

A PRELIMINARY NOTE ON THE RADIOACTIVITY OF WRIST WATCHES WITH LUMINOUS DIALS

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ABSTRACT

The activities of 25 wrist watches with luminous dials were experimentally measured. The mean gamma activity was 0.075 microcurie radium equivalent. Under certain simplifying assumptions the radiation dose to the gonads was calculated. The dose is not likely to exceed about 5 milliroentgens per year in the majority of cases.

The beta and gamma activities of 25 wrist watches with luminous dials were measured using an end-window Geiger counter. The gamma activity was measured by keeping the painted dial face away from the counter; the absorption of the gamma rays by the material of the watch to the rear of the painted face was separately measured. The gamma activities were calibrated against a standard 10-microcurie radium source. The minimum, mean, and maximum gamma activities of the watches tested, expressed in microcuries of radium equivalent, were 0.007, 0.075 and 0.47 respectively. Fifty per cent of the values occurred between 0.014 and 0.085 microcurie radium equivalent. (The absolute microcurie activities are obtained by multiplying the above figures by 2.1, if it is assumed that each disintegration of radium in equilibrium with its daughter products is accompanied by 2.1 quanta, from *RaB* and *RaC*)

The beta activities were measured with the painted dial facing the end window of the counter, and were calibrated against a standard cobalt-60 beta source. The observed minimum, mean, and maximum activities (uncorrected for absorption by the mica or glass cover on the front face of the wrist watch) were 0.006, 0.078 and 0.29 microcurie respectively.

Calculation of the gonad dose

A rough indication of the gonad dose may be obtained under certain simplifying assumptions. First it is assumed that the material of the luminous paint in the dial is radium-226. [In certain cases there may be some amounts of mesothorium (*Ra 228*) also.] Now the gamma ray spectrum from radium and its daughter products is quite complex. But except for *Ra B* and *Ra C*, the energies of the gamma rays are low and the radiation is easily absorbed; further the number of gamma ray quanta per primary disintegration is also small in these cases. Thus it is sufficiently accurate for our purpose to consider only the gamma rays from *Ra B* and *Ra C*. The mean gamma energy from *Ra B* and *Ra C*, weighted for the relative numbers of quanta in the different energies, may be taken as 0.87 mev. The usual expression for the dose rate at a distance d cm in air from a point source of 1 microcurie of radium in equilibrium with its daughter products and shielded with 0.5 mm

platinum (this essentially cuts out all gamma rays except those from *RaB* and *RaC*) is given by $\frac{8.4 \times 10^{-3}}{d^2}$ roentgens per hour. Even though the dial is not a point source we shall assume that the above expression can be applied in this case also. To account for the absorption by the material of the body intervening between the watch and the gonads, taken here to be 25 cm distant, it is assumed that the relevant absorption coefficient is 0.076 cm^{-1} (which is the value of the absorption coefficient in water for 0.87 mev gamma rays). A build-up factor of 4 is also taken. (The build-up factor at a distance of 25 cm for a point isotropic source in an infinite medium of water for 0.87 mev gamma rays is 4. The infinite medium assumption is a crude approximation in the present case). Further it is assumed that the watch is worn 12 hours per day, that the hands are in the normal resting position and that the dial faces the gonads. (If the watch is worn with the painted face away from the body, the dose will be reduced by about 50 per cent, because of the attenuation by the material of the watch to the rear of the painted face and by about 4 cm of the wrist).

Under these conditions the gonad dose per microcurie of radium in the dial is given by

$$\frac{8.4 \times 10^{-3}}{25 \times 25} \times \exp.(-25 \times 0.076) \times 4 \times 12 \times 365 \times 10^3$$

milliroentgens per year or 35 milliroentgens per year.

The average gonad dose from a wrist watch with luminous dial would thus be 0.075×35 or 2.6 milliroentgens per year, while the maximum (among the watches tested) would be 0.49×35 or 17 milliroentgens per year. The average dose is seen to be of the order of 2 per cent of the natural background radiation dose of 100—150 milliroentgens per year.

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