REDUCTION OF OCCUPATIONAL DOSE USING THE UKAEA SIMVIDOSE SYSTEM

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INTRODUCTION

The ICRP recommendations emphasise the need to keep doses as low as reasonably achievable. In order to make the best uses of resources in reducing operator dose it is important to know accurately how the dose is incurred. To allow the radiological protection staff to link dose rate with the particular task being carried out the SIMVIDOSE (SIMultaneous VIdeo and DOSE) system was developed (reference 1). SIMVIDOSE allows the external gamma dose rate to be displayed on a video image of the worker involved.

By recording the combined display the exact details of the exposure can be seen and protection measures targeted to the maximum effect. Experience with a development system has demonstrated has demonstrated its use as a training aid and/or on the spot dose control.

THE SIMVIDOSE EQUIPMENT

The monitoring consists of a GM tube and radio transmitter fitted in a small portable unit worn by the operator. The pulses are transmitted to a base unit with a countertimer module which converts count rate to dose rate and superimiposes a character string of time, dose rate and total dose on the video display from the camera.

In early versions (figure 1) a black and white camera was used. The only record of the dose rate was on the video recording. While this was useful in a qualitative way it was tedious to recover the data for quantitative studies.

A serial interface was added which enabled the data to be collected on a portable microcomputer and recorded on tape. Simple graphs of dose rate against time were then produced using either a printer or a graph plotter.

In low contrast situations a considerable advantage is offered by colour. Unfortunately the equipment had been designed for a camera with external synchronisation. Domestic colour cameras do not offer such a facility but an alternative system using a BBC microcomputer was available. The data from the counter timer is sent via the serial interface to the BBC microcomputer which saves the data and generates the numerical display which is then added to the video image (figure 2). Periodically the dose data is transferred to a floppy disc.

USE OF SIMVIDOSE

Throughout the development of the equipment trials have been carried out on active work. Both routine and one-off tasks have been studied.

Routine Operations:

(a) Silicon Ingot Irradiation. Pure silicon ingots are irradiated in the DIDO and PLUTO reactors at the UKAEA Harwell Laboratories to produce P type doping. Both vertical and horizontal irradition facilities are used. Unloading of irradiated ingots from the vertical facility is carried out by winching the can containing the ingots into a flask. The ingot is unloaded in an active handling cell, a new can is loaded into the flask and transferred to the reactor.

Slight differences exist between the equipment and operations on the two reactors. On Pluto the flask was located over a collar placed on the reactor top and the operator approached the flask during the process. The complete operation took 22 minutes but 60% of the dose was received in the 2½ minutes when the flask was being loaded with the irradiated ingot. On DIDO the flask locates in a larger collar on the reactor top. Transfer operations were observed from behind a shielded screen. In this case the higher doses were incurred in the transfer to the active handling cell (25% of the total), although the total dose was only 70% of that on the other reactor. The dose involved in unloading irradiated silicon from the horizontal facility on the PLUTO reactor and loading a new ingot was about double that for the vertical facility. The whole operation took about 35 minutes. Manipulation of irradiated ingots accounted for 45% of the dose and manipulation of new ingots for 25%. Both operations were carried out within a shielding tank, working from above.

These studies identified the parts of the operation giving most of the dose. While this could have been done using hand held instruments the results would not have been so easy to interpret and extra exposure would have been incurred.

(b) Cropper and Dissolver loading. The spent fuel from the DIDO and PLUTO reactors is reprocessed at the UKAEA Dounreay site. Operations involve the use of long tongs to manipulate elements within a pond into a cropping machine and then into the elevator to the dissolver cell. Results showed a fairly constant dose rate although there were increased levels when sediment was disturbed. In this case the only way to reduce the operator dose was to reduce the overall background level by reducing the residual contamination in the pond.

One-off Operation - Boiling Tube Replacement

During the annual shutdown of the SGHWR (Steam Generating Heavy Water Reactor) at the UKAEA Winfrith establishment a section of one of the boiling tubes below the reactor was replaced to allow tests for hydrogen embrittlement to be carried out on it. Dose rates in the lower lagging box where the tubes run are high due to "crud" deposition.

The camera was mounted on a remote control pan-tilt unit fitted to a specially fabricated bracket in the lower lagging box. The rest of the equipment was set up outside the biological shield. The calibration was adjusted to match the personal radiation monitors worn by the operators.

The SIMVIDOSE equipment was set up in a low dose rate area which effectively served as a control room for the operation. The work of removing the tube section and fitting a new piece was carried out by contractors supervised by UKAEA personnel. A number of entries were required. The use of SIMVIDOSE enabled health physics staff to continuously monitor the dose rate to which the worker was exposed without incurring dose to themselves.

Contractors about to take over could see recordings of earlier entries and locate high dose rate areas. Modifications could then be planned to take account of the dose rates.

At one point the dose rate increased sharply when a bung was removed from the cut pipe. However, the dose rate fell off quickly after an initial peak and the health physics staff allowed the worker to remain avoiding the extra dose from another entry.

It was also valuable to know when the operational dose control limit was being approached so that the worker to be instructed to stop at a convenient point in the job. In one such instance a bolt on a restraining bar broke, the decision was made to cut the entry short and leave the repair for a further entry as insufficient margin was available on the dose limit for the entry.

FURTHER DEVELOPMENTS

The SIMVIDOSE system, as it stands, is very much a development version. Some problems have been encountered with loss of signal from the dose meter. Interference from for example, overhead cranes can give rise to spurious results. The current design also precludes the use of more than one detector. In addition the BBC microcmputer is slow by modern standards and lacks the power and memory of later machines. One possible approach which is being studied (reference 2) is to use dosemeters which record total dose. Each dosemeter is polled by the controlling computer via a "transparent" radio data link. The personal dosemeter transmits the total dose. The current dose rate is then reconstructed by the computer. As the transmission is digital the likelihood of interference is considerably reduced and any loss of data can be recovered on the next transmission. Although this system is intended for emergency use without simultaneous video it will be possible to adopt it for this use.

Another possible development is to combine SIMVIDOSE with an automatic location system which would enable a map of dose rate to be produced for the area under investigation.

CONCLUSION

Simultaneous display and recording of dose rate together with a view of the operations being undertaken has enabled protective measures to be applied effectively to routine tasks. In addition the equipment has proved useful in controlling doses during individual operations and as a training aid.

REFERENCES

1. UK Patent Application G B 2142 500A. Monitoring of dangerous environments. G C Meggitt and A Cook.

2. UK Patent Application 145254. Monitoring of personnel in hazardous environments. S F Hall.

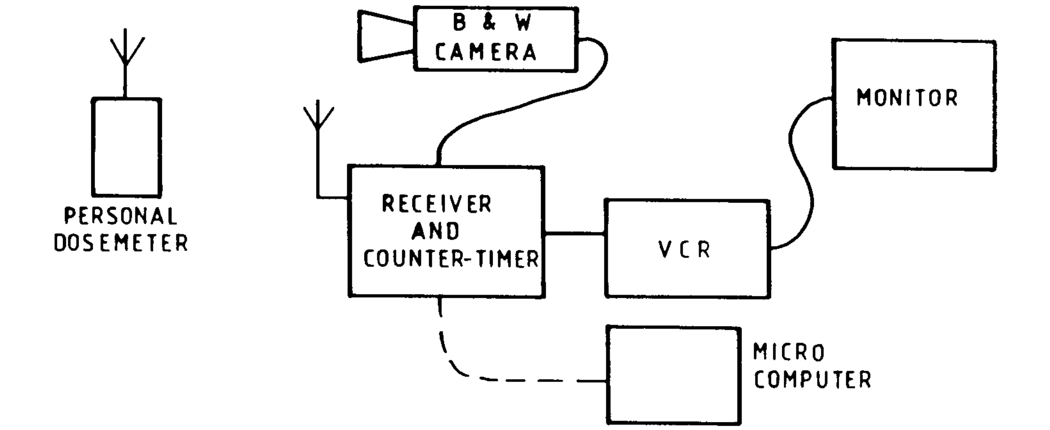

FIGURE 1 SIMVIDOSE VERSION 1

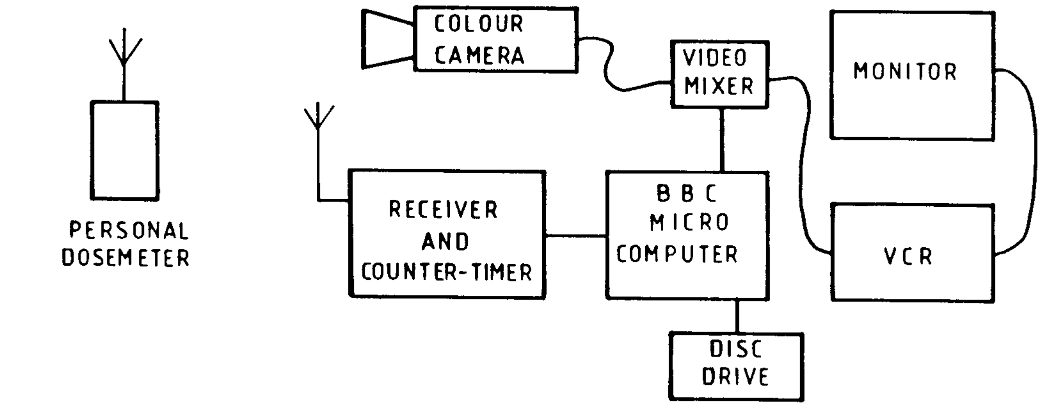

FIGURE 2 SIMVIDOSE VERSION 2