DANISH HEALTH AUTHORITY
Radiation Protection

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Dose monitoring using finger and wrist dosimeters

Extremity dosimetry

The Personal Dosimetry Laboratory at the Danish Health Authority, Radiation Protection (SIS) offers extremity dosimetry based on a thermoluminescent dosimeter (TLD) placed in a finger ring or wrist band.

The dosimeters

The dosimeters are designed to measure radiation doses to the skin of the extremities of the body (hands and feet) caused by X-rays, beta and gamma radiation. The doses are expressed in mSv (millisievert), and the dose equivalent $H_p(0,07)$ is used as a measure of skin dose. The finger dosimeter consists of an adjustable plastic finger ring. The wrist dosimeter consists on a dosimeter holder attached to a wristband.

Both dosimeters contain the same dosimeter element, of the Harshaw DXTRAD™-type, which is a small metal ring with polyimide (Kapton™) and a thin layer of radiation sensitive thermoluminescent lithium fluoride powder. The elements are covered by a flattened plastic dome with a thin window on the outside. The elements can be identified by individual barcodes and are manufactured by Harshaw™, which is part of Thermo Fisher Scientific corporation.

Using the dosimeters

The measurement period is typically 2 weeks or 1 month, or by appointment. The method must be accompanied by whole body dosimetry.

A finger dosimeter is worn as an ordinary finger ring. Unless otherwise agreed, the dosimeter should be placed on a finger that is most exposed to radiation, with the radiation sensitive element facing the source of the radiation. The radiation-sensitive element can therefore, depending on the situation, be on either the outside or the inside of the hand.

Wearing conditions

Finger dosimeters can be worn in all normal working environments, although prolonged exposure to strong ultraviolet light (including sunlight) should be avoided.

Readout

Thermoluminescent materials store and absorb the energy from ionising radiation. By heating the material to around 250 °C the energy is released as light. The amount of light released is proportional to the radiation dose. When a finger dosimeter is returned to the Personal Dosimetry Laboratory for readout, the radiation-sensitive element is removed from the finger ring and placed in a special metal card. The card is then inserted into an automated TLD reader which identifies the dosimeter, heats it to the desired temperature and measures the amount of light.

Quality assurance

The Personal dosimetry laboratory is accredited by the national accreditation body, DANAK for measuring $H_p(0,07)$ with a finger dosimeter towards the standard DS/EN ISO/IEC 17025:2017.[1] This means that the laboratory works after quality assessed procedures and is regularly inspected by DANAK. The laboratory also participates in proficiency tests to independently evaluate the measuring capability.

Technical specifications

The dosimeter elements contain 7LiF: Mg, Cu, P and a cap with a surface density of 3,3 mg/cm^2. They are type tested by Thermo Fisher.[2] They are applicable in the dose range 0,5 mSv – 10 Sv. In performance tests by the UKHSA on comparable systems relative standard deviations and overall bias are approx. 10 %.[3]

The energy response of the dosimeter is from -10 % to +40 % for photon radiation from 20 keV to 1250 keV and beta radiation with E_{max} from 225 keV to 2280 keV. Angular dependence is within ±15 % up to 60° for photon radiation and ±40 % up to 60° for beta radiation.

[1] Accreditation number 503: https://registry.danak.dk/registry/503/TEST503?lang=en

[2] Ling Z. Luo, Ken Velbeck, Joseph Rotunda, and Reiner Esser, An improved HarshawTLD™ extremity dosimeter—DXTRAD beta ring, *Radiat. Meas.*, 2011, vol. 46, nos. 6—7, pp. 621–625

[3] https://www.ukhsa-protectionservices.org.uk/cms/assets/gfx/content/resource_2969cs4664736508.pdf