

# Personnel Monitoring



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# Background

**Radiologists and radiographers are routinely exposed to ionizing radiation. The level of exposure depends on the type of activity in which they are engaged. Determining the quantity of radiation they receive requires a program of personnel monitoring.**

***Personnel monitoring*** refers to procedures instituted to estimate the amount of radiation received by individuals who work in a radiation environment.

- **Personnel monitoring is required when there is any likelihood that an individual will receive more than one tenth of the dose limit. Most clinical diagnostic imaging personnel, must be monitored.**
- **It is usually not necessary to monitor diagnostic imaging secretaries, file clerks, operating room personnel except those routinely involved in fluoroscopy.**

**The personnel monitor offers no protection against radiation exposure. It simply measures the quantity of radiation to which the monitor was exposed and therefore is used as an indicator of the exposure of the wearer.**

- **There are basically three types of personnel monitors in use in diagnostic imaging: film badges, thermoluminescence dosimeters, and pocket ionization chambers.**
- **Regardless of the type of monitor, it is essential that it be obtained from a certified laboratory. In-house processing of radiation monitors should not be attempted.**

# Film badges

Film badges came into general use during the mid-1940s and have been widely used in diagnostic imaging ever since.

Film badges are specially designed devices in which a small piece of film similar to dental radiographic film is sandwiched between metal filters inside a plastic holder.

# Film badges

The film incorporated into a film badge is special radiation dosimetry film that is particularly sensitive to ionizing radiation. The optical density on the exposed and processed film is proportional to the exposure received by the film badge.

# Film badges

Exposures less than 10 mR (2.6  $\mu$ C per kilogram) are not measured by film badge monitors, and the film badge vendor will report only that a minimum exposure (M) was received. When higher exposures are received, they can be accurately reported.

# Advantages of film badge

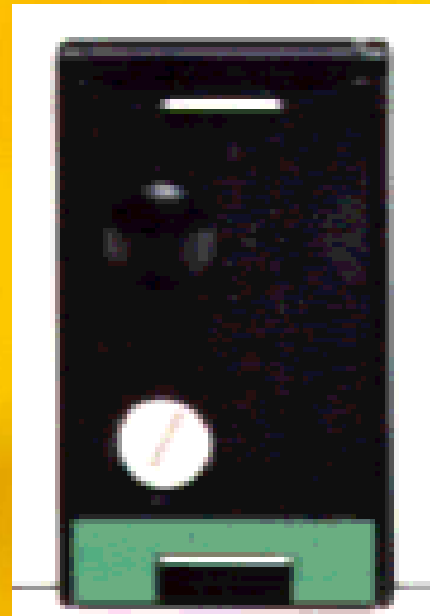
- **inexpensive**
- **easy to handle**
- **not difficult to process**
- **reasonably accurate and**
- **have been in use for several decades.**

# Disadvantages of film badge

- since they incorporate film as the sensing device, they cannot be worn for long periods because of fogging caused by temperature and humidity.
- should never be left in an enclosed car or other area where excessive temperatures may occur. The fogging produced by elevated temperature and humidity will result in a falsely high evaluation of exposure

# Thermoluminescence dosimeters

The thermoluminescent dosimeter consists essentially of two parts - a TLD card and a plastic holder.



# **Thermoluminescence dosimeters**

**The TLD card consists of two or more Lithium Fluoride (LiF) chips mounted on an aluminum card. Each card is identified by a barcode. The issued TLD card is sealed in a plastic wrapper and labeled with the period of issue, wearer's name, wearer's ID number, Company Code and TLD number.**

# **Thermoluminescence dosimeters**

**The card has a cutaway corner to ensure that it fits exactly into the plastic holder. One LiF chip will be behind the open window for estimating skin dose while the other chip is behind a filter to estimate body dose.**

**The TLD card, encased within the holder is called the thermoluminescent dosimeter (TLD) or more frequently referred to as the TLD badge**

# **Thermoluminescence dosimeters**

**The sensitive material of the TLD monitor is lithium fluoride (LiF) in crystalline form, either as a powder or more often as a small chip approximately 3 millimeters square and 1 millimeter thick.**

# **Thermoluminescence dosimeters**

**When exposed to x-rays, the TLD absorbs energy and stores it in the form of excited electrons in the crystalline lattice. When heated, these excited electrons fall back to their normal orbital state with the emission of visible light. The intensity of visible light is measured with a photomultiplier tube and is proportional to the radiation dose received by the crystal.**

# Thermoluminescence dosimeters



**TLDs are available as chips, disks, rods, and powder. They are used for area and environmental radiation monitoring and especially for occupational radiation monitoring**

# **TLD's advantages over film**

- **It is more sensitive and more accurate than a film badge monitor.**
- **Properly calibrated TLD monitors can measure exposure as low as 5 mR (1.3  $\mu$ C per kilogram).**
- **The TLD monitor does not suffer from loss of information after exposure to excessive heat or humidity. They can be worn for intervals up to 3 months at a time.**

# **TLD's disadvantages**

**The primary disadvantage of TLD personnel monitoring is cost. The price of a typical TLD monitoring service is perhaps twice that of film badge monitoring.**

**If the frequency of monitoring is quarterly, however, the cost is about the same.**

# **Pocket ionization chambers**

**Pocket ionization chambers are small devices measuring approximately 2 centimeters in diameter by 10 centimeters long and are designed to be clipped onto wearing apparel like a writing pen. Pocket ionization chambers in diagnostic imaging has a range of 0 to 200 mR (0 to 50  $\mu\text{C}$  per kilogram).**

# Pocket ionization chambers

- they are often used for a day or so to monitor nonimaging personnel such as nurses
- they are reasonably accurate and sensitive, but they do have a limited range. Should exposure to an individual exceed the range of the dosimeter, the precise level of exposure would never be known.
- they are fairly expensive and can be easily damaged.

## **Where to wear a personnel monitor**

**Many radiographers wear their personnel monitors in front at the waist or chest level because it is convenient to clip the badge over a belt or a shirt pocket. If the radiographer is not involved in fluoroscopic procedures, these locations are acceptable.**

## **Where to wear a personnel monitor**

**If the radiographer participates in fluoroscopy, the personnel monitor should be positioned on the collar above the protective apron. The dose limit of 5000 mrem per year (50 mSv per year) refers to the effective dose (E). It has been shown that during fluoroscopy, when a protective apron is worn, exposure to the collar region is approximately 20 times greater than that to the trunk of the body beneath the protective lead apron. So, if the personnel monitor is worn beneath the protective apron, it will record a falsely low exposure and will not indicate what could be a hazardous exposure to unprotected body parts.**

# Where to wear a personnel monitor

**In some clinical situations, it may be advisable to wear more than one personnel monitor.**

- **This is not normally necessary for diagnostic radiographers.**
- **The abdomen should be monitored during pregnancy.**
- **The extremities should be monitored during angiointerventional procedures during which the radiologist's hands are in close proximity to the useful beam.**
- **Nuclear medicine radiographers should wear extremity monitors when handling radioactive material.**

# **Personnel Monitoring Report**

**State and federal regulations require that the results of the personnel monitoring program be recorded in a precise fashion and maintained for review. Monitoring periods and the associated exposure records must not exceed a calendar quarter. Quarterly, monthly, or weekly reports are acceptable, but records reflecting longer periods of time are not.**

# Personnel Monitoring Report

The personnel radiation monitoring report must contain a number of specific items of information:

- the employee name
- an identification number assigned to the radiation worker and monitor
- the type of monitor

# Personnel Monitoring Report

- **personal data required include birth-date, social security number, and gender**
- **exposure data: current exposure, cumulative quarterly exposure, cumulative annual exposure.**
- **Separate radiation monitors (i.e. extremity monitors) would be identified separately from the whole-body monitor.**

# **Personnel Monitoring Report**

**When one changes employment, the total radiation exposure history must be transferred to the records of the new employer. Consequently, when one leaves employment, one should automatically receive a report of the previous total radiation exposure history at that facility. Such a report should be given automatically; if it is not, it should be requested.**

# **Personnel Monitoring Report**

**When establishing a personnel radiation monitoring program, the supplier of the monitor should be informed of the type of radiation facility involved. That information will influence the method of calibration of the monitors and the control monitors.**

**The control monitor is used to measure the background exposure during transportation, handling, and storage. It should never be stored in or adjacent to a radiation area. It should be kept in a distant room or office.**

# **Personnel Monitoring Report**

**All monitors should be returned to the supplier together and in a timely fashion so they can be processed together. Lost or inadvertently exposed monitors must be evaluated and an estimate of the true exposure recorded. Unless there are unusual circumstances, the estimate can be made by averaging the previous 6-month exposures.**

## **Points to be noted**

➤ **Place the TLD card in the holder such that the cutaway corner matches the groove in the holder. The wearer's name should be visible through the transparent window of the holder. The wearer's name should be against the wearer when the badge is worn.**

## **Points to be noted**

- **Do not store badges in a place where they could be exposed to radiation as this could lead to false indication of dose received by wearers.**

## **Points to be noted**

➤ **If the badge was accidentally irradiated e.g. if it had dropped in a place where radiation work was being done, must return the badge to the Centre for Radiation Protection (CRP) immediately and state that the badge was accidentally irradiated. If you do not inform and the TLD card is processed, it will be recorded that you have received the excessive dose and you may be suspended from radiation work, depending on the dose recorded.**

## **Points to be noted**

- **If you suspect that you have received an excessive dose due to an accident, please bring your TLD badge to CRP immediately for evaluation of dose received.**
- **Extreme heat, direct sunlight, pressure (e.g. by finger nails, bending stapling etc.) should be avoided as these can damage the TLD card.**
- **If the TLD card is damaged or lost, a fee is payable.**

## **Points to be noted**

➤ **TLD cards are issued monthly/bimonthly /quarterly. While the holder is purchased, each TLD card issued remains the property of CRP. Hence the TLD card of any worker who has resigned MUST be returned to CRP within 2 weeks. Otherwise it will be assumed that the TLD card is lost and the company will be charged for it.**

## **Points to be noted**

**All TLD cards should be collected from CRP during the last week of the month at intervals of one month/two months/three months and ALL the cards which were previously issued, should be returned to CRP for processing within one week.**

# Bibliography

- **EUCLID SEERAM, Rad Tech's Guide to Radiation Protection, Blackwell , 2001**
- **BUSHONG SC. Radiologic science for technologists-Physics, Biology and Protection. 6th ed. CV Mosby Co, St. Louis, Toronto, 2001**
- **BREASTRUP CB, VICTERIOJ KJ, Manual on Radiation Protection in hospitals and general practice – Basic protection requirements, WHO, Geneva, 1974**
- **Annals of the ICRP: Radiation Protection No 34, 49, 60**
- **EU Directive 97/43 30-6-1997**
- **EURATOM 80/836 & 84/467**

# Personnel Monitoring

## Questions???



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