NPL
National Physical Laboratory

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Ensuring accuracy in radioactivity measurement:

NPL's role in calibration

Why is calibration necessary?

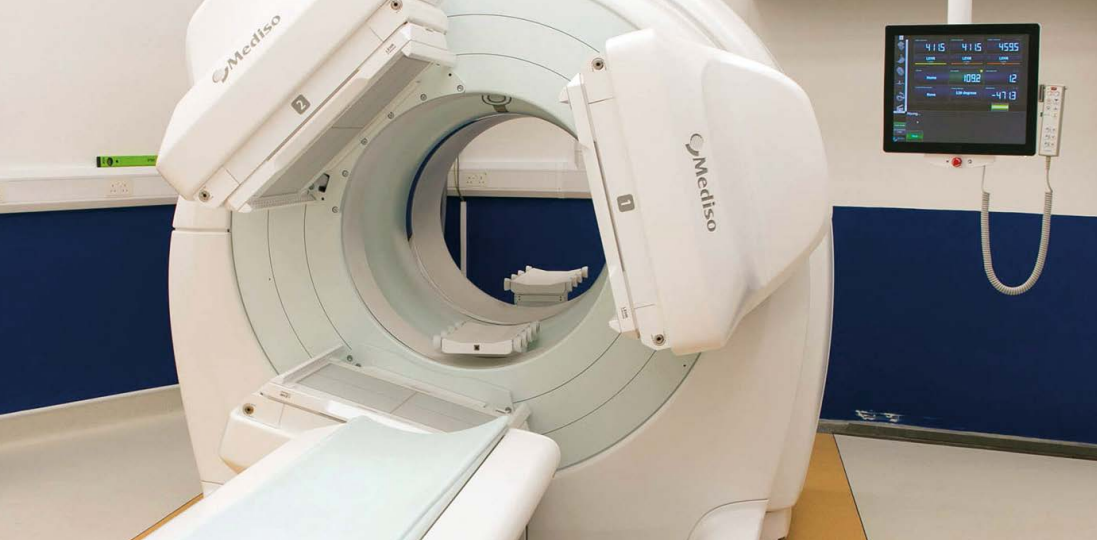
Accurate measurement of radioactivity is essential for safety, regulatory compliance and scientific integrity across sectors such as healthcare, environmental monitoring, energy and defence. In healthcare and life sciences, hospitals and radiopharmaceutical manufacturers rely on precise measurements to ensure correct patient dosing and delivery of effective treatments while minimising radiation exposure. Just as importantly, regulatory and environmental agencies depend on accurate data to assess radioactivity levels in marine and terrestrial environments, while defence and national security operations require reliable detection and monitoring to manage nuclear and radiological threats. The nuclear industry relies on radioactivity measurement for routine operation of facilities and decommissioning activities. Companies in the test, measurement and supply chain sector must verify instrument accuracy before products reach the market. Ensuring these measurements are correct whatever the application requires proper calibration, as errors can lead to serious repercussions including incorrect medical dosages, environmental harm and security risks.

How does NPL support calibration?

The National Physical Laboratory (NPL) plays a critical role in ensuring the accuracy of radioactivity measurements, providing radionuclide standards with traceability, high purity and low measurement uncertainties for precise calibration. NPL also offers proficiency testing (PT) programmes to support laboratories in maintaining accreditation and improving measurement consistency. In addition, NPL provides consultancy and training, guiding end users as they implement best practices for calibration and regulatory compliance.

Radionuclide standards

NPL offers a range of radionuclides to support precise measurement and calibration, including standard, mixed and custom solutions. Standard solutions provide reliable, high-purity sources for routine calibration, while mixed solutions contain multiple radionuclides, ensuring balanced peak intensities for gamma-ray spectrometry end users. Custom solutions are also available for customers requiring specific activity levels, unique radionuclides, or freshly separated materials to minimise interference from radioactive impurities.



Healthcare and life sciences

Accurate radiation dosimetry is essential for nuclear medicine, ensuring that patients receive the correct dose during diagnostic imaging and treatment. Hospitals and radiopharmaceutical manufacturers rely on precise measurements to prevent miscalculations that could lead to ineffective treatment or unnecessary radiation exposure. While hospitals focus on administering calibrated doses, radiopharmaceutical manufacturers work further up the supply chain, ensuring that the products they provide comply with strict quality standards. They also require precise quantification of activity and dose to support clinical trials, a process governed by strict regulatory requirements. NPL supplies certified radionuclide standards for medical isotopes such as F-18, Tc-99m, and Lu-177, allowing healthcare providers and manufacturers to calibrate their ionisation chambers with confidence. All radionuclides are of high purity, lowering measurement uncertainties, and opening up novel options for cutting-edge medical applications to support breakthroughs in areas like cancer and cardiac diagnostics.

Case studies

- **Innovation and quantifying dosage in radiopharmaceuticals:** NPL and Oncoinvent develop new methods to measure and deliver dosage in pioneering forms of radiotherapy
- **Helping deliver world-class cancer care:** We have helped to improve confidence in new radiotherapy treatments for better patient outcomes

Regulatory assurance and environmental monitoring

Environmental monitoring depends on highly sensitive instruments to detect low levels of radioactivity in marine and terrestrial environments, ensuring that potential hazards are identified early. Authorities require precise radionuclide measurements to uphold public health and regulatory compliance, making reliable instrumentation essential. Gamma-ray spectrometers play a key role in identifying radionuclides, while liquid scintillation counters and mass spectrometers can be used to measure weak or non-gamma-ray emitting radionuclides. These instruments must be able to measure radioactivity at trace levels, which requires careful and regular calibration. NPL provides a wide range of certified radionuclide standards that laboratories can use to calibrate their instruments and ensure regulatory compliance. These high-purity materials have minimal background interference, improve confidence in measurement accuracy, and support emerging needs in environmental monitoring.

Defence and national security

Governments and defence agencies depend on precise radioactivity measurements to safeguard national security, ensuring accuracy in nuclear forensics, radiological incident preparedness and radiation protection. In the event of a radiological threat, the ability to swiftly measure and analyse radioactivity levels is essential for an effective response. Portable detectors are commonly used for field assessments, while high-precision instruments support forensic analysis. NPL provides certified radioactive tracers and standards that help defence agencies maintain readiness for radiological incidents. Our offerings strengthen the ability of national security organisations to respond effectively by ensuring high-purity standards, reducing uncertainties and offering novel radionuclides for emerging detection technologies.

Industrial and energy applications

Industries using radioactive materials must measure radioactivity levels reliably and precisely, which is especially important in nuclear decommissioning, where accurate waste categorisation affects both environmental protection and financial costs. Proper classification can mean the difference between disposing of materials as very low-level waste (VLLW) or treating them as hazardous waste, and gamma-ray spectrometers are commonly used to measure radioactivity levels. NPL supports these industries by providing high-accuracy radionuclide standards that can be used to help classify waste, optimise industrial processes and reduce risk of non-compliance.

Manufacturing

Manufacturers of radioactivity measurement instruments need to ensure their products meet stringent quality requirements before distribution. Calibration is an essential step in the production process, as even small measurement deviations can have an impact on instrument reliability. Commonly used calibration tools include radionuclide standards for standardising measurements and calibration sources for verifying instrument accuracy. NPL supplies ultra-pure radionuclide standards to manufacturers, so that they can ensure their devices are correctly calibrated before they reach customers. We assist manufacturers by reducing calibration errors, improving accuracy and supporting the development of new technologies.

Proficiency testing for accreditation

Proficiency testing (PT) uses inter-laboratory comparisons to assess individual laboratory performance, helping to ensure that facilities are performing accurate measurements of radioactivity. NPL provides structured PT exercises that allow laboratories to evaluate their measurement performance, identify measurement problems and validate and/or compare methods. Participation in relevant exercises is often required to demonstrate compliance with both UK and international standards, including UKAS, DAkkS, ENAC, EA-BAS and BELAC. One of the exercises offered by NPL is the environmental radioactivity PT, which involves participating laboratories measuring an unknown mixed radionuclide source provided by NPL containing at activity concentrations typically encountered in environmental samples. By comparing their results to NPL's assigned values, laboratories can assess the accuracy of their measurements and validate existing analytical methods. Another exercise is the nuclear drum PT, which helps laboratories who routinely characterise waste drums to assess and validate new and existing rigs, measurement schemes and modelling protocols. This helps to improve the accuracy and precision of non-destructive waste classification measurements in radioactive waste management.

Why choose NPL?

History and role as the UK's National Metrology Institute

NPL is the UK's National Metrology Institute (NMI) and has a longstanding reputation for excellence in nuclear metrology. Our expertise in radioactivity standards and measurement science makes us a trusted partner for industries requiring precise radioactivity calibration.

Expertise in nuclear metrology and radioactivity standards

Organisations worldwide rely on NPL for our in-depth knowledge and experience in nuclear metrology. We have a proven track record in supporting regulators, healthcare providers and industries with high-accuracy calibration services. NPL is an NMI, putting us at the top of the traceability pyramid, and the accuracy of our offerings is globally acknowledged. By choosing NPL, laboratories, industries and healthcare providers can ensure compliance with regulations, maintain confidence in their measurement accuracy and enhance the reliability of their radioactivity monitoring systems.

Complete range of services

NPL also provides a range of additional services to implement best practices across various industries. These include radioactivity measurement, radioactive gas standards, customer impurity checks, calibration of wide area sources, and performance testing for tritium and medical radionuclides.

For neutron-related work, NPL offers thermal, monoenergetic and broad-spectrum neutron fluence and dose standards. Services also cover the measurement and hire of radionuclide neutron sources, measurements of neutron fields, and expert consultancy in neutron detection and calibration.

Case study

Improving expertise in nuclear data for reduced uncertainty: NPL partnered with the University of Manchester to bring a new approach to nuclear data collection and uncertainty reduction

Reach out to us to find out how we can support you in achieving precise radioactivity measurements.

Supporting literature

1. Environment/mass spec: Russell, B. C. et al. (2023) Development of a single method for direct measurement of multiple radionuclides using ICP-MS/MS. Journal of Analytical Atomic Spectrometry. 38: 97-110. https://doi.org/10.1039/D2JA00174H

2. Medical standardisation: Collins, S. M. et al. (2023) Determination of the Terbium-152 half-life from mass-separated samples from CERN-ISOLDE and assessment of the radionuclide purity. Applied Radiation and Isotopes. 202:111044. https://doi.org/10.1016/j.apradiso.2023.111044

3. Neutron developments: Bunce, Michael et al. (2019) Plans for neutron metrology at NPL. J. Phys.: Conf. Ser. 1643:012201. https://iopscience.iop.org/article/10.1088/1742-6596/1643/1/012201/meta

4. Emergency response/medical standardisation: Collins, S. M. et al. (2022) Determination of the 161Tb half-life'. Applied Radiation and Isotopes 182:110140. https://doi.org/10.1016/j.apradiso.2022.110140

5. Instrument development: Goodwin, M.A. et al. (2022) Enhancing the detection sensitivity of a high-resolution β – γ coincidence spectrometer. Journal of Environmental Radioactivity. 250:106915 https://doi.org/10.1016/j.jenvrad.2022.106915

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