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MORE ON THE PROBLEM OF ROENTGEN DEFINITION

By

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1. In his article "On the Definition of the Roentgen," Prof. P. M. Tikhodeyev acknowledges that the internationally adopted decisions of 1953 in respect of the roentgen "were imperfect". This--as P. M. Tikhodeyev puts it--has lead to a situation where "while it was clear from the conditions of measurement that the roentgen was established for surface density of X and gamma radiant energies... the roentgen (nevertheless) could also be applied as a unit of energy." And further: "The text of the 1953 ICRU recommendations defines the quantity for which the roentgen was established so clearly that varying interpretations of the roentgen designation are now excluded."

I fully agree that the international agreements concerning the roentgen were imperfect. Moreover, they remain imperfect up to the present time. This is precisely what was stated in my article. These imperfections lead P. M. Tikhodeyev to an erroneous interpretation of the roentgen as a measure of incident energy of X and gamma rays ("surface density of X and gamma radiant energies" according to P. M. Tikhodeyev's terminology). The invalidity of this viewpoint was demonstrated in my article and should be clear to any physicist. The formation of ions in any volume is related to the energy absorbed in this or the adjacent volumes, and not to incident energy. Ions are forming in the air only if there is energy absorption. In my article it was shown, on the basis of an example with X-rays and wave-lengths $\lambda = 0.20$ Å and $\lambda = 1.0$ Å, that with the same amount of energy absorption, corresponding to one roentgen, the intensity of incident rays with said wave-lengths will differ more than 15 times! Should these calculations be made for monochromatic X-rays with wave-lengths $\lambda = 1$ Å and $\lambda = 0.004$ Å, then with the same amount of energy absorption, corresponding to one roentgen, the intensity of incident rays ("surface densities of the energies of these rays" after P. M. Tikhodeyev's terminology) would differ by more than 130 times!

Is it possible then to continue to argue that the roentgen serves as a measure of the intensity of incident X and gamma rays?

Only one clear-cut answer can result from the examples cited and that is no. This is acknowledged by all Soviet dosimetrists (see the works of Prof. K. K. Algintzev, I. V. Poroikov, and others).

Moreover, one of the participants of the preliminary discussions of the international recommendations of 1953 has already recognized the inadequacy of the roentgen interpretation as a unit of incident energy (see A. Somerwil, British Journal of Radiology, Vol. XXVII, No. 319, p. 412).

As to the introduction of the rad unit, which P. M. Tikhodeyev proposes on the heels of the ICRU recommendations, it should be clear that the introduction of any unit of measurement must be justified by practical need. So far there are no apparatuses for measurement of radiation energies in ergs. When such equipment is created, there would no longer be any need for the introduction of the rad. The more commonly accepted erg would satisfy everybody.

Hence the introduction of the rad is impracticable and I ignored this unit in my article.

I would also mention that I am in complete agreement with P. M. Tikhodeyev that "it is impossible first to select a unit (or just only a name) and then begin to consider the question what quantity should it be applied to." But this I have never suggested, nor do I suggest this now. Consequently, this remark has nothing to do at all with my article.

The other questions raised in Prof. P. M. Tikhodeyev's letter were dealt with in my article and it is not deemed opportune to revise them again.

In conclusion it should be noted that--as was mentioned in my article-- the definition of the roentgen was formulated by the Coordinate Committee of the MAUSRI under the chairmanship of Academician P. I. Lukirski. Professors K. K. Aglintzev, I. V. Poroikov, V. I. Feoktistov, G. V. Gorshkov, and Candidates of Sciences V. A. Petrov, F. M. Karavayev, and M. F. Yudin took part in the work of the Committee.

2. In the article "On the Shortcomings of the New Definition of the Roentgen," V. I. Ivanoc does not object either to the new concept of radiation dose, nor to the definition of the roentgen suggested for the proposed new All-Union State Standard.

He only suggests the addition of the definition of the roentgen of a statement to the effect that conditions should be created to assure complete utilization of the energy of secondary electrons in reproducing the roentgen. Although in reproducing, the roentgen conditions must be created to insure full utilization of the energy of secondary electrons, it still is believed that the appending of such a statement to the definition of the roentgen is uncalled for. The All-Union State Standard of Units of Measurement should define the dimensions of the units. It is not at all obligatory for the standard to give a description of the conditions for a precise reproduction of some or any unit (see, for instance, the project of the All-Union State Standard for "Electric and Magnetic Units"). As a matter of fact this is precisely the defect of the 1928 definition of the roentgen. A return to this long-since-past stage of roentgenmetrology would require stipulations that in reproducing the roentgen--in addition to complete utilization of secondary electrons' energy in the ionization chamber--measures should also be taken to assure conditions for measurement of the saturation current, precise determination of the magnitude of the measuring volume, and a number of other requirements. This the author of the article, however, fails to specify. This suggestion of the author can, therefore, not be accepted.

The author's proposal concerning the delineation of the application limits of the given roentgen definition is correct. It was clearly stated in my article in the No. 1 issue of Izmeritel'naya Tekhnika of 1955 that the roentgen can be applied for measurement of doses produced by that radiation, for which the average work of ionization can be estimated as equal to 33 eV.

Extensive reference material on this matter can be found in literature. On the basis of this literature it can be assumed that for radiations with quantum energy up to 3 MeV the average work of ionization is constant and equal to 33 eV with an error not exceeding 10%.

In view of this, in approving the All-Union State Standard a statement should be made, in line with the 1953 ICRU recommendations, to the effect that the roentgen can be applied for measuring radiations with quantum energy not exceeding 3 MeV.