Application of Low Pressure Tissue Equivalent Proportional counter for IHEP Radiation Protection

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Radiation behind shields of high energy charge particles accelerators (for example, the IHEP 70 GeV proton synchrotron (U-70)) is of a mixed composition. The major component of radiation is high energy neutrons with energy above 20 MeV. The dose equivalent measurement of high energy neutrons is a difficult problem for the radiation protection dosimetry, because there are no standard devices for this energy region. Now only a measurement method on the base of low-pressure tissue equivalent proportional counter (TEPC) is used as universal in mixed radiation fields. This dosimetric method has more than 20 year history of application at the IHEP accelerator. The method has been improved in measurements, the counter design and application. The linear energy transfer (LET) spectrometer (SLET-03) on the base of TEPC[1] is used for metrological measurements in IHEP radiation protection.

The spherical tissue equivalent proportional counter has been developed in collaboration with the Institute of Biophysics (Moscow) [2] .The TEPC energy response for neutrons and photons is dependent on the counter design (the thickness and the composition of the counter body, the thickness of the aluminum cover). The dependence of TEPC neutron energy response on the counter design has been shown in [2], [4]. The photon energy response of TEPC in the energy range from 29 to 114 keV has been investigated by the National Secondary Standard Field of absorbed dose (VNIIFTRI) [3].

The energy responses has been calculated for neutrons from 0.01 to 800 MeV [4] , [2]. The TEPC energy response agrees closely with H*(10) in the neutron energy range for 0.3 MeV to 800 MeV. The TEPC response is less than H*(10) function for neutron below 0.3 MeV. Table reflects the TEPC measurements results over the ones obtained with other dosimeters. There is the normalization with the TEPC data and the normalization with the expert data for the IHEP reference fields.

Irradiation fields	Dosimeters	Neutron Dose equivalent, rel.units	Photon and charged particles dose equivalent, rel. units
Radiation field behind the top of the IHEP proton accelerator. The average neutron energy is equal to 71 MeV.	TEPC	1.0	1.0
	ACR	0.60	1.12
The radiation fields behind the iron calorimeter . The average neutron energy is 51 MeV.	TEPC	1.0	1.0
	ACR	0.36	0.98
Pu-Be source (IHEP reference field)	TEPC	1.0	1.01
	ACB	1.0	0.83
	BS	0.99	-
The IHEP reference fields based on the ^{252}Cf neutron source.	TEPC	0.95	0.90
	ACB	0.99	0.80
	BS	1.06	----
The reference field based on the ^{252} Cf neutron source in the 30 cm diameter spherical iron moderator.	TEPC	1.00	0.80
	ACR	0.75	0.0
	BS	0.99	---
The reference field based on the ^{252}Cf neutron source in the 30 cm diameter spherical polyethene moderator.	TEPC	0.95	1.07
	ACR	1.63	0.99
	BS	1.04	---

The comparison was carried out with the following dosimetric systems :

The analog component remmeter (ACR) [1], that includes an argon-filled ionization chamber, tissue-equivalent chamber, ^{3} He-filled ionization chamber into the 25.4 cm diameter spherical polyethylene moderator. To minimize the neutron dose equivalent measurement systematic error, the correction method based on additional information about a behavior of the ionization chamber neutron response in different neutron spectra is applied. The Bonner multisphere neutron spectrometer (the dose equivalent measurement method by 6-spheres has been certified by VNIIM)[5].

The photon dose equivalent data carried out by TEPC are not significant as compared with those measured with other dosimeters. The comparative results show that the TEPC data are systematically lower than those of the Bonner spectrometer within 20 % .The systematic error of neutron dose equivalent measurement may be reduced with a correction factor ,when the average spectra neutron energy is less than 0.5 MeV. The correction factor may be obtained by a procedure based on neutron energy dependence of the ratio of neutron response of TEPC to neutron response of another detector [6].

The application of TEPC for IHEP radiation protection dosimetry showed that one may be successful in a variety of radiation fields of a high energy accelerator.

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