Neutron Kerma Factor Measurements in the 25-MeV to 88-MeV Neutron Energy Range

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The interaction of neutron in matter proceeds in a two-step process comprising first the transfer of neutron kinetic energy to charged particles, and second the deposition of that energy as the ions come to rest. Kerma and absorbed dose describe these processes, respectively , and are used to model the response of systems to neutron irradiation. The kerma factor is defined as the kerma per neutron fluence.

Kerma factors were measured between 25 and 85-MeV neutron energy for oxygen, magnesium, silicon and iron. Microdosimetric spectra and absorbed doses were measured with low-pressure proportional counters. Calculated gas-to-wall absorbed dose conversion factors were used to deduce absorbed doses in the walls, which are approximately equal to kerma. The oxygen kerma factor values were deduced from spectra measured with matched pairs of Zr and Zr02 proportional counters, including a newly constructed matched pair of the Rossi-type. Absorbed dose in an A-150 plastic proportional counter was measured as a function of neutron energy at six depths inside a water phantom, ranging from 70 to 360 mm.

The Los Alamos National Laboratory -- Weapon Neutrons Research (WNR) Facility's broad-spectrum pulsed neutron source was used for the magnesium, silicon, iron and A-150 measurements. In order to extract kerma and absorbed dose as functions of neutron energy, those measurements were made with time-of-flight (TOF) techniques. A fission chamber was used to measure the neutron spectral fluences.

The oxygen kerma measurements were made without TOF in the pseudo-monoenergetic neutron beams at the Paul Scherrer Institute (PSI) in the range of 34 to 66-MeV nominal neutron energy, and include kerma from contaminating low-energy neutrons. The nominal-energies kerma factor values were iteratively deduced by comparison of the total measured kerma values with calculated kerma values. The latter were based on spectral fluence measurements, kerma factor values from the literature at neutron energies below 20 MeV, and a cubic-spline fit to trial values at 30 and 100 MeV. Neutron spectral fluences were deduced from measurements made with a proton recoil telescope, an NE213 scintillator and a Bonner sphere spectrometer.