Integral neutron kerma coefficient ratios for Silicon, Iron, and Oxygen to Carbon on the energy range from 15 to 30 MeV

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Kerma coefficient ratios are reported for carbon to oxygen, silicon, and iron in the energy range of 14.5 to 27.3 MeV. The determination was done by measuring dose to the gas of proportional counters exposed to a well-characterized neutron field. The measured dose in the proportional counter gas was then converted to dose in the proportional counter wall material applying Bragg-Gray theory. The proportional counters were made of the material of interest. The oxygen measurement was done by irradiating simultaneously zirconium and zirconium oxide proportional counters and substracting the dose to the zirconium from the zirconium oxide.

Neutrons were generated with the UW Tandem Accelerator. The reaction 3H(d, n)4He provided our neutron source, which consisted of monoenergetic neutrons. Neutrons spectra measurements were carried out for the 27.3 MeV neutron energy. This was necessary because of the presence of contaminating breakup neutrons at this energy. The spectra were measured with a pulsed beam time-of-flight spectrometer and a NE-213 liquid scintillator.

The dose conversion factor r is reported for carbon, oxygen, silicon, iron, zirconium, and zirconium oxide relative to TE-propane gas to neutron energies of 20, 23, and 27 MeV. The factor r, which relates the dose to the gas to that of the proportional counter through the Bragg-Gray theory, was calculated from angle integrated differential cross section. This required a calculation of the initial energy spectra as well as the differential secondary charged particle energy spectra and for the first time a complete treatment of all heavy ions as considered. Furthermore, as the condition required to apply the Bragg-Gray theory are difficult to satisfy (infinitesimal cavity), we report the calculation of the dose conversion factor r for the finite cavity case for carbon/TE-gas in order to test the validity of the application of the theory to this type of applications. We found that the two conditions of the Bragg-Gray theory are violated: the differential secondary charged particle spectrum is perturbed by the presence of the cavity and that the dose absorbed in the cavity is not entirely deposited by the particles crossing it. However, these changes in the spectra and the dose deposition are not very sensitive to the conversion factor r because this factor only reflects the ratio of these changes. Our results are found to be in agreement, within the uncertainty associated to the determination, with the previous published values when comparable data exits.