§8. Training in Laboratory Measurements for New Radiation Workers Using Potassium Chloride Radiation Sources

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Radiation sources were fabricated from potassium chloride chemicals that contained naturally occurring potassium-40 radioisotopes. Thus fabricated radiation sources were applied to giving new workers training in laboratory measurements in courses on radiation protection. The training involved four measurements to evaluate background radiation, dependence on time, dependence on distance, and dependence on shielding effects.

The first training given to student was the measurements to evaluate background radiation. After measurements had started, the counts integrated from the start to the end of the 5-min period were read out at one minute intervals from the GM survey meter. The counts read out were the total amounts of background radiation detected by the GM survey meter for 1, 2, 3, 4, and up to 5 min. Students can directly feel the existence of natural radiation through the first measurement.

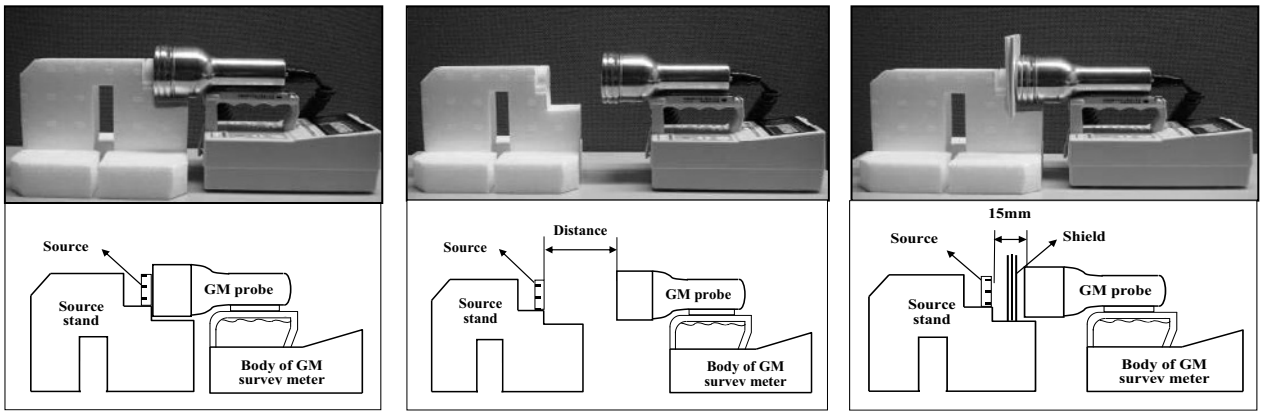
The second measurement was aimed at making students understand that the integrated radiation count was linearly proportional to the integration time, which was the period from the start to the end of measurements. Students in the second measurements used the sources first. The measurement setup is shown in Fig. 1(A). The measurement setup contained a source, source stand, and body of the GM survey meter. The source was used by placing it on the source stand. The GM probe was placed on the body of the GM survey meter in the opposite direction for convenience. The GM survey meter was also positioned so that the source was directly attached at the center of the surface of the GM probe. The GM survey meter was used as a counter for radiation integration throughout the training. The time to integrate the radiation counts was 5 min, and these were read out from the start up to the end of the 5-min period every minute.

The third measurements were done to enable students to understand that the dependence of radiation count on distance could be explained by the inverse-square law. The measurement setup is presented in Fig. 1 (B). The source was placed on a specific position on the source stand and the inside distance between the source and the GM probe ranged from 0 to 30 cm, being zero when the source was placed directly on the surface of the GM probe. The integration time of radiation was set to 1-min and it was measured at these distances.

The last measurement was done using shielding made of Kent paper (thickness: 0.25 mm and mass density: 0.93 g/cm^3) that was cut into 50×50-mm sheets and given numbers of papers were stacked to produce shielding of five thicknesses (0.5, 1, 2, 4, and 8 mm). The measurement setup is shown in Fig. 1 (C). The source was placed at a specific position on the source stand and the GM probe was placed at a fixed location 15 mm from the surface of the source. The integration time of radiation was then set to 1-min and paper shielding with various thicknesses was inserted between the source and the GM probe. The 1-min integrated net counts were measured at all thicknesses.

Nine courses on protection against exposure to radiation have been held and 25 new workers took the courses in the past year to train them in laboratory measurements using potassium chloride sources. Some of these have been staffs, researchers, and graduate students.

It was concluded that students could easily understand the existence of natural radiation and feel naturally occurring radioisotopes through the first measurement to evaluate background radiation. Moreover, the measurements of the dependence on time revealed linearity between radiation counts and elapsed time. The measurements of the dependence on distance demonstrated the inverse-square law. The measurements of the dependence on shielding proved the exponential relationship between the effectiveness of shielding and its thickness. All these results demonstrated that the potassium chloride radiation sources are useful aids in courses on protection against radiation and favorably received by many students who took part in this training.



(A) Time-dependence measurements

(B) Distance-dependence measurements

(C) Shielding-effect measurements

Fig.1 Setup for radiation sources and GM survey meters for training in laboratory measurements.