DANISH HEALTH AUTHORITY
Radiation Protection

November 2022

Dose monitoring using finger dosimeters

Finger 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 - a method commonly referred to as finger dosimetry.

The finger dosimeter
Finger dosimeters, like whole body 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 dosimeter element itself, of the Harshaw DXTRAD™-type, is a small metal ring with polyimide (Kapton™) and a thin layer of radiation-sensitive thermoluminescent lithium fluoride powder. The element is covered by a flattened plastic dome with a thin window on the outside. The elements have individual barcodes and are manufactured by Harshaw™, part of Thermo Fisher Scientific.

Thermoluminescent materials store the energy they absorb from ionising radiation until heated to around 250 °C where 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.

Using the finger dosimeter
A finger dosimeter must be worn as an ordinary finger ring. Unless otherwise agreed, the dosimeter should be placed on the finger considered most exposed to radiation, with the radiation-sensitive element facing the direction of radiation. The radiation-sensitive element can therefore, depending on the situation, be on either the outside or the inside of the hand. The measurement period is typically 2 weeks or 1 month, or by appointment. The method must be accompanied by whole body dosimetry.

Environment of use
Finger dosimeters can be worn in all normal working environments, although prolonged exposure to strong ultraviolet light (including sunlight) should be avoided. In tests, no effect has been found of 48 hours exposure to temperatures of 40 °C and 90 % relative humidity.

Technical specifications
The dosimeter elements contain ^{7}LiF: Mg, Cu, P and are applicable in the dose range 0,15 mSv – 10 Sv. The measurement uncertainty complies with recommendations given in the European Commission report RP 160: "Technical Recommendations for Monitoring Individuals Occupationally Exposed to External Radiation". In performance tests[1] relative standard deviations and overall bias are approx. 10 %, i.e. within the permitted measurement uncertainty of 15 % and 20 %, respectively. The energy response of the dosimeter is from –10 % to +20 % for photon radiation from 20 keV to 1250 keV and ±30 % for beta radiation with E_{max} from 1000 keV to 2280 keV. Angular dependence is within ±25 % up to 60° for photon radiation and ±45 % up to 60° for beta radiation.

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