User's Instruction Guide

Individual Monitoring Service by TLD

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Background

In accordance with the International Atomic Energy Agency (IAEA) International Basic Safety Standards, which is based largely on the 1990 "Recommendations of the International Commission on Radiological Protection" (ICRP Publication 60), doses received by individuals during occupational exposure to ionizing radiation should be monitored. The Health Physics Division, Atomic Energy Centre, Dhaka is responsible to implement the Radiation monitoring Program to ensure a safe environment for workers occupationally exposed to radiation.

The Nuclear Safety and Radiation Control Rules-1997 require that workers occupationally exposed to ionizing radiation should wear devices called thermoluminescent dosimeters (TLDs) for individual monitoring so that accumulated doses can be monitored over a period of time.

It is an essential requirement that the use of individual monitoring devices by radiation workers in order to maintain the occupational exposure within permissible levels.

Prior to commencement of radiation work, Radiation Control Officers and Radiation Workers should have an adequate knowledge about the use of individual monitoring devices to ensure accurate dose estimation. These guidelines provide information for maintenance of a proper dosimetric service in their institute.

This guide provides TLD subscribers with an overview on TLD, and all the information they should know like instructions on how to subscribe, proper handling of TLDs, etc.

This guide aims to educate the subscribers on the basics of TLD, to teach them to become responsible subscribers and also to bring out in them a better appreciation of the service they are being provided.

1. What is Individual Monitoring?

Individual Monitoring is the estimation of the dose received by an individual using a device or instrument carried on the radiation worker during the occupation exposure to radiation.

2. Aim of Individual Monitoring

Aim of Individual Monitoring is to

2.1 Monitor and control individual doses regularly in order to ensure compliance with the stipulated dose limits recommended by ICRP 103 published in 2007.
2.2 Report & investigate overexposures & recommend necessary remedial measures urgently.
2.3 Maintain lifetime cumulative dose (total dose received during life time) records of the users of the service.

3. Legal Requirements

3.1 Use of Individual Monitoring devices by radiation workers is a legal requirement according to Nuclear Safety and Radiation Control Act-1993 and Rules-1997.
3.2 No person shall work with ionizing radiation without use of proper Individual Monitoring devices approved by the Nuclear Safety and Radiation Control Division (Regulatory Authority) unless exempted. Every licensee shall maintain records of Individual Monitoring of each worker.

4. Benefits that may accrue from an individual monitoring programme

4.1 The results of individual monitoring can be used to provide information on conditions of the workplace and thus provide a simple way of establishing good working procedures.
4.2 Individual monitoring data may be used to identify both good and bad features of operating procedures and design characteristics and thereby contribute to the development of safer radiation practices.
4.3 Provision of information in the event of accidental exposures or the assessment of possible high levels of radiation exposures.
4.4 Motivation of workers to reduce their exposure as a result of the information given to them.
4.5 Provision of data for medical and for legal purposes.

5. Dosimeters

The dosimeters used by the Bangladesh Atomic Energy Commission to carry out the individual monitoring service are called Thermoluminescence dosimeters (TLD).

TLD are used to estimate external individual dose from x, gamma, beta and neutron exposures. Phenomenon of thermoluminescence is the emission of light when heated up to a certain temperature after exposure to radiation. The amount of light emitted is proportional to the dose of radiation.

5.1 Types of dosimeters

5.1.1 LiF (Lithium Fluoride) manufactured by Harshaw Co., USA. Two LiF chips are embeded in a card as shown in the Fig. 1. These cards are loaded in black colour holder shown in the Fig. 1.

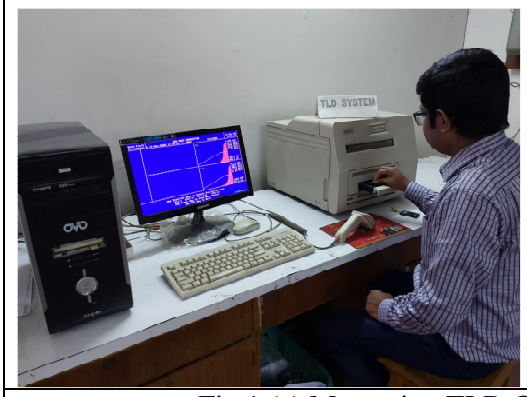

Fig.1 (a) Measuring TLD Card with Harshaw Model 4500 TLD Reader, (b) TLD Cards, Holders, Opener, ring dosimetry

5.2. Specifications

5.2.1 LiF-100 (Lithium Fluoride-100)

- dimensions of the crystals are 3.2 mm × 3.2 mm × 0.89 mm
- the chips are covered by a Teflon foil with a thickness of about 13 mg/cm^2
- filter materials of the holder are 1000 mg/ cm^2 ABS plastic and Teflon for deep dose estimation.

6. Service Procedure

6.1 The service is initiated on receipt of a request from an institution desirous of availing of the TLD individual monitoring services, **Health Physics Division, Dhaka** will send copies of the application form for individual Monitoring, the individual data form and User's Instruction guide. The application form and individual data forms for all persons to be monitored, should be duly filled in and returned to

Head
Health Physics Division
Atomic Energy Centre, Dhaka
4 Kazi Nazrul Islam Avenue, Ramna, Dhaka-1000.

6.2 The total number of TLDs issued is dependent on the number of radiation workers in the institute.

6.3 The first consignment of TLD badges containing TLD cards along with TLD holder will be sent by Registered Post/Courier. This will be for a three months period of use or as determined by the competent authority.

7. Service Period

7.1 The service period is usually three months or as determined by the authority depending upon the type of installation.

7.2 After one service period, the used TLDs have to be replaced by the fresh TLDs sent by Health Physics Division, Dhaka for the next service period.

Note:

a) For all purposes only one address will be kept in our records. Hence addresses of the branches/ temporary sites can not be entertained.

8. How to Use

8.1 The TLD cards shall not be used without being loaded in the holders. Once the card is loaded in the holder it should not be removed till the end of the service period. It is not possible to determine the nature and energy of the incident radiation from a TLD card used without a holder and hence dose estimation will not be possible.

8.2 TLD badge for whole body dose estimation should be worn at chest level as filters of the holder facing incoming radiation (Fig. 2). Whenever working in the radiation field, TLD badge should be always worn by the person.

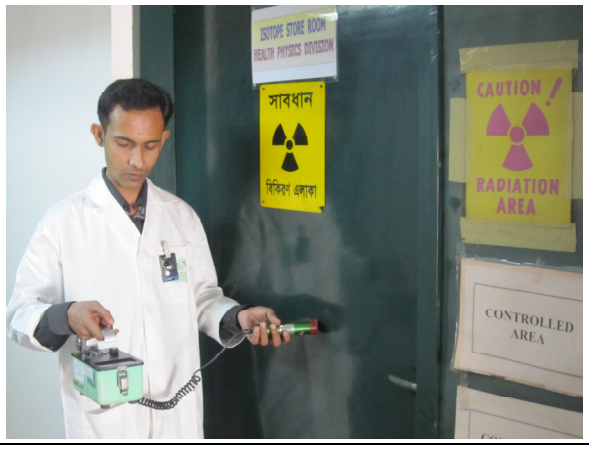

Fig. 2. Wearing location of TLD at chest level.

8.3 **If a lead apron is used, (e.g. in diagnostic X- ray departments) TLD badge should be worn over the lead apron at the chest level**

8.4 A TLD badge allotted to one user should not be shared by any other person.

8.5 While leaving the premises of the institution, workers should submit their TLD badges in the radiation free place.

9. How to Return the Used TLD Cards

9.1 Return all the TLD badges used and /or unused, immediately after the end of the service period in one lot along with the respective distribution forms. Late return/ non-return of TLD badge do not serve the purpose of individual monitoring.

9.2 If a TLD badge is not used, the remark "not used" should be written in the distribution form against the name of the person for whom the TLD badge was assigned.

9.3 Use strong (e.g. cloth in laid) envelopes or plastic boxes for returning the TLD badges to avoid loss or damage during postage.

TLD badges should be sent to us by Courier service or hand delivered only.

9.4 If you have to return some unused TLD badges regularly or no radiation work is carried out for more than a month, you may inform us one month in advance either to reduce the number of TLD badges or to suspend the service temporarily. This is to avoid wastage of TLD badges.

9.5 If high exposures to persons are suspected, their TLD badges can be returned immediately to us along with details of the incidence for urgent processing and necessary action.

9.6 If a TLD badge is lost by you, a declaration stating the circumstances under which the TLD badge was lost, duly signed by the user and the concerned Officer-in-Charge/R.C.O./Physicist, should be sent to us. The details of the radiation work done and the dose expected during the monitoring period should also be intimated to us. [**Note that an amount of Tk.5750/- (Taka five thousand seven hundred fifty only) will be charged for replacement of a TLD badge**].

10. Changes in the Requirements (Addition/Deletion of Names)

10.1 Specify the changes in the requirements, if any, clearly in the following format:

a) Names to be added.
b) Names to be deleted.

10.2 An individual data form should be filled in for each radiation worker and the same should be sent to us. This will help us to maintain correct life-time dose records of the radiation workers. All new names should be accompanied by the completed individual data forms. A copy of individual data form is attached along with this guide (annexure 1).

10.3 Intimation regarding changes in the requirements or suspension of service, if any, should reach **Head, Health Physics Division, Dhaka** one month in advance of the intended period of use. This intimation should be sent by a separate letter duly signed by authorized person.

10.4 All TLD badges once dispatched by us, irrespective of whether used or unused will be charged.

11. Units of Equivalent Dose & Effective Dose

11.1 Sievert is the unit used to express Equivalent Dose and Effective dose

1 Sievert (Sv) = 1 joule/Kg (weighted for type of radiation)
= 100 rem
1 milliSievert (mSv)= 1/1000 Sv = 100 mrem

11.2 There are two types of dose quantities:
a) Hp(10): 10 mm depth dose for strongly penetrating radiation.
b) Hp(0.07): 0.07 mm depth dose for weekly penetrating radiation.

12. Dose Limits

12.1 The cumulative effective dose (whole body dose) constraint for five years shall be 100 mSv for a radiation worker, i.e. annual average individual effective dose (whole body dose) shall not exceed 20 mSv per year.

12.2 Annual equivalent dose limit for the skin, the hands and feet is 500 mSv and for the lens of the eye is 150 mSv.

12.3 However it is strongly recommended to control and minimize the individual doses to **as low as reasonably achievable (ALARA)** by following good work practices.

12.4 Women radiation workers of reproductive age shall not normally be employed in areas where radiation exposures shall be at uniform rate of more than 20 mSv per year. When pregnancy has been diagnosed in a female worker, arrangements should be made to ensure that she will work only in the areas where exposures are most unlikely to exceed 1 mSv (100mrem) during the remaining period of pregnancy.

13. Dose Reports

13.1 The dose reports are sent after processing the respective personal TL cards and contain current period doses. Doses are reported in units of mSv (millisievert). Equipment used to read TL cards is shown in Fig. 1(a).

14. Over Exposures & Investigation Limits

14.1 If the three monthly (quarterly) dose is more than 5 mSv, a report should be submitted by the user to the Head, Health Physics Division, Dhaka within two weeks from receipt of the request, for such a report. Health Physics Division will also send a report to the Bangladesh Atomic Energy Regulatory Authority (Regulatory Body).

14.2 After receiving the investigation reports from the institution the overexposure cases are reviewed by Health Physics Division, Dhaka and advice on necessary follow-up will be intimated to the concerned institution.

15. Terms and Conditions of the Individual Monitoring Service

15.1 Charges for the Service

The Charges for providing the individual monitoring services are as follows:

a) Issuance of a new TLD badge for one worker Tk. 5750/- (Taka five thousand seven hundred fifty only)
b) Processing & reporting charge per TLD badge for three month period Tk.230/- (Taka two hundred thirty only)
c) Missing/damaging charge per TLD badge in case of reissue Tk. 5750/- (Taka five thousand seven hundred fifty only)

15.2 Bills/Invoices

a) Invoices for the charges are sent at the end of each year taking into account the materials and services provided throughout year.
b) The invoices contain details of materials supplied and service charges.
c) TLD personnel monitoring services bills should be paid immediately within 30 days on receipt of the invoice.
d) All charges should be paid by Bank Draft/Pay Order in favor of "**Health Physics Division, Dhaka"**
e) If the institution fails to send the payment towards the estimated bill within 30 days from the date of receipt of bill, then service is liable to be suspended/terminated and Director, Regulatory Body will be informed accordingly.

For further information, please contact:

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16. Instructions for Radiation Control Officers (RCO)

16.1 A TLD holder with any of its filters (metallic pieces loose, falling off) damaged should not be used. Ask for replacement of such holders.

16.2 Ensure that your badge is not left in a radiation area or near hot plates, ovens, furnaces, burners etc. while not in use.

16.3 Institutions using open/unsealed radioactive sources should periodically check the TLD holders for radioactive contamination by using suitable instruments. The holders which are found to be contaminated should be packed in a thick polyethylene and sent to Health Physics Division, Dhaka immediately.

16.4 Personal TLD card numbers are allotted to the radiation workers by Health Physics Division, Dhaka. These TLD card numbers are permanent and should not be changed.

17. Important Instructions for Users of TLD Badges

17.1 Before entering a radiation field or handling a radiation source, ensure that you wear a proper individual monitoring device.

17.2 Once loaded the TLD card into the holder should not be opened.

17.3 Use the TLD badge at chest level. (when a lead apron is used, wear the TLD badge under the lead apron)

17.4 A TLD badge is precious instrument to record your radiation doses. Handle with care.

17.5 If at any time a higher radiation exposure is suspected, promptly report it to Head, Health Physics Division, Dhaka and return the TLD badge for urgent processing, along with the details of the incident.

17.6 When the TLD badge is not worn, ensure that it is stored at a safe place away from radiation source. Never leave the TLD badge in a radiation area, in the vicinity of hot plates, ovens, furnaces etc.

Annexure-1

INDIVIDUAL DATA FORM

HEALTH PHYSICS DIVISION
ATOMIC ENERGY CENTRE
INDIVIDUAL MONITORING SERVICE

(Instructions: Use block letters, leave one blank square between each word)

1. Name in Full:

2. Father's/ Husband Name:

3. Date of birth:

D	D	M	M	Y	Y	Y	Y

4. Sex :

Male		Female	

5. Permanent Address:

6. Designation:

7. Date of Joining:

8. Blood Report: TC, DC, ESR, Hb%, Platelets

9. Qualification (Mark '√' in applicable box)

Graduate Post graduate Doctorate Engineer

Med. Doctor SSC/HSC Dip. Engg. Med. Diploma Others.

10. Nature of work/Practices: (Mark '√' in applicable box)

Ind. Radiography Fixed Radiography Ind. X-ray Diag. X-ray

Radiotherapy Nuc. Medicine Dental Radiography Reactor Operation

Research Health Physics Well Logging Mining & Milling

Fuel Fabrication Mech.Maint. Elect. Maint Nuc. Gauges

Analytical Technique Teletherapy Brachytherapy Radioactive Waste

In vivo diagnosis	Importer/Vendor/ Distributor	X-ray Simulator Machine
Others		

11. Name of the (ionizing) source:

12. Activity of the source : Date: D D M M Y Y Y

13. Physical state of the source : (mark tick)

Solid		Liquid		Gas	

14. For X-ray ,write :

KV		mA	

15. Name of the Department/Plant/Organization:

16. Name of the Installation:

17. Name of Manager/Head of Institution:

18. Address:

19. City:

20. Telephone: Fax: E-mail:

21. Name of the RCO:

22. (a) Have you worked with radiation prior to joining the present Institute:

Yes		No	

(b) If the answer is 'Yes'
From .....To.....
Duration of work

23. (a) Have you availed the Personnel Monitoring service in the previous Institution.

Yes		No	

(b) If the answer is yes, Please give the following details:
(In case of more than one institution, please furnish the information on a separate sheet)

i) Duration of work:
From.....To.....

ii) Dose received during this period: .....mSv.

iii) Name and address of the previous Institution:

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Signature of Head/RCO of Present Institution

Signature of Radiation Worker

Date;---------- Date;----------

Annexure-2

Definition

dose: A measure of the energy deposited by *radiation* in a target.

absorbed dose(D) The fundamental dosimetric quantity *D*, defined as:

$$D = \frac{d\varepsilon}{dm}$$

where $d\varepsilon$ is the mean energy imparted by *ionizing radiation* to matter in a volume element and dm is the mass of matter in the volume element.

annual dose. The *dose* due to *external exposure* in a year plus the *committed dose* from *intakes* of radionuclides in that year.

collective dose. The total *radiation dose* incurred by a population.

committed dose. The *lifetime dose* expected to result from an *intake*.

dose equivalent. The product of the *absorbed dose* at a point in the tissue or organ and the appropriate *quality factor* for the type of *radiation* giving rise to the *dose*.

personal dose equivalent, Hp(d). The *dose equivalent* in soft tissue below a specified point on the body at an appropriate depth *d*.

controlled area. A defined area in which specific *protection* measures and *safety* provisions are or could be *required* for controlling *normal exposures* or preventing the spread of *contamination* during normal working conditions, and preventing or limiting the extent of *potential exposures*.

effective dose, E. The quantity *E*, defined as a summation of the tissue *equivalent doses*, each multiplied by the appropriate *tissue weighting factor*:

$$E = \sum_T W_T H_T$$

where H_T is the *equivalent dose* in tissue T and W_T is the *tissue weighting factor* for tissue T. From the definition of *equivalent dose*, it follows that:

$$E = \sum_T W_T \sum_R W_R D_{T,R}$$

where W_R is the *radiation weighting factor* for *radiation* R and $D_{T,R}$ is the average *absorbed dose* in the organ or tissue T.
The unit of *effective dose* is the *sievert (Sv)*, equal to 1 J/kg. The *rem*, equal to 0.01Sv, is sometimes used as a unit of *equivalent dose* and *effective dose*.

supervised area. A defined area not designated a controlled area but for which occupational exposure conditions are kept under review, even though no specific protection measures or safety provisions are normally needed.

operations area. A geographical area that contains an authorized facility. It is enclosed by a physical barrier (the **operations boundary**) to prevent unauthorized access, by means of which the management of the authorized facility can exercise direct authority.