Refinement of Technique for Monitoring Radiation Safety of X-Ray Diagnostic Apparatuses

E. B. Kozlovskii

Sanitation regulations SanPiN 2.6.1.1192-03 "Hygienic Requirements for Structure and Use of X-Ray Departments, Apparatuses, and X-Ray Examination" determine radiation monitoring of X-ray apparatuses. According to Table 4.2 of SanPiN, allowable dose power (ADP) in the workplace of group A personnel is 13 $\mu\text{Gy/h}$.

According to SanPiN (Appendix 11), ADP in the workplace of personnel should be regularly monitored. Measured ADP value is normalized to standard working radiation load of the X-ray apparatus (Table 4.1):

$$D_n = D_u \cdot W / (1800 \cdot I_u), \quad (1)$$

where D_n is dose power normalized to standard working radiation load of the X-ray apparatus, $\mu\text{Gy/h}$; D_u is measured dose power under given conditions, $\mu\text{Gy/h}$; W is working radiation load (Table 4.1), (mA·min)/week; 1800 is group A personnel working time, min/week; I_u is anode current during measurement, mA. Eq. (1) is taken from SanPiN (Eq. from appendix 11, p. 12).

The SanPiN method for radiation monitoring of X-ray apparatuses implies dose power monitoring. For photographic X-ray apparatuses this requires adequate X-ray dosimeters. In case of short exposure time (~ 1 msec) conventional dosimeters introduce significant error in measured dose power. In addition, it is rather difficult to measure anode current I_u (necessary to calculate D_n) in photographic X-ray mode.

The history of dose power measurement in radiation control dates back to the first stages of development of domestic X-ray apparatuses. The first domestic X-ray analog apparatuses (DRGZ) were able to measure X-ray dose power rather than dose. Radiation safety control in domestic X-ray chest survey units F-1 and 12F7 was implemented in dosimetric mode (photographic working mode of X-ray chest survey unit at anode current 2 mA).

In my opinion, the method of dose power monitoring suggested in SanPiN 2.6.1.1192-03 should be com-

bined with X-ray dose measurement under standard conditions suggested in SanPiN.

X-Ray apparatuses measure electricity Q_{meas} (mA·sec), whereas exposure is performed under conditions specified in SanPiN (Appendix 12); scattered radiation dose R_{meas} (μGy) is measured in personnel's workplace.

Electricity Q_{meas} is set large enough to minimize dosimeter error. Electricity Q_{meas} should be at mid-range of given X-ray apparatuses.

Given weekly radiation load W specified in SanPiN, total radiation dose per week for given X-ray apparatuses is:

$$R_{week} (\mu\text{Gy/week}) = \frac{W (\text{mA} \cdot \text{min/week})}{Q_{meas} (\text{mA} \cdot \text{sec}) / 60 (\text{sec/min})} \times R_{meas} (\mu\text{Gy}).$$

Dose power reduced to 1 h is:

$$\begin{aligned} D_n (\mu\text{Gy/h}) &= \frac{R_{week} (\mu\text{Gy/week})}{t_{week} = 30 (\text{h/week})} = \\ &= \frac{W (\text{mA} \cdot \text{min/week}) \cdot R_{meas} (\mu\text{Gy}) \cdot 60 (\text{sec/min})}{Q_{meas} (\text{mA} \cdot \text{sec}) \cdot 30 (\text{h/week})}. \end{aligned}$$

Simple recast gives:

$$D_n (\mu\text{Gy/h}) = \frac{2 [\text{sec} \cdot \text{week} / (\text{min/h})] \cdot W (\text{mA} \cdot \text{min/week}) \cdot R_{meas} (\mu\text{Gy})}{Q_{meas} (\text{mA} \cdot \text{sec})},$$

where R_{meas} is dose measured during measurement of electricity Q_{meas} .

All symbols in this equation are consistent with SanPiN.

The values substituted in Eq. (2) should be observed exactly: measured dose should be in μGy (1 $\mu\text{Gy} = 114 \mu\text{R}$); electricity should be in mA·sec.

Dose power D_n calculated from Eq. (2) should be supplemented with radiation safety determination according to SanPiN method.

All-Russian Scientific-Research Institute for Medical Instrument Engineering, Moscow, Russia; E-mail: vniiimt@comail.ru