



वार्षिक प्रतिवेदन 2018-19



ANNUAL REPORT 2018-19

सी एस आई आर - राष्ट्रीय भौतिक प्रयोगशाला
CSIR-National Physical Laboratory, New Delhi

National Metrology Institute (NMI) of India



राष्ट्रीय भौतिक प्रयोगशाला, नई दिल्ली (वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद्)

NATIONAL PHYSICAL LABORATORY

(Council of Scientific and Industrial Research)

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गुणवत्ता नीति • Quality Policy

अन्तर्राष्ट्रीय मानकों के अनुरूप बनाए गए राष्ट्रीय मापन मानकों को सतत अनुसंधान और विकास द्वारा स्थापित करना, उनका रख रखाव करना और उनका उन्नयन करना।

आई एस/आई एस ओ/ आई ई सी 17025:2005 के अनुसार शीर्ष स्तर का अंशाकन प्रदान करना एवं मानकों के प्रसार का कार्य करना जिससे गुणवत्ता प्रणाली का सजगता और दक्षता से पालन करते हुए मापों की अनुमार्गणीयता को बनाए रखना।

To establish, maintain and upgrade the national standards of measurement compatible to international standards through continuous research and development.

To provide apex level calibration and dissemination of standards for maintaining the traceability of measurement following Quality System as per IS/ISO/IEC 17025:2005 consciously and effectively.

उद्देश्य • Objectives

पूर्व निर्धारित अवधि में अंशाकन और परीक्षण का कार्य पूरा करना जिससे ग्राहक भी पूर्णतया संतुष्ट हों।

सभी अंशाकन व परीक्षण से सम्बन्धित कार्मिकों को गुणवत्ता प्रणाली की नीतियों और कार्य विधियों के प्रलेखन और कार्यान्वयन से अवगत कराना।

To provide calibration and testing within the specified time, and to the satisfaction of the customers.

To familiarize all personnel concerned in calibration and testing with quality system documentation and implementation of policies and procedures.

डा. दिनेश कुमार असवाल
निदेशक

Dr. Dinesh Kumar Aswal
Director

CSIR-NPL: Vision and Mandate



Shri Narendra Modi
Prime Minister
President, CSIR



Dr. Harsh Vardhan
Hon'ble Cabinet Minister for Ministry
of Science & Technology, Ministry of
Health & Family Welfare,
Ministry of Earth Sciences
Vice President CSIR



Dr. Shekhar C. Mande
Director General,
CSIR and Secretary DSIR



Dr. Dinesh Kumar Aswal
Director, CSIR-NPL

Vision and Mission

“Accurate and precise measurement are essential to drive the growth engines of Indian Science & Industry as it removes chaos and prompts innovations, which in turn, would save precious lives, resources and time....

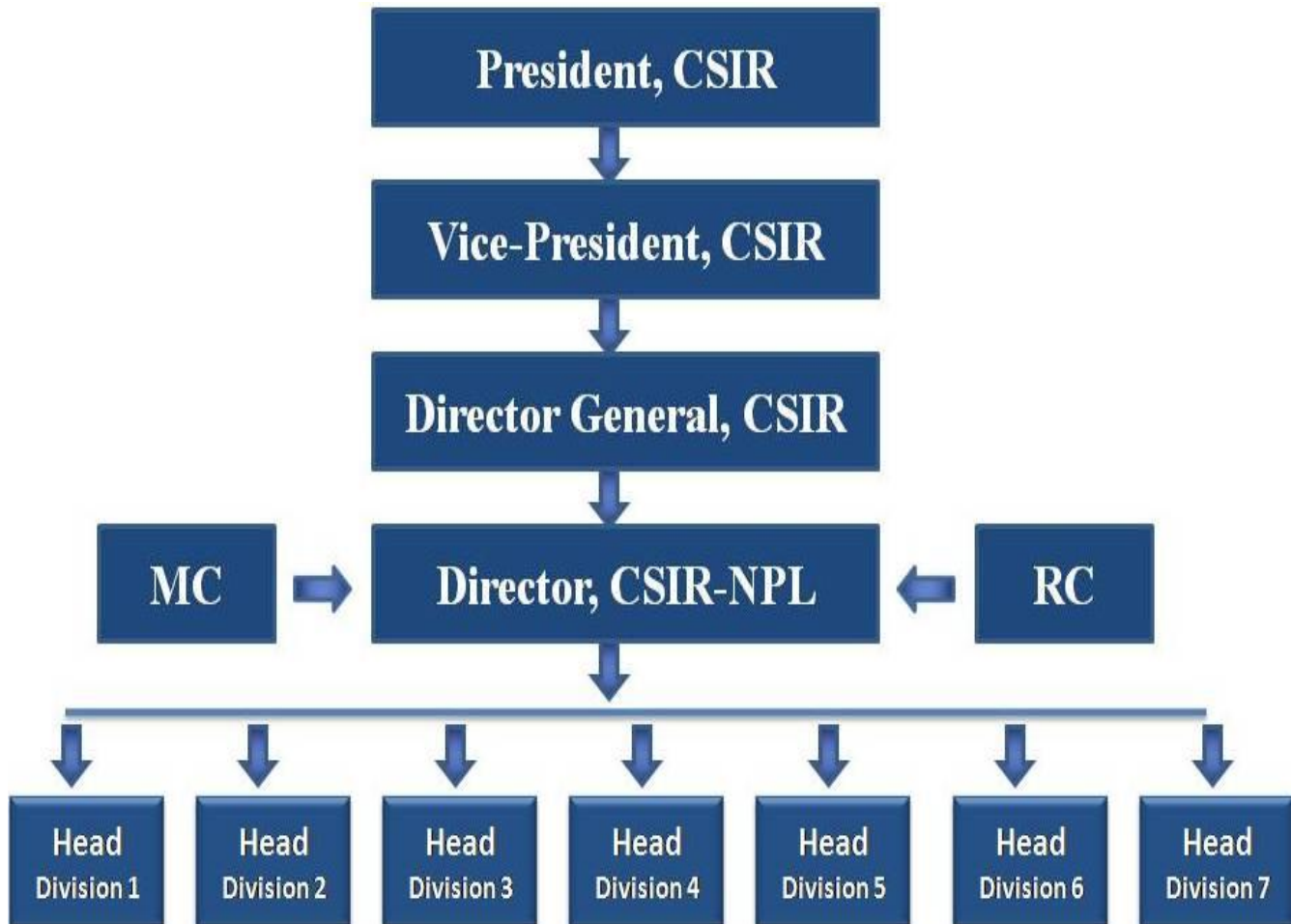
- a) *Developing India’s measurement standards that are internationally accepted and disseminating the measurement capabilities to industry, government, strategic and academia that underpin the India’s prosperity and quality of life.*
- b) *Conducting multidisciplinary R&D with a mission to establish the futuristic quantum standards and upcoming technologies so that India remains on par with international measurement laboratories.*
- c) *Developing sophisticated analytical equipments (i.e. import substitutes) under “Make in India” programme to cater the ever increasing demands of emerging India.*
- d) *Training of young scientists and industry personnel in the area of measurements under “Skill India” programme.*

Mandate

CSIR-National Physical Laboratory (NPL-India) is mandated to be India’s “National Metrology Institute” (NMI) by the act of Parliament and is the custodian of “National Standards” with a responsibility of the dissemination of measurements to the needs of the Country.

Organizational Structure

CSIR-NPL: Assuring Quality of Life



Division 1: Physico-Mechanical Metrology

Division 2: Electrical & Electronics Metrology

Division 3: Environmental Sciences and Biomedical Metrology

Division 4: Advanced Materials and Device Metrology

Division 5: Bhartiya Nirdeshak Dravya (BND®): Indian Reference Materials

Division 6: Indian Standard Time Metrology

Division 7: Directorate

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Preface



I am delighted to present the Annual Report of CSIR-National Physical Laboratory (CSIR-NPL) for the year 2018-19. CSIR-NPL has a mandate to realize and maintain National Standards of Measurement apart from being a premier research laboratory in the field of Physical Sciences. The CSIR-NPL has come a long way and continues to grow its horizons as the National Metrology Institute of India.

Keeping pace with an evolving environment powered by science and technology, CSIR-NPL has to keep orienting itself from time to time to

maintain its significant contribution to India's national competitiveness as well as global image.

The CSIR-NPL has been striving continuously to accomplish its mandate as the National Metrology Institute (NMI) of India and the custodian of the National Standards of Measurement. Thus, maintenance and up-gradation of the National Standards of Measurements remained the statutory responsibility of CSIR-NPL. Besides this, intensive R&D was carried out in frontier areas of Physics under several externally funded and in-house projects.

The year 2018-19 has been one of the productive years for us in all facets of CSIR-NPL mission, including new technologies, new knowledge creation, development of human capital etc. In the domain of Atmospheric Pollution and Biomedical Metrology, CSIR-NPL is promoting the quality measurements under its mission projects. In this connection, the Ministry of Environment, Forest & Climate Change (MOEF&CC), Government of India has designated the CSIR-NPL as the "Certification Agency" for Air Pollution Monitoring Equipments. Given this, a group at CSIR-NPL is actively working to establish a testing and calibration facility for various automated Air Monitoring Systems (AMS) especially for Continuous Emission Monitoring Systems (CEMS) and Continuous Ambient Air Quality Monitoring Systems (CAAQMS), which will be a new national facility to provide Certification. This will help in removing the major barrier in ensuring the quality of environmental monitoring data from various sources.

The World Health Organization (WHO) and Minamata convention have a mission to phase out mercury in health care by the year 2020, and India is a signatory to these missions. To enable this, CSIR-NPL India has initiated work to setup a calibration facility for mercury-free IR clinical thermometers.

To cater the need of lighting industries and energy-efficient LED and LED-based lighting manufacturers in India, 'Creation of Testing and Calibration Facility for LED and LED-based Lighting at CSIR-NPL India as per National/International Standards,' has been initiated, funded by the Bureau of Energy Efficiency (Ministry of Power) and CSIR. CSIR-NPL has established a 5 axes fully motor controlled ultrasonic scanning tank facility. Such an automated 5 axes tank with NPL's own developed customized software will be utilized to provide the improved metrological facility to the end-users.

We have also started providing the time and frequency traceability to times scale systems at Bengaluru and Lucknow of ISTRAC/ISRO. NavIC satellites are also synchronize to time provided by the CSIR-NPL. SAR and Phasor Measurement Unit Calibration Systems to cater DoT and Smart Grids, respectively, are being established. The traceability of AC High Voltage and High Current is also being disseminated to Power Sector.

CSIR-NPL has recently invented Ferroelectric Loop tracer apparatus for polarization and electric field measurement at various frequencies in thin-film samples for in-situ monitoring, and on-screen plotting of PE loop and real-time calculation of various related parameters. Also, a dielectric constant measurement facility is established for solid reference dielectric materials from 1 kHz - 10 MHz

During 2018-19, significant achievements have been made in the area of photovoltaic, new energy materials, sensors and carbon-based products. National facility for primary solar cell calibration has been initiated under an MNRE funded project. Perovskite/Organic Solar Panels and Novel Hole Transport Layer (HTL), Electron Transport Layer (ETL), Solar absorber materials, multifunctional, and luminescent nanostructures were developed for various strategic applications. Technological solutions provided to the rural population of the nation this year includes - a low-cost refrigerator, and a technology for conversion of jute sticks to activated carbon.

Understanding the national need for the development of indigenous reference materials traceable to National Metrology Institute (NMI) of India, CSIR-NPL expanded its mission for metrological traceability and development of indigenous Certified Reference Materials/ Bharatiya Nirdeshak Dravyas (BND®) and joined hands with various Reference Material Producers (RMP's) for creation of new BND's. During 2018-19, CSIR-NPL has developed thirteen Certified Reference Materials (CRMs) / Bharatiya Nirdeshak Dravyas (BND®) in collaboration with Reference Material Producers (RMPs) of India in various parameters such as building materials, high purity compound, aqueous elemental standards, pH standards, and petroleum-based products.

Apart from being a pivotal research and development institute, CSIR-NPL plays a vital role in Human Resource Development in the areas of Metrology. A one year course on Precision Measurement and Quality Control (PMQC) has been started under CSIR integrated skill development initiative. The first batch of this course, comprised of 13 students, who has successfully completed the course and placed well in jobs. For PMQC-2018, there are 45 registered students. Industrial training was also organized in the areas of Metrology as well as other specialized topics. CSIR-NPL provided facilities to students from universities and other educational institutes like IITs, IISc-Bangalore, etc., for project work and training. Under the Academy of Scientific and Innovative Research (AcSIR), 104 students were registered, and 31 were awarded Ph.D.

During the year, a total of 308 papers in SCI-indexed journals were published by the CSIR-NPL researchers. Three patents were filed in India, and four were filed abroad. Eight international patents and four Indian patents filed in previous years were granted during 2018-19. Also, 3130 calibration reports were issued, which contributed to the generation of external cash flow (ECF). ECF generated from testing and calibration is ~Rs 11 crores.

I wish to acknowledge the significant support, cooperation and motivation that CSIR Headquarter, Research Council and Management Council have provided from time to time, which has proved very helpful in achieving our goals. I am also delighted to the external experts who visited CSIR-NPL on various occasions and have always given us a committed and devoted impetus to excellence.

I would also like to recognize all CSIR-NPL staff and young researchers for their valuable contributions and I am sure that they will continue to work harder in the years ahead to make CSIR-NPL one of the most competitive institutions.

(D K ASWAL)
Director, CSIR-NPL

CSIR-NPL: Enabling Quality Infrastructure

List of selected organizations to whom support, advices and apex calibration services are being provided

Government/Semi-government Organizations

Air Force; Air India; Bharat Electronics; BHEL; Bhilai Steel Plant; Bureau of Indian Standards; Central Pollution Control Board; Central Power Research Institute; Central Public Works Department; Railway Information System; Central Institute of Mining and Fuel Research; Defense Electronics Applications Laboratory; Delhi Jal Board; Directorate of Border Security Force; Hindustan Aeronautic Limited; Indian Oil; ISRO Inertial Systems Unit; Maharashtra State Electricity Board; Micro, Small and Medium Enterprise Testing Center; NTPC; Nuclear Fuel Complex (DAE); Ordnance Factory; Rail Coach Factory; FCRI; Defence Research and Development Organisation (DRDO), etc.

Industries

ABB India; ACC; AIMIL Ltd.; Alstom India; Ambuja Cement; Binani Cement; Birla Tyres; Blue Star; Bureau Veritas; Casio India; Crompton Greaves Limited; Diesel Locomotive Works; Essar Oil Ltd.; Godrej & Boyce Mfg. Co. Ltd; Havells India; Honda Cars; International Zinc Association; J.K. White Cement; JK Lakshmi Cement; Kirloskar Brothers; Larsen & Toubro; Maruti Suzuki; Mysore Paints & Varnish; Philips India; Piramal Healthcare; Ranbaxy; Rapid Metro Rail Gurgaon; Samsung India; Endress + Hauser India Pvt. Ltd.; Capital Power; Itron; Padmini VNA Mechatronics etc.

SAARC Nations

Nepal Bureau of Standards & Metrology (MBSM), Nepal; Bangladesh Standards and Testing Institution (BSTI), Bangladesh; Measurement Units, Standards and Services Department (MUSSD), Sri Lanka; National Physical and Standards Laboratory (NPSL), Pakistan; Bhutan Standards Bureau (BSB), Bhutan; Afghanistan National Standards Authority (ANSA), Afghanistan; Maldives Standards and Metrology Unit (MSMU), Maldives.

Significant contributions

during 2018-19

Ultrasonic Immersion C-scan Systems

Ultrasonic Immersion C-scan systems are used to detect the flaws and cracks present in the object under study. C-scan systems provide output in the form of pictorial image containing information about the location and sizing of defects. Recently, CSIR-NPL has established a 5 axes fully motor controlled ultrasonic scanning tank facility. Such an automated 5 axes tank with NPL's own developed customized software will be utilized to provide improved metrological facility to the end users.



Ultrasonic Immersion C-scan Systems

Moisture Measurement Facility

Temperature and Humidity Metrology sub-division has established the facility for the moisture measurements at CSIR-NPL. The loss-on-drying method consists of the precision weighing balance of 1 mg resolution, sample heating oven using the halogen flash lamp from 50°C to 200°C (Shimadzu, Japan). This moisture unit is made traceable with CSIR-NPL mass metrology and a calibrated Pt/Pd thermocouple for the oven temperature measurement. In the Karl Fischer Titration, the moisture sample is dissolved in the alcohol and volumetric sample is compared with the Karl Fischer reagent. This is made traceable using the standard Karl Fischer Titrator reference. With these facilities, CSIR-NPL has participated in APMP TCI Comparison on moisture measurement in wood samples provided by KRISS Korea (Pilot Lab). Detailed uncertainty analysis has been performed on various solid samples. The facility is introduced in the calibration/testing services.



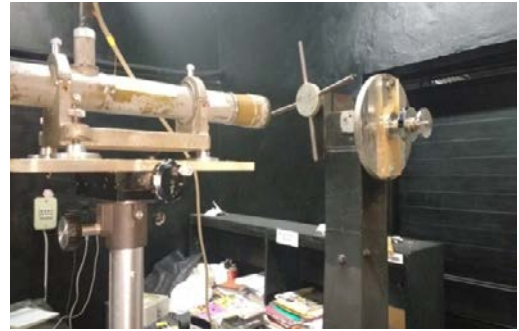
Moisture Measurement Set-up based on Loss-on-drying Oven and Karl Fischer Titrator

Integrating Sphere based Spectro-Radiometer

CSIR-NPL is creating the Calibration and Testing facility for LED and LED based lighting. A 2m integrating sphere based spectro-radiometer is also added to the present installation to disseminate traceability to industries, calibration and test laboratories etc. towards the measurement of luminous flux, correlated color temperature and color coordinates of wide variety of light sources.

Traceability to Angle Measurements in Optical Metrology

Required fixtures and measurement setup are devised to calibrate photo goniometry at CSIR-NPL. Mutually orthogonal rotary stages are measured using polygon and autocollimator. The angular deviations are determined within one degree. This calibration service can be improved up to 0.1 degrees accuracy.



Set-up made for Angle Measurement in Photo Goniometry

Traceability to Hardness Measurement

CSIR-NPL provides the traceability to depth verification of hardness tester. It is required to calibrate the depth measurement scale of hardness test within the accuracy of 0.0001mm without using any magnetic fixtures. Flat mirror interferometer configurations along with indigenously developed fixtures are used for calibration. The calibration is performed at two sites with an uncertainty of measurement in the range of 0.0001mm.



Set-up made for Depth Verification of Hardness Tester

Ferroelectric Loop Tracer

The invention relates to an apparatus for polarization vs electric field measurement at various frequencies in thin film samples comprising in-situ monitoring and on screen plotting of PE loop; real time calculation of saturation field (E_{sat}), coercive field (E_c), saturation polarization (P_s) and remnant polarization (P_r); data acquisition and data saving in file for future analysis; facility for offset removal; compensation setup for lossy dielectric and parasitic capacitance. Technology Transfer took place in 2018 with M/s ATOS Instruments Marketing Services, Bengaluru.



Ferroelectric Property Measurement

Dielectric Constant Measurement of Solid Reference Materials

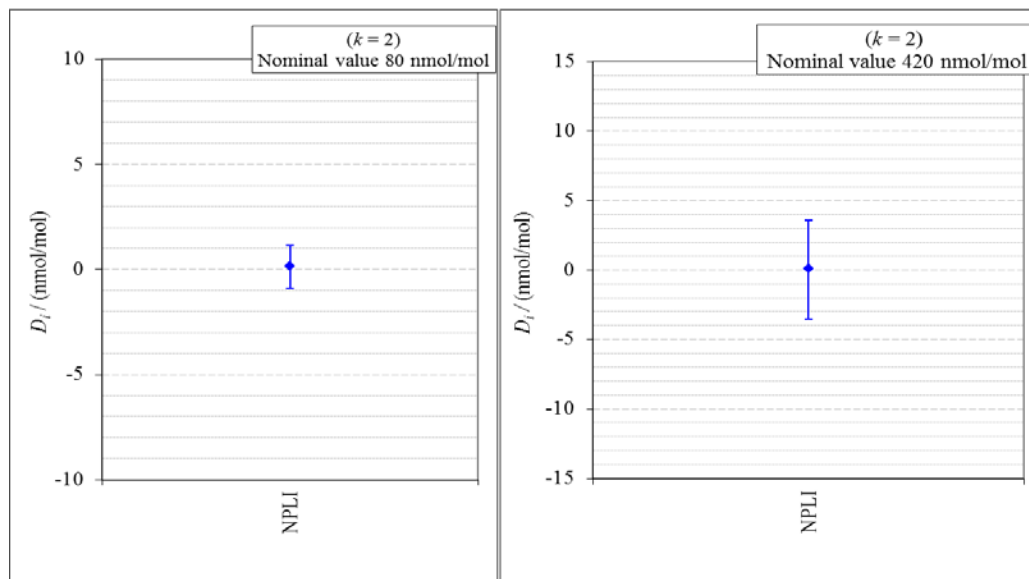
A dielectric constant measurement facility established for solid reference dielectric materials from 1 kHz - 10 MHz. The work complies with ASTM D150 standards and dielectric test fixtures utilized to establish the facility for dielectric constant measurement. The dielectric constant of commonly used reference materials is measured and associated uncertainty-in-measurement computed as per the "Guide to the expression of uncertainty in measurement". The measurement automation program developed to make the efficient and user-friendly measurement procedure. The effect of temperature on reference dielectric materials, linearity of dielectric test fixture studied.



Dielectric Constant Measurement

International Inter-comparison of Primary Ozone Standard

As part of the ongoing key comparison BIPM.QM-K1, the intercomparison of Primary Ozone Standard of CSIR-NPL, India (NPLI) has been carried out at BIPM, France in 2018 and the results are published in Metrologia Journal [Viallon, J., Moussay, P., Idrees, F., Wielgosz, R., Sharma, C., Radha, R.S., & Shukla, D.K. (2018). Final report, ongoing key comparison BIPM.QM-K1, ozone at ambient level, comparison with NPLI. *Metrologia*, **55** (Technical Supplement)].



Degrees of Equivalence of the NPLI at the Two Nominal Ozone Amount-of-substance Fractions 80 nmol/mol and 420 nmol/mol

The degrees of equivalence between the NPLI standard and the common reference standard BIPM SRP28 indicate good agreement between the standards.

The focus of Gas Metrology sub-division at CSIR-NPL is to realize mole in gas measurements through gravimetric preparation of gas standards. The mandate of the activity is to provide traceability for emission gases, green house gases and air quality measurements as per National Ambient Air Quality Standards (12 parameters). The Gas Metrology sub-division is working for the following objectives:

- Primary Reference Gas Mixtures (PRGMs) for green house gases, pollution gases, emission gases, minor impurities in industrial gases
- Calibration of PM₁, PM_{2.5}, PM₁₀ samplers
- Particulate matter standards for Pb, As, Ni
- Air quality related instrument development/ transfer standards
- Participation in inter-comparison study, and do PTs
- Workshop, training and skill development programs
- Air quality related testing and project jobs

National Calibration Facility for PM₁, PM_{2.5} and PM₁₀ Sampling Inlets

A particulate matter (PM) wind-tunnel has been established at CSIR-NPL. This is a first and unique facility in the country to test and calibrate PM₁, PM_{2.5} and PM₁₀ samplers. Using this facility, now all the PM samplers manufactured in the country can be calibrated and certified. Also, all the imported PM samplers can be tested for their suitability under Indian conditions. The CSIR-NPL certified samplers can be exported without any technical barrier to trade as CSIR-NPL is a signatory of CIPM-MRA.



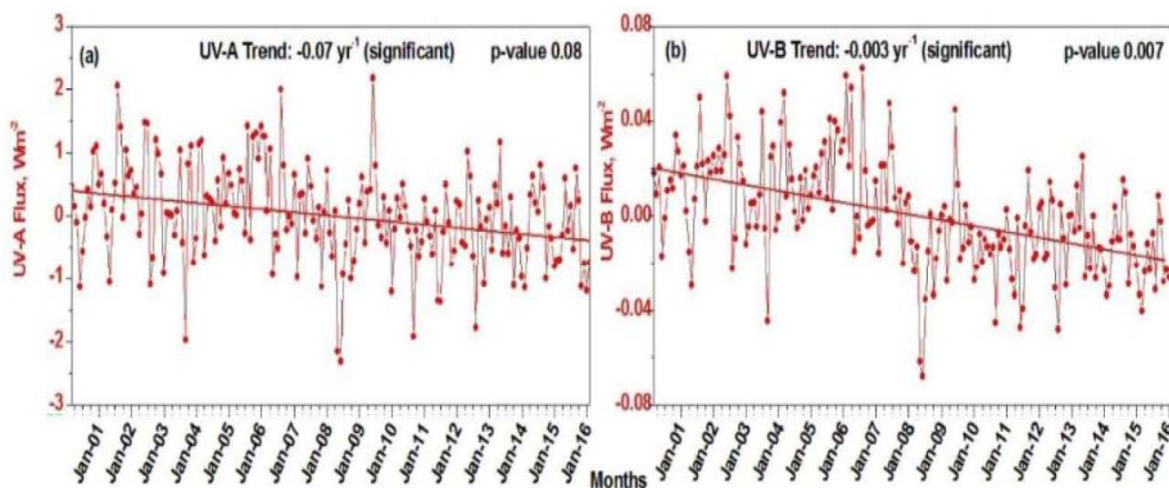
Indigenous Developed Wind-tunnel Facility to Test and Calibrate PM₁, PM_{2.5} and PM₁₀ Samplers

Following parameters of the sampler can be tested and calibrated using this facility:

- **Cutoff size:** The particle segregation device (impactor/cyclone) should be capable enough to segregate coarse sized particles ($>2.5 \mu\text{m}$) and allows particles with $\leq 2.5 \mu\text{m}$ size (PM_{2.5}) to be collected on filter which is placed after this device. Cutoff size of a segregation device is the aerodynamic particle size at 50% of penetration efficiency.
- **Sharpness of cutoff:** The slope of this efficiency curve, i.e. efficiency versus particle size should ideally be between 1 – 1.3.

Trends in UVA and UVB Surface Flux Over Delhi

The measurements of solar UV radiation in UVA (315–400 nm) and UVB (280–315 nm) bands done at CSIR-NPL have been used to validate the satellite retrievals from the Clouds and Earth Radiant Energy System (CERES), at Delhi, India. The MODIS-retrieved aerosol optical depth (AOD) and cloud optical depth (COD) data were also used to see the effect of atmospheric opacity on UV radiation. Surface measurements of UVA and UVB were performed from 01 October, 2012 to 30 September, 2015 and the daily mean data were compared with the CERES-derived surface UV fluxes. The correlation between the two showed very good agreement ($r \sim 0.92\text{--}0.93$) over Delhi. A negative correlation between UV fluxes and AOD over Delhi during all seasons was observed. A unit increase in AOD leads to a decrease of $\sim 4\text{--}5 \text{ Wm}^{-2}$ in UVA and $\sim 0.09\text{--}0.14 \text{ Wm}^{-2}$ in UVB flux over Delhi. The trend analysis from monthly mean CERES-derived UV fluxes for 17 years data reveals that UVA and UVB flux are decreasing by about $0.07 \text{ Wm}^{-2} \text{ yr}^{-1}$ and $0.003 \text{ Wm}^{-2} \text{ yr}^{-1}$, respectively with AOD increase ($\sim 0.005 \text{ yr}^{-1}$) over Delhi. The simultaneous increase in aerosol loading with decrease in UV fluxes at the surface may be explained as a masking effect of ever increasing pollution on surface UV radiation over Delhi. Our results show $\sim 10\%$ and $\sim 20\%$ decrease (with respect to mean) in UVA and UVB surface fluxes, respectively, during last 17 years.

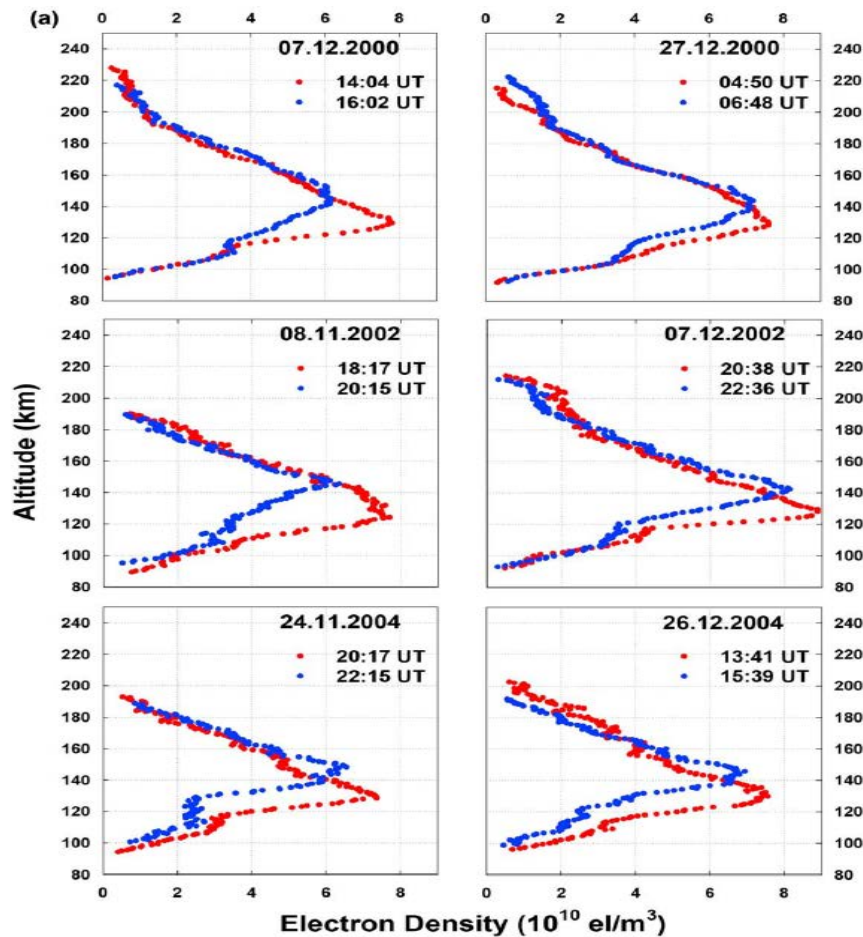


Deseasonalized Pattern of Monthly Mean of (a) UVA, (b) UVB from March 2000 to February 2016 at Delhi using CERES Products. The Solid Line Represents the Trend for each Plot

Martian Ionospheric Study: MGS Observations (Longitudinal Characteristics of Martian Electron Density Profiles: MGS Observations)

An investigation of longitudinal characteristics of 5600 electron density profiles returned from the Mars Global Surveyor's (MGS) Radio Science Experiment shows that the peak altitude of the photochemical F1 layer (hmF1) exhibits a large degree of longitudinal variability. This variability is not seen in Earth's ionosphere. Since F1 layer is isobaric, this variability in hmF1 represents a large degree of spatial changes in the underlying neutral atmosphere. Though this variability is quite chaotic in most of the subsets, a few subsets

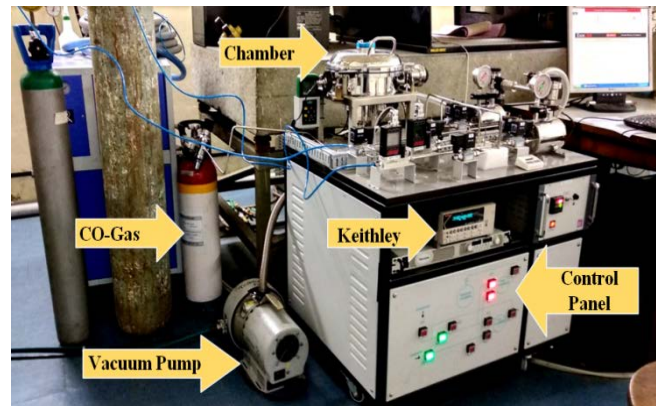
provide some evidence for the presence of a well-defined wave. The investigation of electron density profiles located at the crests and troughs showed abnormal upliftment in F1 layer during consecutive occultations (~2 hours). Rapid spatial changes are observed during intervals as short as two hours.



Plots of Electron Density Profiles Depicting Large Variation in Peak Height (hmF1) during Consecutive Occultations (~2 hr) during High, Moderate and Low Solar Activity Period

Gas Sensor Technology

CSIR-NPL is actively engaged in development of metal oxide and nitride based sensors for atmospheric pollutants. For initial testing of materials for their gas sensing characteristic, a facility has been set up, which is equipped with NMI calibrated gases with precise flow and measurement temperature control.



Thin Film Gas Sensing Setup

Calibration Facility for Defibrillator

Under the biomedical metrology program, an apex level calibration facility at CSIR-NPL India has been established for the first time, for defibrillator analyzer, as per the accuracy requirement of the energy function, specified in the international standard (IEC 60601-2-4) for medical electrical equipments. This facility is providing services to various stakeholders with effect from September 01, 2018. The recent beneficiaries of this service are the testing and calibration laboratories viz. *Lawkim Motors Group (Godrej), Mumbai; Tektronix, Mumbai, TransCal Pvt. Ltd., Bangalore; APEX Laboratories, Jaipur, and Life-Force Pvt Ltd. Faridabad.* Such calibration facility is also being taken up for other biomedical equipment like infusion pump analyzer and incubators.



A Setup of Calibration Facility for Defibrillator and Defibrillator Analyzer

Licensed Technology for High-volume PM2.5 Sampler

Honorable Minister Dr. Harsh Vardhan Ji has inaugurated the indigenously developed high-volume sampler by the M/s Environmental Solutions under the licensed technology (know-how) of CSIR-NPL on August 16, 2018 at CSIR-NPL.



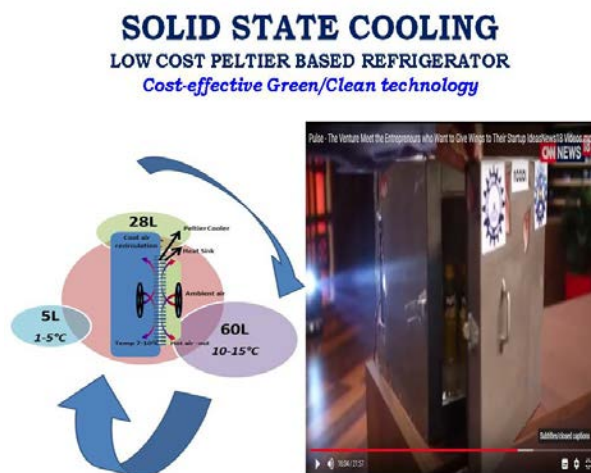
Commercialization of Indigenously Developed High-volume PM2.5 Sampler by M/s Environmental Solutions from the know-how of CSIR-NPL Patented Technology

Peltier based Solid State Cooling Refrigerator

A technology for Solid-State Peltier-based low-cost refrigerator has been transferred to M/s REIL Jaipur. This refrigerator is maintenance-free with a long life, robust, environmentally-friendly, requires less electrical power and hence can be operated on solar power.

Specifications are:

- Cooling chamber ~ 12" x 12" x 12", Temp ~ 5-10°C
- Power requirement: ~75-80W, compatible to operate with Solar panels.
- DC and AC power operated. Weight: 8Kg (max)



Peltier based Low Cost Refrigerator

Reference Material (BND) of Graphitized Petroleum Coke (BND®5102)

The reference material BND®2004 is for the calibration of wavelength / wave number values of Fourier Transform Infrared (FTIR) spectrophotometers in the IR spectral region from 4000 cm^{-1} to 400 cm^{-1} . Reference Material (BND) of Graphitized petroleum Coke has been developed which is intended primarily to ascertain the quality of any lot of carbon additive and in the evaluation of techniques used in the analysis of graphite/ carbon and materials of similar matrix.



BND®2004 FTIR Reference Standard and BND®5102 Graphitized Petroleum Coke

Process for Production of Poly (3,4-Ethylendioxythiophene) Poly(Styrenesulfonate) PEDOT: PSS

Successful development of a novel process for the synthesis of PEDOT: PSS as a conducting polymer for many organic electronic applications. The developing polymerization process is easy, cost-effective and applicable for bulk scale synthesis from easily available precursors. The technology was transferred to M/s Sreeni Labs Pvt. Ltd., Hyderabad.

Technology Development on Utilization of Waste Plastic Bags in Designing Tiles

Waste plastic from poly ethylene bags, bottles, and other containers has been recycled for designing of floor tile, interlock tile, paver tile and roof tile in building of structures and rooms for general public for societal usage. The various challenges like mechanical strength, flame retardancy, water permeability and UV-protection from sunlight & antistatic response are the novelty of the concept. The technology was transferred to M/s Bengal One Enviro Infra LLP, Kolkata on May 14, 2019 and to M/s Esperanza Global Eco Solutions Pvt. Ltd., Chandigarh on December 11, 2018 and several other companies.



Floor Tiles, Interlocking Tiles and Roof Tiles Developed by Plastic Recycling

Production of Indian Certified Reference Materials: Bharatiya Nirdeshak Dravyas® (BNDs)

CSIR-NPL has recently fortified the activity of preparation of certified reference materials (CRMs) under the registered trade name of Bhartiya Nirdeshak Dravya® (BND). During 2018-19, CSIR-NPL has developed thirteen Certified Reference Materials (CRMs) / Bharatiya Nirdeshak Dravyas® (BNDs) in collaboration with Reference Material Producers (RMPs) of India in various parameters such as building materials from NCCBM, Faridabad, high purity compound, aqueous elemental standards, pH standards from M/s Aashvi Technology LLP, Ahmadabad; petroleum based products from HPCL. A list of BNDs released and disseminated is as follows:

List of BNDs Released and Disseminated

S. No.	BND Number	BND Name	Purpose	Available and purchase at /BND Price and other details
1	BND® 5051	Ordinary Portland Cement	Proficiency evaluation of analyst, evaluation and comparison of	https://www.ncbindia.com/contact-us.php

			various test methods and calibration of equipment for analyzing minor constituents for analysis of Ordinary Portland Cement and material of similar matrix	
2	BND® 5052	Portland Pozzolana Cement	Proficiency evaluation of analyst, evaluation and comparison of various test methods and calibration of equipment for analyzing alkalis for analysis of Portland Pozzolana Cement and material of similar matrix	https://www.ncbindia.com/contact-us.php
3	BND® 5054	Fly Ash	Proficiency evaluation of analyst, evaluation and comparison of various test methods and calibration of equipment for analyzing alkalis for analysis of fly Ash	https://www.ncbindia.com/contact-us.php
4	BND® 5001	Ordinary Portland Cement	Calibration of Blaim Air Permeability Apparatus	https://www.ncbindia.com/contact-us.php
5	BND® 5002	Portland Pozzolana Cement	Calibration of Blaim Air Permeability Apparatus	https://www.ncbindia.com/contact-us.php

6	BND® 1003	Copper Standard Solution	Primary calibrations standard for the quantitative determination of copper, calibration of instruments and validation of method for the quantification /characterization of measurand.	https://aashvitechnology.com/place.-order/
7	BND® 1017	Potassium Dichromate	Primary titrimetric standard for the standardization of volumetric standard solutions , calibration of equipments and validation of standard methods	https://aashvitechnology.com/place.-order/
8	BND® 1005	pH Buffer Solution 4.00	Calibration standard for calibration of pH instruments and validation of method for determination of the pH value	https://aashvitechnology.com/place.-order/
9	BND® 1006	pH Buffer Solution 7.00	Calibration standard for calibration of pH instruments and validation of method for determination of the pH value	https://aashvitechnology.com/place.-order/
10	BND® 7001	Sulphur 2.5 ppm	Calibration of instruments and the evaluation of test methods used in the determination of total sulfur in diesel or materials of similar matrix	ravindranthakur@hpc .in

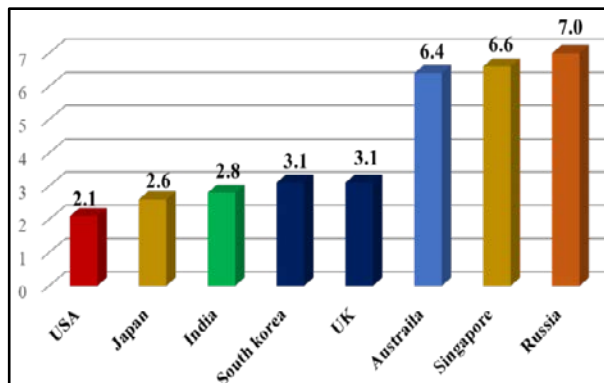
11	BND® 7002	Sulphur 5 ppm	Calibration of instruments and the evaluation of test methods used in the determination of total sulfur in diesel or materials of similar matrix	ravindranthakur@hpcl.in
12	BND® 7003	Sulphur 10 ppm	Calibration of instruments and the evaluation of test methods used in the determination of total sulfur in diesel or materials of similar matrix	ravindranthakur@hpcl.in
13	BND® 7004	Sulphur 25 ppm	Calibration of instruments and the evaluation of test methods used in the determination of total sulfur in gasoline or materials of similar matrix	ravindranthakur@hpcl.in

Contribution in Publishing of ISO Document on Nanotechnology

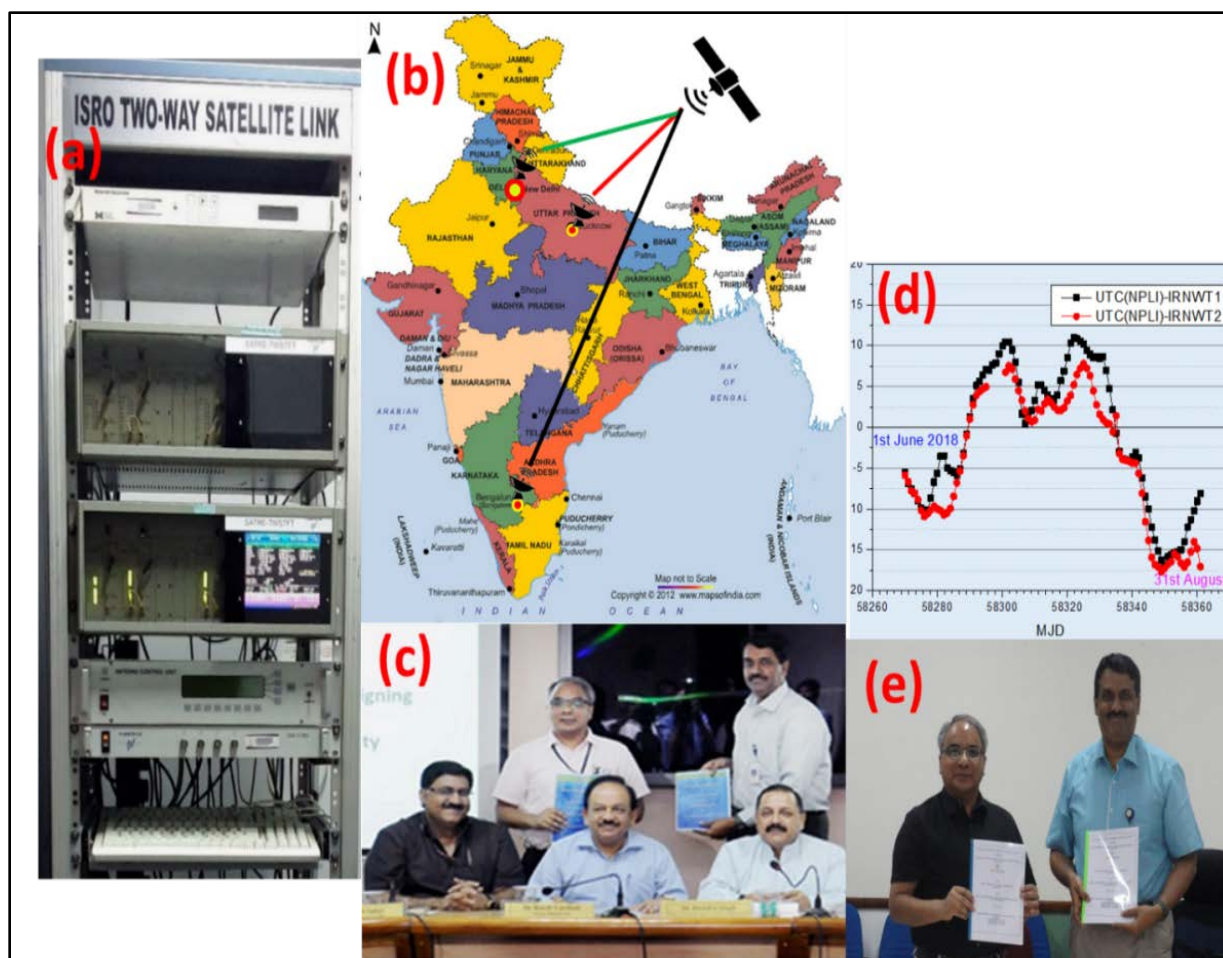
BND division made a significant contribution in preparing first ever ISO document in the country on nanotechnology for “Liquid suspension of magnetic nanoparticles”. Magnetic nanosuspensions have important potential industrial and healthcare applications such as vacuum seals, lubricants, coolants, dampers, magnetic soaps, environment remediation, medical imaging, drug delivery technologies, magnetic hyperthermia therapy, etc. To satisfy the demands of rapidly accelerating application markets, there is a strong need to provide universal definitions and measurement methods for the characteristics of these suspensions. The standard definitions of various terminologies and methods used for magnetic nanosuspension are formulated in association with Bureau of Indian Standard (BIS) and published as specification of characteristics and measurements for magnetic nanosuspensions. The document publication reference number is ISO/TS 19807-1 2019(E), 2019.

Better Uncertainty for Better Timekeeping of the Nation

CSIR-NPL is the timekeeper of the Nation and generates Indian Standard Time (IST) to the highest level of precision in the country. IST is traceable to the Coordinated Universal Time (UTC) provided by the International Bureau of Weights and Measurers (BIPM). The uncertainty of IST (i.e. UTC (NPLI) + 5:30 hours) has a major reduction from ± 20 ns to ± 7.2 ns and finally to ± 2.8 ns w.e.f. October 2018, bringing it at par with many developed countries.



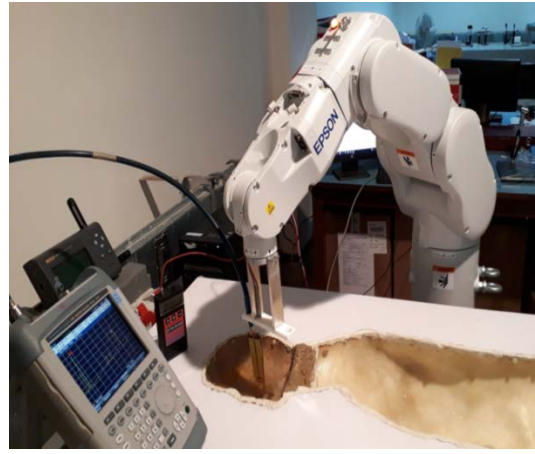
Uncertainty in UTC



(a) Two-way Satellite Time Transfer Link with ISRO Labs in Bangalore and Lucknow Established (b) Schematic of Link between CSIR-NPL and ISRO locations. (c) Signing of MoU between CSIR-NPL and ISRO. (d) Offsets Calculated by CSIR-NPL of ISRO's Time Scales (e) Signing of Contract for Traceability Services

SAR Evaluation System

A Specific Absorption Rate (SAR) evaluation system is indigenously developed by CSIR- NPL. In this setup, E-Field Sensor, Tissue equivalent liquid, Robotic automation (Robotic arm procured from Epson) and a controlled GUI are being indigenously developed. The system is capable to evaluate SAR upto 3W/kg with an expanded uncertainty of $\pm 0.15\text{W/kg}$ per 1.6W/kg. Telecommunication Engineering Center (TEC), approved CSIR-NPL technology for commercial compliance testing of mobile phone SAR based on IEEE-1528 2013 and IEC-62209-1,2 (Technology Developed). A very first center will be established at TEC, New Delhi based on this technology as transfer standard.



SAR Measurement Setup at CSIR-NPL

PMU CAL System

This system is a monitoring device that captures data at a very high speed and each measurement is time stamped to a common time reference. PMU Calibration System is used to test/calibrate PMUs and report the errors, as the difference between the systems reported 'True' values and the measured output. Errors are reported in the form of Total Vector Error (TVE), Frequency Error (FE) and Rate of Change of Frequency Error (RFE) as per IEEE C.37.118.1a-2014 standard. CSIR-NPL PMU CAL System traceability has been established against the primary standards of CSIR-NPL. Director CSIR-NPL has dedicated the PMU-CAL system (National standard) facility in the service of the nation on September 17, 2018.

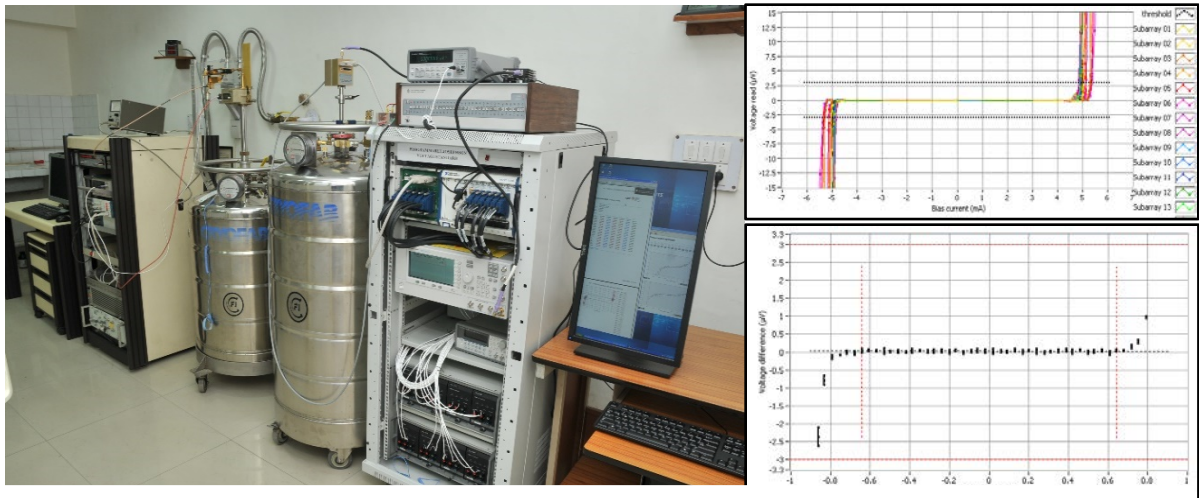


CSIR-NPL PMU CAL System

Programmable Josephson Voltage Standard (PJVS)

The PJVS system is based on 'Quantum Phenomena' (Josephson effect) given by the relation $2eV_n = nhf$, where $n = 0, \pm 1, \pm 2, \pm 3, \dots$, V_n = quantized voltage, f = frequency of irradiation, h = Planck's constant, e = electron charge. The salient features of the system are:

- The non-hysteretic Josephson tunnel junctions made up of Nb electrodes and $\text{Nb}_x\text{Si}_{1-x}$ barriers.
- The 10 V chip contains a total of 256,116 Josephson junctions organised in stacks of three junctions and distributed into 32 microwave coplanar waveguide lines.
- The voltage steps are stable, have superior immunity to noise and have rapid settling time.

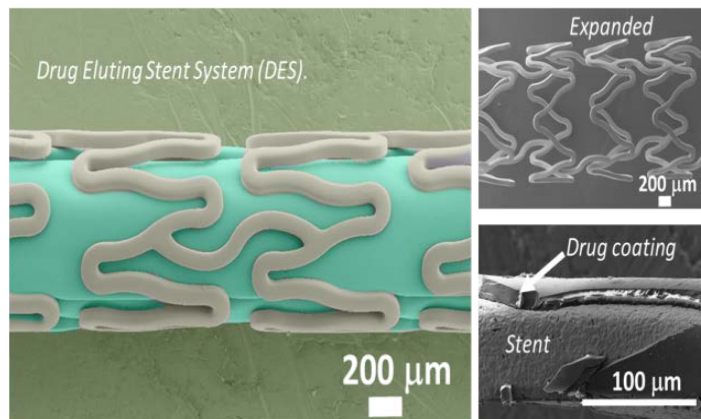


(a) 10 V - PJVS at NPL-India, (b) I-V curves for 23 subarrays and Step flatness test at 18.645 GHz and 0.00 dBm

PJVS forms the basis for standard of the unit 'Volt' in India at par to the international level. The uncertainty in measurement of Zener Reference Standards is ± 350 nV at $k=2$ (inclusive of noise of Zener) at 10V level as per the ISO/IEC 17025:2005.

Drug Eluting Stent

Drug eluting stent (DES) manufacturer industries need high resolution characterization of drug coating and thickness estimation which is essential test when Indian industry approaches to international market for getting an approval from drug evaluator bodies of the respective countries. Characterization of these DES, established the protocols, estimated thickness of drug coating and have successfully helped industries to get an entry into the international market.



Drug Eluting Stent

Glimpses of events

during 2018-19

Training Program on Quality System and Testing & Calibration of Biomedical Devices (April 11, 2018)



Technical Workshop on Understanding of Regulations on Weights and Balance sponsored by M/s Mettler Toledo, Switzerland (April 13, 2018)



One day Seminar on Quality Infrastructure for PV Modules Testing and Performance Evaluation (April 25, 2018)



Training Course on Electron Microscopy (May 22 to June 01, 2018)



In-house BND subdivision have conducted two-week hands on training on electron microscopy during May 22 - June 01, 2018. Twenty Eight participants from various institutions including industries has participated.

प्रयोगशाला के वैज्ञानिकों/तकनीकी अधिकारियों/अधिकारियों/कर्मचारियों के लिए कार्यशाला (मई 23, 2018)

भारत सरकार, गृह मंत्रालय, राजभाषा विभाग द्वारा हिन्दी के लिए जारी वार्षिक कार्यक्रम में राजभाषा नीति संबंधी निदेशक का अनुपालन सुनिश्चित करते हुए हिन्दी में कार्यशाला कराई गयी। दिनांक मई 23, 2018 को प्रयोगशाला के वैज्ञानिकों/तकनीकी अधिकारियों/अधिकारियों/कर्मचारियों के लिए 'प्लास्टिक कचरा निपटान' एवं 'आधुनिक भारत में ऊर्जा की किल्लत: हाइड्रोजन स्वच्छ ऊर्जा स्रोत विकल्प' विशयों पर कार्यशाला का आयोजन किया गया। कार्यशाला में व्याख्यान देने के लिए क्रमशः डा. एस के धवन, एमेरिट्स साइंटिस्ट एवं डा. बिपिन कुमार गुप्ता, वैज्ञानिक को आमंत्रित किया गया था। कार्यशाला में 53 वैज्ञानिकों/तकनीकी अधिकारियों/अधिकारियों/कर्मचारियों ने भाग लिया। इस प्रकार यह कार्यशाला अपने उद्देश्यों में सफल रही।



Inauguration of New National Facility of Backup Time Scale Laboratory by the Honourable Minister Dr. Harsh Vardhan (June 16, 2018)



Technical Workshop on Disseminating Measurement Capabilities of the Weights sponsored by M/s Sartorius, Germany (June 21, 2018)



One day Industry Meet at CSIR-NPL to Bridge the Gap between NMI and Industries through Metrology (July 13, 2018)



Inauguration of Wind Tunnel Facility and Release of Gas BND by the Honorable Minister Dr. Harsh Vardhan (August 16, 2018)



Brochure on Gas Metrology Activity at CSIR-NPL Highlighting the Achievements and Dissemination Services to the Nation was Released by the Honorable Minister Dr. Harsh Vardhan (August 16, 2018)



Three days Training Program on Air Quality Measurement by Gas Metrology Staff was Organized under the HRD Training Program at CSIR-NPL (August 29 -31, 2018)



Self-sponsored Five days Short-term Workshop on Silicon PV Systems: Fundamentals, Design and Metrology (September 10-14, 2018)



In this workshop class room tutorials followed by hands-on experience on various aspects starting from fundamentals of solar energy, solar cells fabrication to design, solar PV systems, measurements of modules and PV systems, PV metrology, battery, inverter and other balance of systems were included. Twenty one participants including students (undergraduate, post graduate, diploma and Research scholars) from various academic institutions, PV systems installers, entrepreneurs in PV sector etc., participated in the workshop.

National Conference on Electrical and Electronics Measurements at CSIR-NPL, New Delhi (September 19-20, 2018)



In this training program different electrical parameters like, “Impedance & Current and Microwave Metrology”, “AC High Voltage and AC Power & Energy Metrology” and “Impedance & Current and Microwave Metrology” were covered. Participation from Private and Government Organizations

like Bharat Electronics Limited, Ghaziabad, ETDC, STQC, Chennai , North Lab India Pvt. Ltd. , Bharat Dynamics Ltd., IDEMI and some private companies from Jaipur and Udaipur were witnessed.

Open Day Celebration in CSIR-NPL (September 28, 2018)



National Workshop on Materials Metrology for Sustainable Society – (NWMMSS- 2018) (November 01- 02, 2018)



WESPAC-2018 held at CSIR-NPL (November 11-15, 2018)



The 13th International Western Pacific Conference on Acoustics (WESPAC-2018) was held during November 11-15, 2018 wherein a total of 8 plenary lectures, 381 oral presentations in 44 structured sessions (including 53 distinguished lectures) and 122 poster presentations in 3 poster sessions were made. There were 26 participating countries, 80% from India and 20% from foreign countries.

Indo-Japan Workshop - 2018 on Highly Conductive CFRP using Conductive Polymers and Nanomaterials for Structural Applications (November 26 - 28, 2018)



प्रयोगशाला के वैज्ञानिकों/तकनीकी अधिकारियों/अधिकारियों/कर्मचारियों के लिए कार्यशाला (नवम्बर 28, 2018)



भारत सरकार, गृह मंत्रालय, राजभाषा विभाग द्वारा हिन्दी के लिए जारी वार्षिक कार्यक्रम में राजभाषा नीति संबंधी निदेशक का अनुपालन सुनिश्चित करते हुए दिनांक नवम्बर 28, 2018 को प्रयोगशाला के वैज्ञानिकों/तकनीकी अधिकारियों/अधिकारियों/कर्मचारियों के लिए “सरकारी कार्य और राजभाषा हिंदी” विषय पर कार्यशाला का आयोजन किया गया। कार्यशाला में व्याख्यान देने के लिए श्री पी आर राव, पूर्व उप निदेशक, राजभाषा, सदस्य सचिव, नराकास, नई दिल्ली को आमंत्रित किया गया है। कार्यशाला में 36 वैज्ञानिकों/तकनीकी अधिकारियों/अधिकारियों/कर्मचारियों ने भाग लिया। इस प्रकार यह कार्यशाला अपने उद्देश्यों में सफल रही।

India-Japan Workshop on Biomolecular Electronics and Organic Nanotechnology for Environment Preservation (December 6-9, 2018)



MNRE, Government of India Sponsored Workshops cum Hands-on Training at CSIR-NPL (December 3 - 7, 2018)



A five days workshop cum training on “Energy Efficiency of Solar PV Systems (EESPV-18)” was organized at CSIR-NPL. In this workshop class room tutorials followed by hands-on experience on various aspects of solar PV systems, starting from fundamentals of solar cells to design, fabrication, measurements of modules and PV systems, PV metrology, battery, inverter and other balance of systems were included. The objective was to provide basic knowledge on Design and integration, Installation and testing, Operation and maintenance of PV systems, Quality management system and PV Metrology, hands-on experience in test and measurement of components and system parameters, assembly, testing and monitoring of components and solar PV systems, create awareness on the importance of PV Metrology and its socio-economic impact on sustainable development in the ambit of CSIR-NPL and skill development of PV work-force towards requirement of multi-GW target of MNRE, Government of India and Industry. Forty three participants participated in the workshop.

Three days Short Term Course on Thin Films Growth: Fundamentals and Real Time Growth Demonstration (December 18-20, 2018)



Indo-China Workshop on Trends of Air Pollution and Strategies for its Mitigation in Asian Megacities Jointly Organized by CSIR-NPL India, IAP & TJU China and IAAPC Delhi Chapter (January 09, 2019)



Workshop cum Training on “Sand to PV Systems: Materials Devices, Measurements and Testing (SPV-19)” (January 14 –February 08, 2019)



A four weeks workshop cum training program was organized at CSIR-NPL during January 14 – February 08, 2019. The workshop was inaugurated on 14th January, 2019. Dr. Bharat Bhargava, DG, ONGC Energy Centre was the Chief Guest at the inaugural function of SPV-19.

Pre-AdMet Workshop titled “Quality System based on IS/ISO/IEC 17025: 2017” (February 18-19, 2019)



About fifty candidates participated in this workshop.

AdMet-2019 held at CSIR-NPL (February 18-22, 2019)

The 10th International Conference on Advances in Metrology (AdMet-2019) was held during February 18-22, 2019 with two Pre-AdMet workshops, one on ISO/IEC 17025 (2017) and another Hindi Karyashala on Redefinition of SI Units. It was inaugurated by the Chief Guest Mr. A.K. Srivastava, Secretary, Ministry of Consumer Affairs, Government of India. The Guest of Honour, Dr. Walter Copan, Director, NIST, USA was the Keynote speaker. The inaugural function was presided over by Dr. A.K. Grover, Chairman RC of CSIR-NPL. The conference was jointly organized by CSIR-NPL and Metrology Society of India (MSI), New Delhi.

Over three days conference, there were four plenary talks, one evening lecture, one popular lecture and twenty nine invited talks were delivered by eminent speakers; ten company presentations were made by different industrial representatives; and one hundred and



forty research papers were presented in two poster sessions of seventy each by scientist, engineers, metrologists and students from different part of the country.

संसदीय राजभाषा समिति की दूसरी उपसमिति द्वारा राष्ट्रीय भौतिक प्रयोगशाला का निरीक्षण (फरवरी 27, 2019)



संसदीय राजभाषा समिति की दूसरी उपसमिति द्वारा राष्ट्रीय भौतिक प्रयोगशाला का सफल निरीक्षण दिनांक फरवरी 27, 2019 को सम्पन्न हुआ। उपर्युक्त उपसमिति में दस संसद सदस्य के साथ 7 सचिवालय स्टाफ होते हैं। इस निरीक्षण कार्यक्रम की अध्यक्षता संसद सदस्य श्री सुनील बलराम गायकवाड़ ने की। प्रयोगशाला से डॉ. दिनेश कुमार असवाल, निदेशक, डॉ. क्षेमेन्द्र शर्मा, वरिष्ठ प्रधान वैज्ञानिक, श्री महेश चन्द्र मीना, प्रशासन नियंत्रक, श्रीमती मंजु, हिंदी अधिकारी, श्री जय नारायण उपाध्याय, हिन्दी अधिकारी तथा मुख्यालय से डॉ. प्रमोद भूषण, मुख्य वैज्ञानिक, श्री रविंदर मेहमी, हिन्दी अधिकारी व मंत्रालय से श्री अश्विनी गुप्ता, विभागाध्यक्ष, श्री दिनेश चन्द्र तिवारी, हिन्दी अधिकारी समिति के समक्ष उपस्थित हुये। समिति सदस्यों ने प्रयोगशाला में निदेशक महोदय व स्टाफ सदस्यों द्वारा राजभाषा हिन्दी के प्रगामी प्रयोग में उत्तरोत्तर वृद्धि हेतु किए जा रहे सकारात्मक प्रयासों व परिणामों की प्रशंसा की। साथ ही, राजभाषा विभाग, गृह मंत्रालय द्वारा जारी वार्षिक कार्यक्रम में निर्धारित लक्ष्यों को पूरा किए जाने के संदर्भ में निदेशक महोदय से आश्वासन लिया। इस प्रकार अत्यंत उत्साहजनक वातावरण में विशिष्ट सफलता के साथ निरीक्षण सम्पन्न हुआ।



Visit of Prof. K. Vijay Raghavan, Principal Scientific Adviser to the Government of India to the upgraded Primary Time Scale Laboratory



Release of Brochure on Indian Standard Time by Honorable Minister, Dr. Jitender Singh and DG-CSIR, Dr. Girish Sahani



Gas Metrology Facility Visited by the Students from different KVVs and other Government/Private Schools under CSIR-NPL Jigyasa Program



Students Visit under CSIR-NPL Jigyasa Program





Divisional activities

during 2018-19

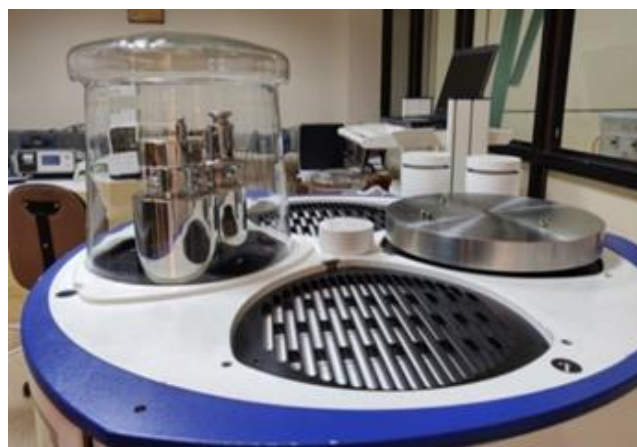
Physico-Mechanical Metrology: Division 1

The Physico-Mechanical systems and transducers enabled with high precision metrology are the backbone of the cyber physical technology based Industry 4.0. This year on 16th November 2018, the historic decision has been made by CGPM to redefine four of the SI base units based on quantum standards/ fundamental constants. The kilogram is redefined by fixing the value of the Planck's Constant (h) and kelvin by Boltzmann's Constant (k), respectively, making them free of material/artefact dependent properties. Physico Mechanical Metrology Division (PMM), responsible for realizing 4 SI units (of mass, length, temperature and luminous intensity), is already working actively to establish these new SI primary standards alongside its international implementations in coming years. The mandate of PMM division is to establish, maintain, disseminate and continuously upgrade the Physico-mechanical standards such as Mass; Length and Dimensions; Temperature and Humidity; Optical Radiation; Force and Hardness; Pressure, Vacuum & Ultrasonic; Acoustic and Vibration, and Fluid Flow Metrology. Several of the Calibration and Measurement Capabilities (CMCs) of the PMM Division are published on Key Comparison Database (KCDB) of BIPM. In continuation of such sustained efforts of global visibility and compatibility, the PMM division has participated in various international inter-comparisons, organized by CCs of BIPM as well as by APMP, to enhance our measurement capabilities and support our existing and new CMCs.

During the year 2018-19, the division has continued its efforts to create the innovation based national quality infrastructure through Bureau of Energy Efficiency (BEE) sponsored mega project on standardization of LED Lighting and Legal Metrology sponsored projects to establish Laser-interferometer based length standard, clinical thermometers and digital blood pressure calibration/testing facilities at few of their Regional Reference Standards Laboratories (RRSLs). A glimpse of activities of each subdivision is described below.

Mass Metrology

The subdivision has been maintaining apex level standards of mass, volume, density, and viscosity and disseminating traceability by calibration. It has also been working on (i) Formulation of detailed project report on "Development of 1 kg Kibble Balance for Redefinition of "kilogram" in Terms of Planck's Constant in collaboration with NIST, USA" to submit to the Department of Consumer Affairs, Government of India. (ii) Re-established national standards of mass in air. Data have been taken in vacuum also to determine the true mass eliminating air buoyancy correction.



Re-establishment of National Standards of Mass in Air

(iii) Provided traceability to the other metrology groups (derived parameters) in CSIR-NPL like Force, Hardness, Pressure, Vacuum, Ultrasonic, Fluid Flow, Gas, Environment, BND etc. to provide further calibration services to the customer, (iv) Calibration of volumetric glassware has been revived after approximately ten years.

Length, Dimension and Nano Metrology

The subdivision has been realizing SI unit 'meter' and maintains apex level standards of length, dimension and nano metrology and disseminating it by calibration. During the year, this subdivision has carried out R & D, added new calibration services, enhanced revenue and prepared reports for inter-comparison. Major achievements during this year include: (i) the traceability to depth verification of hardness tester within the accuracy of 0.0001mm without using any magnetic fixtures. (ii) traceability to angle measurements in optical metrology photo



Portable CMM

goniometry at CSIR-NPL. Mutually orthogonal rotary stages are measured using polygon and autocollimator with an accuracy of 1 degree. (iii) traceability to artificial defects required for ultrasonic, eddy current inspection of rails and (iv) traceability for portable CMM.

Temperature and Humidity Metrology

The apex level calibration services of Temperature and Humidity Metrology are provided from -200°C to 3000°C for SPRTs, RTDs, Thermocouples and Radiation Pyrometers, Thermal Imagers and Blackbody sources and 10 % to 95 % RH, -30 °C to 50 °C dew/frost measurements, moisture measurements and mercury-free (electrical and IR based) clinical thermometers. During the year, research activities include (i) work on the acoustic gas thermometry set-up for realization of Boltzmann Constant based new kelvin and dissemination of thermodynamic temperatures. The fabrication work on combined acoustic-microwave copper resonator and its CMM measurements is completed and confirms the dimensional uncertainty of 1.1 μm (ii) developed Fe-C (1153°C) and Co-C (1324°C) eutectic fixed point blackbodies with indigenous design and development efforts for the dissemination of thermodynamic temperatures above 1000°C and (iii) established moisture measurement in solids using Loss-on-drying oven and Karl Fischer Titrator and participated in APMP TCI comparison on moisture in wood samples.



CMM Measurements on Diamond Turned Hemispheres of Copper Cavity Resonator Developed to Realize Boltzmann Constant based New Kelvin

Optical Radiation Metrology

This subdivision provides measurement traceability of optical radiation related parameters in the wavelength range 200 nm to 25 μm , to a wide range of organizations and industries. One of the seven SI base units, candela is also realized in the subdivision. Testing/Calibration services for various photometric parameters namely luminous flux, illuminance, luminance, luminous intensity, detector responsivity, color temperature and radiometric parameters namely spectral irradiance and for spectroscopic parameters namely spectral reflectance, spectral transmittance, absorbance, and polystyrene film calibration by FTIR are provided. During the year, research activities include gonio-photometry, IR and Raman spectroscopy for bio-photonic applications, axicon attested beam manipulation for its metrological applications, two photon absorption studies in nano-plasmonic systems. The subdivision also focuses on bio-spectroscopic study of therapeutic agents and understanding the interaction mechanism of these agents with nucleic acid and proteins at molecular level. Infrared spectroscopy techniques for distinguishing malignant tissues from the normal ones and to estimate the stage of disease in the cancer diagnosis has also been part of our diagnostic studies.



New Integrating Sphere Established for the LED Photometry Applications

Force and Hardness Metrology

This subdivision has been engaged in establishing, developing and maintaining the primary standards in force, torque and hardness. The subdivision provides the APEX level calibration and traceability in measurement in these physical parameters to several user industries across the county. The subdivision is constantly involved in research and developmental activity for augmenting and upgrading the standards at par with other leading National Metrology



3 MN Build-up System for Force

Institutes (NMIs) to establish equivalence to the international system of measurements by participating in the international inter-comparisons.

Pressure Vacuum and Ultrasonic Metrology

The mandate of the subdivision is establishment, maintenance, up-gradation and dissemination of pressure, vacuum and ultrasonic standards. The various primary standards established are Ultrasonic Interferometer Manometer (UIM), Static Expansion System (SES), Orifice Flow System (OFS), Force Balance Piston Gauge, Air and Pneumatic Piston Gauges, Hydraulic Controlled Clearance Piston Gauges, Large Diameter Piston Gauge, Differential Piston Gauges, Ultrasonic Power Measurements and EMAT based Non Destructive Testing (NDT) facilities. The main achievements include re-establishment of some of the primary and of secondary standards, simulation (Ansys/Solid works/Monte Carlo) studies on pressure sensors and standards, development of Gauss Meter, ultrasonic interferometer, development of high pressure sampler, studies on material at high pressure for possible development of transducers, Raman studies on different strategic materials at ambient and high temperature and development of low cost and high sensitivity polar-resistive humidity sensor. The two technologies developed in the subdivision are i) Improved Variable Frequency Ultrasonic Interferometer for Velocity and Attenuation Measurement in liquids and ii) 3 Tesla Auto Range Pulsed/ Static Field Gauss Meter transferred to M/s Physics Instruments Company, Chennai during February 2019.



APMP Comparison using Ultrasonic Interferometer Manometer (UIM)

Acoustics and Vibration Metrology

The subdivision is responsible for the establishment, maintenance, up-gradation and dissemination of national sound pressure and vibration standards. Also, this subdivision has also been constantly engaged in developmental activities for upgrading the capabilities of the primary standards to keep abreast with the other international NMIs. Recent APMP.AUV.V-K3.1 Key Comparison completed successfully in the year 2018 for Low-Frequency Vibration in the range 0.1 Hz to 40 Hz with 5 participant NMIs. The initial report revealed CSIR-NPL successfully qualified the Key Comparison. A technology entitled, "Acoustical Lightweight Interior Dry Wall Panel for high sound insulation" developed in the subdivision transferred to M/s Shehgal Doors, New



SODAR System Installed at CPCB

Delhi. A newly developed SODAR system installed at CPCB is working properly for atmospheric boundary layer height measurement with reference to the air pollution.

Fluid Flow Metrology

This subdivision has Water Flow Calibration Facility, Water Meter Testing Facility, and Gas Flow Calibration Facility to provide testing & calibration services of various types of water flowmeters such as Coriolis mass, magnetic, ultrasonic, turbine, vortex etc; domestic & bulk type water meters and gas flowmeters such as mass flow controllers, mass flowmeters, air flow calibrators, rotameters, totalizer type flow meters, high precision laminar and sonic flowmeters, orifice flowmeters, etc. The upgradation of old Water Flow Calibration Facility (WFCF) is in the final stage and after upgradation, it will be possible to calibrate

various types water flowmeters upto 600 m³/h with expanded uncertainty in the range of 0.05% to 0.07% which will be, at par, to the international level. The calibration services for totalized mass and totalized volume parameters have been started from November 01, 2018 onwards and for mass flow rate and volume flow rate by the end of March 2019.



Opening Ceremony of the Upgraded Water Flow Calibration Facility

Electrical and Electronics Metrology: Division 2

The division of “Electrical and Electronics Metrology” has continued its apex level calibration and testing services to power industries, utilities, strategic sector, regional calibration and testing labs and R&D organization. The division is upgrading its facilities for various parameters to cater to the needs of the country. It is also participating in various inter comparisons to strengthen the existing CMCs (Calibration and Measurement capabilities) and to be at par with leading NMIs. New facility has been established for Dielectric Constant Measurement of Solid Reference Materials. New measurement facilities like Electromagnetic Interference and Electromagnetic Compatibility (EMI/EMC) are being established to support the quality infrastructure of the country. Development of quantum standards like single photon detection, quantum current standard, Graphene and topological insulators based quantum hall devices is in progress. A glimpse of activities of each subdivision is described below.

LF, HF Impedance and DC Metrology

LF & HF Impedance subdivision is maintaining the standards of capacitance, inductance and ac resistance. Value to the 10 pF capacitor is assigned through primary standard, calculable cross capacitor, with an uncertainty of 0.6 ppm using precision ac bridges. The unit of inductance, Henry, is realized from capacitance and resistance using the Maxwell-Wien bridge. Value to 100 μ H to 10 H is assigned through this bridge. The unit of ac resistance, Ohm, is also realized from capacitance, using Quadrature Bridge and other precision ac bridges at 1k Ω . The scale of resistance from 1 Ω to 1 M Ω builds up with Kelvin double arms ac bridge. Upgradation of DC Metrology lab is in process. 1G Ohm resistance measurement at voltage upto 1000 V will be established within a year.

DC metrology subdivision is maintaining National Standards of DC voltage, DC current and DC resistance. The apex level calibration facilities is being provided to the STQC Labs, Government Organizations and Industries for dissemination of traceability. This subdivision is also providing calibration facility for High Voltage DC equipments i.e. DC High Voltage probe, DC High Voltage divider, DC High Voltage Power Supplies and DC Volt meter, upto 100 kV. Primary standard of DC High Voltage is the Resistive Divider, which is traceable to the Josephson voltage standard.

This subdivision is also working on the development of new quantum based current standard. Quantum Phase Slip phenomenon is being explored in low dimensional superconducting, Nb₂N and TiN structures. Single electron tunneling based electron counting is also being realized for the establishment of quantum current standard.

Establishment of DC High Voltage Standard up to 300 kV at CSIR-NPL involves design and plan of implementation of DC high Voltage measurement laboratory up to 300kV. The Precision high Voltage divider is the Primary standard of the laboratory. It is traceable to the Josephson Voltage Standard through the Binary step up method. Two similar dividers of 150 kV each connected in sequence of steps that combine and separate to evaluate the voltage coefficient of each divider up to 300kV. The expanded uncertainty for the divider up to 300kV is 35×10^{-6} μ V/V. To confirm the validity of the method, the ratio at 1 kV is compared with the resistance ratio of the divider is within 15×10^{-6} .

AC High Voltage and Current Metrology

This subdivision is maintaining the National Standards of AC High Voltage Ratio upto 100kV, AC High Current Ratio upto 5 kA and High Voltage Capacitance & Tan δ facility upto 200 kV. Disseminating the traceability of AC High Voltage and Current Metrology to Power Utilities, Electrical Equipment Manufacturers and Accredited Electrical Testing and Calibration Laboratories.



AC High Voltage Calibration Setup

This subdivision is providing Apex Level Calibration Services for Current Transformers, Current Transformer Testing Sets, AC High Current Sources, Clamp Meters, Current Probes, Current Transformer Burdens, Voltage Transformers, Voltage Transformers Test Sets, HV Probes, Electrostatic Voltmeters (ESVM), HV Break Down Test Sets, Voltage Transformer Burdens, AC High Voltage Sources, HV Dividers, kV Meters, HV Capacitors, Capacitance & Tan δ Bridges, etc.



AC High Current Setup upto 5kA made for 200kV Divider

AC Power and Energy Metrology

This subdivision is engaged in the maintenance and upgradation of national standards for ac power and energy at par with other leading NMIs of the world and disseminates measurement traceability to the power industries, calibration & test laboratories and users of India and the SAARC countries (Bhutan, Afghanistan). The primary Precision Power Calibration System (10-30ppm) and transfer COM5003 (50ppm) standards along with multi-position high stability calibration bench MTS-340 (50ppm stability) have been used for apex level calibration of reference standards (of class: 0.005, 0.01, 0.02, 0.05). Testing and analysis of all types of energy meters (single and three phase) have been performed to cater the needs of industries and users.



AC Power & Energy Calibration and Test

The establishment of national Electromagnetic Interference and Electromagnetic Compatibility (EMI/EMC) Measurement system upto 40GHz and related R&D are in progress. Furthermore, planning to create measurement facilities for Smart Energy Meters as per IEC/IS/CBIP specifications for the growing demands of industries.

Quantum Nanophotonics Metrology

This subdivision is working on realization of superconducting nanowire devices capable of single photon detection for quantum information and quantum communication. Metrology towards photon based quantum standards for optical radiation for assisting optimizations and standardizations in the field of quantum information sciences and technologies.



Establishment of Low Temperature Experimental Setup for Single Photon Detection at CSIR- NPL

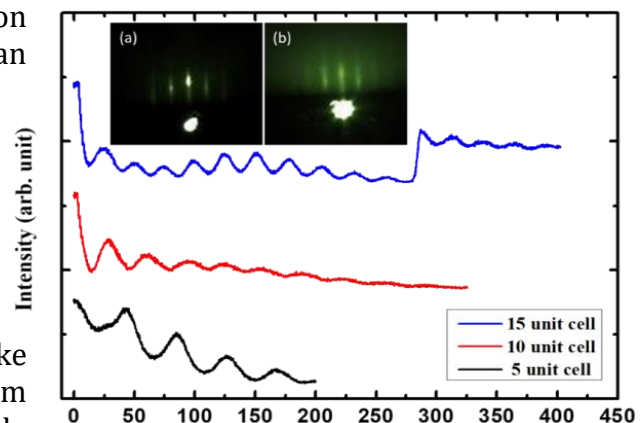
Quantum Hall Resistance Metrology

The main responsibility of the subdivision is to maintain apex level primary resistance standard in India and disseminate standard electrical resistance values to relevant customers. Quantum standard for electrical resistance is based on the Quantum Hall Effect (QHE) of perfectly quantized two-dimensional electron gas (q-2DEG) realized in semiconductor heterostructures (GaAs/AlGaAs quantum wells). The subdivision is also working on the indigenous development of quantum resistance standard by employing various materials such as epitaxial graphene on SiC, magnetic doped topological insulators and oxide based 2DEG systems for Quantum Hall resistance standard. The magnetron sputtering and pulsed laser deposition systems are being used for the growth of various oxides, topological insulator thin films and heusler alloys thin films and heterostructures. GrapE is meant to be used for the growth of metrology grade epitaxial Graphene to be used for Quantum Hall Resistance Standard. The growth setup has been designed and fabricated at CSIR-NPL. The base pressure of the growth system is 1×10^{-7} mbar. Main pumping system is based on a turbo molecular pump backed by a rotary roughing pump. The growth system is equipped with two gas lines controlled by separate mass flow controllers and various valves for attaining a controlled gas atmosphere. A specially designed graphite enclosure can be heated up to 2000°C using a radio frequency induction heating system and the temperature is monitored by an optical pyrometer.



Indigenously developed growth system for Graphene Epitaxy (GrapE)

Oxide interfaces with the typical electron density ($\sim 10^{13}$ - $10^{14}/\text{cm}^2$) being higher than that of the semiconductor heterostructures ($\sim 10^{11}$ - $10^{12}/\text{cm}^2$) show the probable possibility that with time, oxide heterostructures may occupy the area of semiconductor device industry. Oxide heterostructures representing quasi-2DEG are also par from semiconductors by accessing several unique properties like conductivity, superconductivity, magnetism etc. LaScO₃/SrTiO₃ (LSO/STO) oxide heterointerface is explored to probe the quasi-2DEG. The work demonstrates the addition of one new member to the family of oxide heterostructures representing quasi-2DEG.



RHEED intensity oscillation during growth time and (a) streaky RHEED diffraction pattern from SrTiO₃ substrate (b) 10 uc thick LSO film on STO

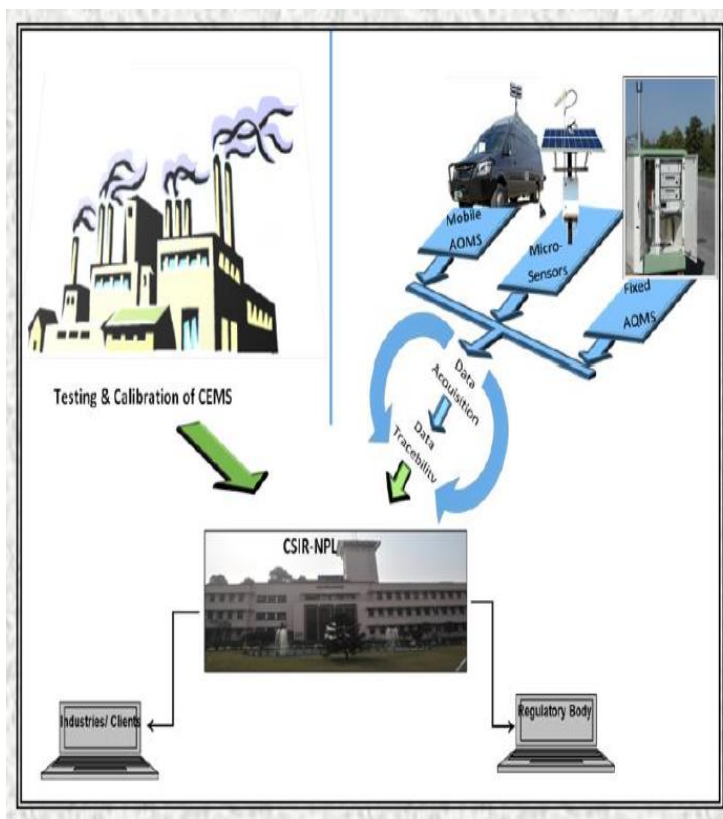
Environmental Sciences and Biomedical Metrology: Division 3

The Environment Sciences & Biomedical Metrology Division (ESBMD) of CSIR-NPL is promoting the quality measurements in the domains of atmospheric pollution and biomedical metrology under its mission project through working with different stakeholders. The division has five specialized subdivisions i.e. Atmospheric Sciences and Metrology, Gas Metrology, Biomedical Metrology, Theoretical Environment and Sensor Devices & Metrology. Each of the five subdivisions is continuously working on the national issues related to the field of environment, gas standards and sensor development and biomedical. A glimpse of activities of each subdivision is described below..

Atmospheric Science and Metrology

In the field of environmental monitoring, the data quality is posing a major challenge as the reliability of such measurements needs to be ascertained. The role of instruments and calibration are the major issues that need to be addressed. While most of the instruments used are usually imported from abroad which comes with certifications from agencies like USEPA, TUV, and MCERT etc. These certificates are issued based on the environmental conditions of the certificate issuing country, which are very different from the environmental conditions prevalent in India. This affects the quality of measurements by the instrument operation in the long run in Indian conditions, which warrants the revisit of the certification process at regular intervals. However, as of now, no

certification system is available in India for environmental monitoring equipments. The traceability of measurement is also an integral part of the generation of reliable data. In December 2018, the Ministry of Environment, Forest & Climate Change (MOEF&CC) has designated the CSIR-NPL as the “Certification Agency” for Air Pollution Monitoring



Schematic for CEMS and CAAQMS Facility

Equipments. In view of this, the subdivision is actively working to establish a testing and calibration facility for various automated Air Monitoring Systems (AMS) especially for Continuous Emission Monitoring Systems (CEMS) and Continuous Ambient Air Quality Monitoring Systems (CAAQMS), which will be a new national facility to provide Certification. This will help in removing the major barriers in ensuring the quality of environmental monitoring data from various sources.

This subdivision is also involved in measuring various atmospheric species including greenhouse gases and particulate matter to study their chemical and physical properties and identifying their roles in influencing the atmosphere and climate through state-of-the-art instruments and models. This subdivision is now working on developing best practices for accurate measurement of atmospheric trace species for adoption by different agencies and institutions in India engaged in atmospheric monitoring. Work in this field is of great importance as air quality and climate change has direct impact on human health and the ecosystem. The improvement in measurement quality will have societal benefits as that will foster better policy formulations for the amelioration of air quality and mitigation of climate change. This subdivision is also working on developing low cost indigenous monitoring equipment for air pollution measurement.

This subdivision is also involved in the characterization of the ionized and non-ionized atmospheric media over Indian latitudes, polar regions and terrestrial environment. The scientific activity involves radio propagation study for the purpose of betterment of radio communication, navigation, atmospheric coupling processes (in lower and upper atmospheres), ionospheric precursor studies and other societal/strategic applications. In line with this, the subdivision also provides ionospheric forecasting to users worldwide through the space weather Regional Warning Centre (RWC, NPL-India).

Gas Metrology

The focus of this subdivision at CSIR-NPL is to realize mole in gas measurements through gravimetric preparation of gas standards. The mandate is to provide traceability for emission gases, green house gases and air quality measurements as per National Ambient Air Quality Standards (12 parameters). This subdivision is working for the following objectives:

- Primary Reference Gas Mixtures (PRGMs) for green house gases, pollution gases, emission gases, minor impurities in industrial gases
- Calibration of PM₁, PM_{2.5}, PM₁₀ samplers
- Particulate matter standards for Pb, As, Ni
- Air quality related instrument development/ transfer standards
- Participation in inter-comparison study, and to do PTs, pilots studies
- Workshop, training and skill development programs
- Air quality related testing and project jobs

Reliable measurements of air quality parameters are highly important as it directly relates to health issues. At Gas Metrology laboratory of CSIR-NPL, the staff prepared/developed gas standards, air quality standards and their calibration, organized training/workshops and has disseminated knowledge on the reliable measurements during the year 2018-19.

The R&D work on aerosol and gas research helps national/international scientific community to understand the aerosol – gas chemistry/metrology in a better way.

The Gas Metrology subdivision successfully participated in four international inter comparisons in the Gas Metrology area, i.e. APMP.QM-S9.2017 Carbon monoxide in Nitrogen (100 $\mu\text{mol/mol}$), APMP.QM-S15 Carbon dioxide in Nitrogen (1000 $\mu\text{mol/mol}$), APMP.QM-S13

Nitrous oxide in nitrogen (1000 $\mu\text{mol/mol}$), and APMP.QM-S7.1CH₄ in nitrogen (2000 $\mu\text{mol/mol}$). Primary Reference Gas Mixtures of CO, CO₂, N₂O, CH₄ were prepared gravimetrically as per ISO 6142 to participate in the above APMP inter comparisons.

Work is focused to achieve traceability in all 12 parameters listed in NAAQS. In this context, piloted APMP.QM-P30, designed and developed PM_{2.5} sampler, setup calibration facility for PM₁, PM_{2.5} and PM₁₀ cutoff size, worked to get another pilot study for PM_{2.5} cutoff size at APMP, etc. Final report on APMP.QM-P30 “Calibration solutions of As, Ni, Pb and Fe” has been presented by APMP Chair in the 18th APMP-TCQM meeting in November 2018 at Singapore. This pilot study has been coordinated by CSIR-NPL India jointly with KRISST Korea. Three different consultancy projects related to “filter testing”, testing of pollution control devices” and “PM_{2.5} sensor calibration checks” have been successfully completed in the year 2018-19.

A new course, ENG(NPL)-2-4623, on “Air Quality Measurement Science and Technology” has been started by the Scientists of Gas Metrology for the Ph.D. students under AcSIR.

Biomedical Metrology

The biomedical metrology subdivision at CSIR-NPL is committed towards the establishment and realization of the National Standards for biomedical metrology. This subdivision is developing measurements compatible with International standards in biomedical instrumentation through continuous research and development. Taking concern of public health in our country, this subdivision is also actively engaged in fabricating indigenous point-of-care devices using novel biocompatible sensing materials for the diagnosis of chronic disease viz. renal dysfunction and heart disease by quantifying their markers and constantly working towards improved detection system of same.

So far, this subdivision has developed national standard for defibrillator analyzer and disseminating its services to the nation through calibration and training. This subdivision is also involved in providing training on biomedical metrology to various stakeholders that include persons from manufacturers, hospitals, clinical laboratories and testing and calibration laboratories. Further, the development of calibration facility for infusion pump analyzers, ECG analyzers and the electrical safety analyzer are in progress.

Defibrillator is used for critical & emergency safety of the patient suffering from cardiac arrest and is commonly available in hospitals, ambulances, medical institutes and public places. However, if the amount of energy applied to the patient is lower than the pre-set value, the signal applied onto a patient will not be sufficient. Alternatively, a high amount of energy applied to the patient than the pre-set value would be detrimental to human life. To measure the energy delivered by a defibrillator, defibrillator analyzers are used. To ensure

the effectiveness and safety of the defibrillators, the output energy level should be calibrated regularly.

The calibration of an electrical safety analyzer is essentially required for electrical safety testing to ensure safe operating standards for any product that uses electricity. Various government organizations and agencies have developed stringent requirements for electrical products that are sold worldwide. To conform to such standards, the products must pass safety tests such as the High Voltage Test (also called as Dielectric voltage-withstand test or high potential test), Insulation Resistance Test, Ground (Earth) Bond & Ground Continuity Test & Leakage Current Test (also called as Line Leakage Test, Earth Leakage Current Test, Enclosure Leakage Current Test or Patient Leakage Current Test). These tests are described in IEC 60335, IEC 61010 and many other national and international standards.

This subdivision emphasizes to enhance the calibration capability in biomedical metrology to cater to the demand of the healthcare sector by providing calibration services using standards traceable to the International System of units (SI).

Theoretical Environment

This subdivision is involved in the modeling of various chemical processes associated with environmental components. This subdivision has been very active for modeling the ozone budget throughout the atmospheric column. The major activities are:

- Modeling the Ozone Chemistry
- Air Pollution Monitoring and Transport
- Atmospheric Chemistry

Sensor Devices and Metrology

Air pollution has emerged as a major environmental health hazard and its impact needs to be regularly monitored & controlled. The growing awareness of air quality is creating new applications and opportunities for sensor developers and manufacturers. Market trends estimate that the gas sensor market is rapidly growing. Currently, solid state gas sensors (SSGS) are increasingly attracting interest as they are economical & portable. In this context, Indian industries require reliable technologies & quality assurance for the manufacturing of SSGS. Quality assurance is a key for SSGS developed indigenously, in view of this, CSIR-NPL has initiated a major activity to set up National Facility for Testing & Certification of SSGS. Further, imported sensors also require



Thermal Evaporation System for Thin Film Deposition

certification for quality assurance as most of them need to be calibrated as per Indian environmental conditions. Further, this subdivision at CSIR-NPL is actively engaged in the development of metal oxide and nitride based sensors for efficient detection of atmospheric pollutants. The sensing films are being developed using PVD processes, which include thermal evaporation, sputtering (RF/DC), e-beam, molecular beam epitaxy, and pulsed laser deposition techniques. Thin film characterization is carried by various state of the art techniques including multi technique surface analysis (XPS, UPS etc.), spectroscopic ellipsometer, stylus profiler, photoluminescence spectroscopy, UV-Vis spectroscopy. For testing of the grown materials for their gas sensing characteristic, facilities have been set up, which are equipped with NMI calibrated gases with precise flow and measurement temperature control.

Advanced Materials and Device Metrology: Division 4

The Division of Advanced Materials and Device Metrology aims towards synergizing the research and development for state-of-the-art bulk and nano-scale materials, process technologies and devices for Industrial, Strategic and Societal applications. The thrust is on the development of indigenous, economically viable and efficient organic and inorganic Photovoltaic and Thermoelectric devices, Luminescent materials, Carbon based materials & composites. The division undertakes this mandated research and development through several International and National projects, including Consultancy, Collaborative, Grant-in-aid and Sponsored projects. A glimpse of activities of each subdivision is described below.

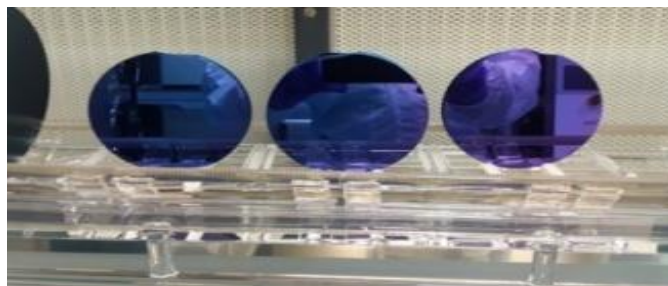
Photovoltaic Metrology

Under the CSIR-skill initiative program, a new solar park was developed at CSIR-NPL with all basic facilities to provide training to students as well as persons aspiring to have a career in solar Photovoltaic (PV) industry. The park also has basic PV training kits. Solar PV Power Monitoring Station has also been developed at CSIR-NPL solar park. The station provides the performance of the PV plant with respect to different climatic conditions over a long period time. The monitoring station has all calibrated sensors to provide accurate data for the analysis of performance of PV modules and its failure mechanisms. The module and environmental parameters are monitored through the internet of things (IoT) enabled sensors.



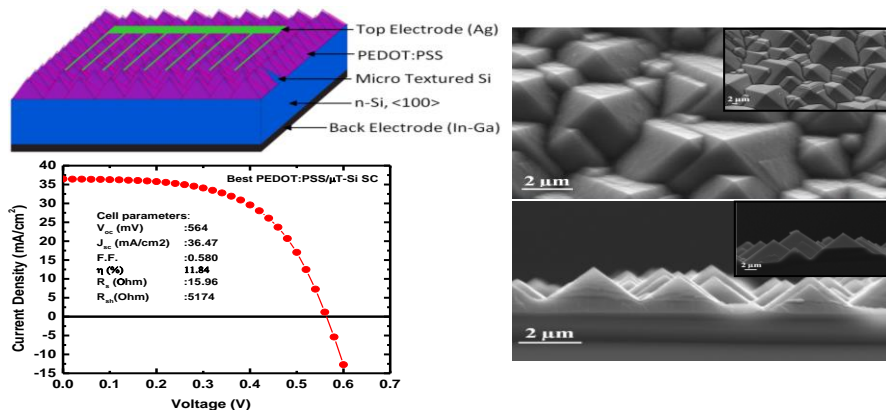
Some Representative Photographs of Solar Park, PV Power Plants, Solar Tracking system and PV Performance Monitoring System

Established process for the growth of High Quality SiO_2/Si by both wet and dry thermal oxidation for solar cells and other semiconductor device applications. Oxide growth with uniformity $<\pm 2\%$ achieved.



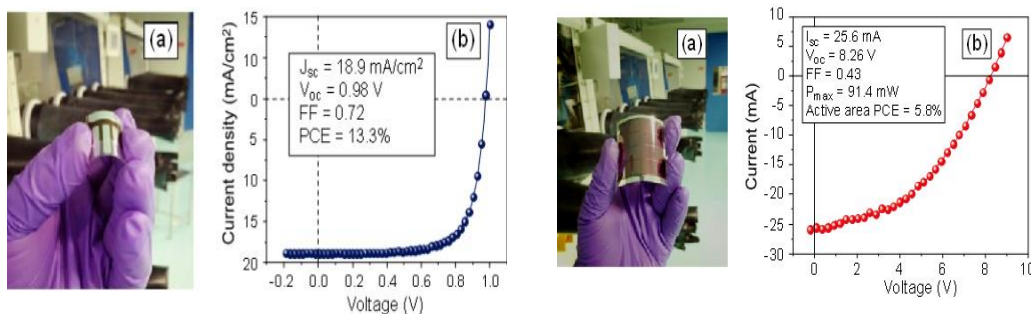
High Quality Silicon Oxide on Silicon Processed at CSIR-NPL

A low temperature solution process for fabrication of silicon/ PEDOT: PSS heterojunction based solar cells with a device structure Ag/PEDOT:PSS/Si/In-Ga has been developed. Almost threefold enhancement in the photocurrent density (J_{sc}) and a fivefold improvement in the conversion efficiency (η) for an optimized DMSO addition in the polymer have been observed compared to that having no DMSO addition. Recently achieved $\sim 12\%$ efficient cell in different optimized fabrication conditions using DMSO added PEDOT: PSS/n-Si solar cells.



Silicon/PEDOT: PSS Heterojunction based Solar Cells, Geometry, I-V and SEM Images

Flexible Perovskite Solar Cells (PSC) are being prepared on indium tin oxide (ITO) coated plastic substrates via spin coating of different materials in the desired structures. CSIR-NPL has achieved over 13% power conversion efficiency (PCE) in flexible PSCs in the device active area of 9.6 mm². Flexible perovskite solar modules with eight cells of ~ 1.98 cm² area integrated in series together. The module exhibited PCE of 5.8 % in the module active area of 15.84 cm² and generated over 90mW of power.



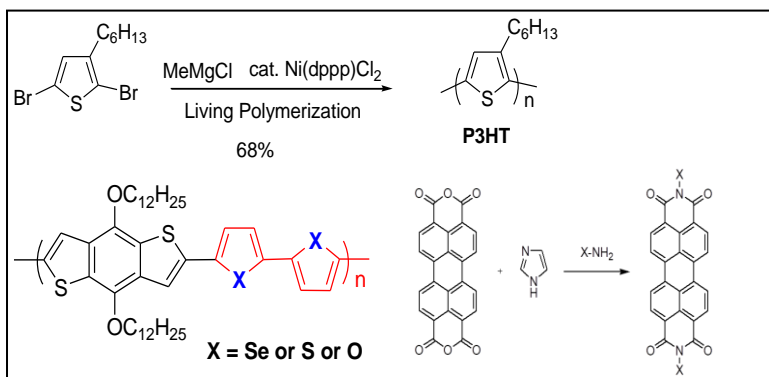
Photograph and I-V Characteristics of Flexible PSCs and PSC Module

Optical spectroscopic tools to study the charge generation mechanism in FLR (1,6,7,10-tetramethylfluoranthene) as a non-fullerene electron acceptor blended with P3HT (poly(3-hexylthiophene)) as an electron donor in five different solvents was done. Further, the Investigation of the influence of charge transport on the performance of PTB7:PC₇₁BM based organic solar cells was done. The influence of incident power light intensity and charge carrier mobility on performance parameters, which limits the power conversion efficiency (PCE) of the OSC has been studied.

A series of polythiophene based donor polymers have been synthesized. A-B type monomer (donor unit and acceptor on the same molecule) were polymerized via condensation polymerization.

Also demonstrated CuBr as a solution processable, efficient and inexpensive inorganic hole transport layer for cost effective OSCs fabrication. Fullerene and non-fullerene based n-type materials have been developed in bulk for applications in organic as well as bulk for applications in organic as well as perovskite solar cells.

Fluorene based acceptor small molecules showed electron mobility in the order of 10-3 cm²/V.s. Perylenediimides (PDI) and naphthalene diimides (NDI) based electron transport materials have been tested in inverted OSCs showing average PCE ~5 %.



Materials for Development of Stable Excitonic Solar Cells

Photonic Materials Metrology

Objectives are to explore the synthesis of lead free new direct bandgap all inorganic double perovskite (DP) bulk crystal and quantum dots for solar cells by the colloidal route. The purified nanocrystals (NCs) exhibit excellent phase and colloidal stability even in ambient atmosphere. High resolution TEM image represents well defined lattice fringes, indicating the highly crystalline nature of nanocrystals. The improved synthetic approach also showed a notable difference in the optical properties. Thin film assembly of these DP NCs ink has been optimized for improved morphology by using layer by layer coating technique for solar cells application.

Development of a Compact Blue Laser using BBO/LBO crystals based on the SHG method. DRDO, Dehradun is interested in blue lasers that are operated at 457 nm for under water communications and imaging of submersible objects. This blue laser is targeted particularly for strategic applications.



Blue Laser Emission at 457nm using BBO/LBO crystals

Bi-fluorescent Golden Ink with the fluorescent security feature has been developed at CSIR-NPL and proposed to replace the present feature of the Indian Passport cover page having golden emblem with a single fluorescent security feature. The bi-fluorescent (red and green) feature of golden ink will be hidden until it will be excited with 254nm and 365nm wavelength for red and green emission, respectively. The developed ink has been tested and qualified for all the standard parameters including chemical test, viscosity etc. for offset printing.



CSIR-NPL Bi-fluorescent Golden Ink with Fluorescent Security Features

Advanced Carbon Products

CSIR-NPL is establishing a standard facility at par with international standards for testing ballistic raw materials developed within the country or imported for precise, accurate and reliable properties measurement (physical, structural, environmental and engineering) to ensure the quality of ultimate body armour.

To mitigate problems due to the burning rice straw is converted into useful product by torrefaction process, i.e. biocoal.



Dried Rice Straw, Chopped Rice Straw, Torrified Rice Straw Product and Pellet from different Torrified Products

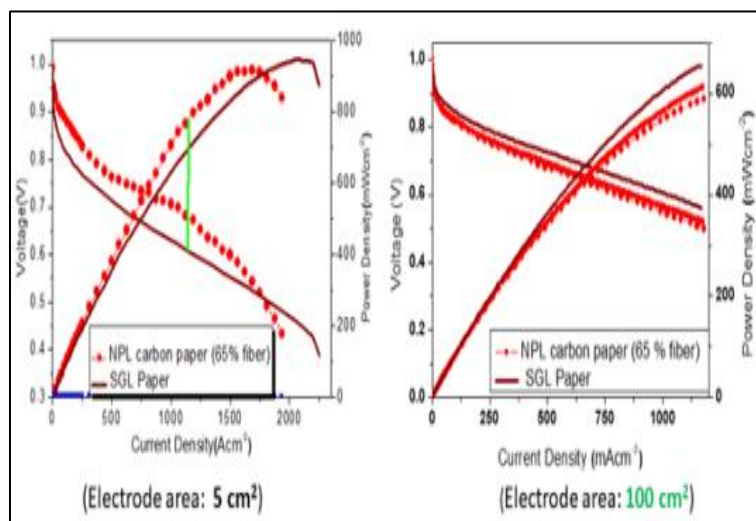
Coal tar is obtained as a by-product in the destructive distillation of metallurgical coal carried out by the steel industry and it is generally a waste material. To make some value added products from waste coal tar, a consultancy project was given by Tata Steel Pvt. Limited, Jamshedpur for converting different four stream of coal tar to Binder and Impregnating grade coal tar pitch as well zero Q.I. coal tar pitch.



Binder Coal Tar Pitch and Impregnating Coal Tar Pitch from Coal Tar

The porous carbon fiber paper as a gas diffusion layer of polymer electrolyte membrane fuel cell was modified by nano-structuring. It was modified by incorporating multiwall carbon nanotubes (MWCNTs) in chopped carbon fiber. The incorporation of MWCNTs reveals an increase in electrical conductivity from 66 S/cm to 175 S/cm and flexural modulus from 5GPa to 20GPa. Also, higher value of electrical conductivity, surface area and optimal pore sizes results in the enhancement of I-V performance.

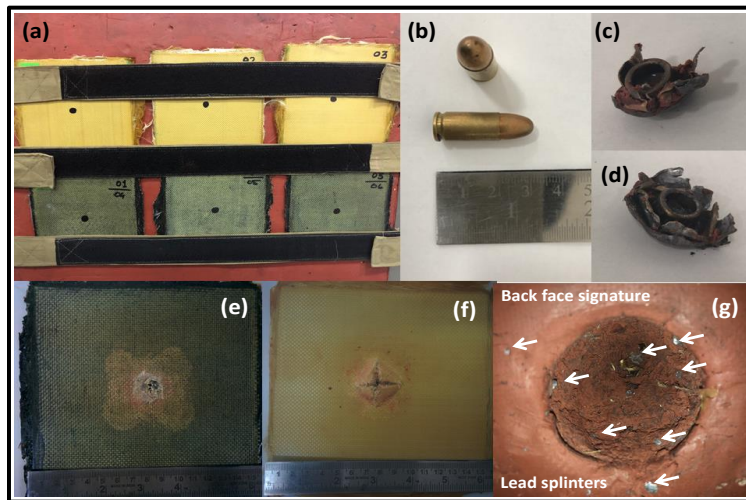
Studies have been conducted to optimize the fiber/ matrix ratio in the carbon paper while ensuring the perfect combination of required parameters. Polarization curve of the unit PEM Fuel cell (effective electrode area 5 cm²) shows similar results to commercially available SGL paper tested under similar conditions. Further scale-up to 100 cm² electrode area shows that the carbon paper not only shows almost repeatable results in a given set up but also in scale up.



Comparative I-V performance of PEM fuel cell using NPL carbon paper and commercial SGL paper

Particle board material has been prepared from waste rice straw of size 20 cm x 32 cm. These have been characterized for the different properties as per IS. The samples conform to the requirements as per IS: 3087-2005 (Amend No-4) for a flat pressed single layer.

Carbon nanotube paper interleaved Kevlar 49 laminar composites have been prepared for improving the static and dynamic mechanical properties of Kevlar reinforced composite. The interfacial property of Kevlar fabric and epoxy resin has been improved by adding MWCNT in epoxy, while bucky paper improves the interlaminar adhesion. Six composite plates of KE and KEBC are clamped over red clay tray using clay adhesion and tie. 9 mm bullet with a projectile velocity of 430 ± 15 m/s is used for penetrating the composite plates as given in the digital image. After impact bullet damages more vigorously, which is confirmed by the dismantling of lead splinters which are stuck inside the red clay hole.

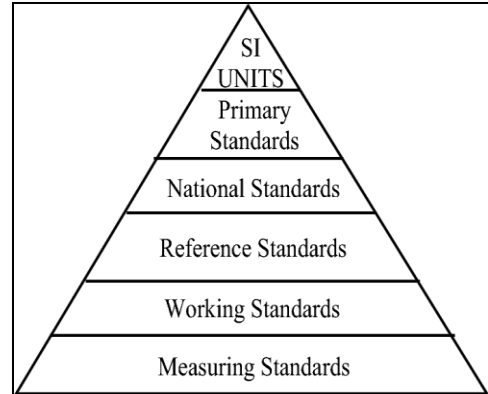


Digital images of (a) clamped composite plates, (b) 9 mm Full metal jacket bullet, (c) bullet after striking KEBC plate, (d) bullet after striking KE plate, (e) KEBC plate after ballistic test, (f) KE plate after ballistic test, and (g) back face signature over red clay plate with white arrow represents the lead splinters

BhartiyaNirdeshakDravya(BND®): Division 5

CSIR-National Physical Laboratory (CSIR-NPL-India) is mandated to be India's "National Metrology Institute" (NMI) by an act of Parliament and is the custodian of "National Standards" with a responsibility of dissemination of measurements to the needs of the country.

CSIR-National Physical Laboratory is the only institute in India which is maintaining standards through traceability of SI unit (Unbroken chain of measurement through traceability). Accurate and precise measurements are essential to drive the growth engines of Indian Science & Industry as it removes chaos and prompts innovations, which in turn, would save precious lives, resources and time. Developing India's measurement standards that are internationally accepted and disseminating the measurement capabilities to industry, government, strategic and academia that underpin India's prosperity and quality of life. CSIR-NPL, owing to its untiring efforts in the establishment, development and maintenance of "Primary Standards" of SI units and its derivatives and their dissemination, has occupied a pivotal position in the country. The rapid advancement in science & technology and globalization of economies poses a strong need for more stringent metrological regulations in trade and commerce. To this end, the Legal Metrology Act, 2009, was enforced by the Government of India (GOI) on April 01, 2011, throughout the country. Under this metrology act, CSIR-NPL is continuously working hard to make an impact on the quality control system up to the mark as per global expectations through compliance of the unbroken chain of measurement traceability to SI units.



Relevance of Dimensional Metrology in Manufacturing Industries through Unbroken Chain of Measurement



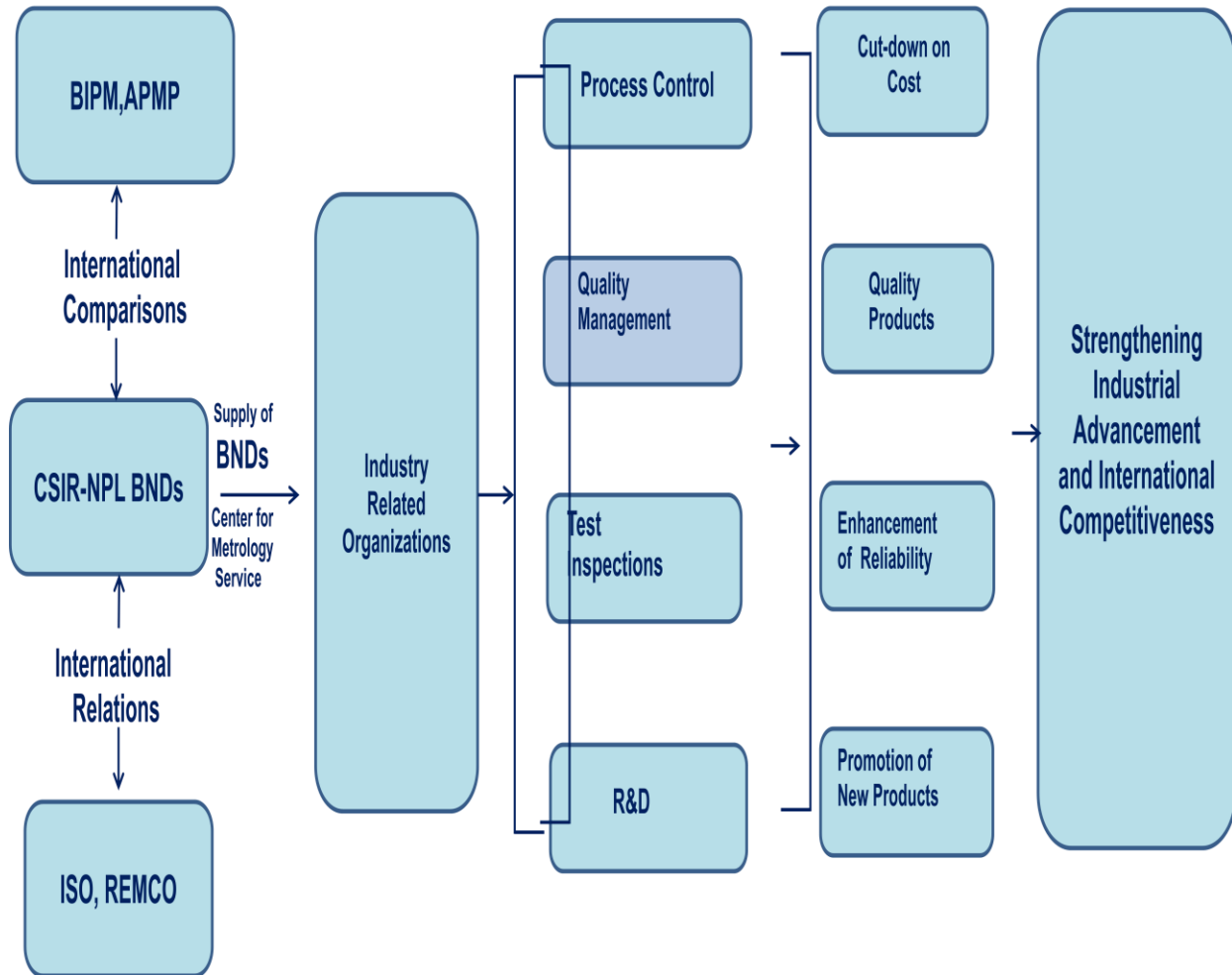
Impact of BNDs on Economic Growth

The Certified Reference Materials are important to calibrate all the analytical equipments for accurate and precise measurement data. In this regard, CSIR-NPL has recently started a mission mode program for the indigenous production of Indian Reference Materials (BNDs) in different areas such as food, fuel, blood serum, ores, and minerals etc. to ensure the quality controls of the processes and products in the country. It is a high time where the National Metrology Institute of the country (NPLI) has taken a lead role in India's economy and quality consumer products to control the quality products.

Thus, strengthening the BND program at CSIR-NPL will improve the quality of products and will certainly increase the exports. The products from India and abroad will be thoroughly checked with BND, which will bring a paradigm shift in yielding major revenue generation to our country and it will indirectly boost our GDP too.

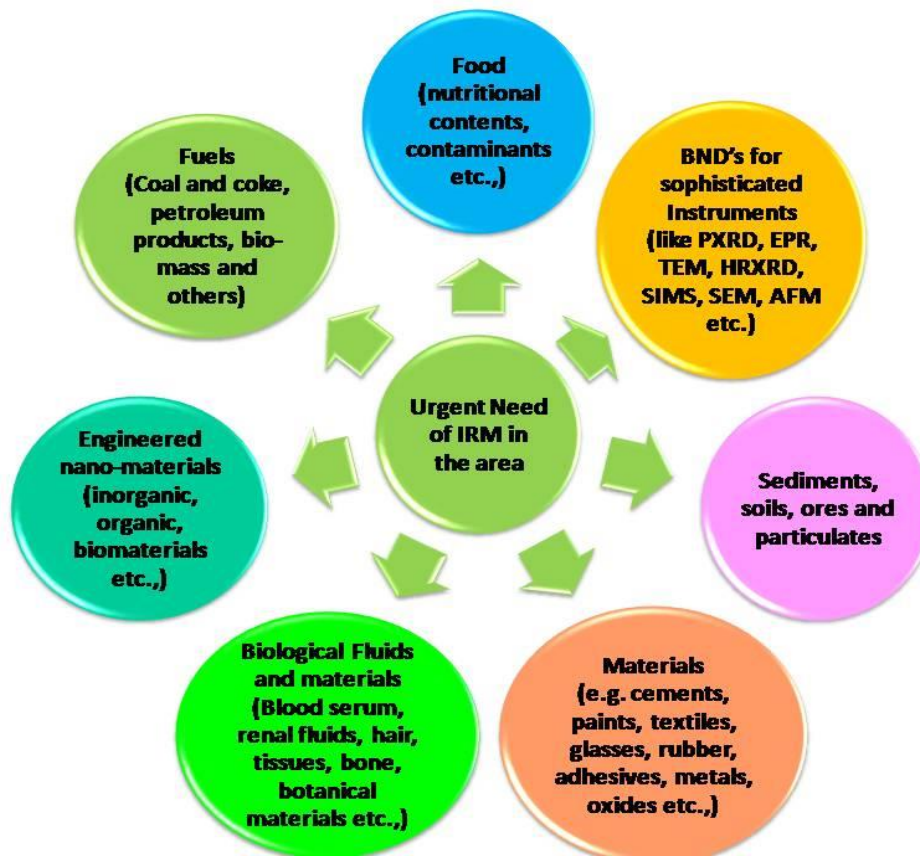
Indian Reference Materials (Bharatiya Nirdehak Dravya®) developed at CSIR-NPL is the key to quality control on the products of industries by establishing its traceability through the SI unit at CSIR-NPL. The role of BND in a broad way is to strengthen industrial advancement and international competitiveness.

Development, Supply of BND and its effect



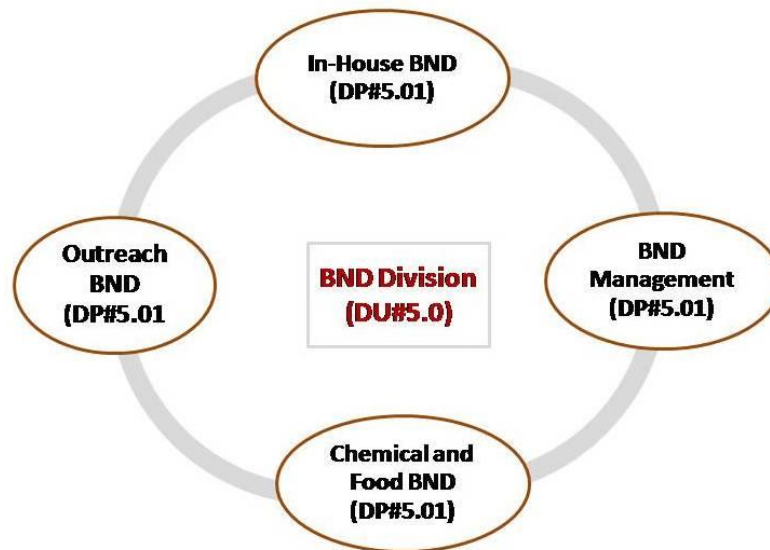
Role of BND for Industrial Advancement and International Competitiveness

CSIR-NPL main focus is to produce BNDs in almost all sectors.



BNDs in Various Sectors

Recently Ministry of Commerce has granted a mega project for the production of BNDs under the TIEs program. To harmonize the whole process on the BND activities, the division is further segmented into four subdivisions and the mandates/activates are as follows:



In-House BND

This subdivision is indulged in preparation of in-house BNDs in the field of minerals, alloy, powder, liquid suspension and nano materials. CSIR-NPL has high end of sophisticated analytical instruments for the characterization of materials. All these equipments come under the quality system. We have initiated a programme for the in-house production of BNDs like Powder X-ray diffraction 'd' spacing standards, viscosity, thin film, polyester, coke, water, and Seebeck coefficient standards.



Analytical Equipments in In-house BND

Outreach BND

This subdivision is engaged in liaising with Reference Material Producers (RMPs) in different sectors and to felicitate MoU's with CSIR-NPL. During the year, several BNDs have been released in several sectors such as building materials from NCCBM, Faridabad, high purity compound, aqueous elemental standards, pH standards from M/s Aashvi Technology LLP, Ahmadabad, and petroleum based products from HPCL.

Chemical and Food BND

The main objective of this subdivision is to ensure and promote the safety issue of hazardous chemicals and food quality by providing specific BNDs. This subdivision deals with BNDs in the field of food, water, trace elements, and gas. Chemical and Food BND activity has developed several reference standards for calibration of the equipments like AAS, ICP-OES, ICP -MS, etc. The standards are helpful for the optimization of their process and to establish the quality of their products. The CRMs have been prepared gravimetrically and are traceable to the SI unit. In order to disseminate SI Traceability and cater to the need of industries/R&D Institutes/ NABL accredited laboratories, effort has been made to liaison with the Reference Material Producer (RMPs) in the various areas.

The Chemical and Food BND subdivision has also been providing support for chemical characterization of materials for their chemical composition, purity/ impurity assessment and conformity requirements needs in CSIR-NPL/ stakeholders like Delhi Jal Board (for PAC), Election Commission of India (for indelible ink). The subdivision is also engaged in R&D related to method development, purity/ impurity analysis by classical gravimetry, titrimetry and instrumental techniques like ICP-HR-MS, F&GF-AAS, IC, UFLC, UV-Vis spectrophotometer analyzers. This subdivision also provides consultancy and R&D services for societal issues viz. recovery of precious metals from process waste and also water purification.

BND Management

This subdivision facilitates the Reference Material Producers (RMPs) in-house/external in certification (as per ISO guidelines and CSIR-NPL quality system) for Reference Materials traceable to SI units.

Indian Standard Time Metrology: Division 6

The main objective of this division is to strengthen and encourage the overall development in the field of science and technology for the country. The main responsibility is the realization, establishment, custody, maintenance, dissemination and upgradation of the national standards for Time & Frequency, LF & HF Voltage, Current, Microwave and Magnetic parameters. The division also has additional capabilities like cryostat system, E-field, RF I-V impedance analyzer, Phasor Measurement Unit (PMU), nano fabrication facility with the help of Focussed Ion Beam (FIB) system. Dissemination of IST is done through network time service and satellite links. Calibration of precision clocks, oscillators, GNSS receivers, stop watches etc. are also provided. Research and development in the state-of-the-art ultramodern atomic clocks and dissemination techniques for improving time keeping and dissemination capabilities is also being carried out. Maintenance and upgradation of the National Standard related to magnetic parameter like Magnetic flux Density, Magnetic flux, turn area of search coil, power loss measurement of electrical steel, through continuous development and providing calibration/test facilities of such parameters to industries and institutions as per ISO/IEC: 17025 guidelines, which are traceable internationally, are also undertaken by this division. The division is also providing various apex level calibration services to the industry & user organizations of the country and provides educational training on industrial metrology to support economic growth. A glimpse of activities of each subdivision is described below.

Time and Frequency Metrology

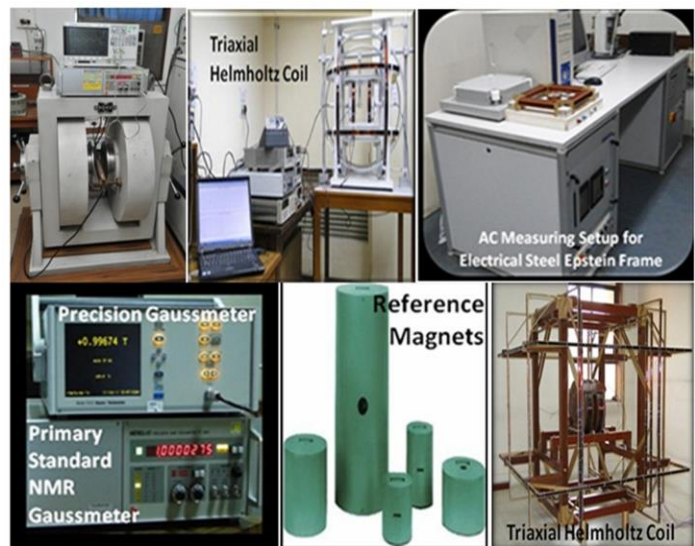
Time and Frequency (T&F) subdivision of CSIR-NPL plays leading role as the Indian Time Authority (ITA), which is responsible for measuring “time” and “frequency” with highest level of accuracy in India and keep them traceable to the International Bureau of Weights and Measures (BIPM) using ultraprecise satellite links to realize “second”, i.e., the unit of time in International System (SI) of Units. CSIR-NPL maintains IST (UTC+05:30) within ± 2.8 ns with the help of atomic clocks in environment-controlled laboratories with uninterrupted power supply. Collaboration and MoUs with the strategic sector, specifically, ISRO, IAF, DoT, DoCA, and NIC-NKN for nation-wide time synchronization have been setup. The training, consultancy and traceability services to the strategic and non-strategic sectors are being undertaken. CSIR-NPL has developed the Primary time scale generating Indian Standard Time (IST) and created the time traceability link to the Indian Space Research Organization (ISRO). ISRO is using the time traceability established via the Satellite link with ns accuracy for national deep space missions and Indian Regional Navigation Satellite System (IRNSS). This subdivision is involved in the National Mission on creation of new timing ensembles which will synchronize all the device clocks in the country to within one second of Indian Standard Time (IST) for social, economic and strategic growth of the Nation. The development of the secondary timing laboratories in different cities of the country has been undertaken by CSIR-NPL.

LF & HF Voltage, Current and Microwave Metrology

This subdivision is involved in developing, upgrading and maintaining the LF & HF Voltage, Current and Microwave related Standards traceable to SI units as national capabilities. LF, HF Voltage, Current & Microwave Metrology Section, contributes by maintaining one of the world's most comprehensive national capabilities for measuring electromagnetic quantities across the spectrum using established National Standards for Low Frequency Voltage & Current upto 1000V & 20A, Microwave Power, Attenuation & Impedance Standards upto 50 GHz along with the associated calibration facilities. This subdivision also maintains the programmable Josephson voltage standard (PJVS) system, which is the primary standard of unit 'Volt' at 1 V and 10 V level. The subdivision also has additional capabilities like cryostat system, E-field, RF I-V impedance analyzer, Phasor measurement unit (PMU), nano fabrication facility with the help of Focused Ion Beam (FIB) system. This subdivision has established SAR measurement system and Phasor Measurement Unit Calibration System (PMU-CAL) as per IEEE standards.

Magnetic Metrology

This subdivision is responsible for maintaining and upgrading National Standard related to the magnetic parameter like Magnetic flux density, Magnetic flux, Turn area of search coil, Power loss measurement of electrical steel, through continuous development and providing calibration/test facilities of such parameters to industries and institutions as per ISO/IEC: 17025 guidelines. This subdivision is also trying continuously the best possible efforts to improve further uncertainty of measurement so that the best calibration and test results with minimum error can be provided. This provides solutions to different industrial problems and also generates industrial consultancies. During last year, the test procedure for magnetic field mapping for DC/AC electromagnets through Gaussmeter was developed. The development of a calibration facility for AC Magnetic field measurement up to 400 Hz (Magnetic field range: 10mG-20G) was initiated. This subdivision also provides the solution to industrial problems as industrial consultancy and is also involved in Material R & D for Magnetic Metrological Applications.



Magnetic Metrology

Directorate

This division comprises of Planning, Monitoring Evaluation and Outreach; Industrial Liaison Group; Centre for Calibration & Testing; Workshop; International Science and Technology Affairs Group; Human Resource Development Group; Administration-Quality Management System; Rajbhasha Unit; Knowledge Resource Centre; Finance & Accounts Store & Purchase Section; Works & Services.

Planning, Monitoring Evaluation and Outreach

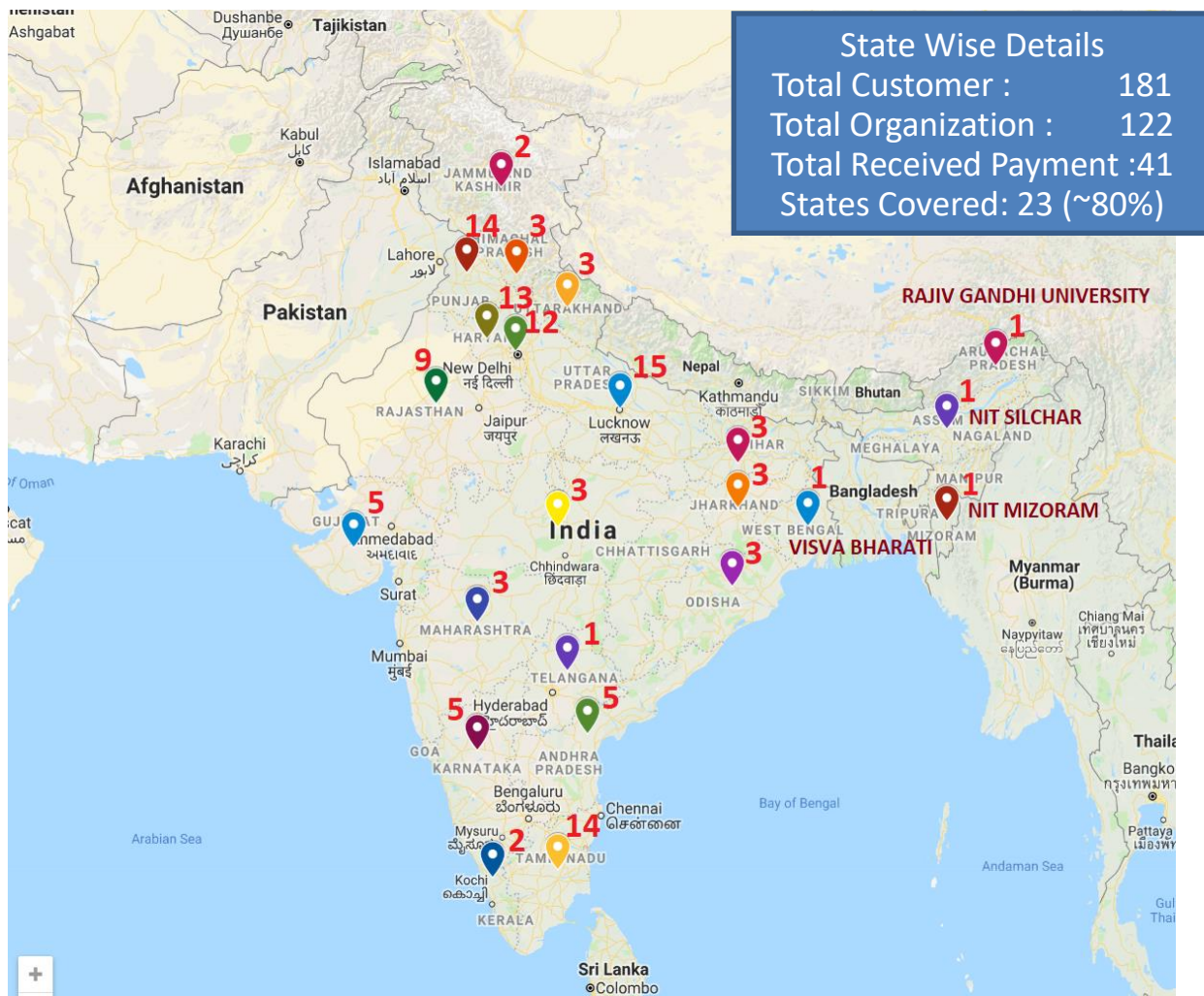
CSIR-NPL undertakes projects sponsored by various external agencies such as Ministry of Science & Technology, MNRE, DST, etc. The department is involved in the planning, monitoring and evaluation of the various type of GAP, TLP, FTT, SPP, CNP & Mission Mode, etc, projects. The details of External Cash Flow i.e., money received from these agencies to carry out specified project is regularly recorded and monitored by PME against the target established by the Institute. Registration of all projects and allotment of specific identity in terms of a Project No. is made at PME, soon after the money for the project is received along with In-Principle approval. Projects are registered in different modes viz FTT, mission mode, Sponsored research, Grant-in-Aid, Collaborative and CNP. The total number of projects registered in different modes is 55. In the year 2018-19, ten new GAP projects have started worth **Rs. 20.68 Crores**, while three New MLP-CSIR Funded projects have taken off, costing **Rs. 65.49 Crores**. A grant of **Rs 12.51 Crores** in the forty-five continuing GAP projects was received.

Apart from this, PME also attends to technical queries, Parliament Questions and technical audit as well as assist Director in liaisoning with CSIR-HQ, Management Council (MC) and Research Council (RC) on project related matters. In 2018-19, **PME has successfully conducted 43 NPL Council Meetings, 03 Research Council & Management Council Meetings and 25 Institutional Scientific Review Meetings**. PME has processed **1464 indents** worth **Rs 18.22 Crores** and **Rs 14 Crore** has been booked in the LRF.

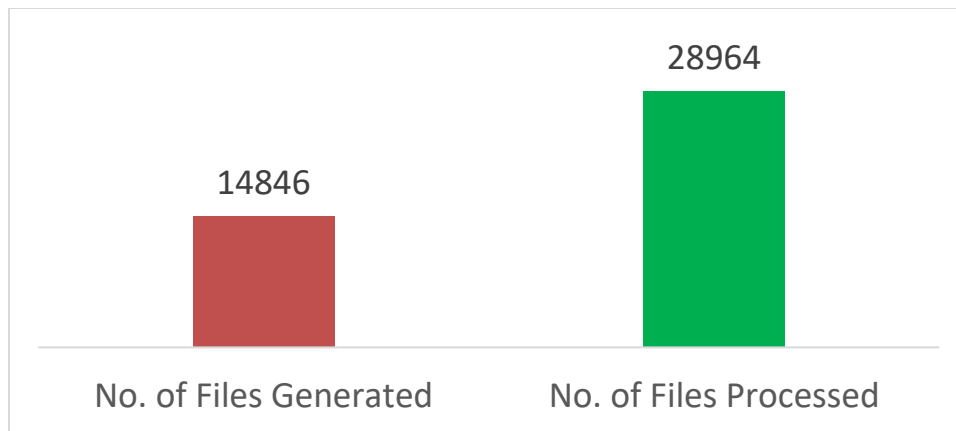
The CSIR-NPL **Outreach** program aims at providing the facility of sophisticated analytical instruments to students and other users from academic institutes to enable them to carry out measurements for R&D and Academic work. PME is the nodal point for this program and is responsible for the enquiry, customer, cluster, instrument, study, payment and report management. The program was formally launched on May 20, 2016 with **102 instruments categorized under twelve clusters** listed on CSIR-NPL website. Through this program, CSIR-NPL is currently catering the need of research students and scientists across India. Outreach program receives on an average more than 20 requests per week in various clusters and has already processed/characterized **200 samples** through this program from across India. Our major customers include IIT Patna, IIT (ISM) Dhanbad, MNIT Jaipur, IIT Delhi, DTU Delhi, Delhi University, Amity, Jaypee, Kurukshetra Univ, Guru Jambheshwar University Hisar, NIT Srinagar, BHU, M S university of Baroda, University Kolhapur, Longowal Punjab, Rajkot, Vellore, SASTRA University, Thanjavur, Mangalore University and Pondicherry University. The CSIR-NPL **Outreach revenue earned till**

January 2018 is Rs 08 lacs, where the average cost per sample for characterization is around Rs 1000 at CSIR-NPL.

PME has developed and implemented barcode enabled **Online File Tracking System (FTS)** across CSIR-NPL, to enable tracking of file movement using web based software. FTS has been adopted a unique bar-coded sticker system to track the location of the file at a single click. The package has features for diarizing of files, updating its status, opening of new files, tracking the movement of files, dispatch of letters/files and record management. All the departments across CSIR-NPL are using the software for their in and out dak entries. From April 2018-January 2019, **14,846 files have been generated and 28964 files have been processed** across various departments.

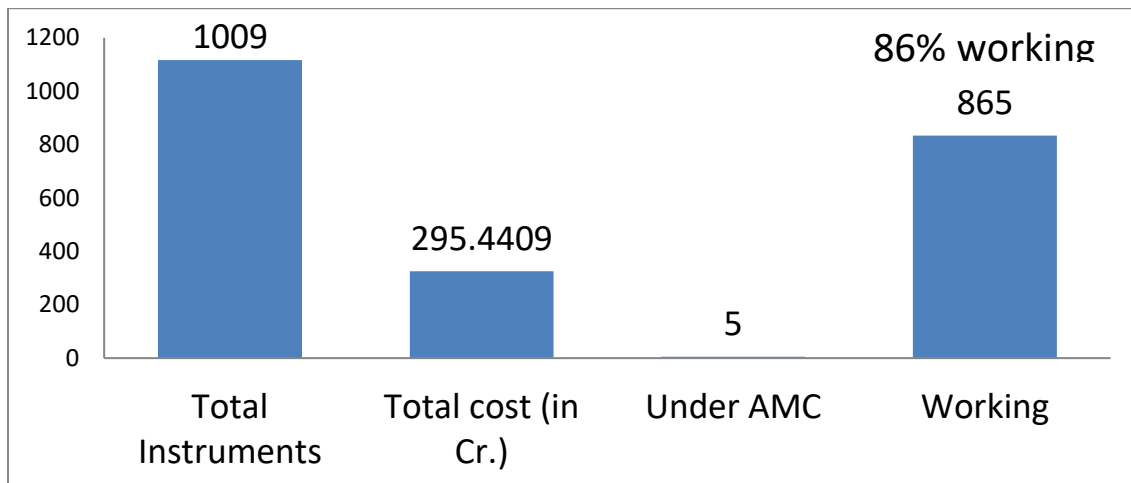


State Wise Outreach Organizations

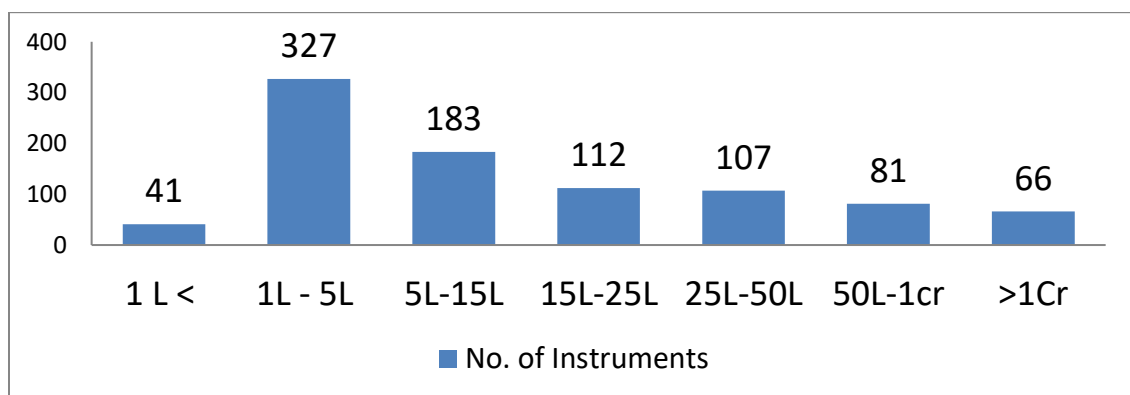


Files Generated and Processed using FTS across various Departments of CSIR-NPL

PME has been a part of instrument audit team for CSIR-NPL and was responsible for data entry, analysis and audit report. Few of the important findings from the audit are highlighted in the following figures. CSIR-NPL has been registered in the national level central facility iSTEM (**Indian Science Technology and Engineering facilities Map, GOI Initiative**), with **103** instruments.



Total Instruments at CSIR-NPL



Cost-wise Number of Instruments

Industrial Liaison Group

The Industrial Liaison Group (ILG) serves as an interface between CSIR-NPL and Government/Public/Private Organizations, Industries, Universities etc. The ILG group facilitates utilization of the technologies/know-hows developed by CSIR-NPL by licensing them to the Industries/stakeholders. ILG group also offers consultancy and technical services to the clients in time bound project mode for utilization of expertise available with CSIR-NPL for development of new products/process and for improvement of Quality System in the country. Further, to meet the objectives, ILG Group plays an active role for show-casing CSIR-NPL technologies, know-hows and expertise to the stakeholders at various platforms. ILG Group also maintains the details of all the Technologies/know-hows available for commercialization on the ILG web page. Apart from management of S&T outputs, ILG group also handles signing of MoUs, MoAs and NDAs with the Indian Industries, Institutes, Research Organizations etc. The details of the technology/know-how transferred, MoUs signed, dissemination of traceability through BNDs and consultancy/sponsored/technical services projects has been given below:

❖ Consultancy Projects (2018-2019)

1. "Development of YAG:Ce yellow phosphor integrated with blue laser to produce white light"; M/s Fiem Industries Limited, Sonapat, Haryana; 01-05-2018 to 31-10-2018; Total project cost: Rs 5,69,940 including GST@18%.
2. "Consultancy Services to Department of Legal Metrology (LM) for conceptualization and providing technical, infrastructural and manpower inputs for establishing the secondary timing systems for dissemination of IST under Legal Metrology Act 2009"; M/s Legal Metrology, Ministry of Consumer Affairs, New Delhi; 19-04-2018 to 18-04-2020; Total project cost: Rs 1,18,00,000 including GST@18%, received a sum of Rs 91,00,000 as first installment.
3. "Performance testing of PM2.5 Sensors under ambient and high emission conditions"; Indian Statistical Institute; New Delhi; 25-04-2018 to 24-07-2019; Total project cost: Rs 6,60,706 including GST@18%.
4. "Conversion of coal tar into coal tar pitch and Quinoline Insoluble (Q.I). free coal tar pitch, and its characterization for various desired properties"; M/s Tata Steel Limited, Jamshedpur; 14-06-2018 to 13-03-2019; Total project cost: Rs 34,28,254 including GST@18%, received a sum of Rs 20,22,088 as first installment.
5. "Verification of Flat Bottom Hole and Foot Angled Defects in Standard Test Rails using Ultrasonic and Dimensional Methods"; M/s Physimech Instrumentation (P) Ltd, Hyderabad; 19-06-2018 to 18-12-2018; Total project cost: Rs 1,77,000 including GST@18%.
6. "Upgradation and maintenance of existing SODAR at CPCB Delhi"; Central Pollution Control Board (CPCB), Delhi, 23-08-2018 to 22-08-2021; Total project cost: Rs 29,50,000 including GST@18%, received a sum of Rs 25,96,000 as first installment.

❖ Sponsored Projects (2018-2019)

1. "Conversion of Waste Biomass (crop stubble) and Municipal Solid Waste (MSW) in to biochar by Torrefaction as useful raw material for co-firing in thermal power plants"; M/s National Thermal Power Corporation (NTPC), Noida; 18-10-2018 to 17-10-2019, Total project cost : Rs 1,95,25,460 including GST@18%, received a sum of Rs 1,17,15,276 as first installment.

❖ Technical Services Projects (2018-2019)

1. "Collection efficiency checks of a pollution control device for particulate matter and pollution gases"; NTPC School of Business, Noida, UP; 09-07-2018 to 08-01-2019; Total project cost: Rs 5,91,845 including GST@18%.
2. "Metrological technical assistance on evaluation, data interpretation and analysis of measurements performed using static, differential and barometric pressure transmitters with in-built air conditioning plant"; M/s Carrier Midea India Pvt. Ltd., Rewari, Haryana; 12-07-2018 to 11-04-2019; Total project cost: Rs 2,12,400 including GST@18%.
3. "Fabrication and Establishment of Pressure Calibration System in the Range up to 140 MPa"; National Council of Cement & Building Material (NCCBM), Ballabgarh, Faridabad, Haryana; 24-08-2018 to 23-02-2020; Total project cost: Rs 10,14,800 including GST@18%.
4. "Technical Services for Phasor Measurement Unit (PMU) Performance Evaluation and Testing"; M/s Valiant Communications Limited, New Delhi; 24-09-2018 to 23-12-2018; Total project cost: Rs 4,98,550 including GST@18%.
5. "Design, development, fabrication and establishment of customized indigenous working standards for verification of blood pressure measuring instruments (2 systems)"; M/s Legal Metrology Department, Department of Consumer Affair, New Delhi; 27-11-2018 to 26-11-2019; Total project cost: Rs 75,84,402 including GST@18%.
6. "Establishment of reference standard for length at Regional Reference standards laboratory, Bangalore using laser interferometer"; M/s Legal Metrology Department, Department of Consumer Affair, New Delhi; 27-11-2018 to 26-11-2020; Total project cost: Rs 1,11,09,110 including GST@18%.
7. "Development, fabrication and establishment of testing and calibration facility for clinical thermometers(liquid-in-glass and electrical) with maximum device at 2 Regional Reference Standards Laboratories at Guwahati and Ranchi centers"; M/s Legal Metrology Department, Department of Consumer Affair, New Delhi; 27-11-2018 to 26-11-2019; Total project cost : Rs 1,19,91,160 including GST@18%, received a sum of Rs 1,10,94,269 as first installment.
8. "Technical Services for performance evaluation for 'M' type Phasor Measurement Unit (PMU)"; M/s Valiant Communications Limited, New Delhi; 24-12-2018 to 23-03-2019; Total project cost: Rs 3,56,012 including GST@18%.
9. "Development of timing laboratories of Legal Metrology Department (LM) traceable to National Time Scale generating IST at five locations and creation of one disaster recovery center"; M/s Legal Metrology Department, Ministry of

Consumer Affairs, New Delhi; 22-01-2019 to 21-07-2021; Total project cost: Rs 91,52,00,000 including GST@18%, received a sum of Rs 15 Crore as first installment and Rs 16.15 Crore as second installment (partial).

❖ **Registration of Bhartiya Nirdeshak Dravya® (BNDTM) with Reference Material Producers (RMPs), 2018-2019**

1. "Dissemination of Metrological Traceability through Bhartiya Nirdeshak Dravya (BND) for development of SI traceable cement BNDs"; M/s National Council for Cement and Building Materials, (NCCBM), Ballabgarh, Haryana; Money received Rs 70,800 including GST dt 20-07-2018.
2. "Dissemination of Metrological Traceability through Bhartiya Nirdeshak Dravya (BND) for development of SI traceable BNDs"; M/s Aashvi Technology LLP, Ahmedabad, Gujarat; Money received Rs 1,77,000 including GST dt 23-08-2018.
3. "Dissemination of Metrological Traceability through Bhartiya Nirdeshak Dravya (BND)"; M/s National Council for Cement and Building Materials(NCCBM), Ballabgarh, Faridabad, Haryana; Money received Rs 35,400 including GST dt 26-09-2018.
4. "Dissemination of Metrological Traceability through Petroleum based Bhartiya Nirdeshak Dravya (BND)", Quality Control Laboratory, HPCL Visakha Visakhapatnam; Money received Rs 2,95,000 including GST dt 22-10-2018.
5. "Dissemination of Metrological Traceability through hardness related BNDs"; M/s Global PT Provider Pvt.Ltd, Okhla Industrial Area, Phase-II, New Delhi; Money received Rs 59,000 including GST dt 15-03-2019.

❖ **Licensing of Technology/Know-How (2018-2019)**

1. "Process for synthesis of PEDOT:PSS"; Licensed to M/s Sreeni Lab Pvt. Ltd., Hyderabad on 04-05-2018; Premium Rs. 4,13,000 including GST.
2. "Recycling of plastic waste into Tiles for Structure Designing for Societal Usage", Licensed to M/s Vyzag Bio Energy Fuel Private Limited, Visakhapatnam, Andhra Pradesh (through NRDC) on 22-06-2018; Premium Rs 16,80,000 including GST.
3. "Recycling of Plastic Wastes into Tiles for Structure Designing for Societal Usage", Licensed to M/s Esperanza Global Eco Solutions Pvt. Ltd., Chandigarh on 11-12-2018; Premium Rs 17,64,000 including GST.
4. "Acoustical lightweight Interior Dry Wall Panel for High Sound Insulation", Licensed to M/s Sehgal Doors, New Delhi on 05-11-2018; Premium Rs 5,93,600 including GST.
5. "3 Tesla Auto Range Pulsed/Static Field Gauss Meter (Digital Gauss Meter)"; Licensed to M/s Physics Instruments Company, Chennai, Tamil Nadu on 18-02-2019; Premium Rs 2,24,000 including GST.
6. "Improved Variable Frequency Ultrasonic Interferometer for Velocity and Attenuation Measurement in liquid"; Licensed to M/s Physics Instruments Company, Chennai, Tamil Nadu on 18-02-2019; Premium Rs 5,60,000 including GST.

❖ MoUs, MoA and NDA (2018-2019)

1. Confederation of Indian Industries (CII), Lodhi Road, New Delhi, for “Implementation of the Prime Minister’s Fellowship Scheme for Doctoral Research”, 01-04-2018.
2. Department of Telecommunication (DoT), New Delhi, for “Providing Indian Standard Time and Frequency Consultancy and Traceability”, 25-04-2018.
3. M/s Sreeni Labs Pvt. Ltd, Hyderabad, Telangana for know how transfer of “Process for the synthesis of Poly(3,4-ethylenedioxythiophene)-poly(styrenesulfonate) (PEDOT:PSS)”, 04-05-2018.
4. M/s Central Pollution Control Board (CPCB), Delhi for “Upgradation and maintenance of SODAR system located at CPCB, Delhi”, 15-05-2018.
5. M/s Aashvi Technology LLP, Ahmedabad, Gujarat for “Production of Bhartiya Nirdeshak Dravyas (BND™)”, 18-05-2018.
6. M/s National Council for Cement and Building Materials (NCCBM), Ballabgarh, Haryana for “Production of Bhartiya Nirdeshak Dravyas (BND™)”, 21-05-2018.
7. M/s Vyzag Bio Energy Fuel Private Limited, Visakhapatnam, Andhra Pradesh, for technology transfer of “Recycling of Plastic Wastes into Tiles for Structure Designing for Societal Usage”, 22-06-2018.
8. M/s Hindustan Petroleum Corporation Limited (HPCL), Mumbai for “Production of Bhartiya Nirdeshak Dravyas (BND™)”, 18-07-2018.
9. M/s Sehgal Doors, New Delhi, for know-how transfer of “Acoustical Lightweight Interior Dry Wall Panel for High Sound Insulation”, 05-11-2018.
10. Thapar Institute of Engineering & Technology (TIET), Patiala, Punjab for “Ph.D., M.Tech. and B.Tech. exchange program in the area of Metrology”, 12-11-2018.
11. M/s Global PT Provider (P) Limited, New Delhi, for “Production of Bhartiya Nirdeshak Dravyas (BND™)”, 27-11-2018.
12. Rajasthan Electronics and Instruments Limited (REIL), Jaipur, for knowhow transfer of “Solid State Peltier Refrigerator”, 10-12-2018.
13. M/s Esperanza Global Eco Solutions Pvt Ltd, Chandigarh, for technology transfer of “Recycling of Plastic Wastes into Tiles for Structure Designing for Societal Usage”, 11-12-2018.
14. M/s Legal Metrology, Department of Consumer Affairs, Ministry of Consumer Affairs, Government of India for “Technical Services for Setting up of “Secondary Time Ensembles” at five Regional Reference Standards Laboratory (RRSL) & one Disaster Recovery Centre (DRC)”, 28-12-2018.
15. M/s Physics Instruments Co., Chennai, Tamil Nadu, for technology transfer of “Improved Variable Frequency Ultrasonic Interferometer for Velocity and Attenuation Measurement in liquid” and “3 Tesla Auto Range Pulsed/Static Field Gauss Meter (Digital Gauss Meter)”, 18-02-2019.

Centre for Calibration and Testing

Centre for Calibration and Testing has been setup to promote calibration and testing services of CSIR-NPL. It acts as an interface between customers and all calibration and testing groups. CFCT is responsible for accepting the applications, generating case files and sending calibration certificates and testing reports to the customers. It maintains a customer database of more than 3700 customers. During the year the revenue generated from calibration and testing is 11crore out of the reports generated for the year 2018-19. This centre follows/maintains the Laboratory Quality System ISO 17025.

Workshop

Central Workshop of the CSIR-National Physical Laboratory provides technical services related to design, drawing, modeling and development of new experimental set up/instruments, fabrication of high precision components, repair and maintenance of existing instruments/setup required by the various section of the laboratory. In addition to that this facility also provides inside campus mechanical maintenance and other related work etc.

The central workshop equipped with the state-of-the-art facilities:-

- 4-Axis Deckle Make CNC Milling Machine
- Precision Lathe Machine
- Micro Milling Machine
- Tool and Cutter Grinder
- Precision Surface Grinder
- Sheet Metal Shop
- Welding Shop

A large number of Instruments/components were fabricated in the workshop such as customized Graphene Growth System (Hardware) and its various components for QHRS, High Density Graphite Crucible and MO cup for Graphene Growth experiment, Low temperature sample stage probe for transport measurement which covers the temperature range from 300K to 4.2K, Sophisticated chamber for the calibration of low cost PM_{2.5} sensor from Light Scattering Technique and fully customized Ultrasonic Liquid Cell for the measurement of Ultrasonic Velocity.

Beside this the central workshop helps in the maintenance of Apex level standards and establishment of new facility/Instrument and other site mechanical works of the laboratory in several manners. The central workshop facility also involves in the fabrication/manufacturing of the accessories and spares using for calibration and testing of the different instruments and notional earning was approximately Rs. 58.0 Lakhs for the year 2018-19.

Latest Developed Products by CSIR-NPL CENTRAL WORKSHOP



Graphene Growth System for Quantum Hall Resistance Standards



High Density Graphite Crucible for Graphene Growth experiment



Device developed for the calibration of Infrared and Digital Thermometer



I-V instrument high precision copper bus bar for the measurement of Solar Cell



Device developed for the testing of thin films sensor for air pollutant gases



Devices fabricated for Advance Material & Devices Division



Micro Milling Machine



CNC Milling Machine



Precision Lathe Machine



Welding Shop



Precision Surface Grinder



Tool and Cutter Grinder



Sheet Metal Shop



Glass Technology Section



Fitting & Assembling Shop

Latest Developed Products

State-of-art Facilities

International Science and Technology Affairs Group

International Scientific Collaborations are assisting the scientists to share their ideas & papers for developing new technologies & bridging the gap between them for the service of mankind. ISTAG group facilitates the overseas visits of scientific and technical personnel of the laboratory to get acquaintance & learn new techniques. It advises the scientists to participate in International Conferences, Seminars and Summer Schools. It helps the scientists to get prestigious international fellowships. This group also advises the scientists to avail bilateral exchange programme. The total numbers of visits conducted by the CSIR-NPL scientists/technologists were 26. The group also encourages and facilitates the visits of young students to abroad. This year total 11 students visited abroad for attending International conferences/seminars/ workshops and others for research oriented programmes. It also organizes the visit of foreign delegations at CSIR-NPL. International experts are also invited to deliver talks and lectures at CSIR-NPL. The total numbers of foreign visitors visited CSIR-NPL were 12. The scientific staff is motivated to avail sabbatical leave/study leave. Arranging training programmes for international candidates

is also the job of this group. International collaborative projects, bilateral exchange programme and MOU are also handled by this group.

Human Resource Development Group

The HRD group represents a central group of the laboratory and is involved in a wide range of HRD related activities in various areas of core competence of the lab and also related to research scholars/students. The basic objective behind these activities is to make the scientific, technical & administrative human resource better informed, knowledgeable and highly skilled & trained so that it can prove to be more competitive, productive and useful to the society and the country. During the period major activities of the HRD group are as follows:

❖ Organization of Industrial Training Courses

Organization of Training Courses on various physical parameters in the area of Metrology / Standards, as well as on other specialized topics is an important activity of the HRD Group. These courses are primarily meant for the personnel belonging to various industries, Testing & Calibration laboratories and other S&T organizations and CSIR-NPL staff.

The Training Courses consist of theory lectures on various scientific & technical aspects of the training course, followed by practical demonstration and hands-on training on the related instruments / apparatus / machines.

Total Training Programme till 31.03.2019 = 14 Non Residential

Total No. of Participant = 144

Total ECF Generated: Rs. 29,51,158/- and \$2124

❖ Ph.D. Registration and other Support to Research Fellows

One of the most prominent activities of the CSIR-NPL is to provide help and support to Research Fellows (JRFs / SRFs), starting from the time they join CSIR-NPL till the time they leave the institute. This includes their placement in a suitable Division / Group and helping them in getting Hostel accommodation, if required. This also includes their Ph.D. registration, assessment for continuance /up-gradation, deputation to attend conferences, etc.

During the period from April 01, 2018 to March 31, 2019, 110 research fellows (JRFs/SRFs) joined CSIR-NPL and AcSIR Ph.D. Programme, resulting in a total strength of Research Fellows (JRFs+SRFs) in CSIR-NPL is 257 as on 31.03.2019.

- Ph.D. Submission: 30
- Awarded : 31

❖ Institutional Visits

Organized CSIR-NPL visits for students / teachers / faculty members / personnel belonging to schools / colleges / universities / technical institutes / S&T organizations. The basic objective is to provide the visitors a glimpse of the CSIR-NPL activities and achievements, and thus enhances visibility of the CSIR-NPL in the society.

During the period from April 01, 2018 to March 31, 2019, two (02) institutional visits were organized by the CSIR-NPL for 159 School children along with their teachers.

Total ECF: Rs. 52,000/-

❖ Organization of Student's Training at CSIR-NPL

CSIR-NPL provides training to students pursuing M.Sc./M.Tech./MCA, or their equivalent degree programmes, at different educational institutions spread all across the country, in the areas of research activities being carried out at CSIR-NPL. The basic objective is to provide the students a feel and importance of the various activities, as well as to motivate them towards scientific research as the career.

During the period from April 01, 2018 to March 31, 2019, 126 students were provided training oriented towards the fulfillment of their academic degree requirements in different areas of research under the guidance of senior scientists.

ECF Generated: Rs. 10,07,720/-

❖ Deputation of CSIR-NPL Staff Members to Attend Conferences / Similar Events

CSIR-NPL encourages and supports its staff members, including the floating members like JRFs, SRFs, PAs, RIs, RAs, SRAs, etc. to attend and present papers at national / international conferences / symposia / seminars / workshops, organized by different agencies in areas relevant to research activities being carried out at CSIR-NPL. This is primarily meant to enable the staff members to put forward their views and research results before the leading national / international experts and interact with them on the latest developments in their research areas.

During the period from April 01, 2018 to March 31, 2019, 407 cases of CSIR-NPL scientists and other staff members including research scholars were nominated to participate in various conferences / similar events and different Training Courses held across the country.

❖ Skill Development Programme in CSIR-NPL

Precision Measurement and Quality Control Certification Course (PMQC) batch 2017-18, Placement interview were organized by inviting interested organization. All the 13 student got job placement. This year, 45 students joined the PMQC 2018 course.

❖ Jigyasa Programme with Kendriya Vidhyalaya Sangathan

- Jigyasa : 580 students and 35 teachers during 2018-2019
- Formally obtained a fund of Rs 31.50 lacs to conduct Jigyasa

❖ AcSIR

- 20 New faculties registered in AcSIR CSIR- NPL in 2018 & Total Faculty 92
- 6 courses modified in Physical Sciences
- 10 courses inducted in Engineering sciences & 2 in Chemical sciences
- 71 number of students registered in August 2018 and 33 in January 2019

Quality Management System

Quality Management System (QMS) of CSIR-NPL is implementing and fulfilling the requirements of IS/ISO/IEC 17025: 2005 for the various sub-divisions covered under QMS. Revisions were made for organization chart for the activities covered under QMS and related documents as per the restructuring of divisions and subdivisions of CSIR-NPL during this year. Recently many activities are in the process of adopting quality system and QMS is providing necessary guidance to them. QMS coordinated the internal audits (2018 schedule) of various sub-divisions, follow up of corrective actions and closure of NCs. The next cycle of internal audit is in planning

Annual report (November 2017- October 2018) of QMS of CSIR- NPL was prepared by taking the necessary inputs from the respective groups and submitted to Technical Committee for Quality System (TCQS) of Asia Pacific Metrology Programme (APMP) for APMP GA 2018. QMS group organized one day training programme for Air India Officers titled “Upgradation from IS/ISO/IEC 17025: 2005 to IS/ISO/IEC 17025: 2017” on August 31, 2018.

Mr. Anil Kumar – Quality Manager of CSIR-NPL delivered invited talks on Quality System in Training Programme on Mass Metrology, National Workshop on Materials Metrology for Sustainable Society – 2018 and Electrical and Electronics Metrology Training Programme held in November 2018.

Knowledge Resource Centre

In CSIR-NPL, the umbrella term 'Knowledge Resource Centre (KRC)' comprised of Library and IT related activities under its domain.

As far as library and information support is concerned, KRC over the years has developed a rich collection of scholarly books and journals, especially in the field of physics and related sciences. During the current year, KRC subscribed to numerous scholarly journals and added a variety of books both in English and Hindi languages to enrich its textual collection. Regarding the services offered, KRC serves the CSIR-NPL community with services like Electronic Document Delivery service, Inter Library Loan service, Reference service, Literature Search service etc.

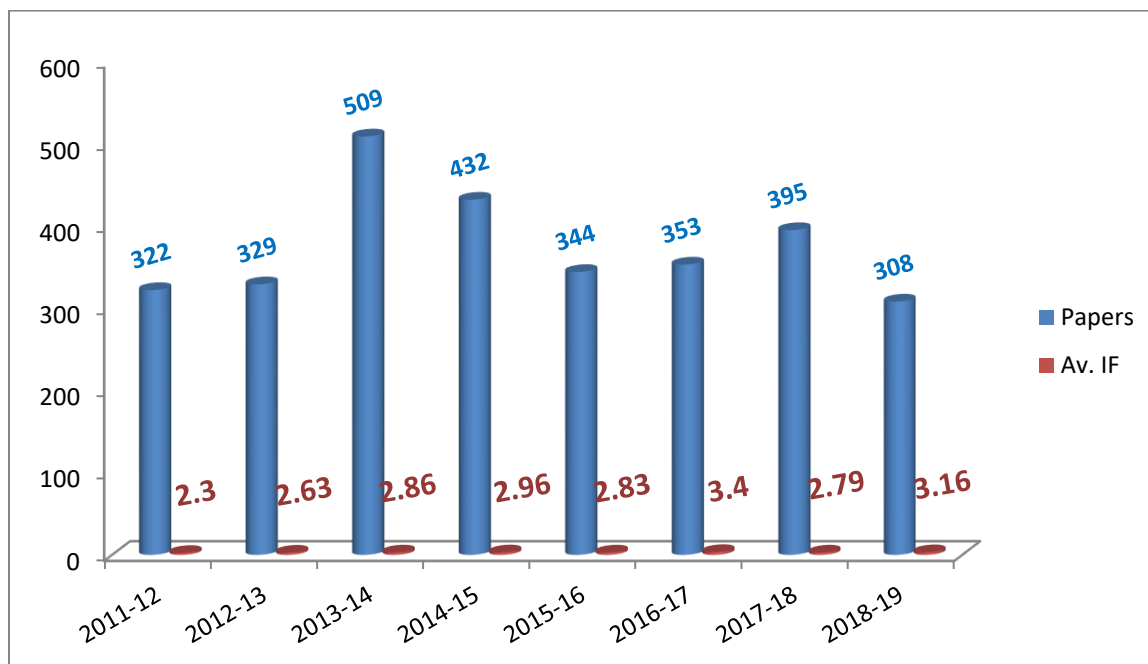
In addition to the printed content, the centre also offers online access to more than 6000+ full text journals under the e-consortium project of NKRC (CSIR+DST). The project facilitates access to the electronic content from various publishers such as, ACS (American Chemical Society), AGU (American Geophysical Union), AIP (American Institute of Physics), APS (American Physical Society), IOP (Institute of Physics), OSA (Optical Society of America), Oxford University Press, RSC (Royal Society of Chemistry), Springer, Wiley etc. KRC also provides access to the Indian Standards.

The shift in technology achieved with the automation of KRC activities and installation of improved routers helped in attracting the R & D personnel in large number to optimize the use of the available resources. Further, to promote free worldwide access to the intellectual outputs of CSIR-NPL in form of journals articles, research papers, conference papers, technical reports, preprints, and other scholarly communication, NPL-KRC has established the Institutional Repository (IR@NPL) <http://npl.csircentral.net/> and till date, around 2800 records have been added. Further, to enhance the use of licensed scientific software(s) available in CSIR-NPL, a central facility 'eZone' for such applications has been created in NPL-KRC.

Apart from the library related activities, NPL-KRC also contributes towards maintaining the CSIR-NPL website (<http://www.nplindia.in>) on the Internet. This is to inform others about the activities of the institute, such as its role towards the society, thrust area of research, facilities, services and achievements.

KRC also provides IT facilities to cater to the computing and communication needs of the laboratory. Data Center services are running 24x7 with in-house set up of various Linux based servers. Internet connectivity has been implemented using 100Mbps through National Knowledge Network (NKN). A gigabit fiber optics backbone network solution is running at various locations across the CSIR-NPL campus and providing CAT6 based ethernet LAN to connect approximately one thousand network based devices i.e. computers, servers, laptops, IP cameras, attendance machines. The gateway security solution has been setup, which includes a Unified Threat Management (UTM) system for multi-level firewall, anti-virus etc. A Radio Link is established between NPL-Campus and NPL-Colony for JRF Hostel Network. JRF hostel is equipped with complete wireless technology solution and devices such as Omni Directional/Directional antennas and various Wi-Fi devices in different modes and configuration. Email services of the laboratory are facilitated using NIC mail services at mail.gov.in.

❖ Papers Published by CSIR-NPL in SCI Journals



राजभाषा यूनिट

राजभाषा यूनिट दिन-प्रति-दिन के सरकारी कार्यों में राजभाषा हिन्दी के प्रगामी प्रयोग को बढ़ाने का कार्य करती है। राजभाषा यूनिट का मुख्य उत्तरदायित्व संघ सरकार की राजभाषा नीति, राजभाषा अधिनियम के उपबंधों तथा आदेशों से प्रयोगशाला के वैज्ञानिकों/अधिकारियों/कर्मचारियों को अवगत कराना, अनुपालन कराना एवं अनुपालन हेतु सहायता प्रदान करना है।

राजभाषा यूनिट के उत्तरदायित्व :

❖ कार्यान्वयन :

- संघ सरकार की राजभाषा नीति, राजभाषा अधिनियम के उपबंधों तथा आदेशों से प्रयोगशाला के वैज्ञानिकों/ अधिकारियों/कर्मचारियों को अवगत कराना, अनुपालन कराना एवं अनुपालन हेतु सहायता प्रदान करना।
- प्रत्येक तिमाही में निदेशक, एन पी एल की अध्यक्षता में राजभाषा कार्यान्वयन समिति की बैठक का आयोजन, कार्य सूची एवं कार्यवृत्त तैयार करना। बैठक में लिए गए निर्णयों पर अनुवर्ती कार्रवाई करना।

- हिन्दी दिवस/ हिन्दी मास तथा प्रत्येक तिमाही में हिन्दी कार्यशालाओं/व्याख्यानों का आयोजन करना ।
- राजभाषा विभाग, गृह मंत्रालय, भारत सरकार से प्राप्त वार्षिक कार्यक्रम में निर्धारित लक्ष्यों को प्राप्त करने हेतु उचित कार्रवाई करना ।
- संसदीय राजभाषा समिति के निरीक्षण सम्बन्धी कार्य तथा समिति को दिए गए आश्वासनों को पूरा करने हेतु कार्रवाई करना ।
- प्रत्येक वर्ष विज्ञान विषयों पर हिन्दी में दो दिवसीय राष्ट्रीय संगोष्ठी का आयोजन ।

❖ प्रशिक्षण एवं प्रकाशन :

- हिन्दी प्रशिक्षण (प्रबोध, प्रवीण एवं प्राज्ञ पाठ्यक्रम) ।
- हिन्दी टंकण/आशुलिपि एवं कम्प्यूटर पर हिन्दी में कार्य करने का प्रशिक्षण दिलाना ।
- प्रत्येक छःमाही में हिन्दी समीक्षा पत्रिका का प्रकाशन ।
- प्रयोगशाला की वार्षिक रिपोर्ट तथा अन्य महत्वपूर्ण प्रकाशनों में हिन्दी अंश का संपादन ।

❖ अनुवाद :

- प्रयोगशाला में प्रयुक्त सभी प्रपत्रों (फार्मों), मानक मसौदों का द्विभाषीकरण ।
- हिन्दी अनुवाद कार्य ।
- राष्ट्रीय भौतिक प्रयोगशाला के वार्षिक प्रतिवेदन के महत्वपूर्ण अंशों का हिन्दी अनुवाद ।
- प्रयोगशाला की वेबसाइट का हिन्दी अनुवाद ।

❖ प्रयोगशाला द्वारा राजभाषा की प्रगति के लिए उठाए गए कदम एवं प्रयास :

- प्रत्येक तिमाही में निदेशक, एन पी एल की अध्यक्षता में राजभाषा कार्यान्वयन समिति की बैठक में वार्षिक कार्यक्रम में निर्धारित लक्ष्यों को प्राप्त करने हेतु चर्चा एवं उनकी समीक्षा की जाती है तथा बैठक में लिए गए निर्णयों पर अनुवर्ती कार्रवाई की जाती है ।
- संघ सरकार की राजभाषा नीति, राजभाषा अधिनियम के उपबन्धों तथा आदेशों से प्रयोगशाला के वैज्ञानिकों/अधिकारियों/कर्मचारियों को अवगत कराया जाता है, अनुपालन कराया जाता है एवं अनुपालन हेतु सहायता प्रदान की जाती है ।
- हिन्दी दिवस/हिन्दी सप्ताह/हिन्दी पखवाड़ा/हिन्दी मास मनाया जाता है । इस दौरान

विभिन्न प्रतियोगिताओं का आयोजन किया जाता है, जिसमें प्रयोगशाला के सभी अधिकारी/कर्मचारी भाग लेते हैं और उन्हें नकद पुरस्कार द्वारा प्रोत्साहित किया जाता है ।

- प्रत्येक तिमाही में प्रयोगशाला के अधिकारियों/कर्मचारियों हेतु हिन्दी कार्यशालाओं/व्याख्यानों का आयोजन किया जाता है । इन कार्यशालाओं के माध्यम से स्टाफ सदस्यों को हिन्दी में अधिक से अधिक कार्य करने हेतु प्रेरित एवं प्रोत्साहित किया जाता है । टेबल-वर्कशाप के माध्यम से व्यक्तिगत रूप से चर्चा की जाती है एवं कठिनाइयों का समाधान किया जाता है ।
- प्रत्येक वर्ष विज्ञान विषयों पर हिन्दी में दो दिवसीय राष्ट्रीय संगोष्ठी का आयोजन किया जाता है। वैज्ञानिकों द्वारा शोध पत्र हिन्दी में प्रस्तुत किए जाते हैं। राष्ट्रीय संगोष्ठी की सारांश पुस्तिका हिन्दी में प्रकाशित की जाती है, जिससे विज्ञान शोध सम्बन्धित जानकारी हिन्दी में आम जन तक पहुंचती है ।
- प्रयोगशाला के अधिकारियों/कर्मचारियों को केन्द्रीय हिन्दी प्रशिक्षण संस्थान से हिन्दी प्रशिक्षण (प्रबोध, प्रवीण एवं प्राज्ञ पाठ्यक्रम) दिलाया जाता है। कम्प्यूटर पर हिन्दी में कार्य करने का प्रशिक्षण दिलाने हेतु कार्यक्रम आयोजित किए जाते हैं।

❖ हिन्दी माह आयोजन

राजभाषा विभाग, गृह मंत्रालय, भारत सरकार की हिन्दी दिवस / पखवाड़ा के आयोजन सम्बन्धी निर्देशों को ध्यान में रखते हुए प्रयोगशाला में दिनांक 07 अगस्त, 2018 से 14 सितम्बर, 2018 तक हिन्दी माह मनाया गया। 14 सितम्बर, 2018 को हिन्दी दिवस समारोह का आयोजन किया गया। प्रयोगशाला में स्टाफ सदस्यों को हिन्दी में अधिक से अधिक कार्य करने के लिए प्रोत्साहित एवं प्रेरित करने के उद्देश्य से हिन्दी माह के दौरान विभिन्न प्रतियोगिताओं का आयोजन किया गया । प्रत्येक वर्ष की भाँति इस वर्ष भी जो प्रतियोगिताएं आयोजित की गयी वे इस प्रकार से हैं :-

क्रम सं.	प्रतियोगिताएं	दिनांक
1	निबन्ध प्रतियोगिता	07 अगस्त, 2018
2	शब्दावली एवं अनुवाद प्रतियोगिता	09 अगस्त, 2018
3	वाद-विवाद प्रतियोगिता	10 अगस्त, 2018
4	सामान्य ज्ञान-विज्ञान प्रतियोगिता	28 अगस्त, 2018
5	वर्ष के दौरान हिन्दी में किया गया अधिकतम कार्य एवं हिन्दी डिक्टेसन	30 अगस्त, 2018
6	गीत एवं काव्य पाठ प्रतियोगिता	04 सितम्बर, 2018

इन सभी प्रतियोगिताओं में प्रयोगशाला के स्टाफ सदस्यों ने अत्यधिक रुचि प्रदर्शित करते हुए उत्साहपूर्वक भाग लिया। प्रयोगशाला के सभागार में दिनांक 14.09.2018 को मुख्य समारोह आयोजित किया गया। इस अवसर पर व्याख्यान देने के लिए डा. मनोज कुमार पटैरिया, निदेशक, निस्केयर नई दिल्ली को आमंत्रित किया गया था। डा. पटैरिया ने हिन्दी दिवस के अवसर पर प्रयोगशाला के सभागार में उपस्थित स्टाफ सदस्यों को दैनिक सरकारी कामकाज में हिन्दी का प्रयोग करने के लिए प्रेरित एवं प्रोत्साहित करते हुए 'राजभाषा हिन्दी के उत्तरोत्तर प्रगामी प्रयोग में वृद्धि' विषय पर अत्यन्त सारगर्भित एवं विवेचनात्मक व्याख्यान प्रस्तुत किया। डा. रंजना मेहरोत्रा, वरिष्ठतम मुख्य वैज्ञानिक ने कार्यक्रम का शुभारंभ किया। इस अवसर पर उन्होंने प्रयोगशाला के स्टाफ सदस्यों को हिन्दी में अधिक से अधिक कार्य करने के लिए प्रेरित करते हुए अपना संदेश दिया। समारोह के अंत में हिन्दी माह मनाए जाने के दौरान आयोजित की गयी प्रतियोगिताओं में भाग लेने वाले 40 विजेता प्रतिभागियों को पुरस्कार प्रदान किए गए।



हिन्दी माह का शुभारंभ उद्बोधन देते हुये निदेशक, एनपीएल



हिन्दी दिवस पर व्यख्यान देते हुये डा. मनोज कुमार पटैरिया, निदेशक, निस्केयर



हिन्दी दिवस पर व्यख्यान देते हुये डा. रंजना मेहरोत्रा, मुख्य वैज्ञानिक, एनपीएल



Annexure

Annexure I

Major R & D Projects during 2018-19

The major projects of value >50 Lakhs are listed below

Sl. No	Project Title	Funding Agency	Contract Value (in lakhs)	Amount Received during 2018-19
1	A system to generate a common synchronised clocks using CVGNSS with an uncertainty of few ns at geographically disturbed sensor nodes	Defence Electronics Research Laboratory (DERL) Ministry of Defence	95.00	-
2	Implementation of IST service using NPL controlled remote oscillator system for national knowlege Network at National Informatics Centre	National Informatics Centre Services Inc. (NICS I)	94.34	-
3	Quality Checks of the Data and Instruments working at Air Quality Monitoring Stations in Raipur City	Chhattisgarh Environmental Conservation Board (CECB)	89.53	-
4	Carbonaceous Aerosols Emissions, Source Apportionment and climate effects	Ministry of Environment & Forest (MoEF)	274.67	50.00
5	National Primary Standard facility for cell calibration	Ministry of New and Renewable Energy (MNRE)	1788.50	-
6	Development of new Interfacial layers for efficient and stable excitonic solar cells	Department of Science & Technology (DST)	92.80	-
7	Growth and study of highly conducting delafossite single crystal: Device application in metrology	Department of Science & Technology (DST)	89.00	6.51

8	Megacity Delhi atmospheric emission quantification assessment and impacts (Delhi Flux)	Ministry of Earth Sciences (MoES)	198.28	50.00
9	Buried contacts high efficiency crystalline radial p-n junction Si Nanocord Solar Cell	Department of Science & Technology (DST)	89.00	14.00
10	Chemical Composition and source apportionment of Aerosols using Receptor Models at urban sites of the Himalayan Region of India	Department of Science & Technology (DST)	71.72	-
11	Creation of Testing and Calibration Facility for LED and LED based Lighting at NPL India as per National/International Standards	BEE (Bureau of Energy Efficiency)	2025.00	-
12	Production of Certified Reference Materials- Bharatiya Nirdeshak Dravya® (BND)	Ministry of Commerce & Industry, Department of Commerce	1627.00	800.00
13	Delineation of Airshed for Air Quality Management in Delhi-NCR	CPCB (CSIR-NEERI)	193.80	100.00
14	Establishment of type testing calibration and certification facility for online continuous Emission Monitoring System (OCEMS) and Continuous Ambient Air Quality Monitoring System (CAAQMS)	Ministry of Environment, Forest & Climate Change (MoEF)	5660.00	44.00
15	Creation of Testing and Calibration Facility for LED and LED based lighting at NPL India as per National / International Standards	Council of Scientific & Industrial Research (CSIR)	3185.00	470.00

16	Electromagnetic interference and Electromagnetic Compatibility (EMI/EMC) measurements system upto 40 GHz which can calibrate any electronics equipment with international traceability	Council of Scientific & Industrial Research (CSIR)	402.00	330.00
17	To establish calibration facility traceable to primary standards of NMI for Phasor Measurement Unit Calibration System(PMU)	Council of Scientific & Industrial Research (CSIR)	300.00	210.00
18	Establishing a Centre of Excellence for Ballistic Material Testing	Council of Scientific & Industrial Research (CSIR)	5847.00	1014.00

Annexure II

Awards & Achievements

1. Ms. Akanksha Singh and Dr. Shailesh Narain Sharma received Best Poster Award at Nano-Science and Technology Consortium (NSTC) Nanotech 2018 Conference held in New Delhi on November 28, 2018. In PQDs: A viable alternative to the Cd-based QD's.
2. Dr. A.K Upadhayaya and Ms. Sumedha Gupta received Best Paper award for the paper Upadhayaya, A.K. and Gupta, S. (2018). Longitudinal characteristics of martian electron density profiles: MGS observations. National Space Science Symposium (NSSS) 2019 organized by ISRO jointly with hosts Savithribai Phule Pune University, Inter-University Center for Astronomy and Astrophysics and the National Center for Radio Astrophysics.
3. Dr. Bipin Gupta received the Asia-Pacific Academy of Materials Fellow/Academician 2018 in International Conference of Asia Pacific Academy of Materials 2018 - Trends and Challenges of Materials Science and Engineering, China. (June 19-22).
4. Dr. Bipin Gupta received the MRSI Medal-2018 for his significant contribution to the field of Materials Science and Engineering.
5. BND division has received CSIR-NPL Outstanding Performance Award 2018 for "Dissemination of Metrological Traceability" through BhartiyaNirdeshakDravyas® for successfully development of SI traceable Cement BNDs 5051, 5052, & 5054 for the determination of Blaine fineness of OPC, PPC and Fly Ash with NCCBM Faridabad.
6. M/s Environmental Solutions has commercialization the indigenously developed high-volume sampler from the know-how of CSIR-NPL patented technology by the team of Gas Metrology sub-division of Atmospheric Science and Biomedical Metrology division.
7. CSIR-NPL issued first External Calibration Report for PMU on CSIR-NPL Foundation Day, Jan 04, 2019.
8. Dr. Mahavir Singh become first recipient of Indo-French Friendship Award on Acoustics in Simulation and also become a Selection Committee Chairperson for Indo-French Friendship Award (on Acoustics in Simulation) for next 10 Years (2019-2029) (includes Citation Certificate plus Cash Prize of \$ 1000 US Dollars).
9. Dr. Mahavir Singh become Member from India, TC 29/WG 5 and TC 29/WG 10 of IEC (Electrotechnical Standardization: IEC Expert Management System: <http://www.iec.ch/dyn/expert>).

10. Dr. Mahavir Singh become Associate Editor, International Journal of Acoustics and Ultrasonics (IJAU) (2018-till now).
11. Mr. Monu Mishra received Frans Habraken Best Paper Award (€1000) for the paper - Mishra, M., Shibin Krishna, Aggarwal, N. and Gupta, G. (June 2017). Influence of metallic surface states on electron affinity of epitaxial AlN films. Applied Surface Science, 407, 255-259.
12. Mr. Monu Mishra received AVS-Applied Surface Science Division Award (US\$1000) for the paper - Mishra, M., Gundimedda, A., Vandana and Gupta, G. An effort to resolve band offset anomalies in ZnO/GaN heterostructures. AVS 65th International Symposium, Long Beach, CA, USA.
13. Ms. P. Tyagi received Best Poster Award for the paper - Tyagi, P., Ramesh Ch, Kushvaha, S.S. and Kumar, M.S. (March 2019). Laser molecular beam epitaxial growth of GaN nanowall networks and their applications. Symposium on Wide Bandgap Semiconductor, organised by Semiconductor Society of India and Society for Semiconductor Devices at NIT Kurukshetra, 15-16 March 2019.
14. Ms. R. Masiwal received Young Scientist Poster Award and Best Paper Award in AdMet-2019 for her case study - Masiwal, R., Shukla, D.K. and Sharma, C. (2019). The impact of dust storm in the concentration of surface ozone – A case study.
15. Dr. S.G. Aggrawal, Dr. P. Patel, Dr. K. Singh, Dr. D. Soni, Dr. P. Johri, Dr. V.N. Ojha, Dr. D.K. Aswal, T.C. Le and C.J. Tsai initiated Patent filling in India and US on “Tangential six-inlet co-cylindrical cyclone for PM₁₀ sampling”.
16. Dr. S.K. Dubey received URSI Young Scientist Award at 2nd URSI AT-RASC, Gran Canaria, Spain for Analytical Discernment of Electromagnetically Induced Transparency from Autler-Townes Splitting for Atom Based E-field Sensing. (April 2018).
17. Dr. Subhadeep De received the Best Paper Award, NCEEM 2018, CSIR-NPL New Delhi.
18. Dr. Subhadeep De received the PTB Travel Support Award for attending CPEM 2018.
19. Dr. Sunil S. Kushvaha received the early career research award from Science and Engineering Research Board-DST for carrying out research for QHR metrology (May-2018).
20. Team of AC Power and Energy Metrology conferred CSIR-National Physical Laboratory’s Outstanding Performance Award 2018 for the Dissemination of Apex Metrology Traceability in AC power and energy.
21. Team of eight-members (Dr. Sukumaran Gopukumar, CSIR-CECRI; Dr. Chandrasekaran Nithya, CSIR-CECRI; Dr. Ramasamy Thirunakaran, CSIR-CECRI; Dr. Arumugam Sivashanmugam, CSIR-CECRI; Dr. Sundeep Kumar Dhawan, retd. CSIR-NPL; Dr. Rakesh Behari Mathur, retd. CSIR-NPL; Dr. Priyanka Heda Maheshwari, CSIR-

NPL; Dr. Bhanu Pratap Singh, CSIR-NPL) were the joint recipient of the prestigious award 'NRDC National Meritorious Innovation Award 2018'. They received this award for the invention entitled "Cathode Material and Lithium Ion Battery there from".

22. Team of Quantum Nanophotonics Metrology received recognition/award ICTP-TRIL 2018.
23. Team of Gas Metrology sub-division of Atmospheric Science and Biomedical Metrology division has developed and released two Primary Reference Gas Mixtures BNDs' (BND™ 6011:Carbon dioxide in Synthetic Air (Nominal Amount of Substance Fraction: 480 µmol/mol); BND™ 6003: Carbon monoxide in Nitrogen (Nominal Amount of Substance Fraction: 5 µmol). These standards are for green house gas and climate changes studies and ambient air quality monitoring respectively.
24. Mr. Umesh Pant, Mr. Hansraj Meena, Mr. Gaurav Gupta, Ms. Komal Bapna, and Dr. Dilip D. Shivagan received Best Paper Award in DAE SSPS 2018 held at Hisar for Determination of Eutectic Melting Phase Transition Temperature of Metal-Carbon Eutectic Fixed Point (18th -22nd December 2018).

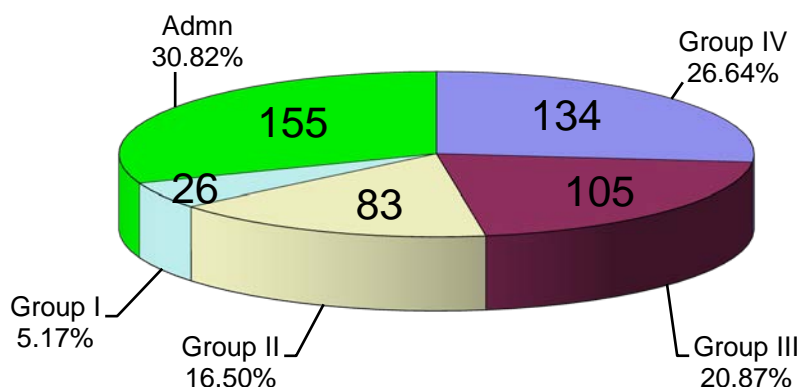
Annexure III

Staff, Patents, Reports and Financial Outflow

Regular Staff in Position

TOTAL NUMBER = 503

Average Age : 46.58



New Recruitments (2018-19)

S. No.	Name	Designation	Date of Joining
1	Dr. Manoj Das	Senior Scientist	20.08.2018
2	Mr. G Anurag Reddy	Scientist	27.08.2018
3	Mr. Abhishek Raj	Junior Secretariat Asstt.(JSA), (F&A)	20.08.2018
4	Mr. Atul Suresh Somkuwar	Scientist	20.09.2018
5	Mr. Sravan Kumar Thakur	Junior Secretariat Asstt.(JSA), (G)	27.09.2018
6	Mr. Saurabh Kumar Jain	Junior Secretariat Asstt.(JSA), (G)	10.10.2018
7	Ms. Madhavi	Junior Secretariat Asstt.(JSA), (G)	30.10.2018
8	Ms. SantwanaPati	Scientist	21.02.2019

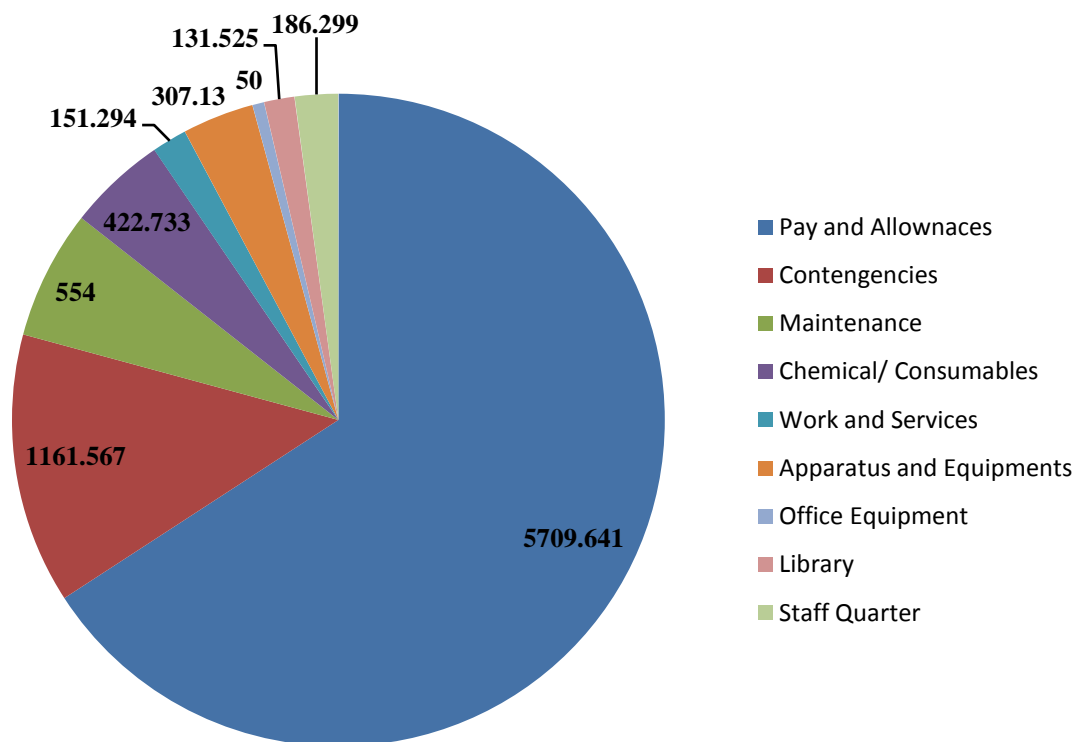
9	Mrs. JankiBist	Multi -Tasking Staff	28.02.2019
10	Mr. Yogesh	Multi -Tasking Staff	28.02.2019
11	Mr. Khajan Singh	Multi -Tasking Staff	18.03.2019

Patents and Reports

- Patents filed in India: 03 [Complete after Provisional Application (CAP)]
- Patents granted in India: 04
- Patents filed abroad: 04
- Patents granted abroad: 08
- Test and Calibration Reports generated: Non-notional - 2477; Notional - 653

Budget flow

(in Lakh)



CSIR-NPL: The National Metrology Institute of India Member, BIPM and Signatory CIPM-MRA

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Editing, Compiling and Publication

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Dr. Dilip Dhondiram Shivagan, Senior Scientist	(Member)
Dr. Sunil Singh Kushvaha, Senior Scientist	(Member)
Dr. Arun Kumar Upadhayaya, Principal Scientist	(Member)
Dr. (Ms.) Rachna Kumar, Senior Scientist	(Member)
Dr. Dinesh Kumar Misra, Principal Scientist	(Member)
Ms. Sandhya Malika Patel, Senior Scientist	(Member)
Mr. Ashok, Principal Technical Officer	(Member)
Mr. Abhishek Kumar Yadav, Technical Officer	(Member)





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