PREFACE

This Report summarises the progress made by the NPL during the two-year period April 1982 to March 1984. The major areas of work were: Standards, Materials Development and Characterization, Radio & Space Science, High Pressure Technology, Solar Energy, Cryogenics and Applied Projects.

The Primary Standards being the statutory responsibility of the Laboratory, much of our efforts and emphasis was devoted to this area. In this, the most important was the increasing effort on intercomparison of standards under Asia Pacific Metrology Programme. The parameters covered were:

a) photometric standards (a set of 4 standard lamps - three participating countries),
b) length standard (a set of 10 slip gauges - eight participating countries),
c) D.C. resistance standard (1 ohm and 10 kilo ohm standard resistors - eight participating countries),
d) High frequency attenuators of 3, 6, 10, 20 & 40 dB calibrated at 30 MHz (carried out amongst Australia, China, India and Singapore).

Intercomparison was also carried out with VNIIM (D.I. Mendeleyev Institute of Metrology, Leningrad), on standards of D.C. voltage and resistance, L.F. and H.F. voltage upto 30 MHz, capacitance, and inductance (at 10 mH level). An atomic clock intercomparison with VNIIIFTRI, Moscow, was also done.

The second major activity of standards concerned the question of using satellites for dissemination of standard time and frequency. Preliminary experiments were conducted with INTELSAT II and INSAT 1B.

An interesting experiment performed by radio astronomers in December 1983 involved very long base-line interferometry (VLBI) in which the participating observatories were Ootacamund (India), Jodrell Bank (UK), Westerbrook (Holland), Torun (Poland) and Crimea (USSR). A crucial component of the experiment was a high level clock synchronisation. This was achieved with two rubidium clocks provided by the NPL and the P&T. The clocks were linked with the primary NPL cesium clock with a synchronisation of 10 μs.

Other important activities in the standards area were: the improvement of capacitance standard to 2-3 parts in $10^7$, based on the vertical model of the calculator capacitor; establishment of primary standard of pressure in the region 7.5 MPa - 500 MPa; realisation of low value inductances (0.1 μH to 10 μH) from capacitance; and evaluation of the performance of the iodine-stabilized He-Ne laser through determination of its stability and reproducibility by beat frequency experiments.

A Regional Working Group meeting on ‘Metrology for South and Central Asia’ was held at the NPL from 9-11 August 1982. A Training Workshop on ‘Metrology and Standardisation for Developing Countries and Small Island States’ was also held from 6-17 February 1984.

Under a bilateral programme of the DST, some equipment for the Quality Control Laboratory of the Weights and Measurement of Srilanka, duly calibrated by the NPL, was also supplied.

In the area of Materials Development, major activities concentrated on were: Carbon fibres & Carbon-Carbon Composites, Beta Alumina, Polysilicon from trichlorosilane (NPL-NCL collaborative programme), and the initiation of work on Microelectronics.
The quality and the reproducibility of carbon fibres were improved, and work was undertaken for the development of two-directional carbon-carbon composites for biomedical applications using coal tar pitch as a matrix. Composites with density of 1.5 gm/cc, flexural strength of 260 MN/m² and flexural modulus of 25 GN/m² were developed.

Beta alumina solid electrolyte tubes were prepared.

Large size CVD reactors for preparation of polysilicon from trichlorosilane with the objective of setting up a pilot plant for 1 tonne/year at the NCL, were designed. In ultrasonics area a major achievement was the generation of wide-band parametric acoustic arrays in air.

Since work on materials depends very critically on the quality of material characterization, facilities for characterization of materials were strengthened. Additional new equipment installed included:

i) JEOL scanning electron microscope, together with energy dispersive spectrometer (EDP) and wavelength dispersive spectrometer (WDS) as attachments; and

ii) JEOL transmission electron microscope with SEM attachment (the first 20 KeV electron microscope in India).

A null detection system for measurement of infra-red radiation was developed at the Laboratory.

The Material Characterisation Group has always been active in several areas of fundamental research in addition to its service functions. An original new study concerned observation of micro-structural changes induced by microwave electric field in silicon single crystals. This was done in collaboration with PTB, F.R.G., by bringing into play the capability of very high resolution X-ray diffraction developed earlier at the NPL.

In the area of Radio Science, the most important activity concerned is the NPL participation in the Indian Middle Atmosphere Programme (IMAP). NPL’s participation occurred in a number of ways: through its own scientific contributions, through its participation in the IMAP Working Groups, and in providing guidance to the entire IMAP programme through the Scientific Advisory Committees of the IMAP.

The NPL experiments for the IMAP were varied and extensive. These included rocket and balloon measurements of ionization, aerosol and Ozone in the middle atmosphere, continuous monitoring of solar UV-B radiations, and work relating to the establishment of a tunable CO₂ laser heterodyne system for the measurement of atmospheric minor species. Two IMAP consolidation reports were prepared by the NPL scientists—one on Reference Ionization Profiles over the Indian sub-continent and the other on Reference Ozonosphere over India.

One of the most important activities concerned NPL’s participation in the Indo-USSR Ozone Intercomparison Campaign conducted during the last week of March 1983 involving a number of rocket-borne optical and chemical ozonesondes (of NPL, PRL and USSR), balloon-borne ozonesondes (IMD), Dobson Spectrophotometer and Surface Ozone measurements (IMD).

A balloon-borne Langmuir probe was launched in May 1983 for the measurement of stratospheric ion densities.

The group contributed substantially to the design of MST Radar which is planned to be undertaken as a national facility.

In addition to IMAP, activities on the tropospheric and ionospheric radio communications continued. A wide variety of organisations including Defence services, P&T, Railways, AIR and Doordarshan continue to seek this consultancy service from the NPL.

A radar campaign was conducted during the pre-monsoon month of May 1982 with cyclone warning radars of IMD located over the east coast of India; the objective was to gather information regarding ducting, super-refraction and anomalous clear-air echoes of critical interest in tactical radar applications.

In regard to communication prediction and prediction of magnetic parameters, the services of NPL were greatly sought after. A new type of prediction introduced was magnetic storm alert
as an aid to low-latitude H.F. communication.

SODAR which was introduced for the first time in India in the seventies went through a new phase it was used on a forward scattering mode. A technique was developed for distinguishing wind shear layers in the atmospheric boundary layer from radiation inversion layers.

Satellite radio beacon observations continued. ETS-II geostationary satellites was used at 136 MHz. A chain of stations was operated by NPL at Delhi, Nagpur, Hyderabad and Bangalore in collaboration with the universities and institutions in these places.

A proposal for an aeronomy science mission in SROSS satellite was submitted to ISRO. A joint NPL-PRL mission on aeronomy is planned.

Efforts to continuously improve the reference ionosphere over India continued. The data used covered observations from a wide variety of sources specially those from incoherent scatter radar.

Four major workshops were also held in this area:

1) Indo-US Workshop on Global Ozone Problems (11-20 January 1983),
2) International Symposium on Beacon Satellite Studies of the Earth’s Environment (7-11 February 1983),
3) Indo-US Workshop on Solar Terrestrial Physics (30 January to 3 February 1984), and
4) Workshop on Radio Propagation in Tropics (1-12 November 1982) at Trieste, Italy.

The Workshop on Beacon Satellite Studies was preceded by a specially organised two-day programme on ‘Beacon Techniques and Applications’ for scientists from developing countries under the sponsorship of URSI. The Trieste Workshop was directed by Dr. A.P. Mitra, and Dr. B.M. Reddy was a member of the Faculty.

In the area of high pressure technology, work continued on synthesis of super-hard materials and material extrusion. A new addition to the facilities was a 1000-tonne hydraulic press commissioned in early 1984. Dialogue was introduced with several industries for the use of the high pressure technology facility and expertise.

Solar Energy has been a programme of interest to the Laboratory for more than two decades. In the thermal area, work continued on the establishment of a national test facility for solar collectors. Lighting of the 9th ASIAD torch by solar energy was successfully executed with a solar concentrator installed by the NPL at the National Stadium, New Delhi. The late Prime Minister Mrs. Indira Gandhi lighted the torch.

On the photovoltaic side, work on the development of polycrystalline silicon substrates continued. Ingots upto 55 mm dia were prepared by directional solidification of silicon melt inside graphite crucibles.

In the Cryogenics area, the major emphasis was in the following directions:

a) Establishment of the Josephson voltage standard,
b) Development of cryogenic materials, devices and systems, and
c) Experiments and theories on the mechanism of superconductivity.

A low-capacity liquid air plant based on Stirling cycle, was successfully designed, developed and assembled.

A two-day workshop on ‘Superconductivity-Magnetism Interplay’ was also held on 14-15 April 1983.

The Laboratory has been contributing appreciably to specific requirements of other agencies. These included development of space qualified interference filters for the ‘Smart’ sensor (payload of Rohini satellite D-2), the development of collimating sight glass for use in fighter planes, and transfer of know-how of infra-red hot axle detection system to CEL.

Work on xero-radiography progressed and a Laboratory model was fabricated.

NPL scientists have participated in all the Indian expeditions to the Antarctic. During this period the second and third expeditions to the Antarctica took place. For the second expedition
Two NPL scientists were sent: Dr. Amitava Sengupta and Dr. P.K. Pasricha. For the third expedition Dr. A.K. Hanjura was the NPL representative.

NPL scientists continue to receive honours and awards, both national and international. Dr. Krishan Lal was elected Fellow of the Indian National Science Academy for the year 1983 in recognition of his fundamental contributions in high resolution X-ray diffraction studies of crystal defects and growth of crystals. Dr. Kailash Chandra was elected as the Regional Coordinator of the Asia-Pacific Metrology Programme for a 3-year period with effect from October 1983. Dr. Y.V. Somayajuly and Dr. A.K. Saha continued to play a major role for the execution of the IMAP programme as Chairman of IMAP Working Groups on ‘Ionization Campaign’ and ‘Minor constituents and Atmospheric Chemistry’, respectively.

A ‘Science Week’ was organised from November 12-18, 1983 in which the Laboratory was kept open to the public, representatives of the industry, and academic community. A Young Scientists’ Programme was organised in which about 10 selected young people were invited to be the guests of NPL. Four distinguished lectures as a part of the Science Week were given.


More than 200 papers were published in professional journals and about an equal number were presented in national and international conferences and symposia. These include about 75 papers presented in about 35 international symposia/conferences held during the period.

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(A.P. MITRA)
Director