TRAINING COURSE ON IMPEDANCE AND DIMENSIONAL METROLOGY AND 4TH INTERNATIONAL CONFERENCE ON ADVANCES IN METROLOGY EQUIVALENCE OF STANDARDS AND GLOBAL RECOGNITION (ADMET-2003), NATIONAL PHYSICAL LABORATORY, NEW DELHI (INDIA), FEBRUARY 4-9, 2003

PARTICIPATING COUNTRIES: 7 MEMBER COUNTRIES OFTHE NAM S&T CENTRE

NUMBER OF PARTICIPANTS SPONSORED BY NAM S&T CENTRE: 6

NUMBER OF RESOURCE PERSONS: 10 FROM CZECH REPUBLIC, FRANCE, GERMANY, INDIA, MALAYSIA, NETHERLANDS, SOUTH AFRICA AND UK

Metrology is the science of measurement and forms the bedrock on which modern day science and technology rests. It has always played a vital role in the development of society, economy and trade. Rapid advances in precision engineering, micro- and nano-technology, space exploration etc. have put pressing demands on National Measurement Institutes (NMIs) for the realization of the standards of physical and chemical measurements, both at micro and macro levels, with highest levels of accuracies and traceability to the international measurement system. Measurement Science has played a key role in understanding physical phenomena and thereby acquiring deeper knowledge of the nature.

The phenomena of Globalization has brought to fore important issues of equivalence and compatibility of measurements made in different locations around the world and considerable efforts are being made in building the confidence so that measurements made in one location in the world are compatible/equivalent to those made in other locations on the same or related products. This ensures that the measurements are repeatable, comparable and traceable to both national and international standards. Mutual Recognition Arrangement (MRA), accreditation procedures, audit processes, standards comparison, Proficiency Testing (PT), Measurement Assurance Programme (MAP) and other techniques are involved in validating these efforts. To realize all these, the NMIs are required to follow international standards such as ISO/IEC 17025: 1999.

In this context, as a sequel of the International Conference on 'Metrology in the New Millennium and Global Trade' during February 8-10, 2001 and the 6th CIMET-NAM-NPL Training Programme on 'Metrology, Quality Assurance and Global Trade' during January 22 - February 2, 2001 which was organized by the NAM S&T Center jointly with Commonwealth-India Metrology Centre (CIMET) and the National Physical Laboratory (NPL), as has been reported in Item III.30, a 3-days satellite meeting on 'Impedance Metrology' and an advanced training course on 'Impedance and Dimensional Metrology' were held at NPL, New Delhi, India during February 4-9, 2003. The NAM S&T Centre organized this advanced training course jointly with the Metrology Society of India (MSI) and the National Physical Laboratory (NPL) of the Council of Scientific & Industrial Research (CSIR), New Delhi, India. In between the Satellite meeting and the

Advance Training course, the participants also attended the 4th International Conference on Advances in Metrology Equivalence of Standards and Global Recognition (ADMET-2003) during February 5–7, 2003 organized by the Metrology Society of India (MSI) and the National Physical Laboratory (NPL), New Delhi and sponsored by the Council of Scientific & Industrial Research (CSIR), Quality Council of India (QCI), National Accreditation Board for Calibration & Testing Laboratories (NABL), All India Council for Technical Education (AICTE), Defence Research & Development Organization (DRDO), National Test House, Indian National Science Academy (INSA) and the Department of Science & Technology (DST), Government of India.

Scientists and Metrologists from seven member countries of the NAM S&T Centre participated in the above training course. These included Mr. Md. Abdus Salam, Senior Engineer, Reactor Operation and Maintenance Unit (ROMU), AERE, Savar, Dhaka, Bangladesh; Dr. Mohamed Ahmed Amer, Researcher, National Institute of Standards, Egypt; Mr. Abdul Rashid Bin Z. Abidin, Principal Metrologist, National Metrology Laboratory, Malaysia; Dr. Veer Singh, Acting Technical Manager, Mauritius Standards Bureau (MSB), Villa Road, Moka, Mauritius; Mr. Ehala Walawwe Kithsiri Janakantha Bandara Ehelepola, Research Officer/Deputy Quality Manager, Metrology and Instrumentation Division, Industrial Technology Institute, Colombo, Sri Lanka; and Dr. Tran Quang Ui, Head, R&D Section, R&D Section of Vietnam Metrology Institute(VMI), Vietnam, besides a few specialists from India.

The satellite meeting on 'Impedance Metrology' was held on February 4, 2003. The speakers included Mr. Jiri Horsky CMI, Czech Republic; Mr. Alexandre Bounouh, BNM-LNE, France; Mr. Jeurgen Melcher, PTB, Germany; Mr. Abdul Rashid Zainal Abidin, SIRIM, Malaysia; Dr. Robert Kaarls, CCQM, Netherlands; Mr. Erik Dierikx, NMI-VSL, Netherlands; Mr. Alan Moodley, CSIR-NML, South Africa; Dr. Bryan Kibble, Consultant, United Kingdom; and Mr. Anil Saxena and Mr. Om Kar Nath from NPL, India. In his inaugural speech, Dr. Krishan Lal, Director, NPL, India, welcomed the participants to the satellite meeting and the training programme. He informed the participants that all NPL base units have achieved international standards and that NPL was aggressively following a policy of upgrading all the other subsidiary units too. This was followed by the Keynote address delivered by Dr. Robert Kaarls, Secretary, CPIM and President, CCQM, Netherlands, in which he apprised the participants with the developments made in applying Metrology to new areas like food testing, biotechnology etc. He also talked about the need of make precise measurements and the need of developing conventions acceptable throughout the world. The inauguration ceremony concluded with the address of the NAM S&T Centre, who stated that the popularity of these training courses has been steadily increasing and this is evident from the increasing number of participants taking part in successive training programs. He also suggested that the training program should include an interactive session so as to provide the participants a platform to discuss the difficulties faced by their respective countries in developing metrology and to help identify and implement requisite solutions with the help of NPL India and other international laboratories.

The satellite meeting was divided into four sessions. The first four sessions comprised of the inaugural speeches, the keynote address and talks by the specialist faculty on various topics. In his talk, Dr. Bryan Kibble apprised the participants about the recent advances made in the design of coaxial AC bridges and talked about the researches being carried out in various laboratories for extending the working frequencies of these bridges from a few kHz to several MHz by reducing the length of certain interconnection cables and components in direct proportion to the operating frequency while retaining measurement accuracy. He also mentioned about the investigations in progress on establishing the Quantum Hall effect as quantum standard of AC impedance. Mr. Eric Dierikx from NMi, Netherlands was the next speaker, who elaborated on his efforts in building a measuring system for absolute calibrations of Inductive Voltage Dividers (IVDs) using the bootstrap method. The same system can also be used to compare an unknown divider with a reference divider. His talk described the setup, the theory of operation and the uncertainty contributions in the measurement. After this Mr. S. S Moodley discussed at length about the progress made by CSIR-NML on deriving the Farad from the Ohm through the quantum hall effect. (QHE) and AC coaxial bridges and the CSIR-NML process to derivation system with details of several key components. Mr. A.K. Saxena discussed about the applications of IVDs in AC measurements. IVDs are used in precision AC bridges for maintaining primary standards of inductance, capacitance and resistances and their calibrations at NPL and have become the heart of AC precision bridges by replacing resistive dividers, because they are immune to temperature and aging effect and are extensively used in development of automatic auto balancing AC bridges also.

Dr. Bryan Kibble in his talk apprised the participants of the work being done at NPL, UK on extending low frequency impedance measurements to 10Mhz while preserving the usual four terminal - pair terminal configuration. These are required for calibrating commercial four terminal - pair network analyzers, which are now in widespread use. Dr. J. Horsky described in detail how the range of calibration of Auto-Balancing-Bridge RLC meters can be minimized so as to conform to the specifications based on the functional analysis of instruments principle. Next, Mr. E. F. Dierikx elaborated on how a resonance bridges could be used in laboratories to obtain traceability for the unit of self-inductance. The last speaker in this session was Mr. Alexander Bounouh, BNM-LNE, France, who discussed a new design of coaxial AC resistance standards with calculable frequency dependence, developed at BNM-LNE. It is based on a metallic thin film of NiCr deposited on a short stick of ceramic. The characteristics have been calculated using both analytical and numerical methods.

The first speaker in the last session was Dr. Jiri Horsky, who briefly described the evolution of impedance measurements and their traceability in the Czech Republic. Mr. A.R.Z Abidin, SIRIM, Malaysia threw light on the preliminary work being done at NML Malaysia on linking the DC resistance scale to the capacitance scale. Finally, Mr. J. Melcher presented the work done by him and his team in establishing a measurement system that allows the calibration of

standard capacitors in terms of $R_{K\text{-}90}$. The satellite meeting concluded with the participants visiting the NPL (I) Impedance laboratories.

The training course on 'Dimensional Metrology' was held at NPL, India during February 8-9, 2003. The speakers included Dr. Rina Sharma, Dr. N.K Aggarwal, Dr. R.P Singhal and Dr. K.P. Chaudhary, from NPL India. Dr. Rina Sharma deliberated on various methods used for calculating uncertainty as per the guidelines laid by *Guide to the Expression of Uncertainty in Measurement (GUM)* published in the name of BIPM, IEC, IFCC, ISO, IUPAP and OIML, *EA-4/0, Assessment of Uncertainty in Measurements* and NABL 141 which are the publications of Europena Cooperation for Accreditation. Dr. N.K Aggarwal talked on factors affecting the measurement uncertainty and ultimately the calculation of overall uncertainty for any given measurement / calibration, which is a universal approach. He explained the methods used for calibrating surface plates, external micrometer, etc. The talk delivered by Dr. R.P Singh dealt with Surface Roughness, its concept, definitions and assessment. Dr. K.P Chaudhary informed the participants of the latest trends in measurement for Dimensional Metrology such as non-contact optical sensors, lasers etc. Apart from this, the participants were also given hands on training in NPL laboratories in handling various tools, equipment etc.

In his concluding remarks Dr. Krishan Lal stressed on the need to explore and exploit the enormous potential for cooperation between the countries in South East Asia. He also informed the participants that NPL, India is undergoing a major up gradation program and other countries lacking the requisite expertise must avail these facilities by associating themselves with this organization.