Neutron field shaper

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When calibrating neutron radiometers and dosimeters according to Draft Standard ***ISO***-8529 in the free geometry a number of difficulties connected with a contribution of scattered radiation emerge. Most of the neutron detectors, e.g. of the Bonner sphere type, along with their own merits have a distinguishing disadvantage inherent in them - high sensitivity to scattered radiation (in some cases higher than to direct radiation). So, in particular, when calibrating detectors of high efficiency against neutron radiation in the "free" geometry a response caused by the scattered radiation can be three - five times higher than the response due to the direct radiation as our experiment shows.

In Russia setups with a collimated neutron beam (UKPN) are being used for almost thirty years.

The main part of the setup is a cylindrical protective container with a diameter and a high of 500 mm. The container is made of high pressure polyethylene with addition of amorphous pure boron. The outside of the container is covered with a cadmium layer 1 mm think. There is a hall 300 mm in diameter in the container wherein a shaper of special design for shaping a field of thermal or fast neutrons can be inserted. A special arrangement allows to fix a radionuclide neutron source at the center of the field shaper. Since the shaper is surrounded by shielding on all sides neutron scattering from floor, ceiling and walls decreases rapidly. By comparison Table 1 shows ratio values of the neutron fluence of the scattered radiation to the neutron fluence of the direct radiation. These ratio values have been obtained at the VNIIM`s laboratory room measuring 4×4×6 m^3 at a distance of 1 m from the ^{252}***?f*** source using a spherical detector 160 mm in diameter (BS-160) and a flat high-effective detector (SRPS) in the "free" geometry and in the field of UKPN.

Table 1

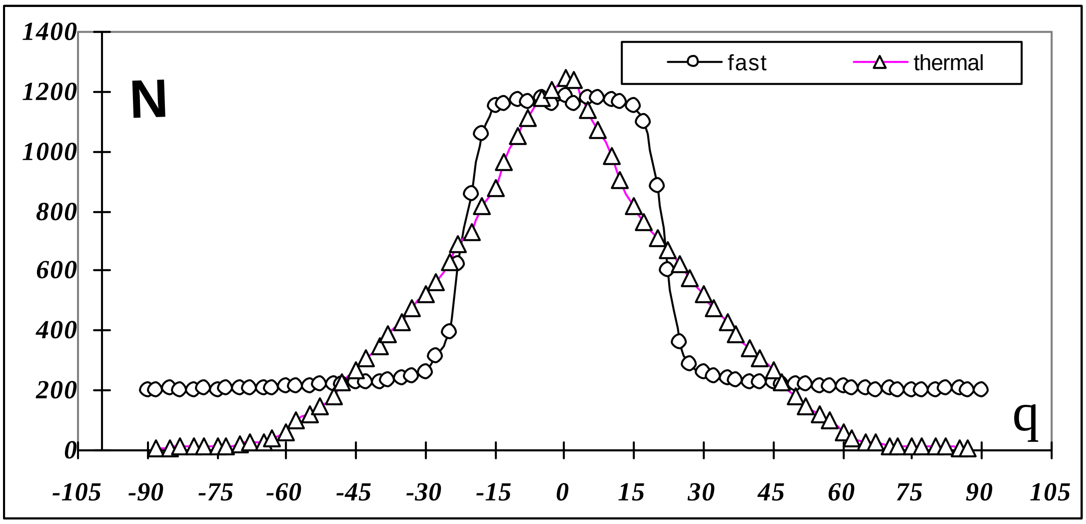
Type of detector	$(N_{scattered}/N_{direct})\cdot 100\%$	
	"free" geometry	UKPN
BS-160	48	4.3
SRPS	85	5.5

Table 2 shows values of the neutron fluence of fast and thermal (subcadmium) neutrons produced by the Pu-Be source in the polyethylene sphere 160 mm in diameter and UKPN at a distance of 1 m relative to the neutron fluence produced by the Pu-Be source in the "free" geometry.

Table 2

Neutron fluence			
"Fast", "free" geometry	"Fast", UKPN	"Thermal", source in ? ?$_2$-sphere ∅ 160 mm	"Thermal", UKPN
1	1.4	0.11	0.45

Fast neutron fluence in a direct beam increases relative to the neutron fluence in the “free” geometry by 30 - 40 % depending on a type of a radionuclide source in use. In this case the mean neutron energy decreases by 10 - 20 %. The neutron fluence of thermal (subcadmium) neutrons in a direct beam is ~ 45 % of the fast neutron fluence produced by this source in the “free” geometry. A beam profile of fast and thermal neutrons is shown in figure.



Thermal neutron fields were investigated with usage of indium and gold activation detectors, for investigation of fast neutron fields a radiometer of a type of a long-counter was applied.

Calibration procedure for neutron radiometers and dosimeters with usage of the UKPN Type facility is following. In the certification of a facility field the neutron fluence at the fixed point and a relative contribution from scattered neutrons are determined for each type of the facilities. To define the response of a device of the known type it will suffice to locate it in the position with the neutron fluence known in advance, to multiply readies of the detector by the coefficient taking account scattered radiation contribution and to devoid into the neutron fluence value.