DEVELOPEMENT OF TLD BADGE READERS FOR PERSONNEL MONITORING IN INDIA

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ABSTRACT

More than 20,000 radiation workers are monitored in India using TLD badges[1] containing three teflon $CaSO_4$:Dy discs fixed on an aluminium card. A microprocessor based semiautomatic version of the TLD reader has been developed to handle about 2000 cards per month. It is having features like automatic dark current cancellation, autoranging, user selectable calibration factor, printer interface, digital glow curve storage, RS-232 serial interface and a built-in LED light source for system stability check. The Reader covers a range of 0-10 Sv with a minimum measurable dose of 50 μSv for X and gamma radiation. The hardware and software details of the TLD Reader are discussed.

INTRODUCTION

Personnel monitoring of radiation workers in India is carried out using both film dosimeters and TLD. However, TLD is preferred to film dosimeters owing to the advantages such as amenability to automation and stability under extreme climatic conditions of high temperature and humidity existing in most parts of India. Personnel monitoring in India is carried out by regional centres and an elaborate quality assurance programme by the Division of Radiological Protection (DRP), Bhaba Atomic Research Centre (BARC) ensures compatibility between centres. A manual type TLD reader indigenously developed was found to be satisfactory for dose evaluation in small centres which handles upto about 1000 cards per month. A microprocessor controlled data logger is used to interface these readers, to an IBM PC/XT for data transfer, glow curve display and storage. This paper discusses the design considerations of a semiautomatic personnel monitoring system having features like built-in interface for a PC/XT, motorised mechanical arrangement to read the three dosimeters of the TLD badge[1] sequentially, a self test diagnostic software, storage of digital glow curve data with high or low resolution etc.

SYSTEM DESCRIPTION

The BARC TLD Badge[1] consists of three 0.8mm thick (13mm diameter teflon $CaSO_4$:Dy) discs fixed to an aluminium card. The card is positioned inside a plastic holder provided with appropriate energy compensation filters, for the three dosimeters. The semiautomatic TLD reader shown in fig.1 is based on a compact 8085 microprocessor system. It consists of a rack

and pinion arrangement coupled to a D.C motor for transporting the dosimeter card to the heating position, a reproducible temperature control circuit for heating TL dosimeter upto 280°C, a multiplier phototube (PMT) having a suitable spectral response (EMI 9924), a regulated EHT(500-1000V variable) for the PMT and a current to frequency (I-F) converter with an automatic dark current suppression circuit. The operation of the TLD Reader is controlled by a ROM based 8K byte assembly language program. Two 6V dc motors are used, the first one for moving the card to the reading position inside the reader and the second for raising and lowering the kanthal heater to make contact with the TL dosimeter. Microswitches are used for sensing proper positioning of the dosimeter over the heater. The TLD reader is provided with a key-board consisting of the numeric and function keys and an eight-digit, seven-segment LED display for diplaying various display parameters and the readings. A separate digital panel meter is used for displaying temperature and the EHT. The TLD reader is provided with a centronic parallel printer interface for an on-line/off-line printout of data, and a serial RS-232 interface for connection to an IBM PC/XT. The detailed hardware and software of the reader can be obtained from the authors.

OPERATION CYCLE

The dosimeter card is manually removed from the plastic holder and fed into the reader. A "Start" key is pressed to start the reading cycle. A buzzer prompts the operator to enter the badge number(B.No.)i.e. the dosimeter identification number which is entered using the numeric and "Enter" keys on the front panel. Prior to this, the instituion number (I.No.) assigned for a batch of badges from an instituion and the location code (LC) to indicate the location on the body where the TLD badge is worn can be entered. A location code of 00 is used for chest,01 for right wrist and 02 for left wrist. If these numbers are not entered,a code of "00" is taken as default value for the the location code and the instituion number remains unchanged. On entering the badge number, the dark current of the PMT is sampled and stored on a low leakage capacitor for automatic subtraction from the output during the reading cycle. The TLD card is then transported by a geared dc motor till the dosimeter one is positioned over the heater. A pulse width modulated drive is used for precise control of the dc motor. The reading cycle is started with energising the heater. A heater control circuit heats the dosimeter to 280°C in less than 10 seconds and maintains it till the end of the reading cycle. A typical temperature profile during the reading cycle is shown in fig 2. The anode current from the PMT is fed to an I-F converter. The output pulses from the I-F converter are fed to a microprocessor compatible 8 digit counter (8253). A 10 pps clock interrupt is used to update the display and to read and store the counter readings every second in a non-volatile RAM (random access memory) for obtaining integral glow curve data. At the end of the read-out cycle, the integral glow curve data is transmitted to the PC/XT. A BASIC program finds the difference between the sucessive readings to

obtain the differential data and displays the glow curve on the PC monitor. The data is also stored on a floppy/hard disk. In addition, at the end of every readout cycle, the dose and the other dosimeter details are stored in a non-volatile RAM which has a capacity for dose data storage of 100 badges and printed on a 24 column dot matrix printer. The dosimeters 2 & 3 are read similarly and the card is ejected out. When the memory is exhausted after readout of 100 badges, the system goes into a lockout mode with a message "FULL" on the display. This ensures that there is no loss of data due to non-availability of memory for storage. The TLD reader cannot be operated unless the memory is cleared by the operator using a code number and pressing the "Enter" key on the panel. The reading stored in the memory can be recalled by using a "RECALL" key and entering the badge number of interest.

RESULT

The TLD reader has a readout time of three minutes per badge[1]. A typical glow curve recorded from a 0.8mm TL dosimeter exposed to 6.2 mSv as stored in PC/XT is shown in fig.2. A low resolution glow curve storage with 60 points per curve as shown in fig.2 would provide enough evidence of a correct read-out and genuineness of the dose and to reject an occasional spurious reading[2]. A software has been written in BASIC to retrieve and display any of the stored glow curves from the database. The dosimeter data stored in the non-volatile memory of the TLD reader is transmitted off-line to a PC/XT for dose evaluation, preparation of the dose reports and record keeping. The system covers a range of 50 μSv to 10 Sv for X & Γ radiations.

CONCLUSIONS

The system costs about $12,000 with 500 badges and the commercial production is already underway. The system will be a low-cost option for any medium scale personnel monitoring centre. The built-in interface in the TLD reader makes it possible to connect two or more such readers to a single IBM PC/XT on time-sharing basis. To achieve a faster read-out time, a modified TLD badge with 0.4 mm $CaSO_4$:Dy teflon dosimeter and a non-contact hot nitrogen gas heating system are under development.

REFERENCES

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FIG. 1. SEMIAUTOMATIC TLD READER

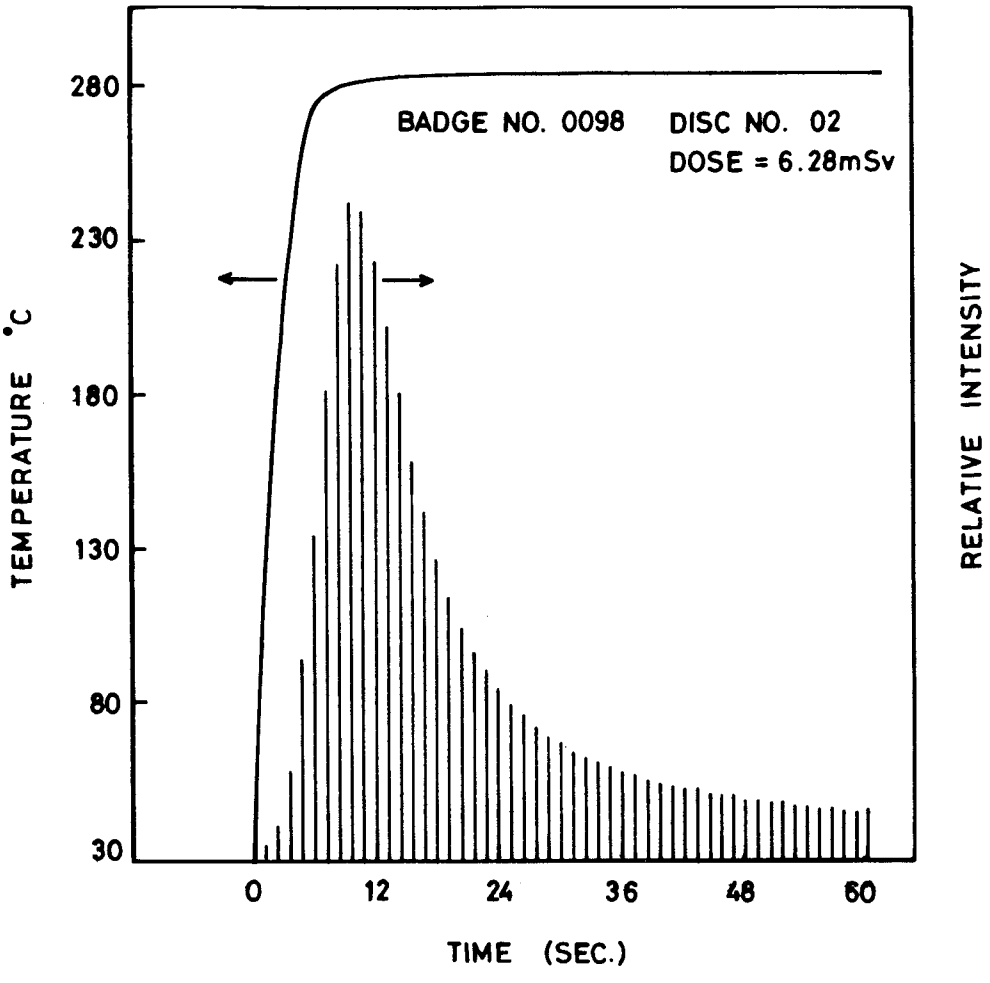

FIG.2. GLOW CURVE & TEMPERATURE PROFILE