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# Method MMK 608 2018

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In-situ method for determination of gamma exposure indoors inside buildings

## 1. Scope

The method is intended for in-situ measuring of gamma dose rate in a building caused by NORM nuclides K-40, Ra-226 (U238 / 235) and Th-232.

The result of dose-rate measurements is used to calculate effective annual dose.

## 2. Definitions

Dose-rate (nGy/h) is a measure of absorbed dose in time and the most frequently used operational unit in radiation protection practice.

Effective dose (mSv/y) is a measure in the national regulatory system for the effective dose caused by external gamma radiation from construction material in a human within a 4-pi exposure geometry.

## 3. Principle for the method

Dose-rate is measured in the air in a room of a building.

Effective dose is calculated and documented in report.

The measurement is instantaneous and can be performed at all times during the year.

## 4. Measurement method

### 4.1 Measurement instrument

Due to the requirement that 1 mSv/a is allocated to only NORM nuclides U, K and Th the following is recommended for the measurement instrument:

- A detector (NaI (Tl) crystal) with a volume exceeding 345 $cm^3$ (diameter 76 x 76 mm);
- Detection limit of the measurement instrument must be known so that the obtained measurement result can be compared to it for the quality assurance purposes;

Dose-rate measurement sensitivity of 5 ηGy/h at the measurement frequency of 1s and relative confidentiality 20 % = 95 %;

- The instrument shall be equipped with an efficient and continuous operating compensation for spectrum positioning. The instrument shall use the radioactivity of the measurement object for this purpose;
- Equipped with memory function and automatic transfer of measurement data to defined network;
- Calibration function programme for background checks.

### 4.2 Calibration

Calibration must be performed by the instrument manufacturer or another authorized party and must be carried out with at least two-year interval.

The calibration certificate must show traceability to the primary calibration source for NORM according to IAEA/AL/148.

### 4.3 Principle for measurement

The measurement shall be carried out in the air in the middle of a room with an instrument reporting dose-rate.

The measurement is performed on c/c dimensions of the area (walls/floor/ceiling = 1 measurement points) in a room.

### 4.4 Measurement place and measurement time

#### 4.4.1 Measurement place

Measurement in dwellings shall be carried out in rooms where inhabitants stay more than temporarily ex. living rooms, bedrooms, and eating/cooking areas.

Measurements at workplaces should be carried out in rooms/facilities where staff stays more than temporarily ex., facilities/rooms where daily operations are carried out, as well as other staff-spaces and dining rooms.

#### 4.4.2 Measurement time

Measurement time minimum = 300 seconds per measurement point.

The measurements shall be carried out at least twice on each point.

### 4.5 Background correction

No correction of the reported values is needed other than within the measurement uncertainty calculation.

## 5. Calculation of effective dose

The results are given in mean value for all measurement points in a room.

The calculation is performed in 2 steps:

*Step 1* Measurement of individual measurement point = mean value for the individual point

*Step 2* The effective dose is calculated and document in the report

$E_{eff}$ = Dose-rate * Exposure time

Exposure time residence/housing = 7000 h

Exposure time workplaces = 2000 h

## 6. Measurement uncertainty

Is based on the following:

| | |
|---|---|
| Measurement time uncertainty 300 seconds | $*X_t$ |
| Activity concentration | $*X_a$ |
| Calibration uncertainty | $*X_c$ |
| Cosmic background radiation | $*X_s$ |

Measurement reliability for individual components (K, U and Th) increases with the level of activity. The reliability for the level that corresponds to their minimum determinable activity shall be taken as minimal level. See instrumental detection limit.

Total measurement uncertainty calculation (K2):

$$K2 = \sqrt{(X_t^2 + *X_a^2 + *X_c^2 + *X_s^2)}, (\%)$$

## 7. Report

Final report to the client shall document the following:

- Requesting organisation (client)
- Place and responsible person for the measurement
- Time of the measurement
- Identification of measurement points and construction
- Institution or company that performed the measurement
- Measurement method
- Type of measurement instrument
- Date of calibration
- Measured dose-rate and calculated effective dose value with associated measurement uncertainty (K2 = increased measurement uncertainty)
- Detection limit of the measurement instrument
- Signature measurement responsible person and the quality controller.


***Referenser***

**1. Naturally Occurring Radioactivity in the Nordic Countries – Recommendations the Radiation Protection Authorities in Denmark, Finland, Iceland, Norway and Sweden, 2000 ISBN 91-89230-00-0.*

**2. Radiological Protection Principles concerning the Natural Radioactivity of Building Materials, EC RP 112 (1999), 1999.*

**3. IAEA-TECDOC-1363 Guidelines for Radioelement Mapping Using Gamma Ray Spectrometry Data (ISBN:92-0-108303-3).*

**4. IAEA-RL-148 Preparation and Certification of IAEA Gamma-Ray Spectrometry Reference Materials.*

**5. Statens Provningsanstalt, SP A2 606 Bestämning av Kermaraten i luft orsakad av gammastrålning, 1983-10-28.*