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10 YEARS EXPERIENCE WITH A LARGE COMPUTERIZED TLD-PERSONNEL MONITORING SERVICE

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It is now 10 years since our institute has replaced its filmdosimetry service by a computerized automated TLD-system. Presently more than 13,000 radiation workers are monthly monitored by three automated TLD-readers linked to the computer center. The paper describes system hardware and software and experience gained in long-term routine operation.

Introduction

Since its foundation in 1958 our radiation protection institute has provided legally authorized personnel monitoring service for Austria, within the first 15 years using filmdosimeters. In 1975 we started to replace film by TLD as the first legal monitoring service in Europe. Resulting extensive practical evaluation of different automated TLD-systems then commercially available [1] we selected the Mod. 2271 system of HARSHAW and used it ever since successfully.

Hardware

A detailed description of the reader system has been published earlier [2]. A particular feature of the HARSHAW system is the design of the dosimeter cards containing two LiF (TLD 100) chips of 3x3x1 mm^3 sealed between teflon foils. The cards are contained in our badge with one TLD behind a window (effective filtration 30 mg/cm^2), the other behind a filter of 600 mg/cm^2 Al. For thermal neutrons an additional dosimeter card containing a $^6LiF/^7LiF$ pair is worn in the same badge. For protection against dirt and misuse the badges are high-frequency sealed in thin plastic bags. The readout system consists of the Mod. 2271 automated reader, integrating picoammeter, digital threshold with TTY-interface and a magnetic tape unit with intelligent interface, designed by our Electronics Department. This interface controls the correct data transfer between reader and magtape to prevent loss of data. Three identical readout systems are used for evaluation of approx. 14,000 dosimeters per months. Complete processing of the dosimeters requires approx. 1 hour for 100 TLDs each.

Software

Evaluation procedure

The main steps of the evaluation procedure are explained in the simplified flow chart (Fig. 1). A more detailed description is given in an earlier publication [3]. Off-line batch processing is applied with a time schedule

firmely tied to the calendar month. Incoming TLDs are received within the first two weeks of each month and immediately evaluated by the three automated reader systems, with all data stored on magtape. After the 15th of each month deadline the tapes are transferred to the central computer.

Central computer

The present configuration of the Seibersdorf central computer is the SIEMENS 7.541 system with 4 MByte real memory, 2 fixed disk memories (420 MByte ea), 5 changeable disk memories (144 MByte ea.) and a fast chain printer (125 k charaters/min). The program is written in FORTRAN and ASSEMBLER using the BS 2000 operating system. Editor (EDT) procedures are used for the data banks and all data files based on Index Sequential Access (ISAM). File updating is via remote terminals in our institute.

Calibration

Long-term experience has shown that reference light sources should only be used for operational checks not for calibration. We apply 5 reference dosimeters exposed by gamma radiation of ^{137}Cs with every reader magazine containing 250 TLDs. Up to 200 TLDs can be exposed with our Panoramic Exposure System [4] at once to a reference dose of 2 mSv within 10 minutes with a repeatibility of $\pm$ 0.1 % (1 sigma). In addition 5 background/sensitivity check cards are used for reader background subtraction.

Dosimetric performance

- Limit of detection (3 sigma of residual dose): 12 µSv
- Practical dose range: 50 µSv - 100 Sv
- Linearity: up to 2.5 Sv, supralinearity range: 2,5 - 10 Sv
- Repeatability of individual dosimeter at 1 mSv: $\pm$ 2 % (1 sigma)
- Batch homogeneity (limited by economic considerations): $\pm$ 15 % of the mean
- Fading: below 1 % per month due to external preheating (20 min at 100°C)
- Energy response: (for measurement of exposure free-in-air):
  "Filtered" TLD (600 mg/cm² Al): $\pm$ 15 % variation in sensitivity (normalized to ^{137}Cs) between 30 keV_{eff} and 1250 keV (^{60}Co)
  "Unfiltered" TLD (30 mg/cm² plastic): $\pm$ 30 % variation in sensitivity (normalized to 240 keV_{eff}) between 17 keV_{eff} and 240 keV_{eff}

Application of the new ICRU- quantities

Up to now the quantity "Photon-dose-equivalent H_x" has been used for photons. The readout of the "filtered" TLD is used for the "penetrating" dose, the difference between "unfiltered" and "filtered" for the "non-penetrating" dose. The possibility of future application of the new ICRU-39 quantities "Individual Dose Equivalent, Penetrating H(10)" and "Individual Dose Equivalent, Superficial H(0.07)" has been evaluated for our dosimeters

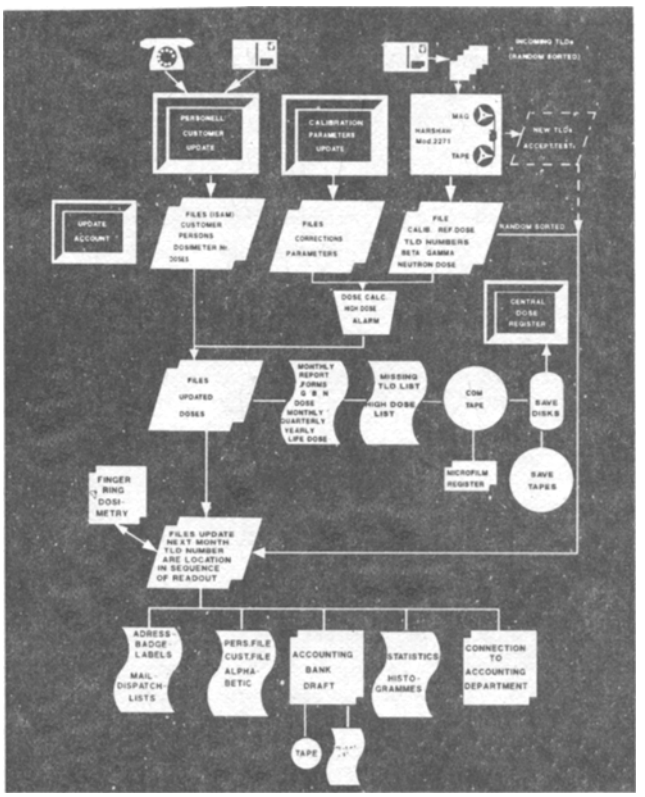

Fig. 1. Simplified flow chart of the TLD-evaluation procedure

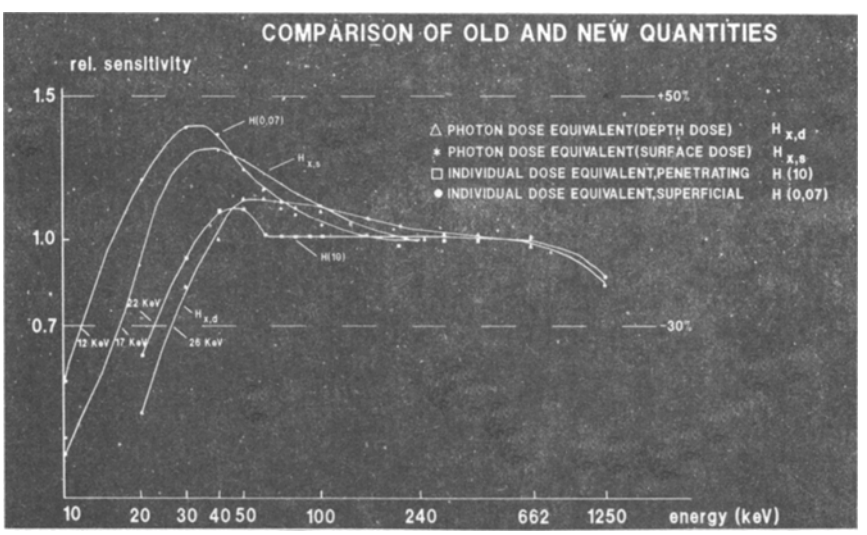

Fig. 2. Energy dependence of Photon-Dose-Equivalent and new ICRU-39 Individual-Dose-Equivalent quantities

during a European Intercomparison Programme organized by the Physikalisch Techn.-Bundesanstalt, Braunschweig (PTB) for the European Communities. For this purpose Photon-dose-equivalent H_x is converted to H(10) and H(0.07) using conversion factors published by the PTB [5]. The dosimeters are irradiated on phantom, ideally the ICRU-sphere. Correction factors for different phantom geometries are also given in [5]. After conversion the readout of the "filtered" TLD is used for the "individual dose equivalent, penetrating", the "unfiltered" for the "individual dose equivalent, superficial". The total dose corresponds to the readout of the "unfiltered" dosimeter. Fig. 2 gives the energy dependence of the old and new quantities in the range of 10 keV_{eff} to 1250 keV (^{60}Co). It can be seen that our dosimeters are also useful for the new quantities. Improvement in the low energy range for the superficial dose equivalent is being evaluated using different filtrations.

Conclusion

The first automated system has now been in routine use since 10 years and proved sufficiently reliable. The mean time between failures (MTBF) is approx. 1 hour (failure rate 1 %). Such failures cause interruption of readout, never loss of data or inaccurate results. Due to our hermetically sealed badges spurious readings are rare. High doses above 10 mSv are verified by a second readout. The central dose register is presently beeing extended for all Austria and provides statistical data on the occupational exposure.

References

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