The results of computational studies of the effect of the building materials used in ING-031, -06 pulsed neutron generators, produced by the Dukhov All-Russia Research Institute of Automatics, on the properties of the neutron and photon fields in the air near them are presented. The studies showed that in the real structures of the generators both the angular and energy distributions of the neutrons and photons change considerably. An isotropic angular distribution of the neutrons emanating from the target becomes anisotropic. Low-energy neutrons, which are not present in a pure target with no structural elements, appear in the energy distribution of the neutrons leaving the surface of the generator. The energy range extends to the thermal region. High-energy photons from inelastic scattering and radiative capture, which are absent in pure targets, appear as a result of the interaction of the neutrons with the structural elements. The building elements in a pulse generator distort the shape of the neutron pulse because of the appearance of moderated neutrons. The regularities found must be taken into account when solving practical problems arising with the use of neutron generators.

Neutron generators as sources of intense neutron radiation are widely used in science and technology. The manufacture of portable pulsed neutron generators expands their range of application even more. It is customarily assumed that the generators emit neutrons in a narrow energy range near 2.5 and 14.7 MeV, depending on the reaction used to obtain them (D, D) or (D, T), and isotropically from the point where the deuteron beam strikes the target. However, the target in any generator is surrounded by different building materials, which can scatter and absorb the neutrons passing through them. As a result, the angular and energy distributions of the neutrons change and secondary photon radiation is produced, which is accompanied by a change of the shape of the pulse of neutrons and photons.

The effect of the building materials used in ING-031, -06 portable neutron generators, produced by the Dukhov All-Russia Research Institute of Automatics, on the characteristics of the field of neutrons and photons near them is studied in the present work. The time and energy distributions of the flux density of neutrons and secondary photons were calculated in the real three-dimensional geometry by the Monte Carlo method using the MCNP-4c2 code taking account of the different building materials near the target, including oil, ceramic, steel, glass textolite, and others [1].

Disk-shaped tritium targets with radius 3.1 cm and 0.5 cm in ING-031 and ING-06 generators, respectively, and with tritium-to-titanium nuclei ratio 1.5 are irradiated with 95 and 85 keV neutron beams, respectively. The deuteron beam is...
directed parallel to the axis of the generator and perpendicular to the target plane. The azimuthal (angle $\theta$) and energy distributions of the neutrons emitted by the target for the MCNP code were obtained by preliminary kinematic calculations for a point target; the distribution over the polar angle was assumed to be equiprobable in the range $0–180^\circ$. Neutron emission from the surface of the target was assumed to be uniform and equal to one neutron from the entire surface. The results in Fig. 1 are renormalized to the real yield of the generators.

The energy and time distributions of the flux density of neutrons and secondary photons were calculated on the basis of a local estimate of the flux at different points in air 1 m from the center of the target at different angles $\theta$ relative to the direction of the primary deuteron beam. The calculations for a generator in a stationary operational state were performed in the range $0–180^\circ$ with step $15^\circ$ and at $0$, $90$, and $180^\circ$ for the pulsed regime. The ENDF/BVI.6 constants library was used in the calculations.

The spectrum of neutrons ranging in energy from thermal to 15 MeV was divided into separate energy groups, specially separating neutrons whose energy corresponds to the neutrons emitted by the generator target (13–15 MeV), and neutrons moderated by the building-material elements: fast neutrons with energy below the energy of the target neutrons (1–13 meV), intermediate energy from 0.46 eV to 1 MeV, and thermal neutrons – below 0.46 eV. For the most part, the statistical error of the computational results for neutrons and photons did not exceed 3 and 5%, respectively.