Update on NIST Beta-Particle Dosimetry Standards and Calibrations

Christopher G. Soares
Ionizing Radiation Division
National Institute of Standards and Technology
Gaithersburg, MD 20899 USA

April 10, 2009

Standards Development

The medical-protocol ISO Working Group 22 within Technical Committee 85 (Nuclear Energy), Subcommittee 2 (Radiation Protection) has completed the standard ISO 21439 "Clinical Dosimetry - Beta Radiation Sources for Brachytherapy," Project leader C. Soares. C.G. Soares also chaired the ANSI working group revising ANSI/HPS N13.11, "Personnel Dosimetry Performance - Criteria for Testing," which is the basis for personal-dosimetry performance testing in the United States. The revision has been completed and the standard was approved and published in early 2009. Now in its fourth edition, this standard has been in place since 1983. Testing under this standard is administered by the National Voluntary Accreditation Program (NVLAP), and accreditation of dosimetry processors under this program is required by US Nuclear Regulatory Commission (NRC) regulations. The US Department of Energy (DOE) also maintains a testing program for its laboratories and contractors, administered by the Department of Energy Laboratory Accreditation Program (DOELAP). A focus in recent years has been the modification of ANSI/HPS N13.11 to allow acceptance by both testing programs in order to bring harmonization to US personal-dosimeter processing testing. The testing philosophy of ANSI N13.11 has always combined elements of type testing and routine performance testing, and is thus different from the testing philosophy used in the rest of the world.

Comparisons

NIST has participated in two bilateral comparisons with the PTB on beta-brachytherapy dosimetry. The first on dosimetry of ^{90}Sr/Y line sources was completed successfully in 2007 with agreement in measured absorbed dose rates of 4 %, which is within the uncertainties of both standards. The second, on planar ^{106}Ru/Rh sources, is ongoing.

Gel Dosimetry

An innovative polymer-gel scanning system has been developed by MGS Research, Inc., Madison, CT, and is being used at the NIST for high-resolution three-dimensional (3D) dose-distribution measurements. The system is capable of voxel resolutions of 0.1 mm in all dimensions and has been used to measure dose distributions from photon and beta-particle brachytherapy sources. A special very small field (1 cm × 1 cm) ^{60}Co gamma-ray beam has been characterized for gel calibrations, and measurements are planned for still more challenging sources, such as concave ophthalmic applicators. Results of gel measurements are being compared with measurements using small-volume ionization chambers, micro-scintillators, radiochromic film, and thin thermoluminescence dosimeters (TLDs). All of the latter are performed in a specially designed

water phantom with the detectors either in water or covered with minimal layers of water-equivalent plastic. Research with the optical scanner is now being focused on application to other imaging media, such as radiochromic plastics.

Radiochromic Film and Reader Research Program

Research into better methods for the use of color-photo document scanners for the readout of radiochromic film continues at the NIST. This research is coupled with the investigation of new radiochromic-film models currently being introduced. These include EBT and EBT2, as well as special single-emulsion films obtained from the manufacturer, which have minimal or no covering layer and which are suitable for contact or skin-dose measurements of beta particle sources. The increased sensitivity of the new film models have allowed their calibration with NIST protection-level beta-particle reference radiation beams, and comparisons of the response of the films to these beams with film calibrations carried out in water in the NIST ^{60}Co vertical beam facility have shown excellent results. Research into the detailed optical-density-scale calibration of the NIST color-photo scanner are in progress using a series of calibrated neutral-density filters.