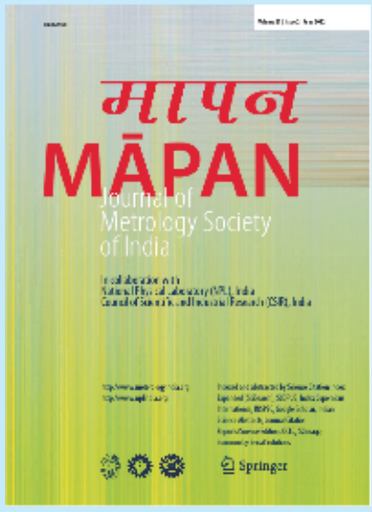
MSI newsletter
Metrology Society of India
Vol. 2, No. 3, July 2012

Highlights of this issue

Metrology in Chemistry (MiC): Current Status, Traceability and Future Challenges
-Mr. Prabhat K. Gupta



World Metrology Day and National Technology Day, Celebrations at NPL

The Metrology Society of India (MSI) and CSIR- National Physical Laboratory (NPL), celebrated, World Metrology Day and National Technology Day on May 21, 2012. Prof. R.C. Budhani, Director, NPL and President MSI, delivered the welcome address. Prof. Anil K. Gupta, IIM Ahmedabad delivered the keynote address on "Coping with Climatic Risks Creatively". Dr. V.N. Ojha, General Secretary, MSI proposed the vote of thanks.

Prof. R.C. Budhani, Prof. Anil K. Gupta, IIM–A (Chief Guest), Dr. V.N. Ojha (from left) are inaugurating the celebrations

Speaking on the occasion, Prof. Budhani mentioned that the nation celebrates World Metrology Day to mark the celebration of signing (on May 20, 1875) of the Metre Convention, the international Treaty to which India became signatory in 1957. Speaking about the theme of WMD 2012, he highlighted the importance of metrology for safety.

Prof. Anil K. Gupta, IIM-A delivering the keynote address

Emphasizing the significance of metrology day, Prof. Budhani mentioned that CSIR-NPL is National Measurement Institute (NMI) and has been given a great responsibility by an act of parliament to serve the nation by R&D, maintenance and dissemination of standards(of physical measurement). He assured that CSIR-NPL is fulfilling the responsibility well and its four pillars (Scientists, Technical staff, Administarion and Students) are working hard to achieve smooth transition from classical metrology to quantum metrology. Speaking on National Technology day, he reminded that the nation celebrates this on May 11, every year to commemorate Pokhran nuclear experiments conducted in 1998. He also mentioned efforts of NPL in technology sector viz. in the field of energy harvesting, photovoltaic conversion of solar energy to electrical energy, use of waste heat for energy, energy efficient batteries, fuel cells, etc.

The World Metrology Day Poster

Dr. V.N. Ojha, Prof. Anil K. Gupta, IIM–A (Chief Guest), Prof. R.C. Budhani and Dr. (Ms.) Rina Sharma (from left) releasing MSI News Letter

Dr. V.N. Ojha, Prof. Anil K. Gupta, IIM–A (Chief Guest), Prof. R. C. Budhani and Dr. A.K. Bandyopadhyay (from left) releasing the MSI Handbook

Delivering the keynote address Prof. Anil Kumar Gupta talked about climatic risks and role of innovation and creativity in coping with these risks. Prof. Gupta cited many examples of how society changes its ways and habits to cope with the situations like scarcity of water. He cited examples of innovations by grass root innovators and also mentioned few examples where the gadgets were modified by innovators for enhancing energy efficiency and lowering impact on climate. He expressed concern about role of documentary standards to get competitive advantage not being harnessed by India. Citing an example of green and energy efficient refrigerator, in which heat exchanger was used to take away the heat from compressor and to use it for heating water, Prof. Gupta stressed upon the need to modify standards for such devices for the competitive advantage of the Indian industry and to cope with climatic risks.

On this occasion the "World Metrology Day Poster" was released. Metrology Society of India released the latest issue of 'MSI Newsletter' and updated 'MSI Handbook'. NPL released five Certified Reference Materials (CRM) of monoelemental aqueous solutions of Lead (two), Calcium, Chromium and Sulphate. The team of innovators from NPL were awarded for their patents, software copyrights and technology transfers.

Dr. V.N. Ojha, Prof. Anil K. Gupta, IIM–A (Chief Guest), Prof. R.C. Budhani and Dr. P.K. Gupta (from left) releasing the Certified Reference Materials (CRM) developed at NPL

Special Feature

Metrology in Chemistry (MiC): Current Status, Traceability and Future Challenges

Metrology in Chemistry (MiC) is a branch of measurement science, which is all about how to get precise, accurate and traceable result out of a chemical measurement. It forms a foundation for analytical chemistry. Ultimately its goal is to realize the amount of substance "mole" in chemical measurements. This article explains the importance of MiC, traceability issues, meaning of "realization of mole through measurements", current status of MiC in India and future challenges.

Most of the measurements under analytical chemistry are aimed to determine the concentration of a measurand in given sample (matrix). For the analysis, techniques used range from conventional to modern. These include gravimetry, titrimetry, potentiometry, electrogravimetry, coulometry, voltammetry, spectrophotometry, fluorometry, molecular and atomic spectrometry, chromatography, and kinetic methods. In these techniques, first step of an analyst is to check the performance of the instrument and the calibration of instrument is required before the analysis work. For calibration and validation, standards are required and traceability issue comes into the consideration for these standards.

Prabhat K. Gupta
Chief Scientist & Head
Analytical Chemistry;
CSIR-NPL

Measurement Traceability

Traceability[1] in chemical measurements is the linkage of the measurement results (produced using an instrument, which is calibrated with a standard) with the international system of units (SI). The SI system rests on seven base units namely; kilogram (mass), length (metre), time (second), temperature (Kelvin) electrical current (Ampere), luminous intensity (candela) and amount of substance (mole). For this link (unbroken chain) to SI units, it is important that the "calibration standards" which are used must have a hierarchy for its assigned quantity values to SI units.

[1](Link: http:// www.bipm.org/en/publications/guides/vim.html), JCGM 200:2012, 3rd edition), pp. 29-30.

Measurements of amount of substance in MiC are usually combined with other quantities such as volume, V, or mass, m, to derive measures such as concentration, $c = n/V$ or amount content $k = n/m$, which have units of mol/m^3 or kg.mol. In other cases, two measurements of amount of substance are combined to measure amount ratio or amount fraction, which have units of mol/ mol. A method that gives a result in moles per unit volume or moles per unit mass can be obtained with a traceable measurement of volume or mass to yield a measurement of amount of substance in moles. MiC has thus unique challenges of requirements of traceability to more than one SI unit to achieve accurate results and with stated uncertainties. It is important to use the calibration standards, having traceability to SI units. A pictorial representation of traceability chain to SI units down to end-users is shown in Figure 1. For calibration, it is always recommended to use certified reference materials, CRMs[2] (of similar or comparable matrix to that of sample which has to be analyzed). CRMs should also be used for the confirmation of performance of the measurement in terms of the precision and accuracy of the results produced, called validation[3]. Proficiency testing (PT) is another way to check the performance of a laboratory. In this exercise, an authentic body having ISO-17043 accreditation provides aliquots of the same homogeneous and stable material to all participant laboratories for analysis.

Realization of Mole in MiC

As given in Chapter 2 of the SI Brochure, the mole (SI symbol: mol) is the unit of amount of substance of a specified elementary entity, which may be an atom, molecule, ion, electron, any other particle or a specified group of such particles, its magnitude is set by fixing the numerical value of the Avogadro constant to be equal to 6.022 14179× 10^{23} when it is expressed in the unit mol^{-1}. The number of entities in one mole is exactly equal to the numerical value of the Avogadro constant. However, the mass of one mole of a pure substance cannot be known exactly. This is because the molar mass of a pure substance $M(X)$ (in kg/mol) is determined by;

$$M(X) = A_r(X)M_u, \qquad (1)$$

where $A_r(X)$ is the atomic weight of X and M_u is the molar mass constant defined by;

$$M_u = m_u N_A, \qquad (2)$$

where N_A is the Avogadro constant and m_u is the atomic mass constant, which can be calculated using the formula;

$$m_u = \frac{2h}{c}\,\frac{R_\infty}{\alpha^2 A_r(e)}, \qquad (3)$$

where the Rydberg constant (R_∞), the fine structure constant (α) and the atomic weight of the electron ($A_r(e)$) are determined experimentally. The speed of light (c) and the Planck constant (h) are fixed. These equations (1) to (3) are discussed further by Milton and Mills[4]. The currently

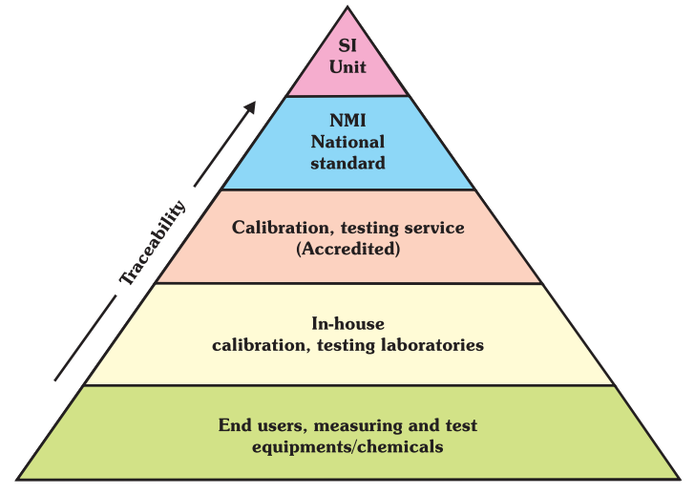


Figure 1: Unbroken chain of measurements at different level to achieve the traceability

accepted value of the molar mass constant is $M_u = 1.0\times10^{-3}$ kg·mol^{-1} with a relative standard uncertainty of 1.4 $\times10^{-9}$. The mole may be realised by several methods. However, here we discuss two methods used widely[5].

Method-1: For a compound X the amount of substance n in a sample may be measured by determining the product of the mass fraction of X in the sample (w_x) and the mass m of the sample and dividing by the molar mass $M(X)$ according to the formula;

$$n = \frac{w_x m}{M(X)}, \qquad (4)$$

when w_x is expressed in kg/kg, the mass m is expressed in kilogram, and the molar mass M in kg/mol, then the amount of substance n is obtained in mol. The molar mass (or mass per amount of substance) can be calculated from the chemical formula of the pure compound together with tables of the atomic weights of the elements. The atomic weights of all the elements are known and tabulated with a relative standard uncertainty of approximately 10^{-7} in most cases, and in some cases less than 10^{-8}. This method of realising the mole is the most preferred, because measuring the mass of a sample is relatively simple and accurate. Most of the laboratories measure the mass using mass spectrometric techniques against the calibration standards (CRMs), which are prepared gravimetrically. When very high purity compounds are available, the uncertainty of gravimetric operations becomes the limiting factors and the mole may be realised with a relative standard uncertainty of less than 1×10^{-6}. This method of realisation is probably the only general method that can be used for all chemical entities. However, there are several other methods that can be used for certain restricted classes of substances.

Method-2: The amount of substance of a sample of a pure gas may be determined by solving the equation of state for the gas for n in mol;

$$pV = nRT\left[1 + B(T)\left(\frac{n}{V}\right) + \ldots\right] \qquad (5)$$

[2]ref.1, P 51
[3]ref.1, P 31
[4]Metrologia 2009, 46, 332-332
[5]Metrologia 2001, 38, 289-296

where *p* is the pressure, *V* is the volume, *T* is the temperature, and *R* is the molar gas constant. The molar gas constant is in the SI unit $Pa \cdot m^3 \cdot mol \cdot K^{-1}$. The term involving the second virial coefficient *B(T)* and possible higher-order terms are generally small corrections. Virial coefficients expressed in SI units are tabulated for a number of simple gases or they may be eliminated by extrapolation of a series of experiments to low pressure. The uncertainty in a measurement of '*n*' made this way depends on the uncertainty in measuring *p, V* and *T*, and in the tabulated values of *B(T)*. This method of realising the mole for a gas relies on the use of a pure sample of the gas.

Prof. R.C. Budhani, Director, NPL with peer reviewers Dr. Detlef Luck, Mr. S.K. Kimothi and NPLI officers

International and National Status of MiC

The consultative committee for amount of substance (CCQM) was established by International Committee for Weights and Measures (CIPM) at BIPM. Since then efforts are being made by National Metrology Institutes (NMIs) world over, to realize mole through chemical routes under MiC. The CCQM has grown to be the largest consultative committee, and now has 7 CCQM working groups, covering all aspects and fields of MiC. These CCQM working groups are for Gas Analysis (GAWG), Organic Analysis (OAWG), Inorganic Analysis (IAWG), Electrochemical Analysis (EAWG), Bio Analysis (BAWG), Surface Analysis (SAWG), and Key Comparisons and Calibration and Measurement Capabilities Quality (KCWG). Members of these working groups are the experts from the NMIs, other designated institutes, other inter-governmental and international organizations, e.g. International Atomic Energy Agency (IAEA), Institute of Reference Materials and Measurements (IRMM), International Federation of Clinical Chemistry and Laboratory Medicine (IFCC), World Health Organization (WHO), World Meteorological Organization (WMO), ISO REMCO Committee on reference materials, Codex Alimentarius Commission, Co-operation on International Traceability in Analytical Chemistry (CITAC) and International Laboratory Accreditation Cooperation (ILAC). The CCQM works on better understanding and definition of the measurands to be measured and the development and validation of primary and other methods of higher order. The main activities of the CCQM working groups consist of the execution of pilot studies and key comparisons. Joint Committee on Traceability in Laboratory Medicine (JCTLM), established in 2002 by the BIPM, IFCC and ILAC with support of WHO, also has working groups for reference materials, reference procedures and for reference laboratory networks, in the field of clinical chemistry.

National Physical Laboratory (NPL) ensures that SI traceability can be provided to all the measurements made in country through unbroken chain of measurements. This is achieved through a series of testing and calibration laboratories accredited by National Accreditation Board for Testing and Calibration Laboratories (NABL). NPL is closely collaborating with institutions like NABL.

National standards including certified reference materials (CRMs) and related calibration network is vital to enhance quality management system in the country. Certified reference material activity had a small beginning during 10th five-year plan (2002-2006) under advances in metrology. However, during 11th five-year plan (2007-2011), NPL had started MiC, as a new activity for realizing the amount of substance 'mole', and to make efforts for dissemination of SI traceability with its linkage to CRM activity. During 12th plan (2012-2017) MiC activity at NPL will be focused on key sectors like food, health, environment and energy with limited partners, having expertise in the respective areas.

Challenges and Future Plan

The biggest challenge for MiC implementation is the vast area of chemical measurements, namely a huge number of food, environment, energy, health, etc. Each of this area further has thousands of species/parameters to be measured with traceability and stated uncertainty and need MiC measurement capability and related CRMs. A good number of expert institutes/ laboratories designated by NPL are essentially needed at apex level for MiC and producing CRMs or providing calibration facilities in respective areas and conducting PTs for dissemination of traceability. In 12th five-year plan, NPL and its partner labs have focused for above few areas for MiC.

The recognized calibration and measurement capabilities(CMCs) and other means of delivering traceability to the stakeholders/ customers of the NMIs and other designated institutes, in particular CRMs, are based on the results of the key comparisons and the implementation of quality systems in conformity with ISO-17025 and ISO-Guide 34 or equivalent. The CCQM-KCWG combines all the available expertise and knowledge in making final decisions on the reliability of the NMIs claimed CMCs and related services like CRMs. Peer review of MiC quality system (ISO/IEC-17025) and the 13 CMC claims for elemental aqueous standards of NPLI, was carried out during February 21-23, 2012 by review comprising of a technical expert Dr. Detlef Luck, Federal Institute for Materials Research and Testing (BAM) Germany and a quality expert, Mr. S.K. Kimothi, Ex. Director, ERTL/STQC. Based on the review results of NPLI quality system and CMCs claimed in inorganic solutions, the reviewers recommended that, the elemental aqueous standards of NPLI has demonstrated the quality

system of their analysis and testing, and the technical competence to prepare and provide elemental aqueous standards. These are additional MiC activity CMCs in addition to ozone standard peer reviewed during January 11-12, 2012.

NPLI intend to focus on gas-aerosol metrology, ozone measurement calibration facility, elemental aqueous standards (CRMs), electrochemistry (pH buffer CRMs), CRMs for X-ray Diffraction (XRD)/ X-Ray Reflectometer (XRR)/ X-Ray Fluorescence, Scanning Electron and Tunnelling Electron Microscopy (SEM-TEM/HRTEM) and Electron Paramagnetic Resonance (EPR) techniques calibration. In India, MiC has just taken off and there is a long way to go to. Apart from issues of support structures, thrust on awareness of MiC to all the users or stakeholders, the future challenge are: organization of PT programs and production of CRMs for traceability dissemination in chemical measurement for the better quality of life for society.

NABL Activities

NABL-CII Laboratory Conclave

The 1st National Conclave for Laboratories was held on April 04- 05, 2012 at Stein Auditorium, India Habitat Centre, New Delhi. The conclave was held in collaboration with CII, India and was inaugurated by Dr. T. Ramasami, Secretary, Department of Science and Technology.

The purpose of the conclave was to develop "Credible Laboratory Practices, building confidence Nation wide".

Dr. Thirumalachari Ramasami, Secretary, Department of Science and Technology and Chairman, NABL delivering the inaugural address at the 1st National Conclave for Laboratories in New Delhi on April 4, 2012. Others from left: Mr. Anupam Kaul, Principal Counselor, CIHQ, Prof. R.C. Budhani, Director, NPL, Mr. Anil Relia, Director, NABL and Mr. N. Kumar

Mr. K.C. Mehra, Chairman, National Borard for Quality Promotion, QCI (right foreground) and Mr. N. Kumar, Chairman, CII-IQ (left foreground) exchanging the QCI-CII MoU signed on April 4, 2012 in New Delhi during the 1st National Conclave for Laboratorries in the presence of Dr. Thriumalachari Ramasami, Secretary, Department of Science and Technology

The conclave was held to discuss the methodologies to be used to bridge the gap in the national system and global demand to build credibility in laboratory system. This conclave helped in resolution of number of stakeholder issues.

The conclave turned out to be a huge success by the active participation of about 400 stakeholders all over the country.

NABL Medical Assessor Conclave

The Second Conclave of medical assessors was held on May 27 and 28, 2012 at St John's Medical College, Bangalore. The conclave was attended by Lead Assessors from Medical discipline and the purpose was to harmonize the assessment process and understanding of ISO 15189. Technical issues being faced in the assessment were also discussed.

Refresher Training for NABL Faculty

A Three-day 'Refresher Training Course for NABL Faculty' was conducted during May 15–17, 2012 to bring uniformity in interpretation of ISO/IEC 17025:2005 amongst the faculty, assessors and committee members.

Assessors Training as per ISO 15189

A Five-day NABL ISO 15189 Assessor's Training course was conducted during May 29–June 2, 2012 at Delhi for doctors working with National and State reference Laboratories of National AIDS Control Organization, Department of AIDS Control (DAC).

World Accreditation Day Celebrations

NABL in collaboration with QCI, celebrated World Accreditation Day on June 9, 2012 at Lemon Tree Hotel, Ghaziabad. The theme of the accreditation day was "Supporting safe food and clean drinking water". Eminent speakers from FSSAI, EIC, QCI emphasized the importance of safe food, drinking water facility and role of testing laboratories in supporting the issue. It was accentuate that accreditation of the laboratory provided assurance in testing facility especially related to food and water.

Launch of NABL Website

A new user friendly NABL website has been launched in July 2012. All the relevant information required by the applicant and accredited labs are provided on the website. All the NABL documents are available free of cost on the website.

Awareness Programs

NABL has conducted awareness programs jointly with different organizations to promote awareness in the area of Medical Laboratory accreditation. The programs have been conducted at Surat, Delhi and at AIIMS, Delhi.

Activities and Events

SAARC-PTB Attachment Training

A training program for participants form South Asian Association for Regional Cooperation (SAARC) countries was organized on June 11, 2012 for a week at NPL under the sponsorship of Physikalischce, Technische Bundesanstalt (PTB), Germany. The aim of this program is to train the participants from SAARC countries to participate in international inter-comparisons. Participants from Nepal Bureau of Standards and Metrology (NBSM), Nepal and from Bangladesh Standards and Testing Institution (BSTI), Bangladesh attended training in the field of Temperature Metrology. After the successful completion of the training, the participants were provided a certificate. All the participants showed their satisfaction after the program.

Participants of SAARC-PTB attachment training

Training Program for Officers of Legal Metrology

CSIR-NPL arranged this training program with Apex Level Standards and Industrial Metrology Division (ALSIM) for the officials of Legal Metrology under training IILM, Ranchi.The programme took place on July 13, 2012 at CSIR-NPL. It was inaugurated by Dr. A.K. Bandyopadhyay. Dr. Bandyopadhyay gave an overview of Apex Level Standards and Industrial Metrology (ALSIM). Mr. Anil Kumar (Head, Mass Standards), Dr. K.P. Chaudhary (Head, Standards of Dimension) and Dr. Sanjay Yadav (Scientist, Pressure Standards) also delivered lectures in respective fields. After the talks a visit was arranged to mass measurement, volume measurement and length measurement laboratories, where the visiters witnessed the national prototypes and exhibition of hierarchy of standard and were given in an introduction to the measurement facilities.

Participants of the training

News and Views

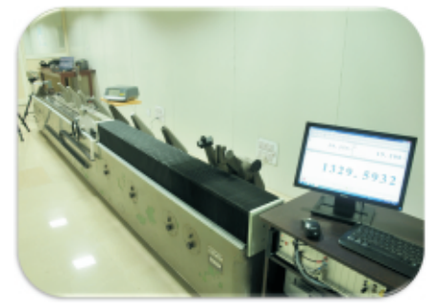
Memorandum of Understanding Signed between CSIR-NPL and INMETRO, Brazil

A Memorandum of Understanding (MOU) has been signed for scientific and technological cooperation in measurement sciences, development of certified reference materials for thermo physical properties, nanometrology, analysis of surface etc. between the Council of Scientific and Industrial Research (CSIR), through National Physical Laboratory (NPL) and the National Institute of Metrology (INMETRO), Brazil. The MOU was signed during the visit of Mr. Anand Sharma, Union Commerce and Industry Minister on June 10, 2012 to Brasilia, Brazil. The purpose of this memorandum is to provide a framework for the exchange of scientific and technological knowledge services and the enhancement of scientific and technical capabilities of the two sides in the areas of chemistry, physics, and engineering measurement sciences.

Establishment of Calibration Facility for Long Gauge Blocks

Long Gauge Block calibration facility using a length measuring machine mounted with a Laser Interferometer has been established by Dr. K.P. Chaudhary and team at Standards of Dimension, National Physical Laboratory (CSIR). This has a nominal length 4000 mm and measurement range 3700 mm with an associated measurement uncertainty of $\pm \{0.3\ \mu m + (L/1200) \times 10^{-6}\}$, L in mm at $k = 2$. This facility will be used for the measurement of Gauge Blocks, Length Bars and other similar artifacts as per IS:2984 / ISO 3650 & IS:7014. Measurement facility follows Abbe's Principle.

Inauguration by Prof. R.C. Budhani



Length Measuring Machine with laser interferometer

The calibration facility was inaugurated by Prof. R.C. Budhani, Director, NPL, New Delhi on April 13, 2012 in the presence of Prof. Vikram Kumar, former Director, NPL; Dr. P. Banerjee, former Acting Director, NPL; Dr. A. Sen Gupta, Scientist H, NPL and Dr. K.P. Chaudhary & team.

Delegation from Botswana Visited CSIR- NPL

A group of scientists from Botswana (Africa) visited NPL on June 25, 2012 under the international co-operation programme of DST and CSIR, to explore possibilities of exchange the co-operation with India. The delegation was briefed by the scientists about the standard activities and visit was organized to take them to some of the activities of the Standards Division. The discussion included mostly Legal Metrological issues concerning with International trade problems and standard related non-compliance.

A New Chapter of Metrology Society of India Formed 'MSI (NR)'

A new chapter of Metrology Society of India, Northern Region (MSI-NR) is formed at Thapar University, Patiala. It is the result of a long pending desire of the members of the northern region of MSI to have their own chapter somewhere in the north region the country other than Delhi.

Prof. Abhijit Mukherjee
President

Prof. Ravinder Agarwal
General Secretary

Following the rules and regulations of the Society, the local chapter of MSI-NR at Thapar University, Patiala will provide a common platform to create two-way communications among the local MSI members to address the challenging needs of metrology to the academic institutions, calibration laboratories, testing laboratories, certifying agencies and industries and to assist the assessors of NABL, etc. Thapar University, Patiala is an excellent academic institutions of the country will play a major role to act as bridge for organizations/laboratories with the academicians. Thus, the goals of MSI-NR will be to support local metrological requirements like calibration / testing procedure, uncertainty analysis, help in proficiency testing, quality management system etc. and also helps in arranging meetings / training of human resources from the calibration / testing laboratories and industries. An adhoc executive council of the chapter has already been formed appointing Prof. Abhijit Mukherjee, Director of Thapar University as President and Prof. Ravinder Agarwal as General Secretary.

Detection of Yoctogram (10^{-24} g)- Latest Capability in Detection of Small Mass Differences*

Researchers in Spain have made a most sensitive mass sensor. It is capable to detect a single proton whose mass value is 1.7 yoctogram (10^{-24} g). The device is made of a suspended carbon nano-tube of dimensions 150 nm, 2nm in diameter and resonates with a frequency of 2 GHz. The device could be used to detect single

molecules or to study chemical reactions as they happen. It could even provide the insight into the fundamentals of quantum mechanics.

The technique based on the use of micro-cantilevers for detection of small mass differences is developing at a much faster rate. It may be noted that the capability of detection of small mass differences was only zeptogram 10^{-21} g till 2008. The day is not far off when the technique is used as a mass measurement tool for atoms and elementary particles.

*[Ref: Nature Nanotechnology 7, 301–304, (2012)] News item curtsey Dr S V Gupta

Consultative Committee for Acoustics, Ultrasound and Vibration (CCAUV)

The Consultative Committee of Acoustics, Ultrasound and Vibration met from June 13 to 14, 2012 at BIPM, France and Dr. Mahavir Singh, Principal Scientist, NPL attended the meeting as NPL representative. The meeting started with oral presentations of specific topics such as "Application of optics to acoustical metrology", "Calibrations for underwater sound level measurements" and "Development of characterisation methods of therapeutic ultrasound" concentrated on current trends in the AUV field. The work issued by the associated working groups was reported, activities carried out in the RMOs and the NMIs were communicated and particular questions concerning ongoing and planned key comparisons were discussed. In particular, the main issues of the outcome of the CGPM ad hoc working group were summarized and the needs for a strategic planning process were emphasized.

Official Time Gets an Extra Second, the Leap Second

June 30 this year was one second longer than a regular day. Rather than changing from 23:59:59 on June 30 to 00:00:00 on July 1, the official time got an extra second at 23:59:60. This is the so called Leap Second by all official Timekeepers worldwide. In India, it was introduced by the Time & Frequency Division of CSIR-National Physical Laboratory, New Delhi.

Let us try to understand the Leap Second and the reason for introducing it. Traditionally, since the introduction of modern scientific methods mankind has used as the basis for timekeeping, the period of the rotation of the Earth around its axis or the solar day as being perfectly constant equal to 24 hours. However, since the invention of atomic clocks, it was found that the length of the solar day, not only has seasonal and periodic fluctuations but is also increasing ever so slightly. This increase is primarily due to slowing down of the earth because of tidal forces between Earth and the moon. Since the year 1972 the time based on the atomic clocks has been adopted as the basis for international timekeeping. Deue to the irregularities of the earth rotation rate and its slowing down, the atomic time scale and the traditional earth rotation based time scale have drifted apart from each other at the rate of approximately one second every couple of years. To keep agreemetn between the two scales a compromise atomic scale has been internationally adopted in the Coordinated Universal Time or UTC, which runs at the rate of the atomic time scale but is stopped by one second occcasionally to keep it in agreement with the earch rotation scale. The International Earth Rotation and Reference Systems Service (IERS) is responsible for monitoring the Earth's rotation and announces the dates of application of any leap seconds required, usually timed for the end of 30 June or 31 December. This was the 26th occasion since 1972 that a leap second adjustment has been made. The previous leap second was introduced on 31st December 2008.

BIPM e-News

International Bureau of Weights and Measures(BIPM) launched BIPM e-News, which will be published twice a year and will highlight some key recent issues and achievements. The first issue can be downloaded from http://www.bipm.org/utils/common/pdf/enews/BIPM_News-2012_06.pdf

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