AN APPROVED PERSONAL DOSIMETRY SERVICE BASED ON AN ELECTRONIC DOSEMETER

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ABSTRACT

An electronic dosemeter has been developed in the U.K. by the National Radiological Protection Board (NRPB) and Siemens Plessey Controls Ltd. It has been designed to measure the quantities $H_p(10)$ and $H_s(0.07)$ for photons and beta-rays and is suitable for use by approved personal dosimetry services.

The specification of the dosemeter and the operational features it provides are described and a summary of the type tests and the dosemeter trials is also given.

INTRODUCTION

Personal dosimetry services, approved by their national authorities for category A workers, invariability use passive dosemeters incorporating photographic film or thermoluminescent detectors. However, for several years the NRPB has felt that the next major development in personal dosimetry should be an electronic dosemeter mainly because the instantaneous indication of radiation levels to the wearer should lead to improved control of exposures and a reduction in individual doses. This became a possibility when an arrangement of solid state detectors and filters was developed at NRPB[1] which was suitable for the measurement of individual dose equivalent penetrating, $H_p(10)$ for photons.

Since then further development has taken place at NRPB[1] for the measurement of individual dose equivalent superficial, $H_s(0.07)$ for beta-radiation. The quantities $H_p(10)$ and $H_s(0.07)$ have been recommended by ICRU[2] for individual monitoring.

NRPB and Siemens Plessey Controls agreed to develop jointly the device which will, in due course, be manufactured and distributed by Siemens Plessey.

THE DOSEMETER SPECIFICATION

It is the intention that the device is suitable for use as a legal dosemeter, i.e., one which in the U.K., for example, could be the basis of a dosimetry service, approved by the Health & Safety Executive (HSE) for "Classified" workers.

The dosemeter will measure $H_p(10)$ and $H_s(0.07)$ for photons and beta-rays both as the accumulated dose or instantaneous dose rate and the wearer is free to choose at any time which of these is displayed. The dose range which can be displayed for $H_p(10)$

and $H_s(0.07)$ is 1 μSv to 999.9 mSv. On its own this range is insufficient but the dosemeter will store up to 10 times this value, which will be accessible with an external reading unit. The dose rate ranges which can be displayed for $H_p(10)$ and $H_s(0.07)$ are 1 to 9999 μSv h^{-1} and 0.01 to 99.9 mSv h^{-1} respectively.

For photons and beta-rays the dosemeter can cover the energy ranges 20 keV to 7 MeV and 250 keV to 1.5 MeV (mean energies) respectively. Over the more important regions of these ranges the response is constant to within about 30% and the variation of response with angle of incidence will be contained within these limits.

Audible and visual alarms are provided, the setting up of which is restricted to authorised persons. The wearer, using keypads provided on the unit, can cause dose rate, or accumulated dose, or the alarm settings or his personal unique identifier to be displayed. Warning signals such as battery low or calibration required are automatically displayed. An essential feature for a legal dosemeter is that the accumulated values of $H_p(10)$ and $H_s(0.07)$ are stored securely. This security will be maintained even if the battery is discharged or the unit is damaged providing the storage chip is intact.

Important internal features are the use of semi-conductor detectors together with state of the art electronics. A customised battery will have a life of at least 1 year under normal conditions. Each dosemeter has a unique identifier and authorised stations (i.e., approved dosimetry services in U.K.) will be able to read and reset the stores for $H_p(10)$ and $H_s(0.07)$ prior to re-issue to a different person. The dosemeter is shown in Figure 1.

TYPE TESTING THE DOSEMETER

The dosemeter is being type tested in order to demonstrate its overall performance characteristics. Central to these tests is an investigation into the way its response varies with radiation type and energy and with the angle of incidence of the radiation. The dosemeter is intended for the measurement of $H_p(10)$ and $H_s(0.07)$ for photons and beta-rays. The above tests are being carried out with ISO reference radiations with energies between 17.4 keV and 7 MeV for photons and with beta particle spectra from ^{204}Tl, $^{90}Sr/^{90}Y$ and ^{106}Rh. In all cases the dosemeters will be exposed at angles of incidence 0°, 20°, 40° and 60°. The dosemeters are being exposed on the phantom expected to be recommended by the ICRU for this type of test namely a slab of dimensions 30 x 30 x 15 cm. Appropriate conversion coefficients, recommended by ICRU, are used to convert the air kerma intensity in the radiation beam to $H_p(10)$ and $H_s(0.07)$ in the phantom, i.e., the quantities against which the reading of the dosemeter is compared. The results will be presented in the form of a family of 4 curves being the energy response for each of the angles of incidence. To gain acceptance the mean of these curves at each energy should be within $\pm$30% of that at the calibration energy over the whole energy range. So far this work has been

completed for photon radiations. Figure 2 shows the photon energy response for the dosemeter at angles of 0°, 20°, 40° and 60°. It can be seen that all values of the combined energy and angular response are within the range 1.0 ± 30%.

In addition the dosemeter has been tested against the Draft IEC Standard for pocket alarm dosemeters and the tests have been successful for all requirements of major importance. This standard prescribes an extensive range of tests which includes the following:

i) effects of temperature and humidity
ii) effects of electromagnetic and electrostatic fields
iii) effects of shock, vibration and immersion in water
iv) the ease of radioactive decontamination

The dosemeter has also been shown to meet the requirements for personal dosemeters given in the Draft CEC document on Technical Recommendations for Monitoring Individuals Occupationally Exposed to External Radiation.

THE WEARER TRIALS

Wearer trials are in progress and are being largely limited to NRPB staff at its centres in Chilton, Leeds and Glasgow using the system described above. The service will be operated from Chilton and the trials at Chilton are being used to simulate an ADS serving its own on-site staff. The staff at Leeds are being used to simulate a remote customer linked to the dose record keeping system by an interactive computerised system and those at Glasgow to simulate a remote customer transferring data by means of some computer compatible medium. During the trials staff are, of course, continuing to wear their current passive dosemeters.

SUMMARY

An electronic personal dosimetry service has been described. The NRPB considers this to be the next logical development in personal dosimetry and it has been shown that the device offers a number of advantages for this purpose.

REFERENCES

1. Burgess P.H. Private communication.

2. International Commission on Radiation Units and Measurements. Determination of Dose Equivalents Resulting from External Radiation Sources. ICRU Report 39, Bethesda, MD, 1985.

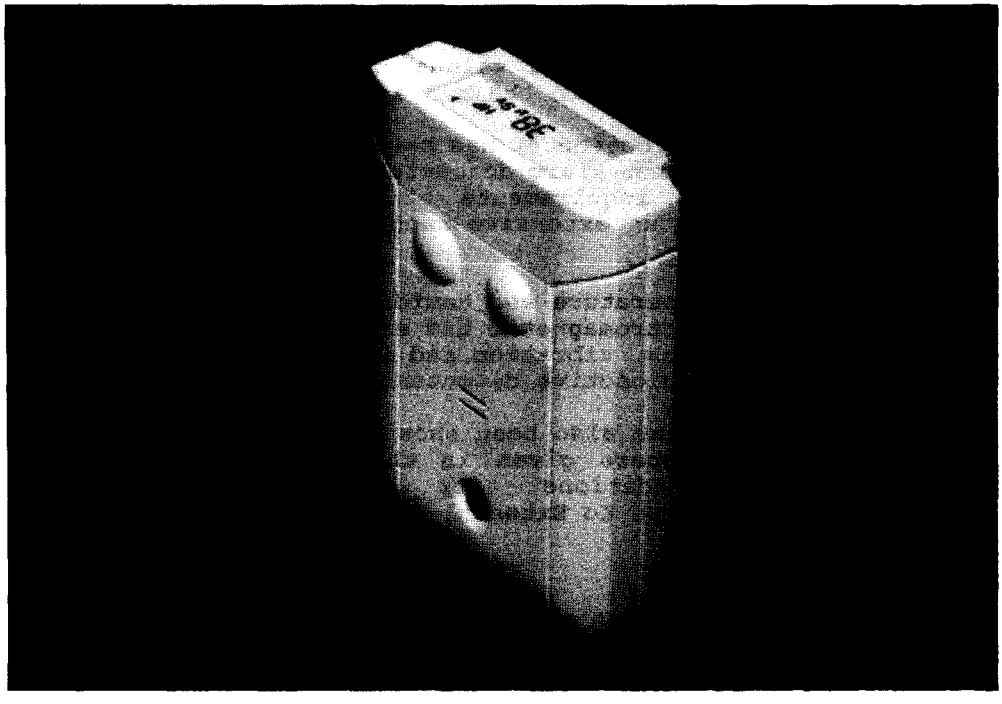

Figure 1 The Electronic Personal Dosemeter

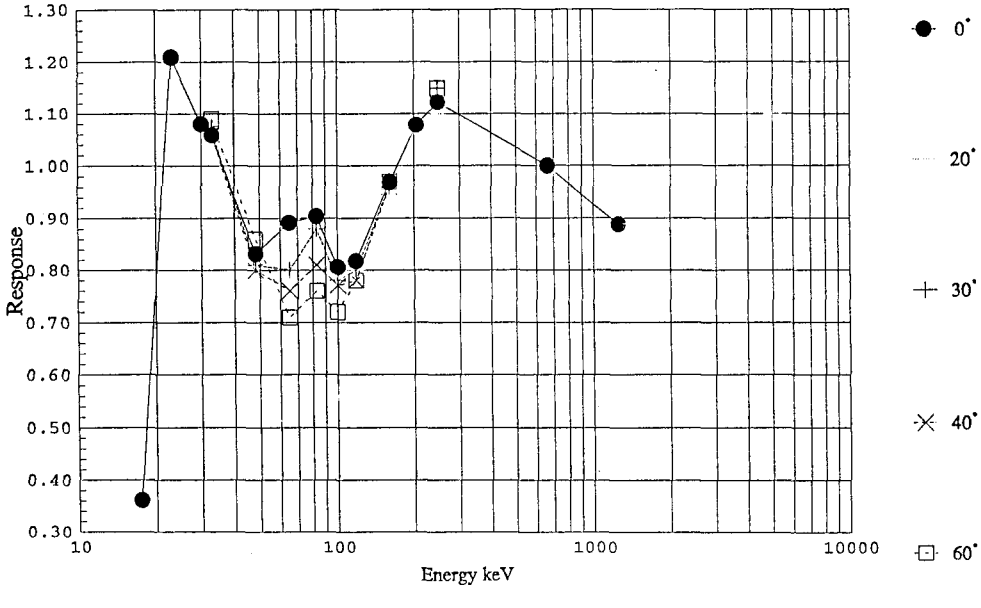

Figure 2 Variation of Response with Radiation Energy and Angle of Incidence