NPL
National Physical Laboratory

Measurement Services

Details of the measurement and testing services provided by the **National Physical Laboratory**

2009

NPL's mission is to deliver the highest economic and social benefits as a world-leading National Measurement Institute through excellent responsive science and knowledge services.

Contents

Introducing NPL

Setting the standard

NPL is a world-leading centre for the development of measurement related standards, technology and best practice. Quality of measurement is disseminated to our customers through a variety of means including collaborative research and development, technology transfer, licensing of intellectual property, various forms of consultancy, knowledge networking and through the provision of measurement services. Our capabilities underpin the UK National Measurement System (NMS), ensuring consistency and traceability of measurements in support of UK and overseas customer interests throughout the world.

Delivering service excellence

NPL's reputation relies on the quality of support we provide, both directly and indirectly, to hundreds of thousands of users worldwide for whom maintaining traceable and fit-for-purpose measurement is vital to their business. Our commitment to scientific excellence is coupled with a determination to offer high quality and affordable measurement services that are of the greatest possible technical and commercial benefit to our customers.

Services delivery options:

Calibration, testing and analysis of customer instruments and artefacts at our laboratories in Teddington is just one of the many ways we can deliver measurement service support to your business. In recent years, customers have also benefited from the following alternatives:

- On-site services provided on a one-off or campaign basis, whether in support of inventories of equipment and instrumentation or to solve specific measurement related problems requiring innovative or bespoke solutions.
- The provision of expert manpower support on a visiting or permanent on-site basis if long term support to measurement-critical operations is required.
- Delivery of measurement infrastructure management and maintenance: our work for DEFRA on managing the national Air Quality Network is a good example of this way of working.
- The establishment of 'bedded' out laboratory based measurement capability where a long term on-site presence, working alongside the customer organisation is desirable.
- Independent Product Assessments - NPL can reduce the risk of buying expensive equipment that may not be fit for purpose by providing a thorough pre-service evaluation of new and novel instruments before the final purchasing decision is made.

Calibration, measurement & testing services

NPL continually strives to make its science and technology as valuable, relevant and accessible as possible to our customers. This guide summarises the range of measurement services offered, together with the relevant points of contact who will help you select and specify the services you need, provide quotations and ensure you receive the very best levels of technical and customer service available.

Working with NPL

We actively encourage our customers to work with us to determine the most suitable means of doing business with NPL. Options include:

- Ad hoc or single orders for customers requiring irregular support. Our Customer Services Executives (CSEs) will help you define your support needs and provide 'immediate response' quotations for particularly urgent jobs.
- Call-off contracts designed to minimise the cost and time spent in managing and processing orders and generating invoices and customer reports. Often the agreement of a pre-authorised 'Limit of Liability' is used to enable customers to place orders quickly and effectively.
- For larger scale or longer term support arrangements, the agreement of a tailored Service Level Agreement (SLA) may offer particular support benefits. Customer-specific service levels can be agreed based upon simple Key Performance Indicators (KPIs).
- Through our established network of preferred suppliers that includes other National Measurement Institutes (NMIs) as well as a range of specialist UKAS accredited laboratories, we are able to offer a 'one stop shop' approach to meeting your high quality measurement requirements. This service offers our customers a single point of access to an unprecedented range of measurement services, configured to meet the needs of your business.

Scheduling and batching of work:

NPL works with its customers to ensure that the timing of the work carried out is optimised to the needs of the customer's business. Due to the extremely wide range of measurement capabilities at NPL, we encourage our customers to work with us to define the most suitable date for releasing their equipment or standards into the laboratory this helps minimise equipment downtime.

By batching similar items into the same time slot, customers are able to enjoy very rapid turn round times at significantly discounted prices. Conversely, high priority, urgent requests for measurement services of all types can be accommodated if required.

NPL is able to arrange collection and delivery of equipment to and from our customers' sites. This is particularly beneficial when high value, perhaps fragile, equipment needs to be transported across national boundaries.

Our CSEs will be happy to discuss these and any other special support arrangements with you.

Most of our commonly used measurement services are listed in this booklet. However, additional services or solutions are available on request and these can be discussed by contacting our Customer Service Executives.

Contacting NPL

The NPL Customer Services Team provides customers with a single contact point for doing business with NPL. Please contact the Customer Services Executive listed on the relevant page of this brochure for information relating to quotations, placing orders, scheduling of work, progressing orders and to discuss any non-technical issues relating to current work or future requirements.

For detailed technical issues or if you need to discuss highly complex technical problems or requirements, please contact the laboratory expert in the relevant area.

For more general enquiries where it is not clear who best to contact, we provide a Helpline that acts as a gateway to the business, particularly for customers new to NPL.

For all other enquiries please contact:

Helpline: **+44 20 8943 6880**
Fax: **+44 20 8614 0446**
E-mail: **enquiry@npl.co.uk**

Acoustics in Air

Accurate and consistent measurements of airborne sound fulfil a wide range of regulatory, health, safety and commercial needs both within the UK and in support of international trade. Applications arise in the measurement of environmental and workplace noise, machinery and product noise, hearing protection, audiometry, and in the quality control of acoustical devices. NPL realises the primary standard for sound pressure in the UK, and disseminates this through a range of calibration services for acoustical instrumentation, which provide traceability for the wide range of acoustical measurements that need to be conducted, leading to greater confidence and good practice in measurement.

Services, Instruments and Artefacts:

- Primary pressure calibration of laboratory standard microphones
- Secondary pressure and free-field calibration of working standard microphones
- Free-field calibration of sound level meters
- Calibration and verification of sound calibrators and pistonphones
- Calibration of ear simulator systems eg. reference couplers, artificial ears, mechanical couplers, and associated reference headphones and bone vibrators
- Measurement of sound absorption of panels
- Consultancy services for acoustical measurement including machinery and environmental noise, and Finite Element modelling
- Training courses on instrumentation and methods for sound-in-air measurement

Contact

Customer Service tel: **+44 20 8943 8631**
E-mail: **acoustics_enquiries@npl.co.uk**

DC & LF Measurements

The great majority of industrial processes and instruments rely on electrical measurements of one form or another. Whether the high power electrical measurements that support the multi-billion pound UK electricity market, or measurements of the atto-Farad capacitance levels which exist between individual cells are sufficient to quantify DNA, traceable applied electrical measurements are key to their success.

In support of such technology and industries, NPL develops and applies standards and methodologies to provide traceable electrical measurements from DC to 1 MHz and beyond covering voltage, current, impedance and power, magnetic materials and instruments.

Services, Instruments and Artefacts:

- DC voltage up to 1 kV
- DC & AC resistance
- DC current shunts
- Standard cells
- DC voltage standards
- Resistance, meters & bridges
- AC power (Wattmeters)
- AC voltmeters
- AC/DC voltage and current transfer
- AC/DC high frequency measurement (up to 1V 100MHz)
- Current transformers
- Selective error voltage transformers
- Harmonic & flicker analysers
- AC (eddy current) conductivity reference standards (supply and calibration)
- On site static and time-varying ambient magnetic field surveys
- AC magnetic field meters
- Flux meters and hall effect meters
- Fluxgate and resonance magnetometers
- Helmholtz coils, search coils & solenoids
- Characterisation of hard and soft magnetic materials
- Low permeability reference standards (supply and calibration)
- DC magnetic field meters
- Capacitance standards
- Capacitance bridges
- Self-Inductance standards
- Mutual inductance standards
- Inductive voltage dividers & strain gauge bridges

Contact

Customer Service tel: **+44 20 8943 7166**
E-mail: **current_enquiries@npl.co.uk**

Dimensional

NPL offers dimensional measurement services and the provision and calibration of transfer standards that are traceable to national standards. A comprehensive range of dimensional measurement facilities, including co-ordinate measurement machines are available for routine or one-off measurements. Other services offered include instrument development, contract research, consultancy and training.

Services, Instruments and Artefacts:

- Gauge blocks and length bars
- Thermal expansion of length bars and long gauge blocks
- Step gauges
- Reference master thread gauges - American Petroleum Institute (API) specifications
- Reference screws
- Diameter and roundness measurements
  - o Plain setting rings and plugs
  - o Roundness of spheres and hemispheres
- Angle measurement
  - o Autocollimators, polygons, angle gauges and index tables
- Surface texture and flatness
  - o Atomic force microscope and step height standards
- Verification and calibration of CMMs and machine tools
  - o On-site laser tracer services
- Extensometer calibration rigs
- High precision optical scales
  - o High precision linear scales and dimensional standards
  - o 2D-grid plates for vision machines
  - o Linewidth standards
  - o Stage micrometers and graticules
- Bespoke measurements
  - o Nanometrology - characterisation of artefacts with sub-micron features
  - o Freeform surfaces
  - o Inspection by CMM

Contact

Customer Service tel: **+44 20 8943 8631**
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Environmental

Environmental measurement scientists at NPL provide high quality, cost effective pollution monitoring and analysis services. NPL has an international reputation and track record based upon years of underpinning research. We also offer a range of services and gas standards for the calibration of gas analysers.

Services, Instruments and Artefacts:

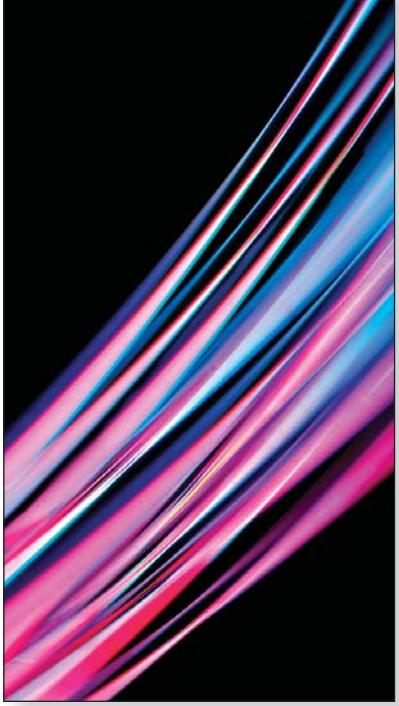
- Ambient air quality surveys
- Stack emissions testing
- Occupational air quality
- Remote sensing surveys
- QA/QC of air quality measurements
- Industrial impact assessment
- Environmental consultancy
- Environmental research and policy
- Particulates, Metals, Anions and PAHs

Contact

Customer Service tel: **+44 20 8943 8637**
E-mail: **environmental_enquiries@npl.co.uk**

Fibre Optics

NPL's support for the optical technology sector includes a comprehensive range of calibration and measurement services for all types of optical fibre, fibre and photonic components in addition to supplying artefacts for the calibration of fibre optic test instrumentation. The breadth of our capability is sufficient to cover most customers' complete fibre optic and photonic requirements.



Services, Instruments and Artefacts:

- Attenuation coefficient uniformity
- Optical fibre length calibration
- Chromatic dispersion in single-mode fibres
- Cut-off wavelength of single-mode fibres
- Effective area of single-mode fibres
- Fibre and coating geometry
- MFD - Mode Field Diameter of single-mode fibres
- NA - Numerical Aperture of multimode fibre
- PMD - Polarisation Mode Dispersion
- Refractive index
- Return loss
- Spectral attenuation
- Optical fibre reference artefacts covering the above range
- Return loss standards for OTDR calibration
- Calibration of fibre optic power meters and associated sources
- Calibration of optical wavelength meters and OSA
- Detector responsivity
- Laser power meters
- Linearity of fibre optic power meters

Contact

Customer Service tel: **+44 20 8943 8538**
E-mail: **fibreoptics_enquiries@npl.co.uk**

Force

Force measurement is of fundamental importance to many industrial sectors. Product liability and safety issues demand that force measurements are traceable to national standards. Competitive advantage can be gained from accurate force measurement. NPL offers traceable calibration services measurement and testing facilities with capabilities from 1.5 N to 30 MN. NPL offers a wide ranging UKAS accredited force calibration service using the UK's national force standard machines – this offers our customers direct traceability to national standards.

Services, Instruments and Artefacts:

- Force measuring devices and systems
  - o Calibration in tension and compression to ISO, BS, ASTM and customer specifications
  - o Manufacture and supply of transducers
- Strain cylinder verification
- DC ratio meters – calibration and adjustment
- Extensometer calibration rigs – calibration and adjustment
- Hire of force standard machines and experienced operators
  - o Deadweight machines up to 1.2 MN
  - o Servo-hydraulic machines up to 30 MN
- On-site calibration and verification of compressive and tensile testing machines

Contact

Customer Service tel: **+44 20 8943 6315**
E-mail: **force_enquiries@npl.co.uk**

Gases & Gas Mixtures

NPL specialises in producing an extensive range of gas calibration standards through a chain of direct comparisons to the national measurement standards. This ensures amount fractions of guaranteed uncertainty and measurement traceability at national and international levels. The current range of standards provides ultimate references for highly accurate measurements of ambient air quality, natural gas, industrial emissions, vehicle and aircraft emissions, odour measurement and occupational exposure.

Services, Instruments and Artefacts:

- Gas calibration mixtures
- Certification of gas mixtures
- Gas standards for calibrating air quality monitors
- Gas standards for calibrating evidential breath-alcohol analysers
- Gas standards for calibrating stack emission monitors
- Gas standards for calibrating vehicle emission monitors
- Natural gas proficiency testing scheme
- Standard mixtures of volatile organic compounds

Contact

Customer Service tel: **+44 20 8943 8637**
E-mail: **gases_enquiries@npl.co.uk**

Humidity

NPL is a world leader in primary realisations of humidity. The standards maintained by NPL provide the reference for humid air mixing ratio, dew point and relative humidity. Calibrations are performed at NPL or at customer premises.

Services, Instruments and Artefacts:

- Hygrometers of all types in terms of relative humidity, dew point, mixing ratio or other humidity quantities
- Air temperature sensors
- Humidity generators
- Humidity calibration salts
- Humidity and temperature chambers
- Relative humidity: 1% rh to 98 % rh at temperatures from -40 °C to +100 °C
- Dew-point temperature: -90 °C to +90 °C
- Air temperature: -40 °C to +100 °C
- Humidity measurement consultancy
- Training in humidity measurement and calibration

Contact

Customer Service tel: **+44 20 8943 8681**
E-mail: **humidity_enquiries@npl.co.uk**

Laser Interferometry & Frequency Stabilised Lasers

Laser interferometer systems are widely used in industry for direct precision measurement of length and displacement particularly in relation to CNC machine tool and co-ordinate measuring machine calibration. NPL offers a routine service for the verification of interferometer system accuracy.

Services, Instruments and Artefacts:

- Auto-compensated laser interferometer system calibration
- Uncompensated laser interferometer system calibration
- Frequency & laser wavelength calibration
- Beat frequency monitoring system
- Iodine-stabilised HeNe reference lasers
- Low drift etalons

Contact

Customer Service tel: **+44 20 8943 6796**
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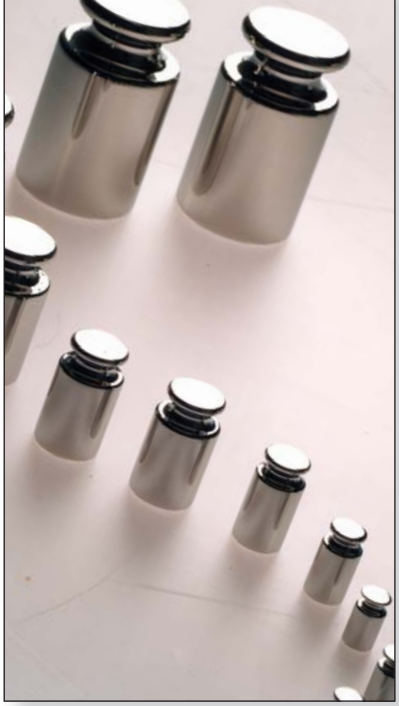
Mass

Accurate measurement of mass is vital in a wide range of applications from product design to ensuring compliance with health and safety requirements. NPL provides a calibration service for weights of all OIML classes, as well as providing 'hands-on' training in mass metrology.



Services, Instruments and Artefacts:

- Calibration of weights, all OIML classes
- Mass from 1 mg to 25 kg
- Density of solid artefacts
- Density of liquids

Contact

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Materials
Mechanical Testing

The characterisation of all classes of materials, components and materials systems such as composites can be carried out over a range of temperatures. Tests may be made on standard macro scale specimens, but increasingly miniaturised tests are being developed which can allow the testing of parts of manufactured components, where properties may vary with position. Techniques and advice on non-destructive testing and structural health monitoring are also available.

Services, Instruments and Artefacts:

- Creep, tensile, compression, multiaxial testing
- Fatigue, thermomechanical fatigue, high strain-rates, fracture toughness, shear
- Impact, hardness, Instrumented scanning microhardness
- Elastic properties, high temperature dynamic modulus, Poisson's ratio
- Residual stress and strain measurement (XRD and hole drilling)
- Full field strain mapping, DIC and ESPI
- Environmental exposure and nonambient temperatures can be included in test programmes
- Structural health monitoring
- Non-destructive testing

Contact

Customer Service tel: **+44 20 8943 8681**
E-mail: **materials_enquiries@npl.co.uk**

Materials
Properties For Process Modelling

A range of measurements are available to provide data on thermal and fluid flow properties from sub-ambient to extremely high temperatures, under controlled atmospheres, for a wide range of materials.

Services, Instruments and Artefacts:

- Thermal analysis of materials - TMA, DSC, DMA, TGA, PVT
- Thermal conductivity and diffusivity
- Thermal expansion (see also thermophysical properties section for additional capabilities)
- Rheological properties including viscosity
- Microfluidics micro particle velocimetry (micro-PIV)
- Density
- Data for process monitoring: cure assessment, melt cleanness, particle sizing

Contact

Customer Service tel: **+44 20 8943 8681**
E-mail: **materials_enquiries@npl.co.uk**

Materials
Degradation & Life Prediction of Materials

The degradation of properties is important for predicting the lifetime of materials and components. Accelerated tests are available to help understand the aging processes in materials under a variety of conditions.

Services, Instruments and Artefacts:

- Testing materials in harsh environments - corrosion (e.g. aqueous, H_2S, steam)
- High temperature degradation, chemical/moisture
- Exposure, environmental stress cracking
- Fatigue, thermal cycling, failure analysis
- Lifetime assessment and structural health monitoring

Contact

Customer Service tel: **+44 20 8943 8681**
E-mail: **materials_enquiries@npl.co.uk**

Materials
Surface Engineering

NPL offers macro to nano-scale measurements of the mechanical and tribological properties of surfaces, coatings and small volumes of material. Tests include surface texture, friction, wear, coating integrity, thickness, adhesion, fracture properties, hardness, elastic modulus and the measurement of residual stress.

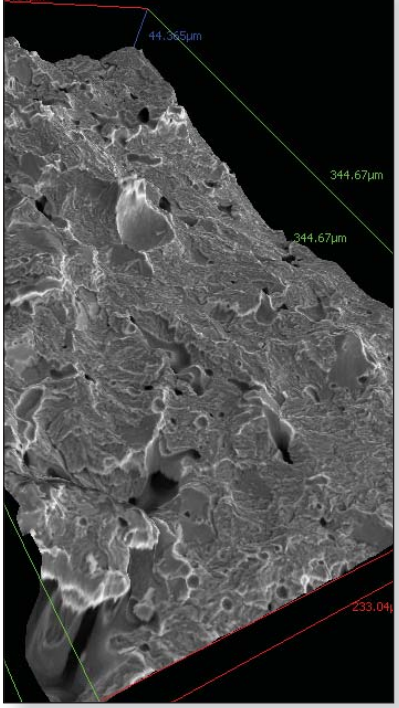
Services, Instruments and Artefacts:

- Nanomechanical testing: nano-indentation and Surface Acoustic Wave Spectroscopy
- Certification for instrumented indentation (indenters and reference materials)
- Sliding and reciprocating wear and friction
- Abrasion and erosion tests
- Coating adhesion and fracture assessment
- Surface texture
- Atomic Force Microscopy

Contact

Customer Service tel: **+44 20 8943 8681**
E-mail: **materials_enquiries@npl.co.uk**

Materials
Microstructural Characterisation & Analysis



NPL has an extensive range of microscopy equipment which underpins our materials testing. Sample preparation, analysis and characterisation methods for materials and structures are available.

Services, Instruments and Artefacts:

- Scanning Electron Microscopy
- Electron Back Scattered Diffraction
- 3D optical and confocal microscopy, image analysis
- Surface topography
- Metallographic preparation, cutting, polishing, etching
- Chemical analysis, EDX, XRD

Contact

Customer Service: tel: **+44 20 8943 8681**
E-mail: **materials_enquiries@npl.co.uk**

Materials
Nanomaterials

NPL nanomaterials effort focuses on the development of reliable and accurate methods to measure the physical properties of nano-objects and the characterisation of transport properties in nanostructured materials.

Services, Instruments and Artefacts:

- Scanning Probe Metrology of nano-structured materials: scanning Kelvin probe, scanning capacitance, chemical force, adhesion, and magnetic force microscopies. From ultra-high vacuum to liquid
- Nanoparticles characterisation: Transmission Electron Microscopy with Electron Energy Loss Spectroscopy, Dynamic Light Scattering
- Self-assembly on surfaces: wettability and nanopatterning, hydrophobicity
- Class 100 and 10 000 clean room

Contact

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Materials
Modelling

Finite element and finite difference simulation, structural and thermal modelling, and thermodynamic calculation of phase equilibria can be carried out to support Industry.

Applications of quantum mechanics, molecular dynamics, multi-physics, multi-scale, thermodynamic and FEA computational techniques are used to assess material properties at the molecular, micro and macro scales. Some software solutions are also available.

Services, Instruments and Artefacts:

- Material chemistry, thermodynamic & phase equilibrium calculations & consultancy
- MTDATA (thermodynamic and phase diagram modelling) – software licences and courses
- MTDATA thermodynamic databases for major metals, oxides, mattes, semiconductors and salts
- Materials modelling calculations & consultancy
- Analysis, multi-scale & multi-physics modelling
- Abaqus, Ansys, Pafec, Lusas, FEA software, Comsol

Contact

Customer Service tel: **+44 20 8943 8681**
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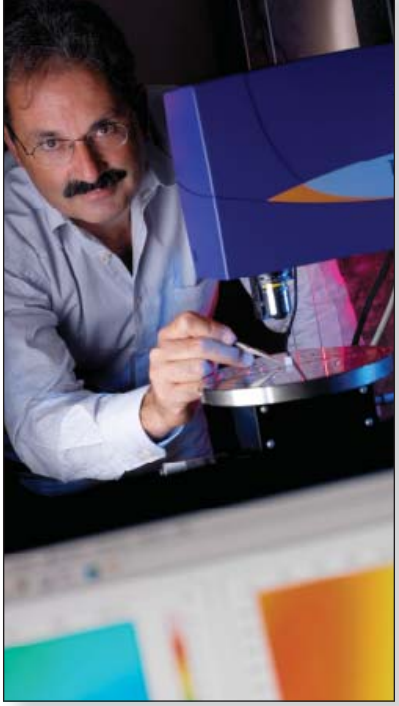
Materials
Biomaterials

Expertise can be provided in materials science and physical chemistry for biomaterial applications, and cell biology. Research and implementation of innovative methods for biomaterials measurement is undertaken to support UK industry.



Services, Instruments and Artefacts:

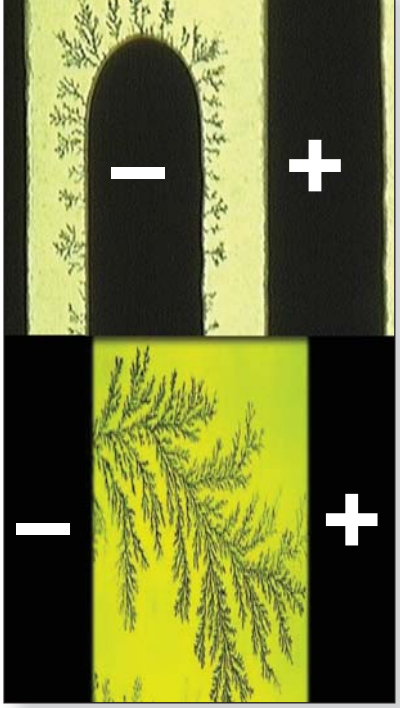
- Characterisation and degradation of tissue scaffolds
- Surface characterisation and assessment of implants
- Bone strength and stability for the selection of load bearing medical implants
- Biomaterials has enabling tools for engineering tissue & enhancing biocompatibility
- Cellular interactions with materials
- Fluid flow through complex porous structures including gels
- Vascular tissue bioreactor
- Mechanical measurement of implants and scaffolds
- Non-destructive evaluation of implants and scaffolds
- Thermal analysis of biomaterials

Contact

Customer Service tel: **+44 20 8943 8681**
E-mail: **materials_enquiries@npl.co.uk**

Materials
Electrical & Electrochemical

Measurements can be made that support the development and manufacture of new products, improve the reliability of equipment, and predict lifetime of components. Electrical and electrochemical measurements includes measurements for fuel cells and photovoltaics, electronic circuit assemblies. The teams can offer key support to industry to understand the performance of lead free solders, improvement in the solderability of circuits, and tools for interconnects in organic/flexible electronics.



Services, Instruments and Artefacts:

- Fuel cell test stations,
- Local electrochemical techniques (scanning electrochemical microscopy)
- Spatial mapping of PV conversion efficiency as a function of specific wavelength, incident angle and irradiance
- Circuit cleanness : Surface Insulation Resistance, Solvent Extract Conductivity
- Accelerated lifetime enclosures
- Mass spectrometry
- Secondary ion mass spectroscopy
- Time of flight secondary ion mass spectroscopy
- Thermal mapping of circuits
- Component solderability, solder reliability

Contact

Customer Service tel: **+44 20 8943 8681**
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Materials

Piezoelectric, Dieletric & Magnetic

Work is focused in determining functional material properties in piezoelectric materials, magnetic materials, multiferroics, shape memory alloys, and electronic ceramics. Magnetic measurements can be carried out on a wide variety of magnetic materials. The parameters and ranges offered are continuously developed to meet the needs of new applications and measurement standards. All measurement services are UKAS accredited. Consultancy on the choice of magnetic material and magnetic circuit design, as well as other magnetic related issues, is available.

Services, Instruments and Artefacts:

- Piezoelectric coefficient measurement
- Ferroelectric coefficient measurement
- Piezoelectric displacement measurement
- LF electrical characterisation: dielectric properties and impedance characteristics
- RF & Microwave dielectric measurement services
- Functional materials research into functional thin film materials and non-linear properties of piezoelectric materials in harsh environments
- RF & Microwave dielectric research
- Modelling of electromagnetic field interactions with materials and metamaterials
- DC measurements of magnetically soft materials: normal magnetisation curve, hysteresis loop, remanence and coercivity
- AC measurements of magnetically soft materials: specific total loss, specific apparent power and AC permeability
- AC properties of soft magnetic materials for operational conditions of stress, temperature and electrical waveforms
- Magnetically hard materials: demagnetisation curve, remanence, intrinsic coercivity, maximum energy product
- Validation of magnetic measurement systems and calibration of magnetic measurement instrumentation
- Low relative magnetic permeability (feebly magnetic) measurements and reference materials: relative magnetic permeability in the range 1.002 to 1.6
- Magnetic signature measurements using the NPL low magnetic field facility
- Determination of the magnetic moment and related properties of items ranging from thin films to mass standards

Contact

Customer Service tel: **+44 20 8943 8681**
E-mail: **materials_enquiries@npl.co.uk**

Neutron Measurements

NPL hosts world-leading facilities for measuring the neutron emission rate from radionuclide sources and for performing fluence and dose equivalent calibrations with monoenergetic neutrons, thermal neutrons, and broad energy range neutrons from radionuclide sources or a simulated workplace field. Services include the characterisation and calibration of neutron detecting devices, in particular personal and area dosemeters, the measurement of radionuclide neutron source emission rates and anisotropy, and also field measurements of neutron spectra and dosimetric quantities.

Services, Instruments and Artefacts:

- Monoenergetic neutron fluence & dose standards
- Thermal neutron fluence & dose standard
- Radionuclide source-based fluence & dose standards
- Transfer standards for thermal neutron fields
- Measurement of radionuclide neutron source emission rates
- Measurement of radionuclide neutron source emission anisotropy
- Hire of radionuclide neutron source
- HSE performance testing of personal dosimetry services for fast neutron radiation
- Neutron spectrometry measurements
- Measurement of dose quantities using microdosimetry
- Measurements of cosmic ray and other high energy fields
- Area survey instruments
- Neutron personal dosimeters
- Fission chambers
- Neutron spectrometers

Contact

Customer Service tel: **+44 20 8943 8637**
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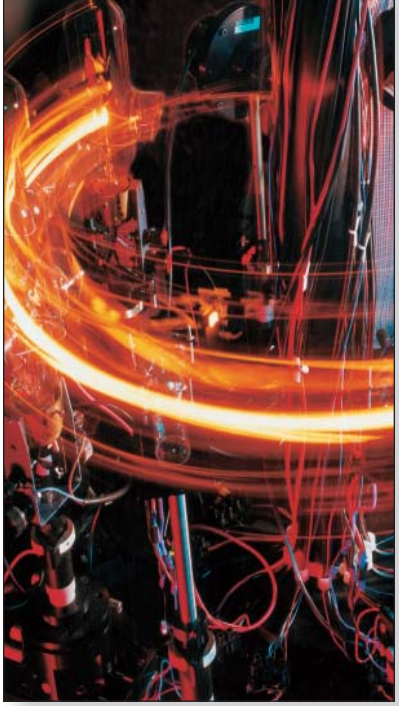
Optical & Photonic



NPL's support for the optical technology sector includes a comprehensive range of calibration and measurement services covering photometry and spectroradiometry, materials characterisation and displays. In addition, NPL offers training, consultancy and contract research covering all aspects of optical radiation metrology, these include the growing area of low energy lighting and support to the requirements arising from the Artificial Optical Radiation Directive.

Services, Instruments and Artefacts:

- Spectral radiance and irradiance measurements
- Directional photometric calibration of sources
- Luminous and spectral total flux measurements
- Determination of luminous and spectral intensity distribution
- Pulsed/flashing light sources characterisation
- Photobiological safety of lamps and lamp systems, including LEDs
- Characterisation of LEDs
- Regular transmittance/reflectance measurements
- Diffuse reflectance and colour measurements
- Refractive index measurement
- Appearance characterisation
- Gloss
- Haze
- Display measurements, luminance, chrominance, and reflectance measurement.
- Display assessment; contrast/ Just Noticeable Difference (JND), daylight legibility
- Display usability evaluation
- Transmittance references artefacts
  - o neutral density filter (UV-Vis NIR)
  - o wavelength std (UV-Vis NIR)
  - o wavenumber (Mid IR)
  - o TQA %transmittance (Mid IR)
- Reflectance references artefacts
  - o Regular reflectance (UV-Vis NIR)
  - o Diffuse reflectance (UV-Vis NIR)
- Ceramic colour standards
- Calibration of photometers and radiance gauges

Contact

Customer Service tel: **+44 20 8943 6151**
E-mail: **optical_enquiries@npl.co.uk**

Optics

Calibration of lenses and optical components used in imaging and dimensional measurement systems. NPL designs and supplies calibrated precision scales for the validation of image analysis and vision measurement systems. An important factor in achieving accurate production of spectacle lenses is the maintenance of consistent standards of lens power in the ophthalmic examination, lens manufacture and subsequent spectacle fitting. Consistent measurements of power may be assessed in all these stages by using focimeters and spherometers which have been calibrated with suitable reference lenses.

Services, Instruments and Artefacts:

- Optical flatness
- Radius and sphericity
- Precision scales for microscopy and image analysis
- Microstructured surfaces
- Calibration of the power of reference lenses in the range ±1 dioptre to ±25 dioptres, with the measurement uncertainty ranging from ±0.005 dioptres to ±0.02 dioptres
- Calibration of the power of weak lenses in the range ±0.05 to ±1 dioptre with the measurement uncertainty ±0.002 dioptres
- Power measurements of spherical, cylindrical and prismatic lenses
- Stage micrometers & graticules
- Linewidth standards

Contact

Customer Service tel: **+44 20 8943 6245**
E-mail: **optics_enquiries@npl.co.uk**

Pressure & Vacuum

NPL offers consultancy services, pressure standards for other laboratories, and an enquiry service for pressure and vacuum related issues. NPL also runs a pressure and vacuum measurement special interest group within EMAN (the Engineering Measurement Awareness Network) called Pressmet, which is for the benefit of instrument end users, manufacturers and academics.

Services, Instruments and Artefacts:

- Vacuum (provided through SP Technical Research Institute of Sweden)
- Barometry
  - o Digital (electronic) barometers
  - o Precision aneroid barometers
- High pressure (Gauge and Absolute)
  - o Pneumatically operated pressure balances
  - o Hydraulically operated pressure balances

Contact

Customer Service tel: **+44 20 8943 8681**
E-mail: **pressure_enquiries@npl.co.uk**

Radiation Dosimetry

NPL deals with the dosimetry of x- and γ-rays, and charged particles such as electrons and protons. We develop, maintain and disseminate the UK national measurement standards for these radiations and engage in research on radiation interactions to address the needs of industry, healthcare and government. NPL is also involved in promoting the role of traceability in quality assurance, international and national specification standards and measurement protocols, for radiation dosimetry, for example through training.

Services, Instruments and Artefacts:

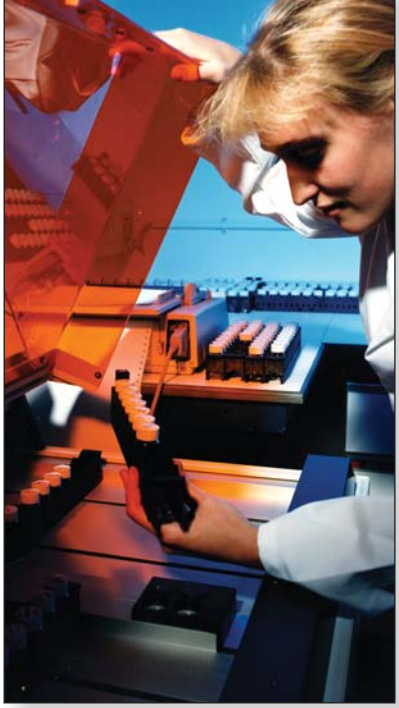
- Electron beam calibration service for radiotherapy (absorbed dose)
- Photon beam calibration service for radiotherapy (air kerma and absorbed dose)
- HDR brachytherapy
- Secondary standard electrometers (charge and/or current)
- Radiotherapy reference dosimetry audits
- Alanine reference dosimetry service for radiotherapy
- Ophthalmic applicators
- Diagnostic and mammographic X-ray dosemeters
- kVp meters
- Alanine reference dosimetry service for 1 MeV to 4 MeV electron beams
- Mail-order alanine reference dosimetry service for radiation processing
- Mail-order dichromate reference dosimetry service for radiation processing
- Protection and environmental level (air kerma)
- High dose cobalt-60 irradiations
- Hire of linear accelerator facility - Electron and X-ray beam irradiations
- Hire of therapy level Cobalt-60 facility
- Hire of X-ray facilities
- Hire of protection level Gamma-ray facility

Contact

Customer Service tel: **+44 20 8943 8695**
E-mail: **dosimetry_enquiries@npl.co.uk**

Radioactivity

NPL is responsible for maintaining the UK primary standards of radioactivity, and disseminating these standards to users of ionising radiation in fields such as nuclear medicine, environmental radioactivity monitoring and nuclear decommissioning. NPL also provides products and services to enable organisations to comply with legislation and good practice related to ionising radiation.



Services, Instruments and Artefacts:

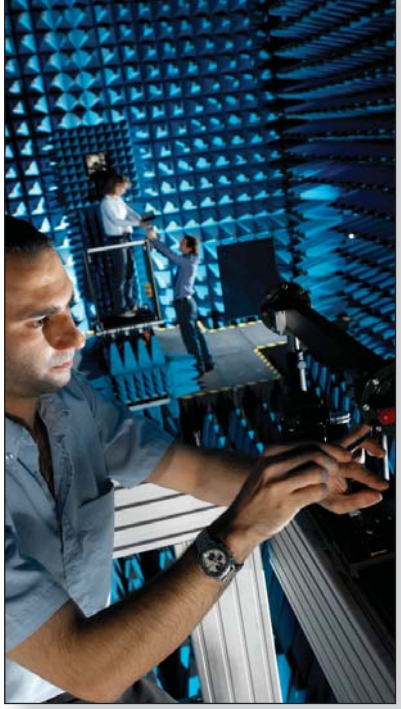
- UK hospital nuclear medicine proficiency test exercises
- Primary and secondary standards of a range of beta- or beta/gamma-emitting radionuclides, including standardised low-level radionuclide mixtures for periodic user proficiency tests
- Radioactive gas standards, e.g. Tritium and ^{85}Kr, the provision of standards of ^{222}Rn and the calibration of gas monitors.
- Standards of radioactive surface contamination for the calibration of surface contamination monitors.
- Radionuclide calibrator services, including the provision of calibration factors for the NPL radionuclide calibrator for beta-gamma emitters, pure beta-emitters and brachytherapy sources
- Standardised solutions of isotopically pure radionuclides, at or near the working level for use by laboratories making measurements of environmental radioactivity
- Tritium measurement proficiency testing
- Secondary standardisation of customer supplied samples
- Radioanalytical services for the radiochemical analysis of complex waste forms such as building materials from nuclear sites.
- Instrument calibration and characterisation

Contact

Customer Service tel: **+44 20 8943 8695**
E-mail: **radioactivity_enquiries@npl.co.uk**

RF & Microwave Free-Field

RF and Microwave free-field measurements are vital to many industrial sectors, including aerospace, telecommunications, automotive, defence and EMC. To meet these needs, NPL has developed a comprehensive range of facilities and measurement techniques for calibrating and testing in the frequency range 20 Hz to 110 GHz.



Services, Instruments and Artefacts:

- Radiation hazard monitors
- Field strength probes
- EMC antennas (loops, monopoles, dipoles, biconical antennas, LPDAs, horns etc)
- VHF antennas, e.g. for vehicle mounting
- Microwave antennas and near-field scanning probes
- Mobile phone basestation antennas
- Electromagnetic materials (dielectrics)
- Test site evaluations
- Electromagnetic field site surveys
- Specific Absorption Rate probes
- CAI digital TV aerial benchmark testing

Antenna measurements include:

- Finite & infinite range gain
- Antenna factor
- Reflection coefficients
- Axial ratio
- Tilt angle
- Radiation pattern
- Efficiency
- Cross-polar levels
- Balun imbalance of dipoles
- Phase centre

Power flux density measurements include:

- Frequency response
- Sensitivity
- Axial isotropy
- Linearity

Contact

Customer Service tel: **+44 20 8943 6796**
E-mail: **rf_enquiries@npl.co.uk**

For Loop Antennas Power Flux Density and Field Strength Probes please contact:

Customer Service: tel: **+44 20 8943 8538**
E-mail: **pfdfs@npl.co.uk**

RF & Microwave Guided Wave

RF and Microwave guided wave measurement standards apply in transmission media, such as waveguide, coaxial lines, and planar lines in high frequency integrated circuits. Power, attenuation, impedance and noise are the four main measurement parameters within this area, all of which underpin RF and microwave manufacturing and industry. NPL offers a number of services within this sector at frequencies up to 110 GHz. NPL also offers measurement services for ultrafast (< 1 ns) electrical pulse generators and photodiodes, as well as high bandwidth (≥ 1 GHz) oscilloscopes.

Services, Instruments and Artefacts:

- Ultrafast waveforms
  - o Fast pulse electrical measurements of pulse generators and photodiodes/photoreceivers - risetime and aberrations
  - o Risetime measurements of sampling and real-time oscilloscopes
  - o Additional parameter measurements on request
- Power
  - o Calibration factor of power sensors
  - o Power meters
- Attenuation
  - o Fixed attenuators
  - o Stepped attenuators
  - o Variable attenuators
- Impedance
  - o S-parameter measurements of:
    - Fixed attenuators
    - Network analyser calibration standards
    - Network analyser verification kits
    - Matched and mismatched terminations
  - o Characteristic impedance of air lines
  - o Internet-enabled network analyser calibrations
- Noise
  - o ENR and noise temperature of noise sources

Contact

Customer Service tel: **+44 20 8943 6796**
E-mail: **rf_enquiries@npl.co.uk**

Temperature

Temperature is one of the most commonly measured properties in industry, medicine, meteorology, and everyday life. Accurate and traceable measurements affect many aspects of business such as materials processing, energy efficiency, medical diagnostics and food safety. NPL offers the calibration of a range of temperature measuring devices including contact and non-contact instruments. We also run the Thermal Measurement Awareness Network (TMAN) and training courses in temperature calibration techniques.

Services, Instruments and Artefacts:

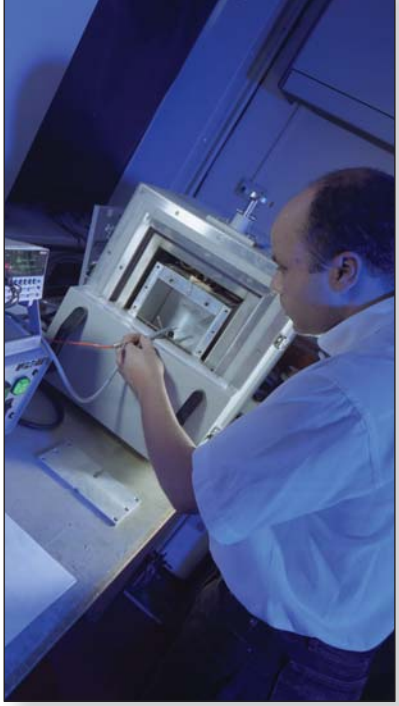
- Calibration of standard long-stem platinum resistance thermometers (-196 °C to 962 °C)
- Calibration and supply of platinum-rhodium thermocouples (0 °C to 1600 °C)
- Calibration of digital indicators and industrial platinum resistance thermometers (-196 °C to 550 °C)
- Supply of temperature fixed-points and triple-point cells for the calibration of standard platinum resistance thermometers and thermocouples
- Calibration of blackbody sources, radiation thermometers and tympanic (ear) thermometers
- Calibration and supply of pyrometric lamps (700 °C to 2300 °C)
- Supply of NPL fixed point blackbody sources (-40 °C to 3000 °C)
- Supply of variable temperature blackbody sources (-40 °C to 3000 °C)

Contact

Customer Service tel: **+44 20 8943 6315**
E-mail: **temperature_enquiries@npl.co.uk**

Thermal Performance

NPL has comprehensive, world class facilities (a number being unique within the UK) for the measurement of the thermal performance of materials and structures used in buildings; pipe insulation; high temperature insulation and refractories; and engineering materials including plastics, composites, ceramics, metals and alloys.



Services, Instruments and Artefacts:

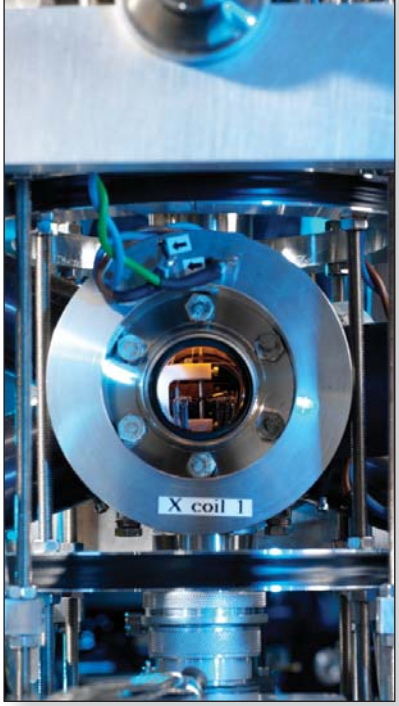
- Thermal conductivity
  - o Thermal conductivity or resistance of insulation and construction materials
  - o Measurements using guarded hot-plates and heat flow meters
  - o Accreditation under 89/106/EEC: Construction Products, Notification id: 1146
  - o Thermal conductivity or resistance of engineering materials
  - o Measurements covering the temperature range -170 °C to 800 °C
- Thermal transmittance
  - o Thermal transmittance of structures (U-value)
  - o Measurements using rotatable and wall guarded hot boxes
  - o Windows, skylights, panels, roof sections and walls (up to 450 kg)
  - o Sample sizes up to 2 m x 2 m x 0.3 m and at any orientation
  - o Measurement apparatus for thermal transmission of pipe insulation up to 250 °C
- Reference standards
  - o Thermal conductivity reference materials and transfer standards to ISO Guide 34
  - o Calibrated thermal transmittance panels for hot box calibration to EN ISO 12567-1

Contact

Customer Service tel: **+44 20 8943 8681**
E-mail: **thermal_enquiries@npl.co.uk**

Time & Frequency

Home of the nation's atomic time scale, NPL is the focus for time and frequency measurements in the UK. The UK atomic time scale is based on an ensemble of hydrogen masers and caesium atomic clocks. These are used to contribute to international atomic timescales and to provide the reference for time and frequency dissemination and monitoring within the UK. We have also developed a caesium fountain primary frequency standard to provide the top-level realisation of the SI unit of time, the second.



Services, Instruments and Artefacts:

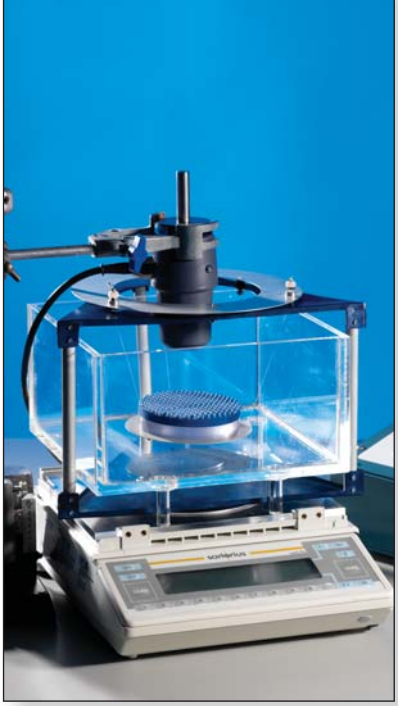
- Computer time services
- Characterisation service for frequency standards and GPS-disciplined oscillators
- GPS common-view time transfer service
- Monthly bulletins for MSF, Droitwich and GPS off-air signals

Contact

Customer Service tel: **+44 20 8943 6796**
E-mail: **timefreq_enquiries@npl.co.uk**

Ultrasound

NPL provides a comprehensive range of calibration, measurement and consultancy services. These cover hydrophones, transducers, radiation force balances and characterisation of medical and industrial ultrasonic equipment to meet the stringent requirements of testing for compliance with regulatory, safety and quality standards. They provide manufacturers and users with acoustic output information at all stages of product development and manufacture.



Services, Instruments and Artefacts:

- Calibration of ultrasonic hydrophones
- Calibration of radiation force balances and ultrasound power meters
- Measurement of the acoustic output of medical ultrasound equipment
- Acoustic property testing of materials (attenuation and speed of sound)
- Supply of thermal test objects
- Supply of tissue mimicking materials
- Training courses on instrumentation and methods for medical ultrasound measurements
- Design, fabrication and supply of specialist measurement/test equipment
- Consultancy services for ultrasonic measurement, including the Finite Element modelling of transducer fields

Contact

Customer Service tel: **+44 20 8943 8631**
E-mail: **acoustics_enquiries@npl.co.uk**

Underwater Acoustics

The applications of underwater sound span positioning, communications, navigation, echo sounding, geophysical surveying, water quality measurement, sonar, weapons systems, and tomographic measurements of ocean currents and temperature. Underwater acoustics is a key underpinning technology in offshore oil and gas activities, is increasingly used in oceanographic and environmental studies, and continues to play a crucial role in marine defence. In addition, the accurate measurement of anthroprogenic noise is key to the assessment of its effect on marine life.

Services, Instruments and Artefacts:

- Calibration of hydrophones and projectors
- Calibration and characterisation of sonar transducers and systems
- Acoustic calibration and testing at simulated ocean conditions (in the NPL Acoustic Pressure Vessel)
- Integrity testing of marine components at elevated hydrostatic pressure
- Testing the acoustic properties of materials eg. echo reduction, transmission loss
- In-situ measurement of radiated underwater acoustic noise
- Consultancy services for underwater acoustic measurement
- Training courses in underwater acoustic measurement and calibration

Contact

Customer Service tel: **+44 20 8943 8631**
E-mail: **acoustics_enquiries@npl.co.uk**

Other types of support offered by NPL:

Measurement Services represent just one way in which our customers can benefit from the wealth of scientific and technical resources at NPL. Other areas of support include:

- Consultancy: ranging from free advice over the telephone to fully or part-funded secondment of NPL experts into customer organisations
- Sale of reference artefacts, samples and measuring equipment
- Licensing of our portfolio of technology Intellectual Property, developed over many years at NPL and now accessible under a variety of exploitation arrangements
- Facility Hire: access to many of NPL's unique laboratory facilities on a pre-booked basis. Customers are able to operate these facilities under the impartial guidance of our technical experts
- Training: our established range of world-renowned measurement-related training products, delivered to meet the specific training and development needs of our customers
- Network Management, including both knowledge network facilitation and measurement infrastructure management
- Modelling of all types, using a wide-range of state-of-the-art techniques and covering the entire breadth of NPL's science and technology base
- Measurements solutions: the development and delivery of bespoke measurement techniques, practices and business solutions, especially at high levels of accuracy or for use in difficult or unusual environments
- Test and measurement instrument design, development, application and impartial evaluation
- Independent measurement, testing and validation of software and systems
- Development of specialist mathematical software for measurement and instrumentation applications.

General business enquiries concerning the above services should be referred to our dedicated Business Development team:

Defence, Security & Aerospace	**Tim Prior:**	**+44 20 8943 6679**
Environment, Transport & Energy	**Frank Pavy:**	**+44 20 8943 7031**
Low Carbon Energy (Nuclear)	**Ray Chegwin:**	**+44 20 8943 6385**
Space & Communications	**John Burton:**	**+44 20 8943 8767**
Training	**Keith Bevan:**	**+44 7718 195 990**
Measurement Services	**Andy Morris**	**+44 7738 894 855**

NPL's commitment to quality

As the national measurement standards laboratory in the UK, NPL offers services at the highest available levels of accuracy. Customers depend on these to achieve direct traceability to nationally and internationally accepted standards. These services are operated within the most stringent quality and procedural requirements. To demonstrate this formally, it is NPL's policy to seek accreditation, where feasible, for its measurement services.

ISO 9001

NPL's quality management system has been registered for scientific R & D and the provision of internal services by LRQA to ISO 9001:2000 and where appropriate in accordance with TickIT.

UKAS Accreditation

NPL's standard calibration, measurement and testing services have been accredited by UKAS. The accredited capability of those services may be found in calibration and testing schedules issued by UKAS.

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Terms & Conditions of Business

For detailed information please refer to the Terms & Conditions page on our website:

www.npl.co.uk/terms_conditions

NPL
National Physical Laboratory

LASER TRACER SYSTEM with NPL Technology

What is Laser TRACER?

NPL with its partner ETALON presents a revolutionary new measurement system for high-speed, high accuracy calibration and verification of CMMs, CNC machine tools, and other, leading-edge measurement applications.

The new Laser TRACER relies on a highly stable laser source and an NPL patented precision internal design that is mechanically and thermally decoupled from the tracking mechanism, providing the ultimate in stability and accuracy. NPL is now able to bring standards laboratory level measurements to the shop floor, delivering significantly improved calibration times and minimum machine downtime.

How does Laser TRACER work?

Laser TRACER uses a laser to track a reflector mounted on the machine tool or CMM probe. The system's internal software automatically generates an appropriate measurement cycle for the machine test and then guides the user in simple steps through the testing process.

Measurement routines can be performed without the need for highly skilled technicians and are significantly quicker than existing traditional methods. Uncertainties of measurements are automatically generated and a comprehensive test report or certificate produced at the point of measurement. We are seeking UKAS accreditation in this area. Automatic correction of stored error-maps is also available for a growing number of machine types. The on-board software is specifically designed to meet the requirements of the emerging standard ISO10360-2.

ETALON
APPLIED TRACEABILITY

NPL
National Physical Laboratory
Technology Applied

National Physical Laboratory

Hampton Road
Teddington
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United Kingdom
TW11 0LW

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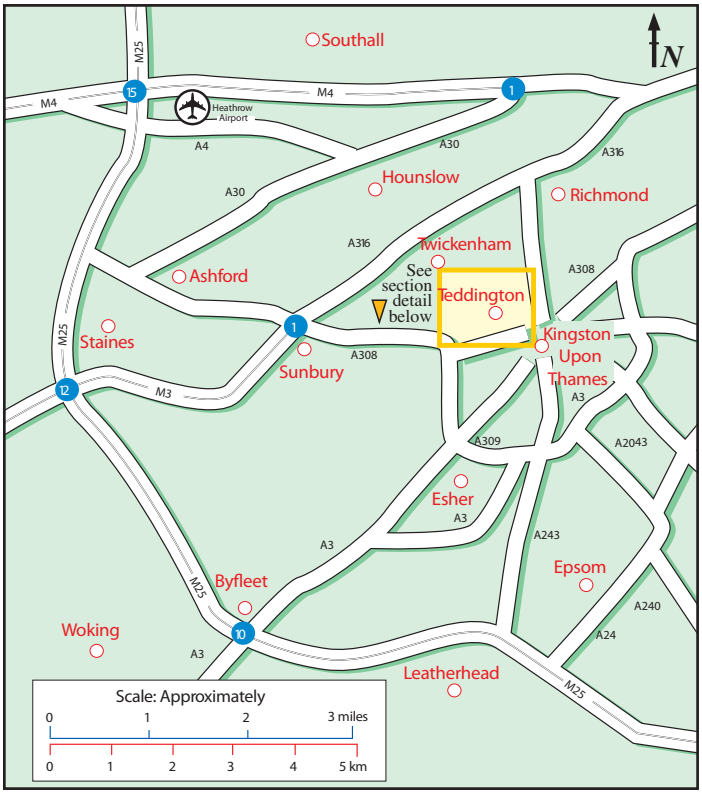
Web: **www.npl.co.uk**

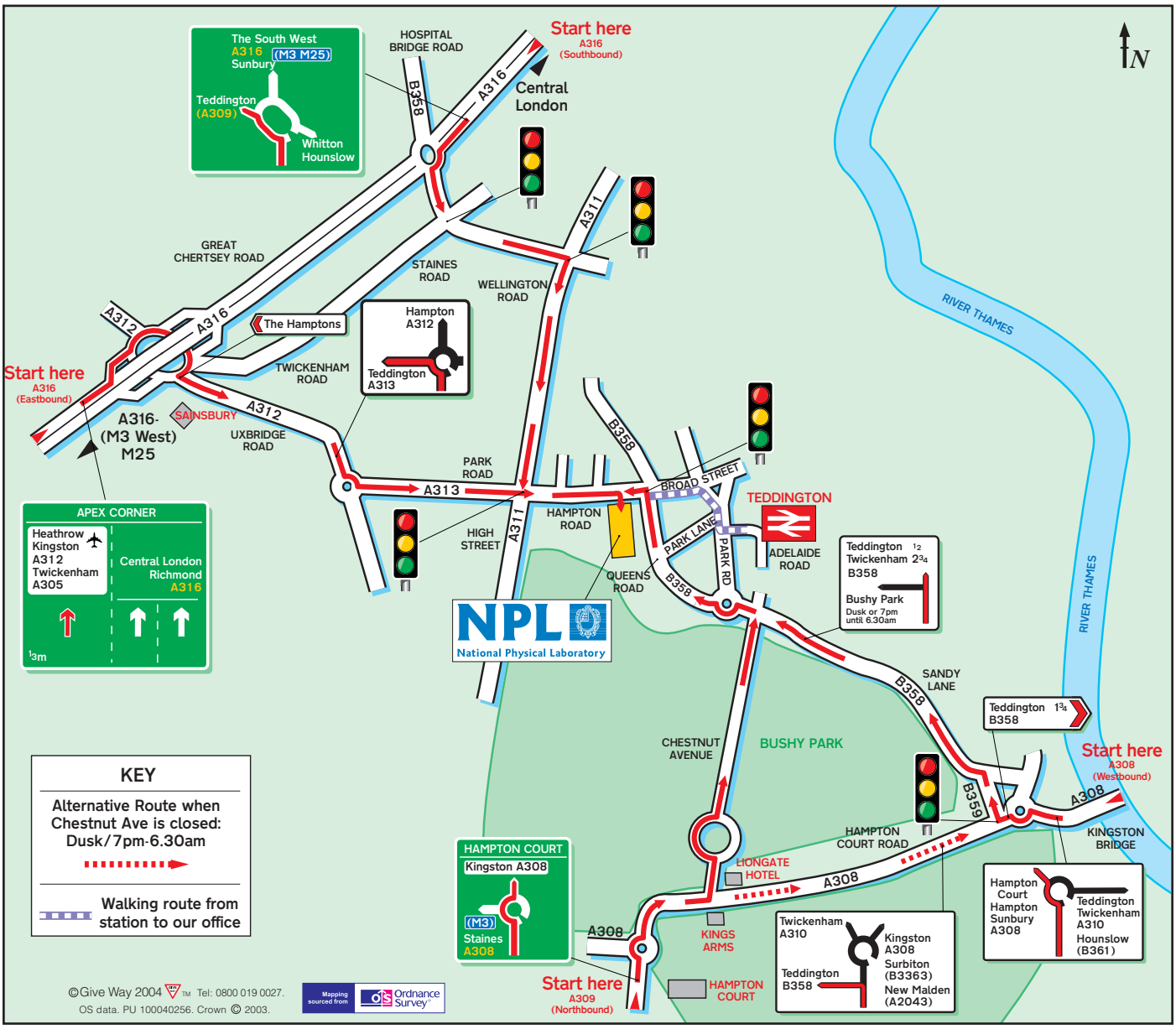


Public Transport

By Rail,
Teddington Station
20 minutes walk to NPL.

Buses.
Teddington is well served by buses (281, 285 and R68) but as routes are subject to change, visitors are advised to check before travelling.

By Air
Heathrow Airport
Take a taxi, approximately 20 minutes. There is a bus service (285) to Teddington.



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