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MINISTRY OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF ATOMIC ENERGY

PERSONNEL RADIATION MONITORING

BY

THERMOLUMINESCENCE DOSIMETRY

(2000-2001)

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Personnel Radiation Monitoring

By

Thermoluminescence Dosimetry

Abstract

Thermoluminescence Dosimetry Service was introduced in 1991. Personnel who exposed directly or indirectly to radiation is monitored by Thermoluminescent Dosimeter. TL materials used for Thermoluminescent Dosimeter are in the form of thin disc. Personnel whole body and extremity doses are measured by Thermoluminescence Dosimetry. The Harshaw Model 4500 TLD Reader and Vinten 654E TLD Reader are used for TLD evaluation. At present about 600 radiation workers are provided with TLD for routine monitoring. It was found that most personnels had received within permissible dose recommended by the International Commission on Radiological Protection (ICRP).

1. Introduction

Personnel Radiation Monitoring Service is concerned to control radiation hazards by keeping a check on radiation exposure of individual worker engaged in used of ionizing radiations and isotopes in medicine, research, industrial, agriculture, etc. Individual monitoring is achieved by using equipment carried on the person or worker. Thermoluminesence Detectors are being used for the personnel radiation monitoring. Lithum fluoride & Calcium Fluorit are currenty in use. The latter is very sensitive but a poor energy response. Lithium Fluoride is less sensitive but its energy response is excellent. TL material is in the form of thin disc. Thermoluminescent detectors (TLD Badges) are used by persons or workers who exposed directly or indirectly to radiation in the work places. Normally, the monitoring period for one service takes two months but sometimes it needs a little shorter or longer than normal period. The absorbed dose are evaluated on TLD reader which is linked to computerized dose recording system. As the atomic number of LiF is very equivalent to human tissue, it gives very reliable results of skin dose & whole body dose.

Thermoluminescent detectors utilize the electron trapping process. When a Thermoluminescent phosphor is exposed to ionizing radiation at a low temperature (eg. Room temperature) many of the freed electron become trapped in lattice imperfection in crystalline solid. TL material is selected so that electron tapped as a result of exposure to ionizing radiation are stable at normal temperatures. If after irradiation, the material is heated to a suitable temperature, usually about 200 C, the trapped electrons are released and return to the valance band with the emission of a light photon. Thus if the device is heated in the dark but under a photomultiplier tube, the light output can be measured and this is proportional to the radiation dose which the detector has received. The TLD system measures the total dose accumulated over the period of exposure.

Dose evaluation is done by means of a TLD reader consisting of a controlled heating element and a photomultiplier system which determines the light fluence emitted during the heating of the dosimeter material. The integrated light intensity is measured as a function of the heating temperature cycle. The resulting graph is called a glow curve.

The purpose of personal thermoluminescence dosimetry is to ensure that workers exposed to ionizing radiation are kept within the dose limits recommended by the International Commission on Radiological Protection and to ensure that no body is exposed to maximum permissible dose.

At present about 500 radiation workers from 30 various departments are provided with TLD for routine monitoring. The work which was done during the fiscal year (2001) are presented in this paper together with the results.

2. Experiment

The Harshaw Model 4500 manual TLD workstation is a state of the art instrument used for thermoluminescent dosimetry (TLD) measurement. Two photomultiplier tubes are incorporated in a sliding housing for rapid manual reading of whole body environmental. TL Cards, extremity dosimeters, TL chips disks rods and powders.

The TL material may be heated by hot gas (either Nitrogen or air) by planchet. Hot gas is used for TL Cards and Chipstrates. The planchet is used for unmounted TL elements: chips, disks, rods and powders.

The gas heating system uses a stream of hot Nitrogen or air at precisely controlled, linearly ramped temperatures to a maximum of 400 C to simultaneously heat two chipstrates in a carrier card or two positions in a four chip TLD card. Four chip cards then are moved automatically into position for a second read cycle to complete the card. The hot gas heating under closed loop feedback control and the superior electronic design produces consistent and repeatable glow curves over a wide dynamic range. This means the card will last longer and can be used more times.

The planchet system uses electric resistance heating with the same closed loop feedback system to produce temperature to 400 C in the standard unit and 600 C with the high temperature option.

The complete workstation includes a personal computer with the Harshaw Radiation Evaluation and Management System (TLD REMS) Software. The workstation computer is an IBM computer PC with the following minimum equipment.

- 386 SX3 20 processor or better
- Math Coprocessor
- 200 Mega Byte hard disk drive
- 2 MB RAM
- one diskette drive
- dot matrix printer – IBM Pro Printer compatible
- optional laser printer – HP Laser Jet II compatible

TLD-REMS software is used exclusively for Harshaw reader. This software also provides a Common interface from reader to a central computer system.

The TLD Irradiation Modal 2210 is consisting in this system for Calibration process, Annealing of TLD cards, Generating the calibration cards, Calibrating the TLD reader, Card Calibration are done before distribution to the users. After the exposed TLD cards are collected, evaluation of fields cards and records for processing are done consequently. The results are stored in the computer systematically and periodic results are sent to users.

The relation between the dose equivalent & the absorbed dose is as follows:

The unit of dose equivalent was originally the rem:

Dose equivalent (rem) = absorbed dose (rad) * Q

In the SI system of units, the unit of dose equivalent is the sievert, abbreviated to Sv, which is related to the gray as follows:

Dose equivalent (Sv) = absorbed dose (Gy)*Q*N

Q = quality factor

N = modifying factor (which might take account of such factors as absorbed dose rate & fractionation)

N = 1 (for the present, ICRP has assigned a value of 1 to N.).

1 Gy = 100 rad

1 Sv = 100 rem

Summary of values of Q

Type of radiation	Q
X-rays, γ-rays & electrons	1
Thermal neutrons	5
Fast neutrons & protons	20
α-particles	20

Absorbed dose is the energy absorbed per unit mass. Unit of absorbed dose is joule per kilogram (or) gray (Gy). Equivalent dose is the weighted dose in Tissue T. Unit of equivalent dose is joule per kilogram (or) Sievert (Sv).

$$\mathbf{H_T = \Sigma_R W_R \cdot D_{T,R}}$$

Where W_R = the radiation weighting factor

$D_{T,R}$ = the absorbed dose average over the tissue (or) organ T, due to radiation R.

3. Results and Discussion

Number of TLDs distributed to various depts. are given in Annex 1. Dose report for the period 2000_01 for all radiation workers is recorded systematically in the personal computer. Maximum and minimum absorbed doses received by the workers are presented in table 1. It can be concluded generally that received doses by the workers lower than the permissible level. The personnel dose higher than permissible is over exposure. Whole body dose equivalent limit recommended by ICRP for a radiation worker is 20 mili Sievert per year. (average over defined periods of five years. Annual dose equivalent limit for skin, extremity eg. wrist, ankle, feet) etc is 500 mSv and for eye is 150 mSv. No worker is exposed to maximum dose level in the year 2001. It is suggested that radiation workers should take care not to be over exposure.

4. Conclusions

Personal Radiation Monitoring is important to ensure that workers exposed to ionizing radiation are kept within the dose limit and to ensure that no body is exposed to maximum permissible dose.

5. Acknowledgement

We are grateful to our Director General, Deputy Director for their encouragement support. And we also thank IAEA for supporting material techniques. We are also thankful to the depts. (Which are using TLD badges regularly) for their keen interest and cooperation and the staffs of our dept. for their help.

6.References

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No. of monitored workers in 2001

Sr.	Department	No. of workers	Freq./ year	Total Badges/ Year
I.	**HEALTH**			
1,	Yangon General Hospital			
	_Radiology Dept.	31	6	186
	_Radiotherapy Dept.	60	4	240
	_Nuclear Medicine	11	6	66
	_Neuro	2	6	12
2,	Children's Hospital	4	5	20
3,	Central Women's Hospital	5	5	25
4,	Cardiac Medical (YGH)	20	4	80
5,	Cardiac Medical (MGH)	8	1	8
6,	Defence Service General Hospital	25	4	100
7,	Defence Service Orthopaedics Hospital	12	5	60
8,	East Yangon General Hospital	3	3	9
9,	Insein General Hospital	6	4	24
10,	Institute of Para Medical Service	50	4	200
11,	Mandalay General Hospital			
	_Radiotherapy Dept.	38	4	152
	_Radiology Dept.	12	4	48
	_Nuclear Medicine	4	4	16
12,	Meikhtila Military Hospital	10	8	80
13,	No. (2) Military Hospital (500)	7	4	28
14,	North Okkalapa General Hospital	8	6	48
15,	New General Hospital	6	4	24
16,	Raynatner Hospital	3	3	9
17,	Thingangyun Ideal Hospital	6	3	18
18,	Union of Tuberculosis Institude	6	4	24
19,	West Yangon General	4	2	8
II	**RESEARCH & DEVELOPMENT/UNIVERSITY**			
20,	Yangon University			
	_Physics Dept.	20	1	20
21,	Department of Medical Research	12	1	12
22,	Livestock Breeding and Veterinary Dept.	5	4	20
23,	Myanma Agriculture Service	2	1	2
24,	Universities' Research Center	4	1	4

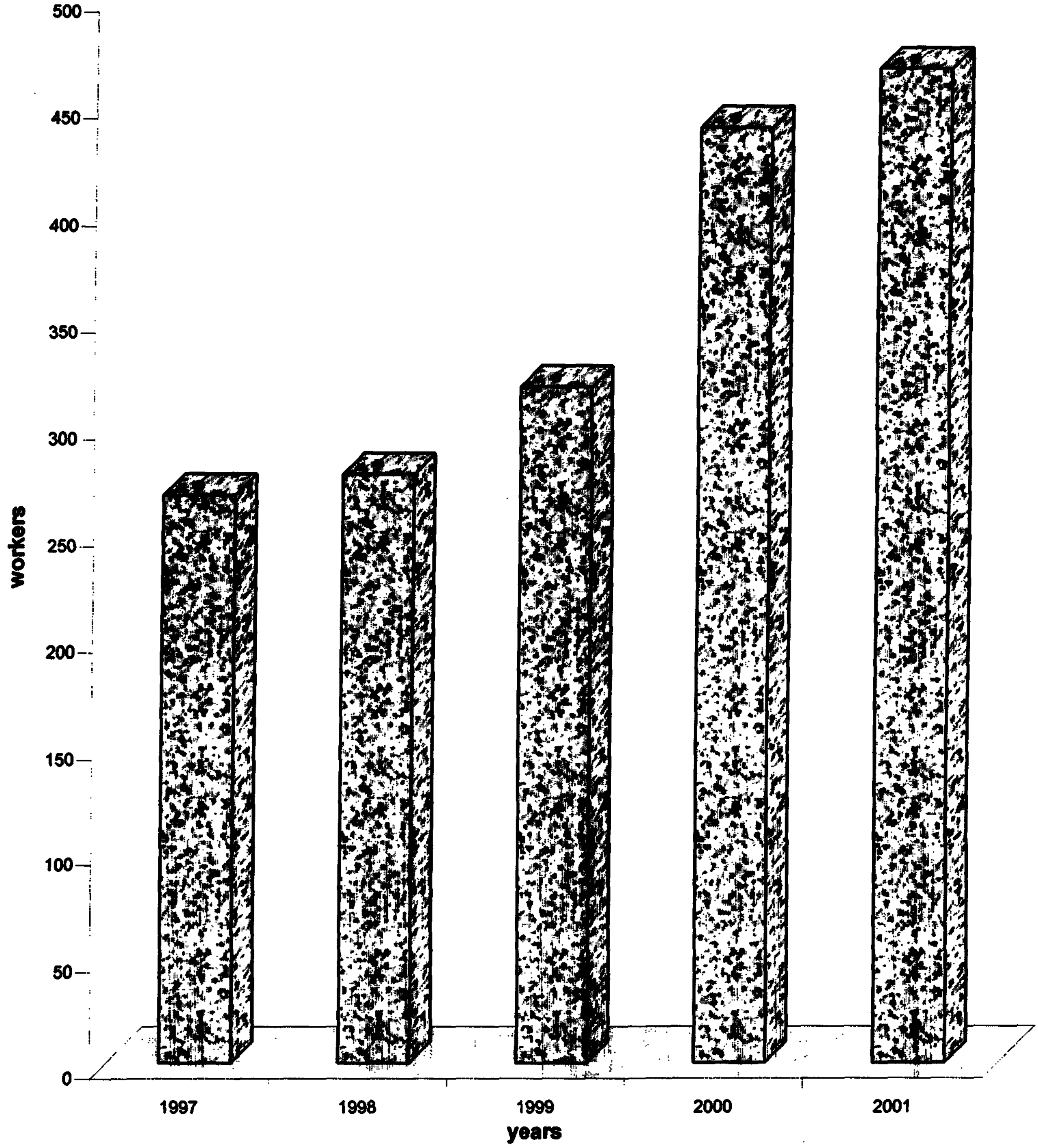
25,	Dept. of Atomic Energy			
	_Inspection	15	1	15
	_Ph.D Thesis	5	1	5
	_MS student	1	1	1
III.	**INDUSTRY**			
26,	Myanma Oil & Gas Enterprise	8	5	40
27,	Metallurgical Research and Development Center	40	3	120
IV.	**PRIVATE ENTERPRISE**			
28,	MEDITECH Co.Ltd	3	5	15
29,	Rothmans of Pall Mall Myanmar Pte.Ltd.	10	6	60
30,	Dagon Brewery Co.Ltd	2	1	2
		468		1801

Year	Medical		Industry		Teaching & Research	
	Government	Private	Government	Private	Government	Private
1997	15	nil	2	1	7	nil
1998	16	nil	1	2	7	nil
1999	17	nil	2	nil	9	nil
2000	22	nil	2	2	9	nil
2001	19	nil	2	3	6	nil

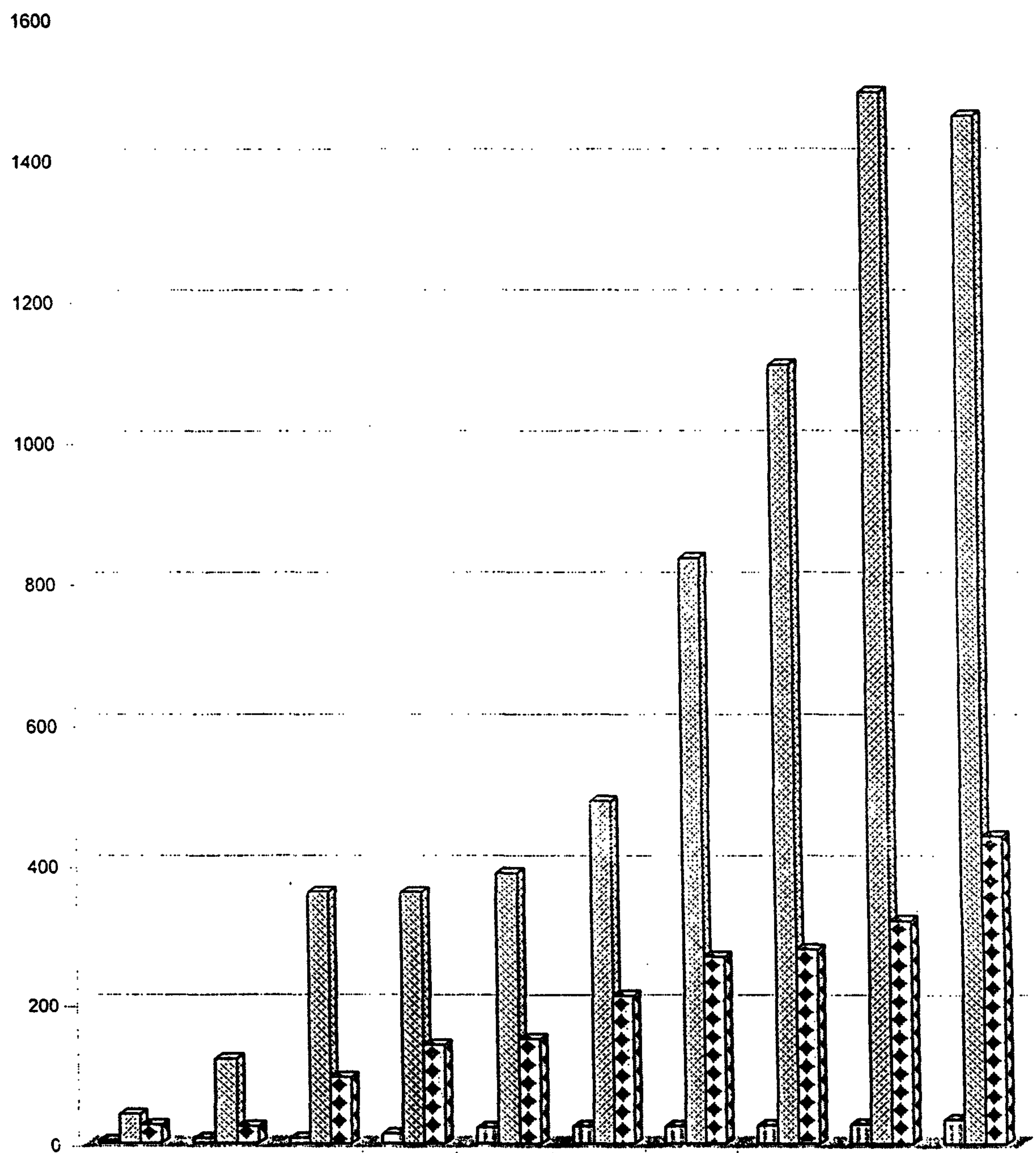
Average annual exposure / Worker

Year	Skin Dose (mSv)	Deep Dose (mSv)
1997	0.5606	0.2928
1998	0.5978	0.3437
1999	0.5822	0.5345
2000	0.6128	0.5762
2001	0.5402	0.3028

PERSONNEL MONITORING SERVICE
Year-wise Growth of Radiation Workers



Personnel Monitoring Services



	91-92	92-93	93-94	94-95	95-96	96-97	97-98	98-99	99-2000	2000-01
No. of Dept.	4	7	8	14	23	25	25	26	28	35
No of Badges	42	121	360	360	388	490	833	1107	1493	1459
No. of Workers	26	24	95	141	150	212	267	277	318	440