Standardization of ^{55}Fe by Isothermal Microcalorimetry
(and its use for a NIST SRM calibration & in the BIPM intercomparison)

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The present work on the difficult-to-measure ^{55}Fe nuclide (low Z, 100 % EC decay) is a return by NIST to the use of calorimetry for primary radionuclidic standardizations. While calorimetry was a classical radionuclidic measurement method used by the NIST Radioactivity Group from the early 1950s through 1975 for primary standardizations, it was not used for the past 30 years or so. In the past 5 years, calorimetry was used by NIST to perform calibrations of brachytherapy sources of ^{32}P, ^{90}Sr, and ^{103}Pd.
A solid 30 GBq of ^{55}Fe was prepared and gravimetrically linked to an ^{55}Fe master solution. The source was used to obtain an accurately-determined power measurement using the NIST dual-cell isothermal calorimeter. The power measurements required many replicate trials of coupled baseline and inserted source determinations to obtain a precise average power value for the source. Thirteen independent trials (having a standard deviation of the mean of 0.25 %) were performed between August 2004 and May 2005. Joule-heating power calibrations of the calorimeter were performed for each trial. The power measurement was converted into an ^{55}Fe activity through the use of an average energy per decay that was derived by M.M. Bé. This activity was in turn be linked to the master solution, which had an assigned (k=1) uncertainty of 0.39 %.
The standardization of this primary solution was used for both the recent BIPM intercomparison and for a newly issued NIST ^{55}Fe Standard Reference Material (SRM). The assay for the BIPM intercomparison and for the SRM calibration was based exclusively on comparative LS measurements of composition-matched sources of the three solutions. The solutions were compared through 776 LS-based activity ratios, with variables that included: 3 different LS counters, 3 different scintillators, 44 cocktails, 4 distinct aqueous (+Fe) fractiuons; 2 NIST solution dilutions; 97 days of aging. The assigned (k=1) uncertainty on the massic activity for the BIPM solution was 0.68 %; whereas that for the SRM solution was 0.84 %.