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^{222}Rn and ^{226}Ra Measurement Standards and Calibration Activities at NIST

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SUMMARY (Extended Abstract)

At the present time, almost all measurements of ^{222}Rn (radon) are ultimately related back to some standard of its radionuclidic progenitor ^{226}Ra (radium). Within the United States, the National Institute of Standards and Technology (NIST), formerly the National Bureau of Standards (NBS), maintains both national and international radium standards that can be directly related to the international primary mass standards of radium prepared by Marie Curie in 1911 and Otto Honigschmid in 1934. NIST has a long and proud 80-year (c.1913-1993) history in measuring, calibrating, and providing radium and radon emanation standards; and is perhaps the only national metrological standards laboratory that disseminates radon emanation standards based on calibrated radium solutions that are still directly relatable to the international Curie and Honigschmid standards. Over the years,the NIST standards have in many ways served as almost informal international standards. In fact, a substantial portion of the radon measurement calibrations made in the world, including most radon measurement interlaboratory comparisons, are based on NIST standards.

From 1913 through the 1940s, NIST had a large and active program in radon and radium metrology, but over the intervening years the program became somewhat dormant and mainly consisted of maintaining a minimum calibration capability to preserve the extant standards. In the past decade (c.1980-1993) however, largely as a result of a renewed world-wide interest in radon measurements, NIST reestablished a substantial radon measurement standards program. This presentation provides an overview and highlights the activities of this current NIST radon standards program.

The primary objectives of the program are threefold, *viz.*, to maintain national standards for ^{226}Ra and ^{222}Rn; to develop new transfer standards and applications; and to disseminate standards, and provide mechanisms for insuring the quality of radon measurements. The major emphases were on improving our primary calibration capabilities, developing transfer standards, other than radium solutions, that could be used in other radon measurement applications, and actively interacting with the radon measurement industry and other principal radon measurement laboratories.

Topics and brief highlights of recent activities that will be discussed include:

The pulse-ionization-chamber based primary radon measurement system that currently serves as the national standard for radon measurements, and its central role in linking all NIST radon and radium measurements, transfer standards, and calibration services.

The NIST radon-in-water standard generator which consists of a polyethylene-encapsulated radium solution in a small-volume accumulation chamber and an ancillary mixing and dispensing system. It generates aqueous solutions of radium-free radon of which multiple aliquots may be dispensed and used as standardized solutions for calibrating radon-in-water assay procedures. The long-term performance of the generator over the past 5 years has been investigated and evaluated.

Development of a new secondary measurement system and transfer standard for radon-in-air measurements based on a calibrated NaI(Tl) well counter used in conjunction with spherical 25-mL glass ampoules containing radon samples. The system was successfully used in the past few years for measurement intercomparisons with five principal laboratories within the US, and for an 11 laboratory international intercomparison. The developed methodology also served as the basis of the recent EUROMET radon intercomparison.

Three new series of ^{226}Ra solution standards for radon emanation which were made available in 1992. As part of this work, a study was conducted to validate the relatability of all radium standards issued by NIST from 1947 to 1992. Additionally, NIST recently provided special ^{226}Ra sources to NPL in the UK and ENEA in Italia to serve as their national radon standards.

Development and calibration of a new NIST emanation transfer standard that is based on polyethylene-encapsulated ^{226}Ra solution sources that emanate well-characterized and known quantities of ^{222}Rn when employed in an accumulation mode. The encapsulated standards have been extensively tested and evaluated over the past three to four years. The utility and efficacy of using the capsules to calibrate electret monitors for integral radon measurements was also recently demonstrated.

An international marine-atmospheric ^{222}Rn measurement intercomparison conducted in Bermuda in which NIST provided standardized sample additions with concentrations from 35 down to 2.5 Bq m^{-3} with overall uncertainties of about 10% that are directly relatable to national standards. The calibration and methodology were unique and the first of its kind for and in-field measurement intercomparison.

Studies of "absolute" (*sic*) primary ^{222}Rn and ^{226}Ra calibrations based on $4\pi\alpha$ and $4\pi\beta^-$ liquid scintillation counting using the CIEMAT/NIST ^{3}H efficiency tracing method. This work will ultimately provide a primary radon calibration that is not dependent on an indirect or comparative measurement against a ^{226}Ra standard, and will also serve to independently verify the extant artifact standards of radium.

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ABOUT THE SPEAKER

Dr. R. Collé
is a specialist in radionuclide metrology, and currently serves as a research chemist in the Radioactivity Group of the NIST Physics Laboratory (Ionizing Radiation Division) where his primary responsibilities involve maintaining the national standards for radon-222 and radium-226, and developing new transfer standards and measurement methodologies for them. He has been at NIST since 1974 holding several positions within the Radioactivity Group and the Office of Radiation Measurement. In these latter positions, he worked on developing and establishing the first national standards program for the radiopharmaceutical industry; developing and implementing national guidance for the reporting of environmental measurements data; developing international conventions for the treatment of measurement uncertainties; and establishing and coordinating measurement assurance programs for various ionizing radiation measurement applications. Previously, he held positions at Brookhaven National Laboratory, the State University of New York at Albany, and the University of Maryland where he conducted low- and medium-energy accelerator-based studies of atomic structure (inner-shell ionization phenomena) and nuclear reaction systematics, all of which were based on radiochemical and nuclear chemistry approaches. He received a B.S. in Chemistry from the Georgia Institute of Technology (Atlanta, GA) in 1969, a Ph.D. in Chemistry (Nuclear and Radiochemistry) from Rensselaer Polytechnic Institute (Troy, NY) in 1972, and a M.S. Adm. (Administration of Science and Technology) from George Washington University (Washington, DC) in 1979.