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#1-224 Development of a possible secondary standard to determine the neutron emission rates from 252Cf and 241Am-Be calibration sources

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The Laboratory for micro-irradiation, neutron metrology and dosimetry (i.e. the LMDN from IRSN/Cadarache/France, close to Marseille) has two radioactive reference sources (241Am-Be and 252Cf) whose neutron emission rates have been determined using the Manganese bath method at LNE-LNHB (CEA/Saclay/France, close to Paris). These sources are the French metrological reference for neutron fluence and associated dosimetric quantity. The radioactive decay of these sources is assumed to be equal to the decay of the main actinide contribution (respectively the 241Am and 252Cf). However, the 252Cf source (t ½ = 2.645 years) contains Californium isotopes with generally 10%-15% of 250Cf (t ½ = 13.08 years) which has a significant spontaneous fission branch (0.077% compared with 3.092% for 252Cf). The contribution of 250Cf to the total neutron emission rate, negligible close to the production time, is no longer so after a few years. Therefore, according to the initial 252Cf/250Cf isotopic ratio, the age of the source and the time between manufacture and measurement by the Manganese bath method, it is necessary to apply a correction. This correction is increasingly important and difficult to follow as the source ages, especially as the contribution of the descendant of 252Cf (the 248Cm) ends up no longer being negligible. For this reason, ISO 8529 recommends recalibrating the 252Cf source every five years. Similarly, the ISO8529-1:2021 standard recommends recalibrating 241Am-Be (and 241Am-B) sources every five years. For the LMDN, recalibrating its sources would mean moving them over 1600 km. This requirement is cumbersome in practice, costly and means that the device is unavailable for several weeks. The LMDN is therefore working, with the help of the Paul Scherrer Institute (PSI Switzerland) and the National Physical Laboratory (NPL United Kingdom), on a dedicated device and an associated methodology that will make it possible to monitor, in situ and in relative, the evolution of the sources and thus determine the correction factor. This would make it possible to apply a correction and maintain metrological traceability. The primary objective of the study is to be able to determine experimentally the number of 250Cf and 252Cf nuclei in the source and thus avoid having to repeat several measurements over time. A method has been proposed and developed to meet this need. It is based on the use of 4 scintillators placed approximately at 1 meter from the source and at 90° one to the other. They will detect in coincidence mode neutrons and photons emitted. The scintillators will: identify the incident particle (neutron or photon), allow the energy deposited to be determined by calibration, and determine the reaction time in scintillator with an accuracy of better than 1 ns. Differences are known in the fission process between 252Cf and 250Cf, particularly the number of neutrons per fission, their directional probability and energies. Statistical variations in coincidence are therefore expected, according to the 252Cf or 250Cf spontaneous fission and the relative position of the detectors (at 90° or 180°). These differences can be predicted and estimated from a simulation of the fission process, which helps to determine experimental signatures of the spontaneous fission of 250Cf and 252Cf. Eventually, and once clearly identified, any equivalent set-up could be calibrated on already known 252Cf sources. Several experiments were carried out on seven 252Cf sources of different ages, from 40 years to a few years old. These experiments were carried out at LMDN, at PSI and at NPL. In particular, the source used for the CCRI(III)-K9.Cf.2016 intercomparison, with is about the measure of the total neutrons emission with the manganese bath device was also measured at NPL. This work is being carried out under the behalf of the French National Metrological Institute (NMI, the "LNE"), which has designated the LMDN as the French reference laboratory for the determination of neutron fluence and associated dosimetric quantities. The presentation will present: the 252Cf sources status, the measurement device as well as the first results of the inter-source comparison. The calculation scheme used to estimate the experimental differences will also be presented. Finally, the qualification of an operational system as a secondary standard will also be discussed.

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