NIST ^{60}Co Radiation-Processing Calibration Fields

Marc Desrosiers and James Puhl
Ionizing Radiation Division
National Institute of Standards and Technology
Gaithersburg, MD 20899 USA

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1. Excerpts from a notice to customers

For high-dose-rate irradiations and dosimeter calibrations, the Radiation Interactions & Dosimetry Group utilizes three ^{60}Co irradiators: an underwater source (referred to as the Pool source) and two Nordion Gammacell 220 sources (GC-45 and GC-232). The calibration history of these sources is described in Ref. 1. In this document, the Pool-source rates are listed as a historical reference. Calibrations in this source are done on request only; the last request was in 1996.

In 1996, NIST determined by direct measurement the absorbed-dose rates for all irradiation geometries used for calibrations in the high-dose-rate ^{60}Co irradiators. The goal was to establish a consistent set of standards among our high-dose-rate sources, all directly traceable to the NIST primary standard for absorbed dose in water for ^{60}Co gamma rays determined by water calorimetry. Since this earlier work, several significant advances in alanine dosimetry and in our experimental design made it possible to improve our realization of the absorbed-dose rate for gamma rays in water. The major improvements are listed below.

1995 – 1996	1999 – 2000
Used high-quality alanine dosimeters manufactured by NIST	Use Gamma Service alanine dosimeters, a new and improved high-accuracy/precision dosimeter
Used the scaling theorem to relate water calorimetry measurements to alanine in plastic	Irradiate alanine directly in a watertight holder in the water calorimetry apparatus
Used alanine dosimetry system procedures then accepted as the state-of-the-art[2]	Use newly developed alanine dosimetry procedures aimed at reducing environmental effects;[3,4,5] developed and built an EPR spectrometer reference device for unprecedented accuracy and precision[6]

In 2000, An internal reevaluation of the dose rates for NIST's radiation-processing (high-dose) calibration service ^{60}Co irradiators. These new dose rates are listed in Table 1. Table 1 gives the absorbed-dose rates for each calibration geometry and, where applicable, the percent change from the previous value. An additional benefit of this work is that the uncertainties associated with these new dose rates are significantly lower.

Table 1. NIST High-Dose ^{60}Co Calibration Facility Dose Rates for December 31, 1999

Gammacell 220-232		
Calibration Geometry	Dose Rate, kGy/h	Percent Adjusted
Alanine Vial	7.154	-1.8
Film Block	7.106	-1.2
Perspex Cup	6.985	-1.3
Ampoule Cup	6.915	-0.7

Gammacell 220-232 with stainless-steel dewar		
Calibration Geometry	Dose Rate, kGy/h	Percent Adjusted
Alanine Vial	6.972	-0.8
Film Block	6.935	-0.5
Perspex Cup	6.803	-0.2
Ampoule Cup	6.702	-0.7

Gammacell 220-45		
Calibration Geometry	Dose Rate, kGy/h	Percent Adjusted
Alanine Vial	2.161	-1.9
Film Block	2.147	-1.4
Perspex Cup	2.110	-1.6
Ampoule Cup	2.090	-1.1

F101 Pool Source		
Calibration Geometry	Dose Rate, kGy/h	Percent Adjusted
Alanine Vial	0.7869	0.0
Film Block	0.7788	-0.4
Perspex Cup	0.7721	-0.7
Ampoule Cup	0.7686	+0.2

2. Effects on previous comparison

In 1998, the BIPM organized a comparison of absorbed-dose standards for ^{60}Co high-dose irradiators at NIST, NPL, ENEA (Italy), NIM (China), PTB (Germany), IAEA and the BIPM. Results of the comparison at three high dose levels (5 kGy, 15 kGy, 30 kGy) were given in Ref. 7. Both NIST and NPL provided alanine dosimeters, and each performed analyses of the delivered dose based on their standards for absorbed dose to water. Although the results indicated agreement within combined uncertainties among the participants and demonstrated significant improvement compared to a previous comparison, the results also indicated a mean value of 1.015±0.002 for the ratio $D_{w,NIST}/D_{w,NPL}$. The recent reevaluation of our dose rates in 2000 effectively eliminated this discrepancy as noted by the –1.8 % change in the measured GC220-232 calibration field for alanine vials (Table 1). A comparison of NPL and NIST high-dose calibrating fields done in March 2000 with NPL alanine dosimeters indicates a value of 1.005±0.001 for the ratio $D_{w,NIST}/D_{w,NPL}$ in the NIST ampoule-cup geometry, in the range of absorbed dose to water of 5 kGy to 30 kGy.

References

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