASs
- toxicological effects of EASs and risk assessment for humans
- effects of EASs in wildlife species

Eminent international experts were invited to cover these issues in a total of 55 sub-topics and there were 6 supplementary workshops addressing related issues. Additionally there were poster sessions for submitted papers and for the 55 main, orally presented sub-topics (a rather unique, but effective way of encouraging dialogue). The excellent facilities of the Yokohama Convention Center proved equal to the task of accommodating over 350 participants. The culmination of the project will be the publication during 2003 of the final report in *Pure and Applied Chemistry* containing the 55 manuscripts for the sub-topics (with conclusions and recommendations) and an executive summary.

Efforts are underway to improve EAS exposure assessments in humans and animals.

The overall recommendations for risk management of EASs are as follows:

- Environmental monitoring programs should be focused on high priority EASs, including relevant metabolites, and be designed to support exposure assessment.
- Quantitative correlations for chemical analyses and bioassays (TIE) should be used to reevaluate the biological relevance of target EASs for monitoring programs.
- In addition to source control, available technologies for reducing environmental entry should also be considered.

Research priorities to improve exposure assessment of humans and wildlife are as follows:

- increased reliability of detection methods for EASs
- elucidation of metabolic pathways, including potential activation vs. detoxification
- key environmental fate parameters should be generated for highly active EASs (e.g., steroid hormones, certain industrial chemicals, drugs)
- improved models for exposure assessments
- development of more efficient processes for reducing environmental loadings