



TLD PERSONNEL MONITORING SERVICE

USERS INSTRUCTION MANUAL

(KINDLY PRESERVE THIS INSTRUCTION MANUAL FOR FUTURE REFERENCE)

AVANTTEC LABORATORIES PVT LTD.

**No. 17, ANNA INDUSTRIAL ESTATE, METTUKUPPAM,
VANAGARAM,**

CHENNAI - 600 095, INDIA

E - Mail: tldlab@avanttec.net Tel : +91-44-2386 2025

S.NO	CONTENT	P. NO
1.	INTRODUCTION	5
2.	SCOPE	5
3.	GENERAL FEATURES OF TLD SYSTEM	5
3.1	TLD CARD	6
3.2	TLD CASSETTE	6
3.3	TLD READER	6
4.	INFRASTRUCTURE	7
4.1	MAN POWER	7
4.2	SPACE	7
4.3	EQUIPMENT AND MATERIALS	7
4.3.1	TLD CARDS	7
4.3.2	TLD BADGES	7
4.3.3	TLD READERS	8
4.3.4	CALIBRATION SOURCE	8
4.3.5	SURVEY METERS	8
4.3.6	ANNEALING Oven	8
4.3.7	NUMBERING MACHINE	9
4.3.8	PC	9
4.3.9	STORAGE	9
4.3.10	SEALING MACHINES	9
4.3.11	X ray film LED Illuminator	9
4.3.12	FIRE EXTINGUISHER	9
5.	PROCEDURES	10
5.1	NUMBERING OF TLD CARDS	11
5.2	INDIVIDUAL CALIBRATION OF CARDS	11
5.3	ANNEALING OF CARDS	12
5.4	EXPOSING THE CARDS USING Cs 137 SOURCE	13
5.5	READING OF THE CARDS	14
5.6	DOSE ESTIMATION	15
	Important points to be remembered	17
5.6.1	American National Standards Institute (ANSI) Criteria	17

5.6.2	TRUMPET CURVE CRITERIA	18
5.6.3	PROCEDURE FOR TAKING THE REPORT	19
5.7	Quality Control procedure followed in the Laboratory	20
5.8	PROCEDURE FOR ENROLLMENT OF NEW INSTITUTION	21
5.9	PROCEDURE FOR ADDITION/DELETION OF CARD	21
6.	GRIEVANCES REDRESSAL	21
7.	JOB RESPONSIBLE	22
	Details of the Appendix given as enclosure	23
	Appendix – 1	
	Appendix – 2	
	Appendix – 3	
	Appendix – 4	
	Appendix – 5	
	Appendix – 6	
	Appendix – 7	
	APPENDIX – 3	
	TLD PERSONNEL MONITORING SERVICE	
	USER INSTRUCTION MANUAL	
8.	FEATURES OF TLD BADGES.	25
8.1	General	25
8.1.1	TLD Card:	25
8.1.2	TLD Cassette	26
8.1.3	Types of TL badges	26
8.1.4	Loading and unloading of TL card into cassette	26
8.2	SERVICE PROCEDURE	27
8.3	SERVICE PERIOD	28
	NOTE:	28
8.4	WHO SHOULD USE	28
8.5	WHERE TO WEAR	29
8.6	HOW TO USE	29
8.7	HOW TO RETURN THE USED TLD CARDS	30
8.8	CHANGES IN REQUIREMENT/ADDITION/DELETION OF NAMES	31
8.9	UNITS OF EQUIVALENT DOSE	32
8.10	EQUIVALENT DOSE/EFFECTIVE DOSE	32

8.11	DOSE REPORTS	32
8.12	OVER EXPOSURES	33
8.13	TERMS & CONDITIONS OF PERSONNEL MONITORING SERVICE	33
8.13.1	CHARGES	33
8.13.2	BILLS	34
8.13.3	OTHER TERMS & CONDITIONS	34
8.14	IMPORTANT INSTRUCTIONS	34
8.14.1	Address for all Correspondence	35
8.14.2	Service Suspension	35
	APPENDIX - 4	
9.	QUALITY ASSURANCE PROCEDURES FOLLOWED AT	
	AVANTTEC LABORATORY	
9.1	Numbering of the cards	36
9.2	Individual Calibration	36
9.3	Calibration Source.	36
9.4	Contamination Check	36
9.5	Annealing of the cards	37
9.6	Details of the procedures followed for reading the TLD cards	37
9.6.1	Testing procedure followed on daily basis	37
9.6.2	Testing procedures followed on monthly basis	37
9.6.3	Procedures followed for reading the field cards (Monthly / Quarterly)	38
9.7	Quality Assessment checks by external body	38
9.8	TL response – Dose linearity test.	39
9.9	Minimum Detection Threshold	39
9.10	Residual TL study	40
9.11	INTERNAL QAC AND RELATED WORK	40
9.11.1	READERS.	40
9.11.2	FIELD CALIBRATION CARDS	40
9.11.3	TL RESPONSE VARIATION STUDY AND DAILY CALIBRATION	41
9.11.4	CALIBRATION of Randomly Selected cards	41
9.11.5	Reader Factor Setting	42
10.	Types of Records Maintained in the Laboratory	42
	APPENDIX - 5	
	STAFF MEMBERS	44

PERSONNEL MONITORING SERVICES (PMS)

OPERATION MANUAL

1. INTRODUCTION

Personnel monitoring and dose estimation are very important in radiation protection program. One of the main aims of radiation protection is to keep radiation dose “as low as reasonably achievable (ALARA)”. BARC started providing Personnel Monitoring Service (PMS) to radiation workers since 1952 using film badge system. With the indigenous development of Thermo Luminescent Dosimetry (TLD) system PMS with film was gradually replaced from 1975 onwards. Presently this system is widely used for external dose estimation. The TL phosphor used in this system is CaSO₄: Dy. The advantages of this system over film badge are higher sensitivity, insignificant fading, reusability, low cost, indigenously made in large quantities, easy preparation, dose and dose rate independence etc.

BARC had given accreditation to private laboratories to conduct PMS. One such laboratory is Avanttec Laboratories (P) Ltd. Accreditation was accorded to this laboratory in January 2004. Personnel monitoring service had started from April 2004 for the radiation workers of southern states viz Tamil Nadu, Pondicherry, Kerala, Karnataka and Andhra Pradesh. Radiation workers include those who are working in Industrial, Medical and Research units of non – DAE establishments of the above states are being monitored using this system of dose estimation.

2. SCOPE

This manual gives the procedures followed in this laboratory to estimate individual doses of radiation workers using TLD system; It includes the infrastructure needed for PMS and the procedures followed for all the steps leading to dose estimation. It is prepared as per the requirement for an accredited laboratory based on the BARC report “Handbook on the use of TLD badge based on CaSO₄:Dy. Teflon TLD discs for monitoring – BARC/2002/E/025”.

3. GENERAL FEATURES OF TLD SYSTEM

The system is used to measure external individual doses from X, beta and gamma radiations when a worker is using radiation sources. It consists of a TLD

card loaded in a cassette having suitable metallic filters. It is based on the phenomenon of thermo luminescence, the emission of light when certain materials are heated after exposure to radiation. It gives very reliable results since no fading is observed under extreme climatic conditions

3.1 TLD CARD

A TLD card essentially consist of three CaSO₄ : Dy-Teflon TLD discs (13.3mm dia x 0.8 mm thick) mechanically clipped over three symmetrical circular holes each of diameter 12 mm, on a nickel plated aluminium plate (52.5mmx29.9mmx1mm). An asymmetric V cut provided at one end of the card ensures a fixed orientation of card in the TLD cassette. A thin paper wrapper provides personal data and the period of use. To protect the TLD discs from dust and mishandling, the card along with its wrapper is sealed in a thin plastic (polythene) pouch. Pouch also protects the card from radioactive contamination while working with open sources.

3.2 TLD CASSETTE

TLD cassette (card holder) is made of high impact plastic. TLD card when inserted in the proper position in the cassette will have the first disc (D1) sandwiched between a pair of filter combination of 1 mm Al & 0.9 mm Cu (1000 mg/cm² , total thickness). Copper filter is nearer to the TLD disc. The second disc (D2) is sandwiched between a pair of 1.5 mm thick plastic filters (180 mg/cm²). The third disc (D3) is positioned under a circular open window. A clip or strap attachment affixes the badge to the user's clothing or to the wrist. Two types of the badges are available; one worn at chest to measure whole body dose and another at wrist to measure extremities doses

3.3 TLD READER

Semi-automatic TLD reader is used to measure the doses. It consists of a photomultiplier tube, EHT module, heater control module and the associated electronic to measure the light emitted by the phosphor when heated. EHT is adjusted to give one to one corresponding readings of the dose given and the dose measured. The magazine holds 50 TLD cards and takes about 1 hour 50 minutes to read them. The glow curves and the integrated doses are stored in the hard disc of the PC as well as printed in a hard copy. Nitrogen gas is used to heat the discs at 285° Celsius.

4. INFRASTRUCTURE

The infrastructural facilities available in the laboratory are listed below

4.1 TECHNICAL MAN POWER

The lab is having 10 technical and 3 administration/accounts staff. The technical staff includes Senior Scientific Officer (cum RSO level –3) (1), Scientific officer (1), Junior scientific officer (3), Service engineer (2), Admin (5) and tradesman (2). Their qualification and experience are as per requirement mentioned in the accreditation handbook. The details are enclosed in the appendix – 5

4.2 SPACE

The lab is situated in the First floor of the building having an area more than 1500 sq. feet. It consists of office cum reception, reading room, oven room, calibration cum source storage room, Nitrogen Plant room, records room etc.

4.3. EQUIPMENT AND MATERIALS

Following equipment and materials are procured to process about 138500 TLD cards annually.

4.3.1. TLD CARDS:

About 95000 TLD cards are used to monitor about 2500 industrial workers on monthly basis and about 25000 workers of hospital cum research units on quarterly basis. The card number is more than twice the number of the workers as one set of cards will be in the lab while another set of cards with the workers. These cards are individually calibrated before their field use and strict quality control procedures are followed as per the BARC handbook to maintain the required accuracy and precision in dose estimation.

4.3.2. TLD BADGES:

Sufficient number of TLD badges (cassettes) are procured and used. They are of two types; one to measure whole body dose worn at chest and another at wrist to

measure extremities dose. One set of badge will be with the institution to be used with the cards.

4.3.3. TLD READERS:

Two numbers of semi-automatic readers of Type BR-7B(Sr.No.:1029 Aug 2003 and 1114 Mar 2005) supplied by M/s. Nucleonix Systems (P) Ltd is in use along with three readers made by us. The functioning of the reader is controlled by a PC, Window based software, developed by RSSD, BARC, is in use. Steady and unfluctuated voltage to the reader/PC is provided by stabilizer and UPS respectively.

4.3.4. CALIBRATION SOURCE:

Cs – 137 calibration source is available for exposing the TLD cards for individual calibration, reader calibration, testing the cards during OER cases etc. This source was supplied by BRIT with initial activity of about 566 mCi. This source gives an output of 6.98 mSv/hr at 50.5 cms(as on 01-06-2006). The source is stored in a pit situated in a corner of the calibration room. A calibration table is fabricated to expose the cards where in circles of radii 25 and 50 cms are drawn. The cards are arranged in the periphery of the perimeter of the circles and source is kept at the Centre of the circle. The plan of the calibration was approved by BARC.AERB. Radiological Protection survey of the room was carried out. Approval letter is attached in appendix - 4.

4.3.5. SURVEY METERS:

Micro processor controlled survey cum contamination monitor 2 Nos. (Model No. CM 710E Sr. No. 1006 Nov. 2003), (Model : PCRM 152D Sr No: 065 May 2013) and gamma zone monitor (1 No. Model # GA720 Sr.No.1029 Nov 2003) are procured and used. The area monitor is fixed inside wall of the source room wherein the movement of the source is monitored by this unit. Survey cum contamination monitor is used for checking the contamination in the cards and for measuring the radiation levels during radiological protection surveys etc. This unit is a portable one.

4.3.6. ANNEALING OVEN :

The cards are reusable after annealing them at 230 deg Celsius for 4 hours. Two annealing ovens are used for this purpose.

4.3.7. NUMBERING MACHINE:

The Impact Marker (Model IP 28 H/PN) has been used to number the card on the aluminium portion of the cards.

4.3.8. PC:

22 no of PC's are available for taking dose reports, delivery challan, Administration/Accounts, and other related works.

4.3.9. STORAGE:

10 SS boxes for storing TLD cards, 20 double trays for annealing the cards and 50 wooden trays for arranging the cards during receipts/dispatch.

4.3.10. SEALING MACHINES:

4 Nos of sealing machines used to seal the polythene pouches as all the cards are sent to the users in the sealed condition only.

4.3.11. X RAY FILM LED ILLUMINATOR:

It is used to find out the coloration of the discs in the cards during their field use as coloration reduces the TL response of the card. 2 such units are available.

4.3.12. FIRE EXTINGUISHER:

It is a 4KG portable dry powder extinguisher used for fire safety plan when the fire broke out. Below figure 1 shows how to use it.

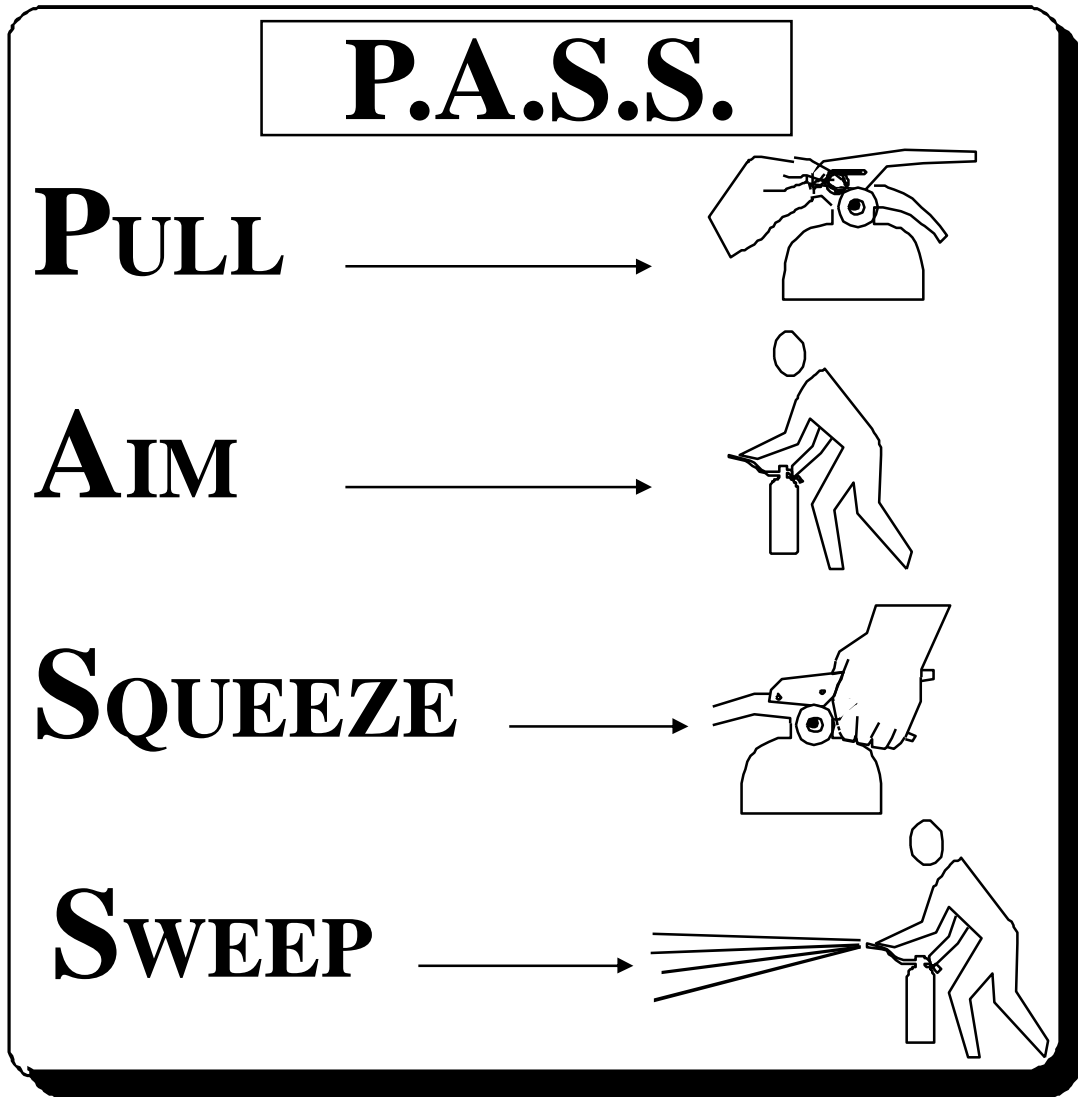


Figure 1.

5. PROCEDURES

Procedure followed while carrying out various operations are elucidated in this section.

5.1 NUMBERING OF TLD CARDS

The radiation detector used in this system is the TLD card. All cards are numbered before their field use. The system followed as A BBB CCCC (A-Avanttec, BBB-Batch Id, CCCC-Card no Ex: A 150 0001 (A-Avanttec, 150-Batch Id, 0001-Card no)

- ❖ Numbering of the card is essential for identification of the card
- ❖ Numbering is done by Impact Marker unit
- ❖ A numbered card can be retrieved any time for checking purpose
- ❖ It helps to record the doses received by the card when the history of the card is maintained.
- ❖ When the card is dispatched to any institution, the card number sent for the particular person is recorded and the same is confirmed while return of the card so that any loss, changing of the card etc can be traced.

5.2. INDIVIDUAL CALIBRATION OF CARDS

All the cards are individually calibrated by giving 3 mSv dose. New cards receiving date, annealed date, exposed and reading dates are maintained in a log book. The procedure for individual calibration as follows.

- ❖ Physical inspection for all the fresh cards to check any coloration, loose clipping etc(LED illuminator can be used)
- ❖ Number the cards using numbering machine E.g.: A 150 0001
- ❖ Anneal the cards as per standard procedure given above
- ❖ Expose the cards to a dose of 3 mSv by sandwiching them in between two Perspex sheets of thickness 3 mm in the calibration table for Cs 137 gamma radiation
- ❖ Read the cards after 7 days using one of the reader

- ❖ Group the cards as per their response wise i.e. Cards whose uncertainty level falls between $\pm 10\%$ and the cards whose uncertainty level fall beyond $\pm 10\%$.
- ❖ Accept all the cards which gives the response variation within $\pm 10\%$ for field use. Send the other group to the supplier for replacement.

5.3. ANNEALING OF CARDS

- ❖ Annealing is essential for erasing the residual TL, common for fresh or used Cards.
- ❖ Freshly annealed cards only should be used for field and laboratory studies.
- ❖ Arrange the cards in the cleaned SS trays meant for annealing. One tray will contain 300 cards
- ❖ Clean both inside and outside surfaces of the oven for use
- ❖ Keep the loaded SS trays inside the oven
- ❖ Switch ON the mains and then make Control switch ON.
- ❖ Set the annealing temperature of 230 degree Celsius in the PID Controller. The room temperature will be displayed
- ❖ Set the annealing time of 4 hours in the timer
- ❖ Wait for a minute and make Heater switch ON and set temperature alarm switch ON.
- ❖ Heating process will start and it will take about 60 minutes to reach the set annealing temperature of 230 degree.
- ❖ An audible alarm will be initiated when 230 degrees is attained.
- ❖ Make the set alarm switch OFF and then make timer switch ON
- ❖ Annealing time of 4 hours will start now.
- ❖ 230 ± 1 degree will be maintained through out the annealing time.
- ❖ Before the completion of the annealing time of 4 hours, measure the

actual temperature using another calibrated thermometer.

- ❖ An audible alarm will be initiated once 4 hours of annealing is completed.
- ❖ Switch OFF the heater and keep the fan ON for another 2 hours
- ❖ After two hours switch OFF Fan switch, then control and finally mains
- ❖ Remove the plug from the mains.
- ❖ Remove the cards next day for use.
- ❖ Select few cards randomly and read them. If the reading of the selected card <75 micro Sieverts then the annealing process is satisfactory. If the reading of the card is more than 75 micro Sieverts then the annealing process is not satisfactory. Then repeat the procedure.
- ❖ Record the data viz. date, starting time, Number and detail of cards, temperature recorded by additional thermometer in the log book with signature of the person.

5.4. EXPOSING THE CARDS USING Cs 137 SOURCE

- ❖ Randomly select the cards for exposure from the annealed lot of cards
- ❖ Load the cards sandwiching it between specially made perspex sheet and tie it with rubber band
- ❖ Make ON the area monitor kept inside the calibration room
- ❖ Arrange the loaded cards in the calibration table kept in the calibration room. 58 cards can be exposed at a time when arranged in the periphery of the circular line of radius 50 cms.
- ❖ Calculate exposure time from the Table to give the desired dose.
- ❖ Using the long tongue, bring the source and keep it in the centre of the circle where the cards are arranged in the table.
- ❖ Simultaneously, make stop watch also ON to reckon the exposure time.

- ❖ When the exposure time is completed, remove source and keep it in the pit and collect the cards.
- ❖ Wait for 7 days and then start using the cards. If immediate reading of these exposed cards is needed, then anneal them for 15 minutes at 80 degree Celsius. This sort of low temperature annealing treatment is essential to eliminate 140 degree low temperature peak.
- ❖ Alternatively, 10% of the net value of the TL response can also be deducted from total value measured to account for the effect of low temperature peak.

5.5. READING OF THE CARDS

- ❖ Keep two dummy cards in the first place of the magazine.
- ❖ Keep a field calibration card in the second place of the magazine
- ❖ Create a new personnel file in the Win TLD “Software for Semi Automatic TLD Reader “provided by BARC.
- ❖ Enter the Personnel information in the 16 digit format as given below :

05	06	1	015529	1255	0
Year	Month	Service M/Q	Inst. No	Pers. No	Chest/wrist
- ❖ As 50 cards can be loaded in the magazine, 47 field card details can be entered in it.
- ❖ At 50th position keep a field calibration card
- ❖ Verify whether all the entries made are correct using the verification option.
- ❖ Save the information as “ info file E.g.: D\ April – June 2015.info “
- ❖ Click the “ start the readout process icon in the menu bar
- ❖ The window of readout parameters will appear and display 50 cards
- ❖ Enter the number of cards loaded the magazine and then click “Next “icon.

- ❖ “Select the personnel file” window appear in which select the drive\folder \ file details. The details of the cards to be read will appear in the file name window and then click select option in the window.
- ❖ “Select/create glow curve file” window will appear in which scroll drive\folder\file details. In the region where “untitled “appears give the name of the glow curve file to be created or open the existing glow curve file.
- ❖ Click the select icon
- ❖ Automatically the reading process will be initiated. Light source reading will be carried out first and then heater stabilization will be carried out next. Once the heater temperature reaches 285 degrees Celsius, the first card will be taken in front of the PM tube and disc 3 of the card will be read followed by disc 2 and then finally disc 1.
- ❖ The magazine will be moved one step ahead in y direction and next card will be taken to PM tube in X direction. The process will be continued till all the 50 cards are read. Automatically the magazine is brought back to first card position
- ❖ Full Information is printed.

5.6 DOSE ESTIMATION

Let,

- ❖ D1 be the reading of dosimeter under Cu – Al filter
- ❖ D2 be the reading of the dosimeter under plastic window
- ❖ D3 be reading of the dosimeter under open window
- ❖ RV be the minimum reporting value
- ❖ ND1, ND2 and ND3 be the D1, D2 ,D3 minus control card reading
- ❖ Minimum Reporting values for Gamma = 0.1 mSv
- ❖ Beta = 0.5 mSv
- ❖ X ray = 0.05 mSv low energy beam
- ❖ Dose is equated to zero if it is less than the reporting value

- ❖ If the ratio of ND3 to ND1 is less than 1.3, then evaluate for gamma dose as follows
 - Gamma dose = ND1 (equated to zero if less than RV)
 -
- ❖ If the ratio of ND3 to ND1 is more than 1.3, also the ratio of ND3 to ND2 is more than 1.3 and ND1 is very close to control reading, then evaluate for beta dose as follows
 - Beta dose = $BMF \times (ND3 - 1.3 \times ND1)$
= Zero if less than RV
 - Where BMF is the Beta Modification Factor and is dependent on the beta energy.
- ❖ For Natural Uranium source, $BMF = 1.1$
- ❖ For Sr 90 source, $BMF = 1.1$
- ❖ If the ratio of ND3 to ND1 and ND2 to ND1 are more than 1.3, also the ratio of ND3 to ND2 is more than 1.2 and ND1 is significantly higher than the control, then evaluate for beta and gamma doses as follows
 - GAMMA dose = ND1
- ❖ BETA dose = as per the formula given above
- ❖ If the ratio of D2' to D1' is less than 1.3, gamma ray / X- ray (>200 keV) dose should be evaluated using the value of D1'

Dose = D1' (equated to zero if less than RV)
- ❖ To evaluate for X ray dose: if the ratio of ND3 to ND1 and ND2 to ND1 are more than 5, and ND2 – ND3 are within 20%, evaluate the X ray dose as follows
 - X-ray dose = $(ND2 + ND3) / 20$

(This will mean that the badge is exposed to x rays of energy less than 40 keV or the badge is over lead apron).
- ❖ If the ratio of ND2 to ND1 & ND3 to ND1 is More than 1.3 but less than or equal to 5, the badge is exposed to X rays of energy 40 to 200 keV or the badge is worn under the lead apron. The X ray dose is evaluated as follows

- X ray dose= $ND1 \times (A2 + A1R12 + A2R12^2 + A3R12^3 + A4R12^4)$

Where $R12 = ND1/ND2$ and $A0 = 2.6017$, $A1 = -15.8861$, $A2 = 45.5412$, $A3 = -53.2834$,

$$A4 = 22.5612,$$

Important points to be remembered

- ❖ In case of any ambiguity in the ratio of $ND2/ND1$, and $ND3/ND1$ etc, information regarding the nature of the radiation handled by the worker should be obtained and accordingly the dose should be evaluated.
- ❖ Beta and gamma doses are evaluated when it is ensured that photons of effective energy less than 60 KeV are not encountered significantly.
- ❖ X ray doses are evaluated when it is ensured that beta radiation is not encountered.
- ❖ Evaluated doses should be rounded off to nearest multiples of five.

5.6.1. American National Standards Institute (ANSI) Criteria:

American national standard Institution (ANSI) provides a producer for testing the performance of Dosimetric system. These producers are periodically reviewed by ANSI and the latest revision has been carried out in 2009. According to ANSI performance criteria, the definitions of some parameters which need to be evaluated are given below.

Performance quotient P_i is the relative difference of the personnel dose equivalent reported by the TLD unit (H') from the delivered personnel dose equivalent (H) which for the i^{th} dosimeter is

$$P_i = \frac{H_i' - H_i}{H_i} \quad i = 1 \text{ to } n \text{ (number of sample i.e. 25)}$$

H_i

(H_i' = Estimated Dose, H_i = Delivered dose)

The mean value of performance quotient of a set of dosimeters (P) or Bias (B) is

$$B = \sum_{i=1}^n P_i/n$$

Where sum is extended over all n values of P_i , The large magnitude of B indicates the bias in the data. A positive value of B means the reported dose is higher than the delivered dose, and a negative means that the reported values are less. If B is systematically too high or too low for all the tested categories, it may indicate calibration or algorithm error.

$$\text{THE STANDARD DEVIATION } S (\Sigma P) = \left\{ \left[\sum_{i=1}^n (P_i - \bar{P})^2 \right] / (N - 1) \right\}^{1/2}$$

Where the sum is extended over all n values of P_i for a particular test in a given radiation category or test category. If the values of σ_p are large, it indicates a lack of precision or large random scatter.

$$B^2 + S^2 \leq L^2,$$

$$\text{Or, } \{B^2 + S^2\}^{1/2} \leq L$$

Performance in a given radiation category is considered to be acceptable if the specified Tolerance Level (L) is not exceeded by the sum of the absolute value bias B and the standard deviation S is less than 0.3

$$\text{i.e } \{B^2 + S^2\}^{1/2} \leq 0.3$$

It has to be noted that lesser the tolerance value the better the accuracy and precision of dose determination.

5.6.2. TRUMPET CURVE CRITERIA:

The Upper limit of allowable accuracy level denoted as H_{ul} ,

$$H_{ul} = 1.5\{1 + H_0/(2H_0 + H_t)\}$$

The Lower limit of allowable accuracy level denoted as H_{ll} ,

$$H_{ll} = 1/1.5\{1 - 2H_0/(H_0+H_t)\}$$

Where H_t is conventional true dose (delivered dose) & H_0 is the lowest measurable dose i.e recording level.

(The performance is satisfactory if, for 95% of all measurements the ratio of measured and true dose [H_m/H_t] lies within the limits of the trumpet curve)

5.6.3. PROCEDURE FOR TAKING THE REPORT:

PMSM (Personnel Monitoring Service Management) software developed by Avanttec Medical System is used for taking the report. Further the software is used for printing the paper wrappers, address list and accounting for the addition/deletion of radiation workers.

- ❖ Open the PMSM by clicking the icon
- ❖ Among many options displayed, click ADMINISTRATION and in the resultant window click SETTING.
- ❖ Choose the origin of the glow curve data from the WIN TLD software and save the same in *.data file. Return to main menu.
- ❖ Click DOSE EVALUATION button and in the resultant window click LOAD selecting report generating date and reporting institution and click OK.
- ❖ In the resultant menu, choose the institution details. The disc values of the working of the respective unit will be displayed.
- ❖ Provide the control and type of radiation for the concerned person.
- ❖ Click the EVALUATE button on the upper tool bar. The doses are evaluated and displayed. This can be verified by manual calculation also.
- ❖ Save the dose data.
- ❖ Click the BACK button and return to main menu

- ❖ Choose REPORTS button and provide the service nature, year, Service month in the respective windows.
- ❖ Click NEXT button. Institution details will be displayed. Choose concerned institution and click OK.
- ❖ The REPORT for the respective institution will be displayed in the screen.
- ❖ Print the REPORT.

5.7. Quality Control procedure followed in the Laboratory

- ❖ All cards are numbered so that any card can be retrieved anytime for testing purpose and their dose history is maintained.
- ❖ Individual calibration of all fresh cards is done. The selected cards will have response variation within $\pm 10\%$ of the given dose.
- ❖ Physical inspection of all the cards are done using film viewer before they are loaded in the paper wrapper and polythene pouch.
- ❖ Control over Light source and heater temperature in the reader.
- ❖ After annealing the cards, to find out the completeness of annealing, few cards are randomly chosen and read.
- ❖ While reading field cards, calibration cards are kept in 3rd and 50th positions in the magazine and dummy in the first position.
- ❖ Cards selected on random basis, exposed and read to check sensitivity of the card.
- ❖ Linearity check, residual TL check disc ratio check are carried out once in every three months.
- ❖ Participation of BARC and MAPS QAC programmes
- ❖ Details of QA programme is given in the Appendix 4.

5.8. PROCEDURE FOR ENROLLMENT OF NEW INSTITUTION

- ❖ Send PMS, PDF/2 forms, Fee structure and TLD Personnel Monitoring Service – User Instruction Manual to the institution who wants to avail PMS with a request to return the forms along with registration and processing fees for the year in advance. Respective forms are enclosed in the appendix.
- ❖ On return of PMS and PDF/2 forms, verify the entries and forward them to Head, NODRS, RPAD, BARC, Mumbai 400 085 for getting the institution number and personnel number for the institution
- ❖ After getting the Inst. and personnel numbers from BARC, the wrappers are taken for that institution & cards are packed in the polythene pouch and sealed. The card number for personnel of that institution is noted in the software called PMSM (Personnel Monitoring Service Management).
- ❖ Dispatch the sealed cards along with DC and relevant papers to the institution either by courier service or by registered post.
- ❖ Maintain a record in software having details like Sr, No., Institution Number, name of the Inst., date of dispatch etc.

5.9. PROCEDURE FOR ADDITION/DELETION OF CARD

- ❖ Addition/ deletion details will come from institution.
- ❖ Make entries of addition/deletion details in the software (PMSM) and save.
- ❖ In cases of additions, cards are sent to the respective institution. Card dispatch is withdrawn for deletion cases

6. GRIEVANCES REDRESSAL

- ❖ Institutions sends mail to our official E-mail id or they contact us on the phone or sends letter for any information required or complaint.
 - (a) **Level - 1:** Replies to the details requested by them.
 - (b) **Level - 2:** If customer is not satisfied with the reply or no response is

received, they get in touch with this level.

(c) **Level - 3:** If not satisfied with level – 2, they approach this level.

- ❖ These interactions with institutions are recorded in the 'customers grievances' logbook as well as a soft copy in the system.

7. Job Responsible

The following responsible will be allocated to the each and every designation.

SENIOR SCIENTIFIC OFFICER (SSO)

- ❖ Dose report authorization
- ❖ OER authorization
- ❖ Managing all technical aspects

SENIOR OFFICER (SO)

- ❖ Managing the lab affairs

JUNIOR SCIENTIFIC OFFICER (JSO)

- ❖ Reading
- ❖ Report generation
- ❖ Addition
- ❖ Deletion
- ❖ Individual calibration
- ❖ Card expose

ADMIN STAFF

- ❖ Covers receiving
- ❖ Card barcode entry

- ❖ Contamination check

TRADESMEN

- ❖ Wrapper cutting
- ❖ Sealing
- ❖ Card receiving
- ❖ Card packing
- ❖ Filing

Details of the Appendix given as enclosure

APPENDIX – 1 APPLICATION FOR PERSONNEL MONITORING SERVICE (PMS FORM)

APPENDIX – 2 PERSONNEL DATA FORM (PDF/2 FORM)

APPENDIX – 3 USERS INSTRUCTION MANUAL

APPENDIX – 4 QUALITY ASSURANCE PROCEDURES BEING FOLLOWED AT AVANTTEC LABORATORIES

APPENDIX – 5 STAFF LIST

APPENDIX – 6 ORGANIZATIONAL FLOW CHART

APPENDIX – 7 SOURCE ROOM LAYOUT

APPENDIX-3

TLD PERSONNEL MONITORING SERVICE

KINDLY PRESERVE THIS INSTRUCTION MANUAL FOR FUTURE

(USERS INSTRUCTION MANUAL)

REFERENCE

AVANTTEC LABORATORIES PVT LTD.

NO.17, ARIGNAR ANNA INDUSTRIAL ESTATE,

METTUKUPPAM, VANAGARAM,

CHENNAI – 600 095.

EMAIL : tldlab@avanttec.net

TEL : 044-23862025

FAX : 044-23862024

TLD PERSONNEL MONITORING SERVICE

USER INSTRUCTION MANUAL

Personnel doses, received by Radiation Workers, are determined from the measurements are made by using Thermo luminescent Dosimeters (TLD) carried on the person. This type of dose estimation is called Personnel Radiation Monitoring.

Aim of personnel monitoring programme as outlined in Radiation Protection Rules-1971 promulgated by Government of India under Atomic Energy Act 1962 (33 of 1962) is to:

- ❖ Monitor and control individual doses regularly in order to ensure compliance with the stipulated dose limits.
- ❖ Report & investigate over exposures & recommend necessary remedial measures urgently.
- ❖ Maintain lifetime cumulative dose records of the users of the service.

As a rule no person is permitted to work in the radiation (X-rays, gamma rays, beta & neutron) field without the use of a proper personnel monitoring badge / device unless exempted & authorized by Radiological Physics & Advisory Division, Bhabha Atomic Research Centre, Mumbai. In case of any employer/manager or some other person compels a worker to perform certain radiation work without providing personnel monitoring badge, the matter must be immediately brought to the notice of Head, Radiological Physics & Advisory Division, Bhabha Atomic Research Centre, Mumbai – 400 085 & Atomic Energy Regulatory Board (AERB), Niyamak Bhavan, Anushakti nagar, Mumbai – 400 085.

8. FEATURES OF TLD BADGES.

8.1. General

It is used to measure external individual doses from X-ray, beta and gamma radiations. It consists of a TLD card loaded in a cassette having suitable metallic filters. It is based on the phenomenon of thermo luminescence, the emission of light when certain materials are heated after exposure to radiation. It gives very reliable results since no fading is observed under extreme climatic conditions (ambient temperature and humidity).

8.1.1. TLD Card:

A TLD card essentially consist of three CaSO₄: Dy-Teflon TLD discs (13.3mm dia x 0.8 mm thick) mechanically clipped over three symmetrical circular holes each of diameter 12 mm, on a nickel plated aluminium plate (52.5mmx29.9mmx1mm). An asymmetric V cut provided at one end of the card ensures a fixed orientation of card in the TLD cassette. A thin paper wrapper

(12mg/cm²) provides personal data and the period of use. To protect the TLD discs from dust and mishandling, the card along with its wrapper is sealed in a thin plastic (polythene) pouch. Pouch also protects the card from radioactive contamination while working with open sources.

8.1.2. TLD Cassette:

TLD cassette (card holder) is made of high impact plastic. TLD card when inserted in the proper position in the cassette will have the first disc (D1) sandwiched between a pair of filter combination of 1 mm Al & 0.9 mm Cu (1000 mg/cm² total thickness). Copper filter is nearer to the TLD disc. The second disc (D2) is sandwiched between a pair of 1.6 mm thick plastic filters (180 mg/cm²). The third disc (D3) is positioned under a circular open window. A clip or strap attachment affixes the badge to the user's clothing or to the wrist.

8.1.3. Types of TL badges:

- ❖ Chest badge: used for estimation of the whole body dose, worn at the chest level.
- ❖ Wrist badge: has a strap to be worn around wrist. It is used to estimate the dose to hands and to the forearms when they are likely to be selectively exposed.

8.1.4. Loading and unloading of TLD card into cassette:

The sealed TLD card can be loaded in the cassette in such a manner to match the V-cut of the cards to the provision available in the Badge. Extreme care must be taken, as the wrong loading will lead to improper dose assessment. Figure 2 may please be referred for loading and unloading of the cards to the cassettes



Figure 2. Loading & Unloading of TLD card to the cassette.

8.2. SERVICE PROCEDURE

- ❖ On receipt of a request from an institution desirous of availing of the TLD personnel monitoring services, Avanttec Laboratories Pvt Ltd will send copies of the application form for Personnel Monitoring (PMS form) and the Personal Data Form (PDF-2) and User's Instruction Manual. The application form and personal data forms for all persons to be monitored should be duly filled in and returned to Senior Scientific Officer, Avanttec Laboratories Pvt. Ltd., #17 Arignar Anna Industrial Estate, Mettukuppam, Vanagaram, Chennai – 600 095.
- ❖ Depending on the radiation work and the sources being handled, the institution will be informed about the total number of TLD badges for use on chest/wrist.

- ❖ The first consignment of TLD badges containing TL cards will be sent by Speed Post/Courier. This will be for a specified period of use.

8.3. SERVICE PERIOD

- ❖ Depending upon the type of institution, TLD service to an institution may be on monthly or quarterly basis. The institution will be intimated about the same.
- ❖ After one service period, the used cards have to be replaced by the fresh cards sent by Avanttec Laboratories (P) Ltd for the next service period.

NOTE:

- ❖ For all purposes only one address will be kept in our records. Hence address of the branches / temporary sites cannot be entertained.
- ❖ Since the materials are sent by Speed Post/Courier, instead of individual's name, designation e.g. Officer-In-Charge, Doctor-In-Charge, Director, etc., should be given in the address.
- ❖ The address should be complete with Pincode, Phone no., Fax no, Telex no, email address.
- ❖ Each institution and all radiation workers who are monitored will be allotted an Institution number and personnel number by NODRS, Radiological Physics & Advisory Division, Bhabha Atomic Research Centre, Mumbai – 400 085, which will be intimated to the user institution by BARC/Avanttec Laboratories (P) Ltd and the same should be referred to in all correspondence with us. Normally the TLD cards for use during a particular period will be sent in advance so as to reach the user institution during the last week of preceding month. In case the TLD cards/cassettes are not received in time as stated above or there is any discrepancy in the receipt of the materials, the same should be intimated to us immediately.

8.4. WHO SHOULD USE

- ❖ The TLD badges to be used only by persons as approved by AERB directly working with radiation sources such as X-ray units, radioisotopes etc. The dark room technicians, sweepers, helpers etc. need not normally be provided with TLD badges. In case of doubt kindly write to Avanttec Laboratories (P) Ltd.

- ❖ Please note that TLD badge is used to measure the radiation dose to which the user is exposed. It does not protect the user from the radiation.

8.5. WHERE TO WEAR

- ❖ One TLD badge should be worn compulsorily at the chest level. If a lead rubber apron is used, (e.g. in diagnostic X- ray departments) TLD badge should be worn under the lead apron at the chest level.
- ❖ The dose recorded by the TLD badge worn at the chest level represents the whole body dose equivalent.
- ❖ In special cases, depending upon the nature of radiation work, if the doses to the hands and forearms are expected to be significantly higher than at the chest level, additional wrist badges may be procured and used. Examples of such categories are persons handling radioisotopes from close distances and radiologists /doctors doing the special investigations such as cardiac catheterization, angiography's etc.
- ❖ Persons who are working with industrial radiography cameras should compulsorily use wrist badges in addition to chest badge.

8.6. HOW TO USE

- ❖ The TLD cards shall not be used without being loaded in the holders. Once the card is loaded in the cassette 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 TL card used without a cassette and hence dose estimation will not be possible.
- ❖ Whenever the person works in the radiation field, TLD badge should be always worn.
- ❖ A TLD badge allotted to one user should not be shared by any other person.
- ❖ Each institution should keep apart one TLD card loaded in a chest TLD holder as Control which is required for correct dose evaluation. The control badge should be stored in a radiation free area where there is no likelihood of any radiation exposure. Places such as X-ray rooms, rooms in which radioactive materials are

stored, handled or used and areas in the immediate vicinity of such rooms are not radiation free areas and should be avoided for storing the TLD cards. Kindly note that the TLD card and cassette for control TLD badge will also be charged.

- ❖ While leaving the premises of the institution, workers should submit their badges in the place where the control badge is kept. Also when no radiation work is being carried out, badge should be kept along with the control TLD badge.
- ❖ A TLD cassette holder showing any of its filters (metallic pieces) loose or falling off or otherwise damaged should not be used. Ask for replacement of such holders. The cassette for replacement will also be charged.
- ❖ Ensure that your badges is not left in the radiation field or near hot plates, ovens, furnaces, burners, etc.
- ❖ Institutions using open/unsealed radioactive sources should periodically check the TLD cassette for radioactive contamination by using suitable instruments. The cassette which is found to be contaminated should be disposed of at your end as radioactive waste. The contaminated badges should not be returned to us.
- ❖ Personnel numbers are allotted to the radiation workers by Calibration & Dose Record Section, Radiological Physics & Advisory Div, BARC, Mumbai. They are permanent and should not be changed at your end.

8.7. HOW TO RETURN THE USED TLD CARDS

- ❖ Return all the cards, (not the cassette), used and /or unused, immediately after every service period in one lot within 5 days after the end of the service period provided the cards to be used for next cycle are received. Unused TLD cards should not be retained at the users end for use during subsequent period. Please note all the TLD cards sent should be accounted for by the user institution. In exceptional cases when fresh cards are not received in time, the old TLD cards may be continued to be used until the new cards arrive, but the extended period of use should be clearly indicated on the TLD cards by sticking a label on the polythene pouch. Late return/ non-return of TLD cards do not serve the purpose of personnel monitoring.
- ❖ The institutions should always send back the TLD cards to be read by registered post Sending of TLD by air courier should be avoided as it is possible that airport authorities will screen the package under X ray machine at the airport.

- ❖ If a TLD card is not used, the remark “not used” should be written on the TLD card.
- ❖ While returning, arrange the TLD cards in the ascending order. Write the nature of radiation sources handled against the respective names in the PMS form.
- ❖ Use plastic boxes for returning the cards to avoid loss during transit. The boxes in which we are sending the TLD cards may be reused for returning the TLD cards.
- ❖ If you envisage that some workers who are already availing the service are not going to work in radiation field in the immediate future, the information about that should be sent at least one month before the start of the next cycle. The no of cards to be sent will be reduced accordingly.
- ❖ If high exposures to persons are suspected, their TLD cards can be returned immediately to us along with details of the incidence for urgent processing and necessary action.
- ❖ If a TLD card is lost at your end, a declaration stating the circumstances under which the card was lost, duly signed by the user and the officer-in-charge/R.S.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 Rs.125/- + Sales Tax will be charged for replacement).

8.8. CHANGES IN REQUIREMENT/ADDITION/DELETION OF NAMES

- ❖ Specify the changes in the requirements clearly if any,
1) Names to be added. 2) Names to be deleted. 3) Total monthly requirement of TLD cards. 4) Additional requirement of chest/wrist TLD cassettes.
- ❖ A personal 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 personal data forms. A copy of personal data (PDF/2) form is attached along with this manual.
- ❖ Intimation regarding changes in the requirements or suspension of service, if

any, should reach Avanttec Laboratories Pvt Ltd one month in advance of the intended period of use. This intimation should be sent by a separate letter duly signed by authorized person.

- ❖ All cassettes and TLD cards once dispatched by us, irrespective of WHETHER USED OR UNUSED WILL BE CHARGED.

8.9. UNITS OF EQUIVALENT DOSE

Sievert is the unit of Radiation Equivalent Dose

1 Sievert (Sv) = 1 joule/Kg = 100 Rem

1 millisievert (mSv)= 1/1000 Sv = 100 m Rem

8.10. EQUIVALENT DOSE/EFFECTIVE DOSE

- ❖ The cumulative effective dose (whole body dose) constraint for five years block (the current year + previous four years) shall be 100 mSv i.e. average 20 mSv per year in this five year block. In one calendar year in this period the individual effective dose (whole body dose) shall not exceed 30 mSv.
- ❖ Annual equivalent dose limit for the skin, the hands and feet is 500 mSv and for the lens of the eye is 150 mSv.
- ❖ However it is strongly recommended to control and minimize the individual doses to as low as possible by following good work practice. In this connection it is suggested that all individual whole body doses exceeding 1mSv (100 mRem) in a service period may be investigated and justified at your end.
- ❖ Women radiation workers of reproductive age shall normally be employed in areas where radiation shall be at uniform rate not more than 20 mSv per year. When pregnancy has been diagnosed, arrangements should be made to ensure that she will work only in the areas where exposures are most unlikely to exceed 2 mSv (200mRem) during the remaining period of pregnancy.

8.11. DOSE REPORTS

- ❖ The dose reports are sent after processing the respective personnel TL cards and contain current period doses and the up-to-date cumulative doses of the

current year. Doses are reported in units of mSv (millisievert).

- ❖ Annual dose reports are sent after the end of the year and contain annual doses and cumulative life time doses of all radiation workers. Any discrepancy in the annual dose report should be intimated to us promptly and positively within three months from the date of dispatch of the report. Complaints received subsequent to this period will not be entertained.

8.12. OVER EXPOSURES

- ❖ Dose equivalent recorded by the chest badge exceeding 10 mSv (1000 mRem) is treated as overexposure and the same is reported promptly to the institution and the individual concerned. The institution should arrange to investigate the causes of overexposure and report the findings to Avanttec Laboratories Pvt Ltd, which will be communicated to the appropriate authorities for overexposure at BARC.
- ❖ The persons receiving more than 100 mSv will be subjected to hematological examination including differential blood counts and chromosome aberration test at Bhabha Atomic Research Centre, Mumbai – 400 085.
- ❖ After receiving the investigation reports from the institution the overexposure cases are reviewed by B.A.R.C and advice on necessary follow-up will be intimated to the concerned institution.

8.13. TERMS & CONDITIONS OF PERSONNEL MONITORING SERVICE

8.13.1. CHARGES:

The charges for TLD cards and Cassettes are as follows:

- | | |
|---|--------------------|
| ❖ Processing charge per TLD card | Rs.150+Service tax |
| ❖ Lost/Tampered/Not Returned Card which needs to be replaced. | Rs.250+Sales tax |
| ❖ Overexposure Cards | Rs.250+Sales tax |

8.14.1. Address for all the correspondence regarding TLD personnel monitoring service:

**SENIOR SCIENTIFIC OFFICER
AVANTTEC LABORATORIES PVT LTD
NO. 17, ARIGNAR ANNA INDUSTRIAL ESTATE,
METTUKUPPAM, VANAGARAM,
CHENNAI-600 095.
PH: 044 – 23862025
MOB: 9345981511, 9444400385, 9884357891
Fax: 044 – 23862024
Email: tldlab@avanttec.net
Web: www.avanttec.net**

8.14.2. Service Suspension:

The service is liable to be suspended for any of the following reasons and Head, Radiological Physics and Advisory Division, BARC & Atomic Energy Regulatory Board will be informed accordingly.

- ❖ Irregularities in returning the TLD cards for processing.
- ❖ Non-payment of bills within 180 days.
- ❖ The investigation reports for overexposure not sent promptly.
- ❖ Misuses of TLD badges like tampering of TLD card, deliberate exposure to the TLD badge etc.

APPENDIX - 4

**QUALITY ASSURANCE PROCEDURES FOLLOWED AT
AVANTTEC LABORATORY**

9. QAC

Following are the procedures followed to achieve and maintain the expected accuracy

and precision

9.1. Numbering of the cards

All the cards are numbered so that any card can be retrieved at any time for checking purpose. When the card is dispatched to any institution, the card number sent for the particular person is recorded and the same is confirmed while return of the card.

9.2. Individual Calibration

All the cards are individually calibrated by giving a dose of 3 mSv. They were read in one reader. Those cards which give a response variation within $\pm 10\%$ with the given dose only are accepted for the field used. The cards falling beyond this value are sent back to the supplier for replacement.

9.3. Calibration source

A Cs – 137 calibration source procured from BRIT is used to expose the cards for calibration / testing purposes. The output of the source was measured using a calibrated condenser R chamber brought from HASL, IGCAR, Kalpakkam. On the basis of the output, decay correction was applied to arrive the doses at anytime .QAC studies carried out by BARC, MAPS and IGCAR confirms that the output value for this source is as close to the true value as possible technically. A log book is maintained wherein the details about date and time of use and number of cards exposed are recorded with the signature of the person who had done the exposures.

9.4. Contamination Check

On the receipt of parcel from Institution contamination check is done. The following procedures are carried out,

- ❖ After keeping all the parcel in polythene covered table, the parcels are scanned using the contamination monitor.
- ❖ If it shows above the background reading, that parcel has been removed & separately scanned again.
- ❖ Using rubber gloves we open it & scan all the cards which got contaminated.
- ❖ Uncontaminated cards are segregated & sent for reading.
- ❖ Contaminated cards are discarded as radioactive waste.
- ❖ Incident will be report to that particular institution to keep them more careful in future by recommending them to scan while dispatching the cards.

9.5. Annealing of the cards

Standard annealing procedure of 230 ° C for 4 hours is followed for annealing the cards. The temperature of the oven is shown by a built in digital thermometer. The temperature of the oven is further confirmed using a calibrated digital thermometer. This thermometer is calibrated locally by Regional Testing Centre .A log book is maintained having the details like no. of cards, time in and out, additional thermometer value are recorded. About 15 cards per annealing tray are selected randomly and read to assess the annealing status and record of such data is maintained.

9.6. Details of the procedures followed for reading the TLD cards.

9.6.1. Testing procedure followed on daily basis:

- ❖ Light source readings and Temperature of the heater were measured and recorded in the respective log book and maintained in system for all the readers.
- ❖ Five AC cards for each reader were read and their responses were recorded. This study is being carried out to assess the loss of response due to the increase in the cycles of use. These cards were exposed to an identical dose of 3 mSv. Their response variation is assessed and recorded and included in the respective monthly report
- ❖ While reading the field cards, identically exposed calibration cards are placed in the 3rd and 50th position in the magazine. Their response is evaluated in the month end and given in the respective monthly report. The hard copies of the read cards are filed in box files. Dose report is generated using the software developed by our sister concern.

9.6.2. Testing procedures followed on monthly basis:

- ❖ About 50 cards are randomly selected from the lot of annealed cards meant for dispatch and read in each reader to know the residual TL after annealing. The hard copy is filed in the respective file.
- ❖ About 50 cards are randomly selected from the annealed lot of cards meant for monthly/quarterly dispatch, exposed to 3 mSv and read. Response variation is assessed and included in the respective monthly report.
- ❖ Study of minimum measurable dose, linearity and TL response, determination of

disc factors and calibration factors are carried out to confirm the already record value and the data is filed.

9.6.3. Procedures followed for reading the field cards (Monthly / Quarterly):

- ❖ With the use of software, paper wrappers with card ID were printed and cut to the size
- ❖ The card number is entered in the PMSM software and loaded with respective paper wrapper and put inside the polythene pouch and sealed. Along with other enclosures like dose report, DC etc, the same are dispatched to the institution.
- ❖ On receipt, the card number of the dispatch and receipt for the concerned institution and person are confirmed and recorded in the respective PMSM software.
- ❖ Field cards are arranged in the magazine in ascending order and read in the readers.
- ❖ The dose report is prepared using the software giving the whole body (X and gamma) and beta doses in mSv.

9.7. Quality Assessment checks by external body

- ❖ The laboratory takes part in the QAC programme conducted by BARC. 75 randomly selected cards are sent to BARC where these cards are given unknown doses and returned. The doses as measured by reading the cards are intimated to BARC. The accuracy and precision of the dose estimation are assessed using ANSI – 2009 guidelines. Since April 2004, the Laboratory tookpart in 39th and 40th cycles of QAC conducted by BARC and the performance in estimating the doses by the Laboratory is said to be satisfactory. The results are given below

Cycle	Radiation	By ANSI criteria
39 th 2013	Gamma	P Avg = 0.11
		P std dev = .016
		L value = 0.20
	Others	P ave = 0.11

		P std dev = 0.15
		L value = 0.18
40 th 2014	Gamma	P Avg = 0.01
		P std dev = 0.06
		L value = 0.06
	Others	P ave = 0.11
		P std dev = 0.15
		L value = 0.18

9.8. TL response – Dose linearity test.

- ❖ Cards are sandwiched in between perspex sheets are exposed to various doses ranging from 0.3 to 20 mSv in convenient steps.
- ❖ The cards are read in all the readers.
- ❖ A plot can be made with dose in the x axis and TL response in y axis. The straight line will reveal the dose is linear to the TL response.
- ❖ Alternatively, TL per mSv can also be calculated. TL/mSv will be same for all the doses will confirm the TL vs dose is linear.
- ❖ Minimum of 3 cards can be taken for each dose and the average value can be estimated and plotted.

9.9. Minimum detection threshold

- ❖ 10 cards can be taken randomly from the lot for this study
- ❖ These cards are annealed as per standard procedure
- ❖ These cards are read in all the readers.
- ❖ The readings should be carried out within 24 hours after annealing
- ❖ Average read out of the cards along with their standard deviation is estimated.

- ❖ The value of three times of the standard deviation arrived at is considered to be minimum detectable limit for the reader.

9.10. Residual TL study

- ❖ Sets of 3 cards are exposed to various doses and read in all the readers.
- ❖ Without disturbing anything, the cards are read second time.
- ❖ The ratios of the net values of a particular disc during the second reading to that in the first reading are estimated.
- ❖ The ratios should be within 10%

9.11. INTERNAL QAC AND RELATED WORK

9.11.1. READERS:

- ❖ Reader parameters like EHT, Light Source readings (LS), the heater temperature, calibration Factor and disc factors are noted for all readers and the values are recorded daily in the respective log books.

S.NO	DATE	L.S	TEMP	EHT	LPM	PEAK	RCF	D1	D2	D3	SIGN	CHECKED BY
READER #												

- ❖ Reader calibration is carried daily before starting the reading of field cards as well as while reading the field cards in the following manner.

9.11.2. FIELD CALIBRATION CARDS:

All calibration cards were exposed to 3.0 mSv using perspex sheet sandwiching. These cards are placed in the 3rd and 50th positions in the magazine while reading the field cards in different days. After the completion of the readings in that month, dose data of all such calibration cards are pooled together and dosimetric parameters were estimated.

Dosimetric parameters	Readers #
Performance Quotient (P)	
Std Dev of P	
Tolerance Value L	
Arithmetic average(mSv)	

9.11.3. TL RESPONSE VARIATION STUDY AND DAILY CALIBRATION:

1000 cards are selected and kept separately for this study. They are exposed to 3 mSv of dose using Perspex sheets. These cards are read daily (5 cards per day) in each reader before starting of the regular readings of field cards. Such cycle of use is repeated every month. These cards are in their 14th cycle of use. Dosimetric parameters were estimated and the response of the cards were recorded and compared. Daily data was collected together by the month end and dosimetric parameters were evaluated. As all the three discs are exposed using Perspex sheet and each disc's response can be used for dose evaluation. In 14 cycles of use, no significant variation in the TL response was observed.

Dosimetric parameters	Reader #
Performance Quotient (P)	
Std Dev of P	
Tolerance Value L	
Arithmetic average(mSv)	

9.11.4. CALIBRATION OF RANDOMLY SELECTED CARDS:

50 cards were randomly picked up from the lot of annealed cards meant for dispatch in the month. These cards were given an identical dose of 3 mSv and read in each reader.

Dosimetric parameters	Reader #
Performance Quotient (P)	
Std Dev of P	
Tolerance Value L	
Arithmetic average(mSv)	

9.11.5. Reader Factor setting:

Reader calibration procedure as follows,

- ❖ For calibrating the reader factors 5 control & 20 calibration cards(3 mSv) are used.
- ❖ Before readout of the cards change all the disc factors D1,D2,D3 & RCF to be 1.
- ❖ Then 1st & 2nd position are dummy, 3rd to 7th position are control cards, from 8th to 27th position are calibration cards.
- ❖ The formulas are

$$RCF = \frac{\text{Given Dose (3000)}}{\text{Avg of D1}}$$

$$D1 = 1.00$$

$$D2 = ND1/ND2$$

$$D3 = ND1/ND3$$

- ❖ Read some exposed cards to confirm the reader calibration.
- ❖ Repeat the procedure if the readings are not satisfied.

The reader calibration must be done in first week of every month or whenever needed.

10. Type of records maintained in the Laboratory

- ❖ Individual log books as well as softcopy for all the TLD Readers are made in which daily entries are made on the observations like EHT, Heater temperature, Light source readings, AC cards study readings. Any changes made in the reader parameters are also recorded.
- ❖ A log book is maintained for recording the details of the use of Cs 137 calibration source. Entries are made when the source is taken out for exposure. Details like date, number of cards exposed, dose given time in time out and signature of the person used are entered.
- ❖ A log book is maintained for annealing of TLD cards in which the annealing

details like date, number of cards annealed, temperatures as recorded by built in thermocouple as well as external thermometer.

- ❖ In addition to this separate box files are made for linearity of TL response with dose, Response of TL sensitivity reduction, if any, due to cycles of use
- ❖ Hard copies of all monthly/quarterly and experimental cards are stored in respective files kept for BARC inspection and for future reference.
- ❖ A log book is maintained for individual calibration cards details like batch number, total no of cards accepted/rejected & sensitivity of the cards.
- ❖ A separate log book is maintained for the use of contamination check.
- ❖ Abnormal/damaged/oily received cards are maintained in separate log book.
- ❖ Abnormal readout of the cards are maintained along with glow curves in the log book.
- ❖ A log book is maintained for the use of periodic acetone wash of the cards.

- ❖ Customer clarification & complaints over telephone are recorded in separate log book.

APPENDIX - 5
STAFF MEMBERS

S.#	NAME	DESIGNATION	QUALIFICATION	DATE OF JOINING	TRAINING
1	SHRI.P.AYAPPAN	S.S.O	M.Sc	OCT 2003	RSO LEVEL III
2	SHRI.S.SIVARAMAN	S.O	B.E	OCT 2003	TRAINED AT BARC (TWICE)
3	SHRI.R.GANESH	J.S.O	M.Sc	MAR 2012	TRAINED AT BARC
4	SHRI.P.VELAYUTHAM	J.S.O	M.Sc	JAN 2012	TRAINED AT BARC
5	SHRI.P.RAJESH	J.S.O	M.Sc	MAR 2012	IN HOUSE TRAINED
6	SHRI.P.CHINNAMAHARAJA	SENIOR SERVICE ENGINEER	B.E	FEB 2008	TRAINED AT BARC
7	SHRI.N.SUDHARSAN GOPINATH	SERVICE ENGINEER	B.E	APR 2011	IN HOUSE TRAINED
8	SHRI.S.MUNIVEL	J.O	B.A	APR 2004	IN HOUSE TRAINED
9	SHRI.V.PUSHPARAJ	TRADESMAN	+2	JUN 2010	
10	SHRI.B.KARTHICK	TRADESMAN	10 th	DEC 2009	
11	SMT.A.JANAKI	ADMINISTRATOR	MA	OCT 2003	
12	SHRI.R.SANAD MURARI	CUSTOMER REDRESSAL	B.A	JAN 2012	
13	MS.R.MALA	OFFICE ASSISTANT	+2	JUL 2014	
14	SHRI.M.MANIMARAN	ACCOUNTS EXECUTIVE	B.COM	APR 2014	