Development and adoption of new reference neutron fields within the U.S. radiation protection framework

A.V. Mozhayev and R.K. Piper

Pacific Northwest National Laboratory, Richland, WA, 99354

The radionuclide Californium-252 (^{252}Cf) has been broadly relied upon as a neutron reference source for radiation protection applications because of its high specific activity and the most accurately evaluated energy spectrum. The point-like source is typically used in two standardized configurations: unmoderated, to yield a fission energy spectrum, or placed within a heavy-water moderating sphere to produce a softened spectrum that is deemed more appropriate for evaluating dosimetry used in nuclear power plant work environments. These two reference fields have been dominantly used for personal dosimetry proficiency testing in the U.S.

The discontinuation of federal funding for ^{252}Cf production escalated the cost of its resourcing and distribution since 2012 and made the acquisition of high-intensity [$>10^9$ s^{-1}] sources challenging. On the other hand, compact neutron generators, based on deuterium-tritium (DT) and deuterium-deuterium (DD) fusion reactions, became economically competitive in recent years, with their yields rivaling intense ^{252}Cf sources. While discrete narrow energy fields produced by the fusion reactions are recognized internationally as important calibration and test standards, by complementing these neutron generators with specifically designed convertors, the energy profile of neutrons may be shaped to simulate broad energy fields found in the nuclear workplace. Several such configurations had been developed and internationally adopted as reference fields; however, these spectrum shaping approaches have not yet been implemented in the U.S.

This presentation reviews some of the efforts the authors made over the last decade in developing various concepts of shaping assemblies used in tandem with DT generators to surrogate the ^{252}Cf-based reference fields. One of the concepts to produce a fission-like neutron spectrum has been adapted, constructed, and tested. The practical application of the produced neutron field was assessed by examining the response of various health physics instruments and personal monitoring devices in comparison to the response of those devices when exposed to ^{252}Cf. The results of the initial field demonstration, further investigation needed and application challenges are presented.