Dose response of PADC neutron dosimeters used at L.N.L. for personal monitoring

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Personal monitoring plays an important role in the concept of protection against occupational exposure by external radiation. Its primary function is providing information on exposures of individuals to ionizing radiation. Enables control of exposure in order to make sure that exposure limits are not exceeded and support measures for reduction of exposures even far below these limits.

In 1996 the new Italian radiation protection law imposed new reduced limits for occupational and public exposure. The dose limit for occupational exposure has been reduced to 20 mSv/year averaged over 5 years with a maximum of 50 mSv within one year. 20 mSv received by continuous occupational exposure during 12 months would result in a mean dose per month of about 1.7 mSv. An individual dosemeter which is used monthly recording of doses should be able to register at least about 10% of this dose. Such new limits increase the demands made on personal monitoring.

For neutron personal monitoring at the L.N.L. the poly-allyl-diglycol-carbonate (PADC) dosimeter is used (1). The dosemeters are supplied every 8 weeks by the National Radiological Protection Board (NRPB), UK. The PADC is a passive device for the detection of thermal, epithermal and fast neutrons, able to give neutron radiation personal dose equivalent at a depth of 10 mm; it is insensitive to other radiations (gamma, X, betas and alphas), has a low radon sensitivity, is relatively unaffected by environmental factors such as heat and humidity.

To test the reliability of such a type of dosimeter, we periodically carried out a "blind" test consisting in irradiating a certain number of the dosemeters at the L.N.L. facilities with known doses and returned them for reading at the NRPB. For the irradiation experiments a 100 mCi Am-Be source and the neutron facility (2) set up at the CN 7 MV Van de Graaff Accelerator of the INFN-Laboratori Nazionali di Legnaro were used.

During 1996, 151 dosemeters have been irradiated. In particular, 39 of them have been irradiated with 0.570 MeV neutrons, 43 with 2.120 MeV neutrons and 53 with 4.034 MeV neutrons. The monoenergetic neutrons were produced by using the $^7\text{Li}(p,n)^7\text{Be}$ reaction. Dosimeters were located at 32 cm from the target and at $0^\circ$ with respect to the direction of the beam in such a condition that the neutron field can be considered homogeneous. In addition 12 dosimeters were irradiated using the 100 mCi Am-Be source. The range of doses given in all situations was between 0.2 and 1 mSv.

Figures 1,2,3,4 and 5 report the interpolation curves of the doses given vs. read dose (as furnished by NRPB). Each data point, reported in the graphs, is the mean of all the dosimeters irradiated for a given dose and energy.
Figs. 1, 2, 3. Read dose vs. given dose for neutrons of energy 4.034 MeV, 2.120 MeV and 0.570 MeV (each data point is the mean of at least 8 independent irradiations).

Fig. 4. Comparison of the interpolated curves of figs. 1, 2 and 3.

Fig. 5. Read dose vs. given dose for neutrons of an Am-Be source (each data point is the mean of 4 irradiations).

Fig. 6. 34 dosemeters irradiated with low doses (0.2 mSv) and by different neutron energy.

The PADC dosimeter when irradiated with the choosen monoenergetic neutrons, at the already described conditions, overread the given dose, while the responses are in good agreement with the given doses when the Am-Be source is used for the irradiations. In low doses (i.e. 0.20 mSv), and independently from the energy of the incoming neutrons, the dosimeter response results satisfactory (see fig. 6). Further experiments and in different conditions are planned.

References