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# Natural Radiation In Mining



# Natural radiation in mining

This brochure covers the main obligations set for mining in the legislation in Finland concerning radiation and nuclear energy.

Mining companies are required to determine the exposure to natural radiation caused by mining, as well as the occurrence of any materials that are subject to licensing due to natural radionuclides. Varying levels of natural radionuclides, such as radionuclides of the uranium- and thorium-series, occur in all types of rocks and minerals. The decay of natural radionuclides emits ionizing radiation, which poses a detriment to health.

The purpose of the Radiation Act is to protect human health from the detrimental effects of radiation. The purpose of the Nuclear Energy Act is to ensure that nuclear energy is used in a way that is safe for humans and the environment and does not promote nuclear proliferation. Compliance with the Radiation Act and the Nuclear Energy Act is supervised by the Radiation and Nuclear Safety Authority (STUK), to which notifications, assessments and licence applications related to natural radiation in mining are submitted in most cases.

## **I. Obligations for the mining industry**

### **Exposure to natural radiation arising from mining must be assessed**

The obligation to assess radiation exposure from natural radiation applies especially to activities exploiting soil, rock or other materials occurring in nature and the materials brought about by the utilization of the aforementioned, including mining. These activities may result in the formation and processing of materials that cause exposure to natural radiation.

The assessment has to consider the external and internal radiation exposure of workers and public caused by mining and exceeding the natural background, while also taking into account the measures taken to limit the exposure. However, the radiation exposure resulting from radon in indoor air shall not be taken into account in this assessment as the radon levels at workplaces are monitored on the basis of separate reference values (see p. 5).

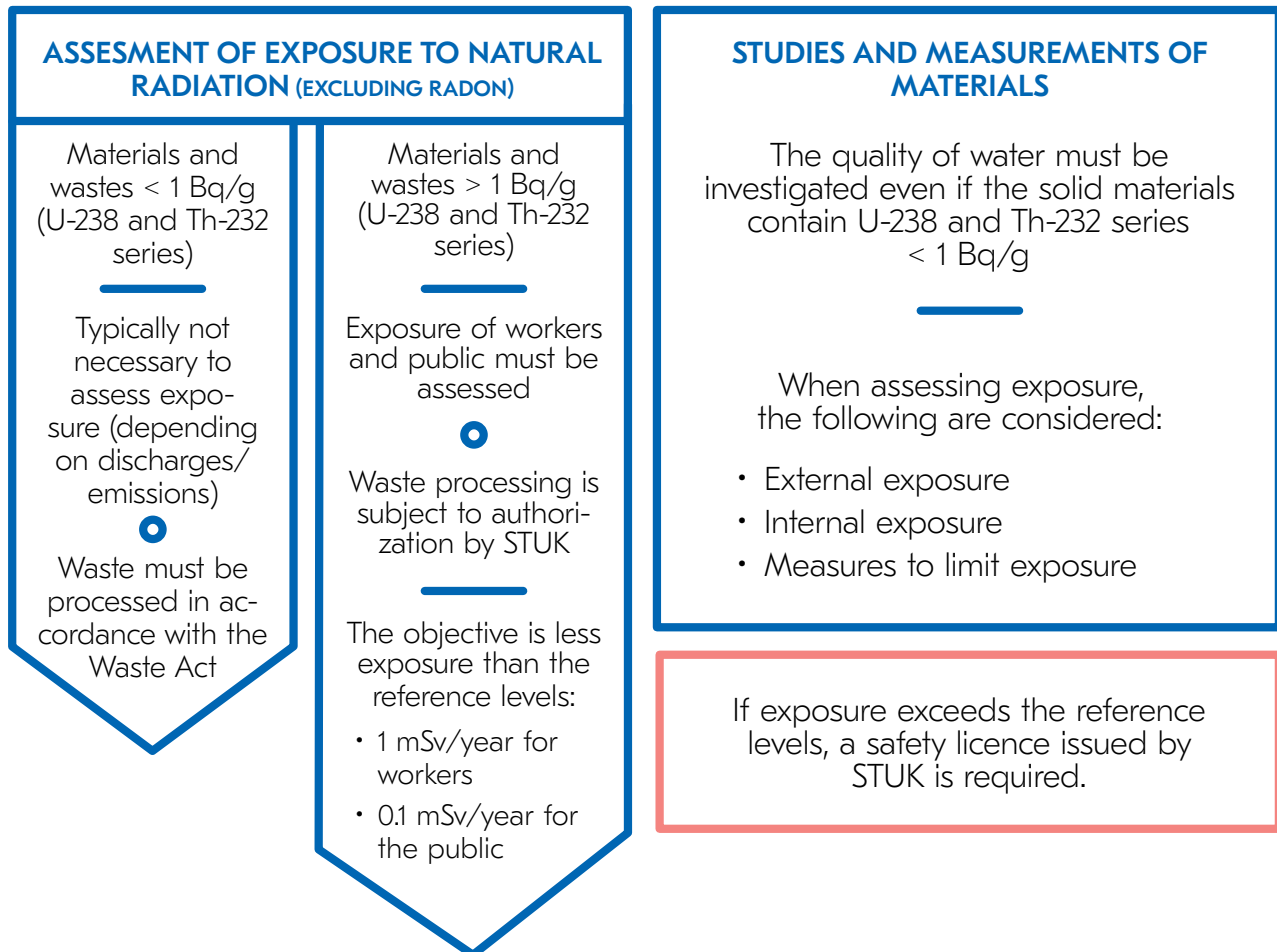
The reference levels for exposure resulting from natural radiation other than radon or cosmic radiation are 1 mSv per year for workers and 0.1 mSv per year for the public. **If, despite measures taken to limit exposure, exposure exceeds the reference levels, mining is regarded as a radiation practice, which is subject to a safety licence** (see p. 6).

### **Radiation has to be measured and the concentrations of natural radionuclides need to be investigated**

To assess the level of external radiation exposure, the ambient dose rate needs to be measured at different working areas and near materials that may be radioactive. To assess the level of internal exposure, the materials must be subjected to radioactivity determination. Activity concentrations can be determined, for example, by using gamma spectrometry, liquid scintillation, or radiochemical analyses. For the isotopes uranium-238 and thorium-232, methods such as mass spectrometry can be used.

It is not necessary to assess radiation exposure if, through measurements or other investigations, it is demonstrated to STUK that the activity concentrations of uranium-238, thorium-232 and their decay products are no more than 1 Bq/g at any point in the processing of materials. The amount and quality of discharges from mining must be taken into account, i.e. the natural radionuclides in water fractions must also be investigated. Radiation exposure to the public must be assessed if it is possible that natural radionuclides are released into water bodies as a result of mining.

## Assessment of exposure to natural radiation in accordance with the Radiation Act



## New operations must submit a notification to STUK concerning activities causing exposure to natural radiation

Before starting operations, the responsible party must submit a notification to STUK:

- **on mining;**
- on activities involving the processing, use, storage or utilization of materials including natural radionuclides or waste in which the activity concentration of **uranium-238, thorium-232 or their decay products is higher than 1 Bq/g; and**
- on work conducted underground for more than 100 hours per year.

The notification needs to include information that is important for radiation safety. Those required to submit a notification must also conduct an assessment of radiation exposure. The contents of the notification and the assessment are specified in more detail in STUK regulation S/3/2019.

## **The indoor radon concentration of underground workplaces must be determined**

The radon concentration in underground mines must be measured regularly. Radon measurements must also be conducted at other workplaces that are located underground or in areas with a high radon risk.

The reference level for indoor radon concentration at a workplace is 300 becquerels per cubic meter when people work for 600 hours or more per year. If work is carried out in several locations (e.g. maintenance work), the assessment concerns occupational exposure. The reference level for occupational exposure to radon is 500,000 becquerel hours per cubic meter per year. Exposure is calculated as the sum of the exposures in all work spaces during the year. For more information, please refer to STUK regulation S/3/2019 or contact STUK's radon control.

## **The principle of optimization of radiation protection applies to mining – exposure must be minimized**

To optimize radiation protection, occupational exposure and public exposure to ionizing radiation shall be kept as low as is reasonably and practically achievable, taking into account current knowledge and technology, as well as financial and social factors. Optimization considers the dose caused to a person, the likelihood of exposure, and the number of persons that are exposed.

## **Approval from STUK must be acquired for waste processing if the amount of natural radionuclides in the waste is higher than the clearance levels**

If the activity concentrations of natural radionuclides in solid materials are lower than clearance levels, the waste may be recycled, utilized and disposed in accordance with the Waste Act. When processing waste, the chemical properties of the waste must also be considered.

<b>Clearance levels for naturally occurring radionuclides in solid materials:</b>	
Natural radionuclides from the U-238 series	1 Bq/g
Natural radionuclides from the Th-232 series	1 Bq/g
K-40	10 Bq/g

## **2. Radiation practices that cause exposure to natural radiation**

### **Mining may be subject to a safety licence as referred to in the Radiation Act**

A safety licence issued by STUK is required for mining if the exposure to natural radiation to the workers and public can exceed the reference levels despite measures to limit exposure. A safety licence may be issued if:

- the radiation practice follows the principles of justification, optimization and limitation;
- a safety assessment has been made for the radiation practice;
- the practice can be carried out safely; and
- the operator is licensed to engage in a trade in Finland.

### **The operator is responsible for radiation safety**

In order to be granted a safety licence concerning a radiation practice that causes exposure to natural radiation, the applicant must prepare a safety assessment and prepare a plan for radiation safety incidents. The safety assessment is a document that is regularly updated and contains exposure estimates and dose constraints, the classifications of radiation exposure and descriptions of measures to ensure radiation safety and optimize radiation protection. In addition, the applicant must demonstrate that its radiation safety officer, radiation safety expert, management system and quality assurance system comply with the requirements.

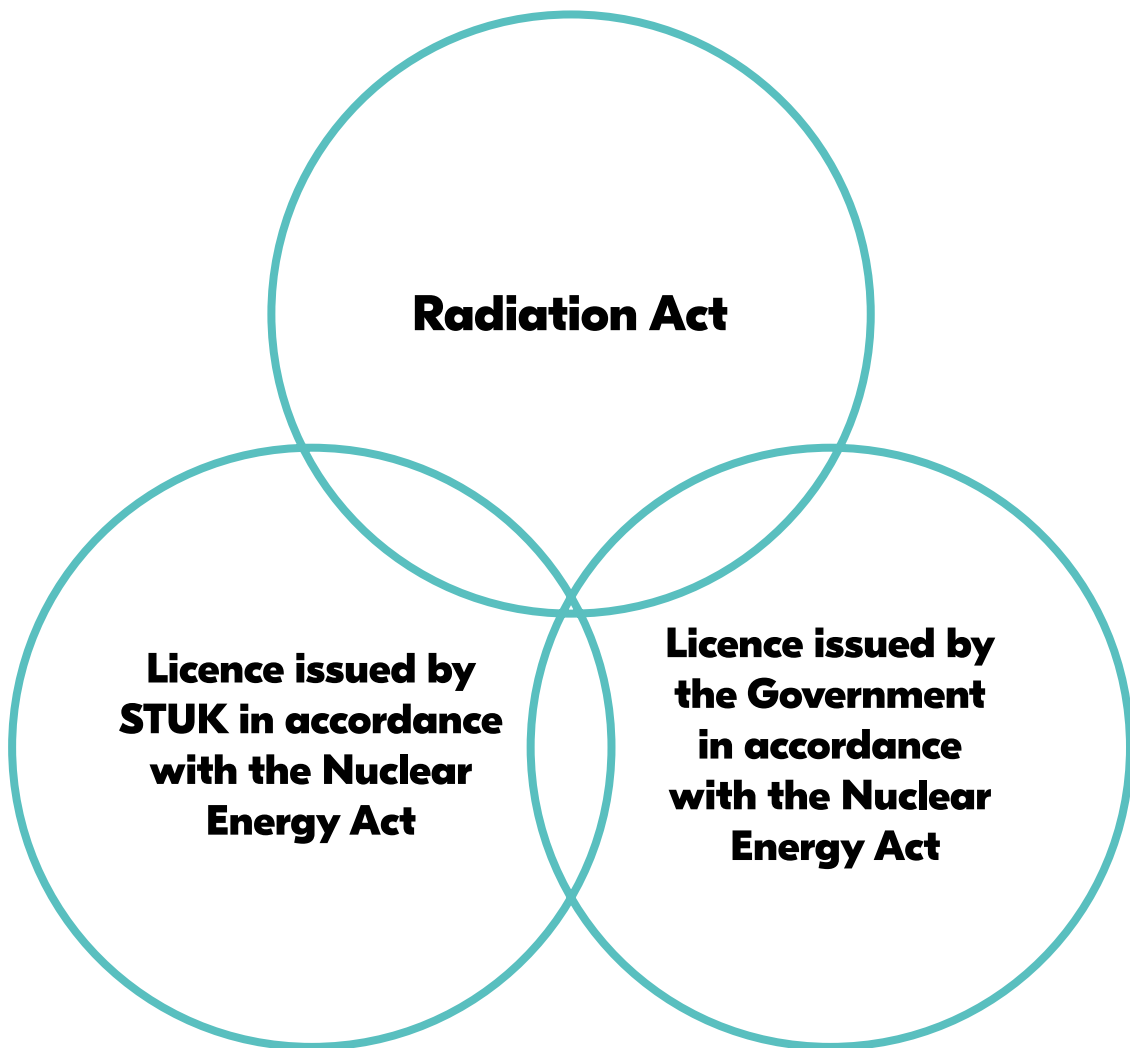
If a safety licence is required for mining due to discharge or emissions that may cause exposure of the public, the operator must prepare a report on the baseline of environmental radioactivity before starting the operation. The baseline report is an account of the state of radioactivity in the environment before the operations, making it possible to measure how much of the natural radiation exposure is due to the discharge or emissions during the operations. In addition, emissions, discharges and public exposure levels must be monitored during the operations.

## **Emissions and discharges must be minimized and recorded**

If mining is subject to a safety licence, the operator must limit the discharges of natural radionuclides to the environment and the sewerage system to a minimum. Discharge levels must be lower than the level for minor discharge/emissions, and all releases must be recorded. The minor discharge limit for the effective dose caused to the public due to natural radionuclides discharged into water is 0.1 mSv per year. The corresponding limit for the emissions of natural radionuclides into outdoor air outside the operating site is 0.01 mSv per year, except for radon.

The minor emission limit for the annual average radon concentration caused by radon that is released into outdoor air outside the operating site is 10 Bq/m<sup>3</sup>. In exceptional cases, STUK may issue a permit for discharges/emissions that exceed the limit for minor releases based on a plan of releases and exposure assessment.





### **Mining-related procedures in accordance with the Radiation Act and the Nuclear Energy Act**

#### **Radiation Act**

- Notification and dose assessment to STUK on activities that cause exposure to natural radiation (mining; uranium, thorium or decay product > 1 Bq/g)
- Safety licence issued by STUK if exposure > reference levels

#### **Licence issued by STUK in accordance with the Nuclear Energy Act**

- Uranium + thorium > 0.5 kg/tonne in product, intermediate product or waste;
- uranium or thorium production < 10,000 kg/year;
- export of uranium or thorium ore

#### **Licence issued by the Government in accordance with the Nuclear Energy Act**

- Licence from the Ministry of Economic Affairs and Employment for the production of uranium or thorium > 10,000 kg/year



### **3. When is the Nuclear Energy Act applied to the processing of natural radionuclides?**

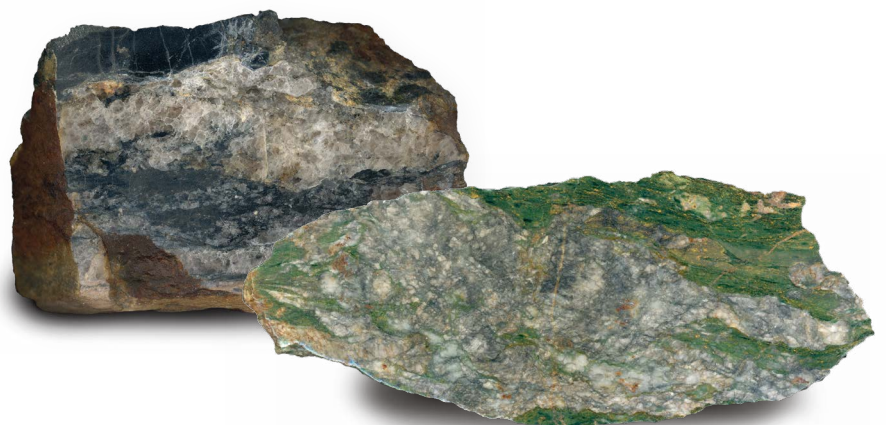
#### **Authorization for mining and mineral processing practices in compliance with the Nuclear Energy Act**

Mining and mineral processing practices are in certain cases considered as use of nuclear energy. In accordance with the Nuclear Energy Act, official authorization for them is required if the practices result in the creation of products that contain uranium or thorium, or waste with a combined uranium and thorium concentration of more than 0.5 kg per tonne (500 ppm of weight). If the purpose of the mining practices is to produce uranium or thorium, authorization as referred to in the Nuclear Energy Act is always required.

Applications for licences for producing uranium or thorium, as well as concentrates with uranium or thorium content that exceeds the limits listed in the previous paragraph, can be submitted to STUK or the Government depending on the extent of the operations. STUK may issue a licence for producing a maximum of 10,000 kg of uranium and thorium per year. More extensive operations need to be authorized by the Government. The application process for the licences is described in Chapter 6 of the Nuclear Energy Decree.

Supervision necessary for non-proliferation measures is required if the purpose of the mining or mineral processing practices is to produce uranium or thorium. The European Commission must also be notified of the operations in accordance with the Commission Regulation on the application of Euratom safeguards. The operator must have:

- appointed a responsible manager and their deputy to be approved by STUK;
- nuclear safeguards manual approved by STUK;
- security arrangements approved by STUK; and
- solutions for the disposal of managing the radioactive waste created in their operations.



## **The production of nuclear material is subject to authorization by STUK in accordance with the Nuclear Energy Act**

Nuclear materials may be formed in the metal processing industry when processing ore concentrates with small uranium concentrations, resulting in the uranium being concentrated in an intermediate product or waste. Nuclear material refers to processed material with a combined uranium and thorium concentration of more than 0.5 kg per tonne. A licence application must be submitted to STUK for the production of nuclear material. The application shall include the names of the responsible manager and the deputy to be appointed, as well as include the aforementioned documents. STUK requires annual reporting on the practices in order to ensure that the nuclear materials are produced in compliance with the licence.

The European Commission safeguards for nuclear materials are not applied to natural end products containing uranium or thorium if the products are used for purposes other than nuclear technology, and if the nuclear materials included are in practice irrecoverable.

### **Uranium ores**

In accordance with the Nuclear Energy Act, uranium ore is a mineral with an average uranium concentration of more than 1 kg per tonne (1,000 ppm of weight). STUK and European Commission must be notified of all uranium ore export activities. Authorization from STUK is required for exporting amounts of uranium or thorium higher than 1 kg. The transportation of ore is subject to regulations applicable to the transportation of dangerous goods.



## **Regulations**

Radiation Act 859/2018

Governmental Decree 1034/2018

Decree of the Ministry of Social Affairs and Health 1044/2018

Radiation and Nuclear Safety Authority regulation on activities causing exposure to natural radiation S/3/2019

Radiation and Nuclear Safety Authority regulation on exemption values and clearance levels SY/1/2018

Radiation and Nuclear Safety Authority regulation on activities that require a safety licence S/6/2019

Nuclear Energy Act 990/1987

Nuclear Energy Decree 161/1988

Radiation and Nuclear Safety Authority Regulation on the Safety of Mining and Milling Operations Aimed at Producing Uranium or Thorium (Y/5/2016)

Commission Regulation (Euratom) No. 302/2005

## **Notifications, assessments and licence applications concerning mining in accordance with the Radiation Act**

Regulatory control of natural radiation (radon not included): lsv@stuk.fi

Workplace radon control: radonvalvonta@stuk.fi

## **Matters falling under the scope of application of the Nuclear Energy Act**

Nuclear Waste and Material Regulation ydinjate@stuk.fi, safeguards@stuk.fi

Notifications and licence applications: stuk@stuk.fi

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Makolan vanha kaivosomnttu. (Täytetty vedellä.) Nivala. © Ilkka Laitakari, Geologian tutkimuskeskus, 1992

Kuparikiisu. Kiskon Orijärvi. GTK:n kivimuseo. © Jari Väätäinen, Geologian tutkimuskeskus, 1994.

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