



Neutron dosimetry Information sheet

Mirion Dosimetry Services in Arnhem provides dosimeters to its customers on the basis of the approval granted by the Autoriteit Nucleaire Veiligheid en Stralingsbescherming. The dosimeters are intended for use as a personal dose control device as described in het Besluit basisveiligheidsnormen stralingsbescherming. Different types of dosimeters are available. This information sheet covers the dosimeters for determining the dose due to exposure to photon, beta and neutron radiation.

Dose quantities

In accordance with the recommendations of the International Commission on Radiation Units and Measurements (ICRU), the European Recommendation RP160 and het Besluit basisveiligheidsnormen stralingsbescherming, the dosimeters provided by Mirion Dosimetry Service are designed to measure the dose quantity personal dose equivalent. This dose equivalent is determined at a depth of 10 mm in soft tissue, the so-called deep dose $H_p(10)$, and at a depth of 0.07 mm, the so-called shallow dose $H_p(0.07)$.

Combi dosimeter

Figure 1 shows the combi-dosimeter, consisting of a thermo-luminescent dosimeter (TL dosimeter) and a PADC dosimeter. The PADC dosimeter guarantees an accurate measurement of the neutron dose, but has a relatively high detection threshold. Therefore, the TL dosimeter, which is renewed every four weeks, is equipped with a specific detector, which is very sensitive to neutrons, but which does not allow the neutron dose to be determined with sufficient accuracy. Based on the indication of this detector, it is assessed whether the neutron dose should actually be quantified and the PADC dosimeter is called back for evaluation. When the result of the neutron-sensitive detector shows no sign of neutrons, the PADC dosimeter remains with the wearer. Every calendar year starts with a new PADC dosimeter. Using this procedure, the estimated threshold for the annual dose due to neutron radiation is approx. 0.2 mSv.



Figure 1: The combi-dosimeter consisting of the combination of a TL-dosimeter (above) and a PADC-dosimeter.

The detection threshold for neutrons is independent of photon dose.

Thermoluminescence dosimeter

In addition to the neutron-sensitive detector, the TL dosimeter contains another three detectors. These three detectors provide information on exposure to photon and beta radiation. The detectors consist of thermo-luminescent material. Figure 2 shows the components of the TL-dosimeter.



Figure 2: The TL- dosimeter seen from the inside: above the beta detector, to the left and right the photon detectors and below the neutron detector.

Ionizing radiation brings electrons to a higher energy level in the crystal lattice of the detector and captures them there. The number of electrons stored in the higher energy level is proportional to the radiation dose absorbed by the detector. When the detector heats up to about 200°C, these electrons fall back to their original level. The stored energy is released as light (thermoluminescence). The amount of light emitted by the detector during heating is measured and is directly proportional to the absorbed dose of ionizing radiation. After this heating in the reader, the detector has returned to its original state and can be used again.

PADC dosimeter

The principle of this dosimeter is based on the fact that neutrons cause minor damage in a film made of polyallyldiglycol carbonate (PADC). Figure 3 shows the opened PADC dosimeter with the film. The film is etched in the laboratory, after which these damages can be counted using image processing equipment. The number of traces per cm^2 is then a measure of exposure. Figure 3 shows an example of an etched film. The PADC dosimeter has the advantage over a TL dosimeter that it is much less sensitive to the type of neutron source and not sensitive to photons and wearing conditions.

Dose registration and privacy protection

In accordance with legal regulations, the measured deep dose is recorded in the NDRIS, the Nationaal Dosisregistratie- en Informatiesysteem. In addition, the personal data, including the dose results, are exclusively disclosed to the client and, if requested, to the Inspectie-SZW. For more information please refer to the general terms and conditions available at the website www.dosimetrie.nl.



Figure 3: Left: opened PADC-dosimeter showing foil. Right: example of an etched foil.

Periodic dose reporting

The measurement results are reported periodically. The dose is reported in the millisievert unit (mSv). If the set warning level per reading is exceeded, the result is reported immediately by e-mail. By default, this level is set to 1 mSv. However, the settings of this level can be customized using our customer web application. If the annual dose limit is exceeded, a prominent warning is printed on the dose report. An overview of the individual dose data for the past year will be sent around the beginning of April.

Managing dosimeter subscriptions

Using the customer web application at www.dosimetrie.nl simplifies the management of dosimeter subscriptions. Access to the customer web application can be requested at dosimetrie-nl@mirion.com.

Identification dosimeter

Both the TL dosimeter and the PADC dosimeter have a label. The color of the edge and the Mirion logo on this label varies from period to period. The label contains the following information:

- The name of the wearer (maximum 20 positions)
- Group number and subscription number
- The periodicity (4W), year number and period number
- The dosimeter number

The TL dosimeters do not belong to one particular person, but rotate randomly. For each issue period, a link is made between the carrier and a TL dosimeter. The PADC dosimeter is assigned to a wearer once. This relation person/dosimeter/period is recorded in the dosimetry service database.

Renewal and mounting

A combi holder is available for the TL and PADC dosimeter (Figure 1). The rectangular PADC dosimeter can be positioned from the rear through the recess. The round TL dosimeter can then be pressed into the holder at the front. Upon receipt of the new dosimeter, the TL dosimeter can be pushed out from the back of the holder. The PADC dosimeter can then be removed from the back of the container. As mentioned above, only those dosimeters have to be changed which were sent by Mirion Dosimetry Services for exchange. In general, only a new round dosimeter will have to be exchanged and the rectangular PADC dosimeter will remain in place. The combi holder comes standard with a clip; other

fastening options can be found on our website. The combi holder remains with the user until the subscription is terminated.

Mounting location

A representative wearing position on the body must be chosen. In general, a collar, breast pocket or belt around the hip is a suitable place. If a lead apron is worn, it is recommended to attach the dosimeter outside the lead apron, preferably to the collar. Because the dosimeter is not completely symmetrical, the back of the combi holder should be facing the body.

Return

After receiving the new dosimeters, the used ones without the combi holder will be returned to Mirion Dosimetry Services immediately. The same packaging can be used for the return as in which the new dosimeters were received.

Please do not close the envelope using a stapler. By using the enclosed address label with the reply number of Mirion Dosimetry Services the package can be sent unstamped within the Netherlands. Upon termination of the subscription, the combi holder will also be returned.

Loss and damage

The dosimeters are made available on loan and remain the property of Mirion Dosimetry Services. The dosimeters are relatively expensive, especially because of the detector material. In the interest of the reliability of the dosimeter measurements and the processing of the dosimeter in the equipment, it is important that the dosimeters remain clean and undamaged. In the event of damage, contamination such as contamination by tape and felt-tip pen or loss, the replacement costs stated in the price list will be charged.

Other dosimetry systems

The personal dosimetry system described here is intended for monitoring the radiation doses of individuals by photon, beta and neutron radiation. Mirion Dosimetry Services also offers a number of other dosimetry systems, including for use in non-neutron fields, ring dosimeters for measuring the dose on the hands and a headband dosimeter for determining the eye lens dose. Please refer to our website. Here you will also find answers to frequently asked questions and information about the uncertainty in the dose result.

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