

INFORMATION NEUTRON DOSIMETRY

General

The individual monitoring service of NRG in Arnhem provides its clients with dosimeters on the basis of an approval granted by the Ministry for Social Affairs and Employment. The dosimeters are intended for use as individual monitoring device as described in the Radiation Protection Act. There are many different types of dosimeters available. The explanation below deals with personal dosimeters for determining dose as a result of exposure to neutrons. Figure 1 shows the neutron dosimeter that consists of a combination of a thermoluminescence dosimeter (upper one) and a PADC dosimeter.

Thermoluminescence dosimeter

The thermoluminescence (TL) dosimeter contains three detectors, which provide information about exposure to photon and beta radiation. There is also a fourth detector that is very sensitive to thermal neutrons. This detector cannot be used to quantify neutron dose, but a higher indication in comparison with the other detectors can provide a sensitive indication whether the wearer has been exposed to neutron radiation. The four detectors are made of thermoluminescent material. The electrons in this material are brought to a higher energy level by ionizing radiation. These electrons can be brought back to their original energy state by heating the detectors to approximately 200° C. This releases energy in the form of light. The amount of light is a measure of the radiation dose collected by the detector. Figure 2 offers a view into the insides of the TL dosimeter.

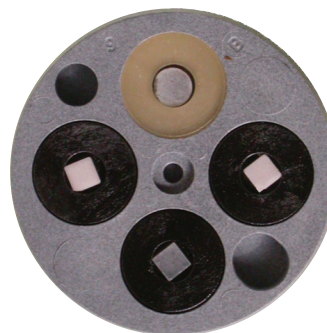


Figure 2: The TL dosimeter seen from inside. Top: the beta detector. Left and Right: the photon detectors. Below: the neutron detector.

Combination dosimeter

The combination of a TL and a PADC dosimeter offers the advantage that it does not need to be read out at the same intervals. The TL dosimeter is exchanged for a new one every four weeks. Depending on the results of the neutron-sensitive TL-detector, one can decide if it is necessary to quantify the neutron dose where upon the PADC dosimeter will be recalled for evaluation. If the neutron-sensitive detector does not indicate a need for this, the PADC dosimeter can remain in the possession of the wearer for up to a year. The estimated detection threshold for an annual dose of neutron radiation is then approximately 0.2 mSv. This detection threshold is independent of the contribution of photons.



Figure 1: The neutron dosimeter consisting of the combination of a TL dosimeter (top) and a PADC dosimeter.

PADC dosimeter

This dosimeter is based on the principle that neutrons cause tracks of damage in foil made of polyallyl-diglycolcarbonate (PADC). Figure 3 shows an open PADC dosimeter with the foil. This foil is etched in a laboratory in order to quantify the amount of damage it has accumulated with the help of image processing instruments. The number of tracks per cm² is used to calculate the degree of exposure. Figure 4 shows an example of an etched and a non-etched foil. This dosimeter has an advantage over an albedo dosimeter in that its response is much less dependant on the type of neutron source and the manner of wear. The PADC dosimeters are insensitive to photon radiation.

Dose quantities

Following the recommendations of the International Commission on Radiation Units and Measurements (ICRU), the European directives and the Radiation Protection Act, the dosimeter provided by NRG is designed to measure the quantity "personal dose equivalent". The NRG dosimeters can measure the personal dose equivalent at a depth of 10 mm in soft tissue also referred to as depth dose. Besides the personal dose equivalent at a depth of 0.07 mm in soft tissue is determined, the surface dose.

Dose registration

All measurement results are recorded in the National Dose Registration and Information System (NDRIS) that NRG manages on behalf of the Ministry for Social Affairs and Employment. Individual dose data are used exclusively for radiation protection. In order to protect personal information, NRG provides information about individual dose data only to subscribers and, if asked, to the Labour Inspectorate. The personal registration is notified to the Dutch Data Protection Authority under number m1010955. The privacy regulations are available as a PDF file on our Internet site www.dosimetrie.nl.

Periodical dose report

The measurement results are reported in writing every four weeks. The dose is given in the measurement unit millisievert (mSv). If the annual dose limit is exceeded, a clear warning is printed. If an unusually high dose is measured for a wearer and this dose also exceeds the value of 1 mSv, then the wearer will be contacted by telephone. An explanation of the report can be found on the back of the page. An overview of the individual dose data for the preceding year is sent out around April.

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Amendments

To make amendments to a subscription, we would request you to use the amendment form that is sent automatically with every dose report. The amendment form must be in our possession at least five weeks before the dosimeters are sent. An explanation can be found on the back of each form. Please do not enclose the amendment form with the used dosimeters but send them separately by post or fax.

Identification of dosimeter

The dosimeters are marked with a label. The colour of the edge and the NRG logo on the label change from period to period. The label bears the following information (Figure 1):

- the name of the wearer (maximum 20 characters). Spare dosimeters are printed with the word 'RESERVE' instead of a name
- the subscriber number followed by the subscription number
- the issuing period (4W means 'four weeks'), year and period number
- the dosimeter number.

The dosimeters do not belong to one particular person, but circulate randomly. For every issue period, a link is made between the wearer and a dosimeter.

This person-dosimeter-period relationship is recorded in NRG's dose registration database.



Figure 3: The opened PADC dosimeter with foil.

Exchange and attachment

A combination attachment is available for the TL and PADC dosimeter (Figure 1). The rectangular PADC dosimeter can be attached to the rear of the holder via the recess provided. The round TL dosimeter can then be pressed into the front of the holder. Upon receipt of the new dosimeter, the TL dosimeter can easily be removed from the rear of the holder. The PADC dosimeter can then be removed via the rear of the holder as well.

As mentioned above, the dosimeter should only be exchanged when you receive a new one. In general, you will only receive a new round dosimeter, and the rectangular PADC dosimeter will remain in place. The combination attachments are equipped with a standard clip, but can also be used with a safety pin or other attachment method.

For questions, please contact the addresses printed on the reverse. The attachment plate remains with the user until the subscription has ended.

Attachment location

The dosimeter must be placed on a representative place on the body. In general, the collar, front pocket or belt are suitable places. Because the dosimeter is not entirely symmetrical, the holder must be turned to the body.

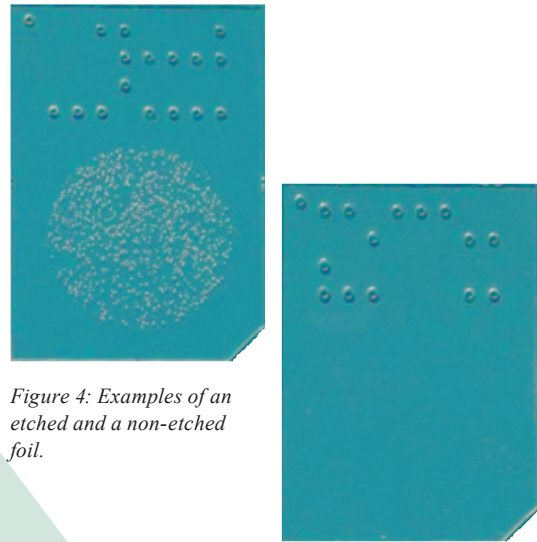


Figure 4: Examples of an etched and a non-etched foil.

Return shipments

After the new dosimeters have been received, the used ones are sent back to NRG without the holder by return post. The same packaging can be used to return the dosimeters as was used for the new dosimeters.

Please do not use a stapler to close the package.

The package can be sent postage-free in the Netherlands by using the enclosed address label with the reply number of NRG. When a subscription is ended, the holder is also returned.

Loss and damage

The dosimeter is made available on loan and remains the property of NRG. The dosimeter is relatively expensive, particularly due to the detector material. In the interests of reliability of the dose measurements and fitting the dosimeter into the reader, it is important that the dosimeter remains clean and undamaged.

In the event of damage, such as contamination by adhesive tape or felt-tipped pen, or loss, the cost of replacement as stated in the list of rates will be charged.

Other dosimeters

The personal dosimeters are intended exclusively for checking the doses of radiation received by people. For measuring ambient doses, both inside and outside, and for experiments, there are other measurement systems available.

The reader can be used to process both dosimeters and separate TL detectors. The dynamic range of the systems runs from less than 1 μGy to 1000 Gy. So-called extremity dosimeters can be provided for measuring the dose at the wrist, hands or other places on the body. For more information, please contact the employee mentioned on the front page. If it is not likely that a person may be exposed to neutrons, it is advised to use a different dosimeter to the one described above. Separate information is available for this.